world congress on integrated
crop-livestock-forest systems

3rd International Symposium on Integrated Crop-Livestock Systems

towards sustainable intensification

brasilia • brazil • 2015

Congress Proceedings

Anais do Congresso

These Proceedings organize the papers and abstracts presented at the 2015 World Congress on Integrated Crop-livestock-forest systems (WCCLF) incorporating the Third International Symposium on Integrated Crop-Livestock Systems, held from July 12 to 17, 2015, at the Ulysses Guimarães Convention Center in Brasília, DF.

The objective of the Congress was to discuss the state-of-the-art of integrated agricultural systems as well as its perspectives as main 'drivers' of sustainable intensification on agriculture all over the world. The event was organized and promoted by the Brazilian Agricultural Research Corporation and the Federal University of Rio Grande do Sul, with the support of many national and international institutions including CIAT, CIRAD and USDA.

The event was based and three pillars. Plenary presentations of international scientific results on ICLF systems; technical training of technicians with focus on existing recommendations; and teaching conferences to discuss inclusion of the ICLF in the Universities agendas.

Scientists, experts, technicians, professors, students and leading producers of different fields participated in the Congress, which was organized into three main topics: technology, environment and social economy. The subjects distributed in many topics in the agenda include issues related to global agriculture sustainability; opportunities and limitations on the adoption of integrated systems; environmental costs of intensive agriculture; contributions of integration for family farming; efficient use of water and nutrients; carbon sequestration and greenhouse gas emissions, among others.

More than 350 scientific papers were selected for presentation. Forty of these scientific submissions were chosen for oral presentation, arranged in ten parallel sessions. The other submissions were presented in poster format, and remained displayed in the panels during the entire event. This present publication is divided in three sessions: Abstracts of plenary speakers, Abstracts of Oral Presentations in parallel sessions and Posters' Abstracts.

RESULTS

The program of the Congress, both technical and scientific, was substantial and produced significant statistics. A total of 24 scientists participated in the Plenary Session, from several different countries including five from Brazil. The two Special Sessions, for technicians and for teaching, had 23 presentations. A total of 907 attendees were pre-registered and 602 were present at the event. Twenty six Brazilian states were represented as well as 22 countries. Two hundred and twenty eight public and private institutions were represented by different attendees. Three hundred and fifty four submitted papers were presented either as posters or as oral presentations. The total of 1,075 co-authors contributed with scientific papers submitted. An intensive debate was encouraged in the teaching Special Sessions in order to discuss the inclusion ICLF systems courses in the universities and technical schools. Professors, students and technicians appointed limitations in the curricular plans and course programs. They proposed alternatives, new procedures and recommendations to improve ICLF disciplines, considering the complexity of the systems and the need of a systemic multidisciplinary approach of this subject

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Tom Goddard

Integrated crop-livestock-forest systems in temperate regions – how they address the challenges of a sustainable future

http://www.wcclf2015.com.br/program/works/tomgoddard.pdf

Integrated crop-livestock-forest systems in temperate regions – how they address the challenges of a sustainable future.

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Integrated cropping-livestock-forestry systems (ICLF) have seen a growth in interest over the last decade or two. Arising from the last conference, three special editions of journals published reviews and key papers stemming from the scientists working in the area around the world. Introductions to the series of three can be found in Franzluebbers et al. (2014a, b, c).

Temperate region countries have adopted intensive and often specialized agriculture systems that achieve immediate economic efficiencies of scale often incorporating large platforms of production, intensive inputs and monoculture or homogenous commodities. Resulting disservices to the environment include nutrient and pesticide loadings, reduction in biodiversity and hydrologic cycle capacities, and soil degradation and erosion. Government support programs for agriculture have been developed and tuned to those systems, which seriously threaten future ecological and economic sustainability. ICLF systems research has shown it can mitigate or ameliorate all of the deleterious environmental and production impacts while at the same time improve total land productivity and profit as well as the flow of ecosystem services. Most research is centred on the production and environmental aspects in the temperate region. Increased attention is needed in the economics, and lengths of systems sustainability in order for field professionals and farmers to increase adoption levels. There are many opportunities to link ICLF to the many drivers in its favour.

Drivers for adoption of ICLF in the temperate region include high land prices, labour costs and availability, market price volatility, environmental pollution and herbicide resistance. ICLF systems often incorporate smaller fields (cross fencing), diversity of crops and field boundary plantings, all which can align with government's policies directed to greening of agriculture. Farm subsidies in temperate countries amount to the billions of dollars. The public is starting to question the ongoing public cost to support farming systems for private benefits. Increasingly there is a desire to couple farm payments to 'green' practices and move away from the counter-cyclical market risk payment schemes to allow farmers to be responsive to market signals. Private policy signals from the marketplace are becoming a new player in favour of ICLF.

The new drivers of private policy expressed in the form of social licence, sustainability metrics and certifications, retail demands and sustainable round tables are all having a big impact on agriculture systems. At the same time, global agreements in climate change, ecosystem services, biodiversity and multilateral trade are presenting drivers and opportunities for ICLF. It is up to the research scientists as well as farm organizations and policy makers to provide evidence and impetus for ICLF to become a favourable option for mainstream agriculture in the temperate region.

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Incentives for Diversification and Intensification of crop-livestock systems in Sub Saharan Africa

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The livelihood of more than 70% Africa's population relies on agriculture while close to 72% of agriculture is in five different crop-livestock systems, ranging from the low altitude and warm Sahel to the humid equatorial region to the cool Ethiopian highlands. However, these systems also share common system constraints including recurrent drought, soil fertility decline, low system productivity, poor market infrastructure and weak policy support in terms of extension, input delivery systems and access to credit. Other major challenges include weak local institutions to respond to climatic and market shocks, limited human capital in the farming sector, limited agribusiness opportunities to add value to agricultural produces, high population density and growth, severe soil erosion, farm fragmentation, and overstocking. About 40% of the population is living with an income of less than $1.25 per day. There is an increasing trend of climate change, seasonal rainfall variability, increasing expansion of farmlands to hills and higher slopes, which is putting pressure on the remnant forests. It is a low-input low-output agriculture but with high potential for intensification. Productivity gains could be made in these more extensive mixed rainfed areas with targeted intensification and risk reduction technologies. Increased land, water and livestock productivity through targeted use of external inputs and knowledge transfer are entry points for intensification. It may also arise from improved varieties and breeds, utilization of unused resources, and better farm management. Interventions including more watering points for livestock drinking, reforestation of hillsides and water towers and protection of valley bottoms and wetlands would enhance resilience of systems. However, the benefits of these technical interventions could be realized only when public and private investments create access to functional input-output markets, develop rural infrastructure, strengthen value chain actors and support farmers in accessing credit and extension systems. Improved access to markets is one of the major incentives for intensification, exuberated by the rapid rate of urbanization, where demand in some areas already far exceeds supply. Enhancing these markets, removing policy barriers and construction of all weather roads would drive market participation, enable the formation of collective cooperatives, increase produce volume and improve negotiation capacity of communities in selling their goods and services. Moreover, the expansion of mobile phone connectivity and radio stations to reach isolated communities would create local capacity, facilitate input-output markets and link farmers to diverse livelihoods opportunities including off-farm jobs. Specific mountain and savannah products and services including tourism, medicinals, highland fruits, flowers, honey and other organic food items are in increasing demand at global markets. Niche markets would be incentives to exploit their agro ecological and societal peculiarities by producing quality products, develop distinct capability to certify food origins and fulfill sanitary requirements. Moreover, the rapid growth in demand for meat and milk products globally represents great incentives for poor-performing but high potential livestock-based systems of SSA. For instance, the Middle East markets are offering a huge opportunity for livestock keepers. However, unlike the developed countries, these systems lack a quality grading system that would reward quality and promote market transparency. In general, the paper would highlight the intensification pathways and policy options to increase crop-livestock system productivity and profitability in the continent. We will highlight policy option that would improve production efficiency, create market linkages, create rural job opportunities and lead to sustainable intensification of these systems.

Tilahun Amede

Incentives for Diversification and Intensification of crop-livestock systems in Sub Saharan Africa

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Diversifying farmer and rancher skills – problems and solutions

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The integration of crops and livestock increases the complexity of farming systems. Greater diversity of biotic components involved leads to increased complexity of potential interactions. This feature makes research in integrated crop-livestock systems (ICLS) a huge challenge, so multidisciplinary approaches are mandatory. At the whole farm level, an even higher degree of complexity is reached, as ICLS practices interact with economics, regulations and human behavior. For example, additional complexity may arise from contractual arrangements whereby tenants manage crops in ranches or livestock are brought to crop farms under grazing leases or joint ventures. Therefore, the skills required for farmers and ranchers to deal with such systems are consequently massive compared to specialized systems.

Problems concerning the diversification towards ICLS usually arise from the lack of knowledge of about the component being added to the existing system. We focus on the typical ICLS of southern Brazil (on-farm), which are: i) farmers who integrate livestock into crop production systems; ii) and ranchers who add crops into livestock systems. In southern Brazil livestock is typically cattle (beef and dairy) and crops are mainly soybean, maize, rice, bean and wheat. Typically, ranchers practice "extensive" production, lack knowledge in crop management and trade, and do not have sufficient financial resources for the necessary investments. Natural grasslands do not return to their original composition after crops. Introducing crops in livestock areas increases risk. Conversely, farmers usually don't have the facilities for livestock operations, and lack knowledge in animal management. Usually they expect negative impacts of animals on croplands, that are normally managed on no-till. Frequently, farms are located in specialized crop regions where animals are not readily available. Both ranchers and farmers require capacity building. Diversification needs investment and impact cash flow.

Solutions involve participatory approaches, collective learning and knowledge sharing in order to empower farmers and ranchers with the skills they lack. Partnerships among public and private stakeholders are critical to foster ICLS adoption. In order to illustrate solutions, we present and discuss the PISA case study (*Produção Integrada de Sistemas Agropecuários em Microbacia Hidrográfica),* a successful extension program currently being applied in ~790 farms in southern Brazil.

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Manejo sostenible de suelos e Intensificación de la producción con buenas prácticas en sistemas agroforestales en Honduras

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The experience that appears here has been developed through many projects where the author have been working for more than 205 years and mainly in the areas of the Project Pro Suelos that Catholic Relief Services is implementing with its public-private alliances with small farmers of familiar agriculture, in Central America, which is a region composed by seven countries: Guatemala, Belize, Honduras, El Salvador, Nicaragua, Costa Rica and Panama, with a territorial extension of 522, 760 km^2 and count on a population near the 45 million people. 41,4% of the population in Central America live in the rural area, on which 62,7% live under the line of poverty. The region has its own challenges, among others: high environmental vulnerability, weak institucionality and gobernanza, with low transparency in the markets, worsening the poverty and the hunger, and less important is not the lost one of the nourishing patterns of the population, based on grains of maize (Zea mays),bean (Phaseolus vulgaris L.) with low yields due to a great extent, to the lack of access of the small farmers to soil sustainable management and lack of intensification with seeds of good quality and to the vulnerability of its production systems. The strategies and methods of work on this experience have had an approach, of participative technological innovation, based on the development of sustainable agroforestry systems from the production, commercialization, trade, market development and use of good soil management practices that increases water retention capacity and productivity. The use of not firing in agriculture with soils covertly, soil rotations and minimum tilling in Agroforestry systems with seed of good quality increased in an average of 32% the maize yields and 43% of bean of familiar agriculture. Exists positive results in the parcels where it has been implemented good agricultural practices: in the parcels of small producers (less than 3 has) it has increased the productivity of the maize (from 1 mt/ha to 3.5 mt/ha), of beans (from 0.7 mt/ha to 1,5 mt/ha); there is an important improvement in the moisture of the ground in the driest months (from a 8% to a 29% of moisture retention capacity in the soil). These changes with good practice of use of good seeds and of sustainable soil cover management, they mark important differences for the producers of Central America, when sometimes 20 days dry in a rainy month are had, now the percentage of moisture allows that the maize crops resist better events and between 20 and 40 days without rain, with which the losses are reduced of important form. From this, it is possible to conclude that as a simple technique as to leave the residues of crops in the surface of soils instead of burning it, brings positive effects in the erosion, the infiltration of the water, the decomposition of the organic matter, the microbiology of the ground, and mainly in the global heating of the Earth surface. Pro Suelos CRS have been implementing 14 indicators for measuring annually soils physical, biological and chemistry properties for all means it is necessary to measure with greater intensity these impacts in each agro system at the local level.

Key words: sustainable intensification system, soil management, conservative agriculture, familiar agriculture.

Getting integrated systems accepted

Luis Alvarez Welchez

Success story/ies of adoption of a recently introduced ICL or silvo pastoral (ILF)

http://www.wcclf2015.com.br/program/works/luiz.pdf

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Experiences with small holder silvopastoral systems in Central America

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Summary

In Central America, family and/or small holder farms play an important role in food security and in the livelihoods of rural communities, and a large percentage of these farms (close to 70%) are mixed crop and livestock systems. The region is very vulnerable to climate change which threatens food security and livelihoods, and small farmers have been increasing the integration of trees in their farming systems as a strategy to increase and diversify production; and to manage environmental, climate and market risk. Small farms are generally characterized with a diversity of species (6- 20 species) that have multiple functions including the provision of shade and forage for livestock, timber and firewood; and provision of ecological services (e.g., soil and water conservation); and farmers use local or indigenous knowledge on functional traits in the selection of tree and shrub species for their farms. Trees are managed in different configurations and in Central America, more than 80% of farms have live fences with multi-purpose species, and there is trend of integrating high value timber species to increase the economic and environmental value of live fences. In Costa Rica, tree cover measured on small beef farms was higher than that of medium and large scale beef farms, and a large percentage of trees were managed for their timber value; and to provide shade for animals which is associated to reduce heat stress of animals and increased animal productivity. On the other hand, forage trees and shrubs are managed for dry season feeding and have resulted in improvements of milk yields and liveweight gains of cattle and small ruminants. Lack of farmer's knowledge and capital are among the main barriers for the adoption of silvopastoral systems on small farms. Recently there has been interest in promoting policies to foment the mainstreaming of silvopastoral systems. A pilot study conducted by CATIE in the region demonstrated that payment for environmental services resulted in an increase in the adoption of silvopastoral and forest systems, and income per family household of small farmers, and the design of green credit schemes is also associated to adoption of these systems. In addition, modernization of rural extension system which include farmer field schools have had impacts in improving farmer's skills and decision making for farm planning and integration of silvopastoral systems. Currently, policy makers in the region are developing the national appropriate mitigation action plans for the livestock sector and which has an emphasis on promoting policies for silvopastoral systems.

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Mixed crop-livestock systems across scales: toward new agroecological models?

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Introduction

Integrated crop-livestock systems (ICLS) are recognized worldwide as a way to improve farming sustainability (Hendrickson et al., 2008; Ryschawy et al., 2014). Interactions between crops, livestock and grasslands potentially provide multiple ecosystem services. Soil quality improvement would result from organic fertilization from livestock waste and crop-grassland rotations; increased landscape heterogeneity through the integration of grasslands within diversified crop rotations would enhance biological regulation. According to these assumptions, ICLS would be a key agroecological model for rethinking agriculture (Bonaudo et al., 2014). However, ICL farms are decreasing due to workforce and skills constraints and the strong specialization trend linked to the economic and politic contexts. A new opportunity would be to develop ICLS at local scale based on exchanges between specialized farmers (Moraine et al., 2014). We present here some case-studies considering these different scales of interest: from the ICL farm to the local level integration.

Opportunities and limits of conceiving sustainable ICLS at the farm scale

Ryschawy et al. (2014) studied 56 ICL farms in a south-western France less-favored region. ICLS at the farm scale allowed farmers to benefit of economies of scope and limit inputs through combining crops and livestock enterprises. High level of spatiotemporal coordination required thus implementing diversified crop rotations, integrating grasslands, and adapted fertilization or feeding practices. These results highly depended on farmers' management of interactions between crop, grassland and livestock activities (Bonaudo et al., 2014). However integration required a high level of technical skills and additional labor (Hendrickson et al., 2008). Despite low labor availability and work conditions, some farmers maintained their ICL farms (Ryschawy et al., 2014).

Opportunities of up-scaling: conceiving between-farm exchanges at the regional scale.

Conceiving ICLS at the local scale goes beyond farm-scale workforce constraints while providing comparable benefits. Spatial and temporal coordination would provide landscape heterogeneity and soil quality improvement. Collective organization allows farmers to combine and share their technical skills while limiting qualitative and quantitative workforce constraints. Crop farmers could diversify their rotations while integrating grasslands and obtaining manure. Livestock producers could benefit from local traceable and lower-cost feed production. Moraine et al. (2014) and further studies were based on between-farmers exchanges in the French Tarn-Aveyron Basin. Exchanges were studied at three scales: i) between 6 neighboring farmers including collective technical changes, ii) between 24 local farmers including investment in collective equipment, iii) wider exchanges involving local cooperatives and supply chains. ICLS at the local scale would require new research effort to design relevant technical and social practices and evaluation indicators. Design and assessment tools should integrate local knowledge and be easily out-scaled.

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Julie Ryschawy

Mixed crop-livestock systems across scales: toward new agroecological models?

http://www.wcclf2015.com.br/program/works/julieryschawy.pdf

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Steps towards sustainable livestock – the balance between yield and impact

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Introduction We are at a critical juncture for global livestock production, when competing requirements for maximal production and minimal pollution have led to the concept of *sustainable intensification*. Ruminants make an important contribution to global food security by converting feed that is unsuitable for human consumption to high value protein, demand for which is currently increasing at an unprecedented rate. Sustainable intensification of ruminant livestock may be applied to pastoral grazing, mixed-cropping, feedlot and housed production systems. All these systems have associated environmental risks such as water and air pollution, carbon emissions, soil degradation and erosion, as well as issues affecting production efficiency, product quality and consumer acceptability, such as reduced animal fertility, health and welfare. These challenges necessitate multidisciplinary solutions that can only be properly researched, implemented and tested in real-world production systems (Eisler et al., 2014). Moreover, Dumont *et al.* (2014) recently highlighted a major need to 'redesign' livestock systems including integration of crops and livestock. To this end, we have developed a network of 'farm platforms' across different climatic and eco-regions as a global resource for optimising and exemplifying research on the contribution of sustainable ruminant livestock production to global food security (www.globalfarmplatform.org). The farm platforms focus on: optimising production systems, animal genetics and nutrition; improving soil, plant, animal and human health; and minimising impacts of livestock production on welfare, ecosystem services or biodiversity. Some examples of farm platforms in the network are given below:

Palo a Pique, Uruguay - Four different no-till soil use intensities: long rotation (4 years of cultivated pasture; 2 years of annual forage crop); short rotation (2 years cultivated pasture and 2 years annual forage crop); permanent oversown sward; continuous annual forage crop. The winter annual crop is a mixed pasture of oats and ryegrass, the summer annual crop is grain sorghum.

UWA Future Farm 2050, Australia - The foundation is agriculture for food production based on a profitable mixed-enterprise farm, at the cutting edge of practical technology. There are four major activities: Livestock, Conservation cropping, Management of ecosystem and biodiversity, People: happy farmers and vibrant rural communities.

Wisconsin Integrated Cropping Systems Trial (WICST) - Established in 1989 to compare six alternative farming systems with respect to productivity, profitability, and environmental impact.

Thiruvazhamkunnu, India - The research farm includes a dairy, fodder and agroforestry plots, cashew, coconut and other agricultural crops. This model integrated farm grants utmost importance to sustainability, ecosystem services and biodiversity in the face of climatic change.

North Wyke Farm Platform, UK – Temperate grassland research facility which allow whole scale system research of grazing practices. Current comparisons include the use of novel grasses and mixed clover systems. Future research could include mixed cropping systems with livestock.

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world congress on integrated crop-livestock-forest systems

Financial and Economic Benefits of Integrated Crop-Livestock-Tree Systems in Europe

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Introduction

During the past 100 years, the separation of arable, livestock, and tree-crop enterprises in Europe has provided production benefits per unit land and per unit labour. However it has been associated with high agrochemical use, reduced soil carbon and increased runoff on farms, reduced numbers of farmland birds, and reduced rural employment opportunities. In view of these negative externalities, policy makers are attracted by the economic benefits (from a societal perspective) of agroforestry (the integration of trees with crops and livestock). However the implementation and sustainability of agroforestry is dependent on it being financially profitable for individual farmers.

Material and Methods

AGFORWARD (AGroFORestry that Will Advance Rural Development) is a large four year research project (2014-2017), funded by the European Union, that is promoting agroforestry in Europe. During 2014, the project established 40 groups across Europe with an interest in different types of crop-livestock-tree systems. These include traditional wood pasture, the intercropping and grazing of orchards, and trees with conventional or organic arable and livestock production. Each stakeholder group has proposed a research and development protocol to address their key opportunities and constraints (as described on the AGFORWARD website: www.agforward.eu).

Results and Conclusions

Across the 40 groups, about 120 research and development interventions were identified. Some of these focus on a synthesis of existing information, and some on field experiments and demonstration of issues such as tree-protection. However about 20-30% of the interventions could be addressed by a clearer assessment of the inputs and outputs of the system using models. During the next three years, the project will be developing and using existing biophysical models such as Yield-SAFE (van der Werf et al, 2007) and Hi-sAFe (Talbot, 2011) with economic models such as Farm-SAFE (Graves et al., 2011) to identify where agroforestry can provide financial benefits for the farmer and economic benefits to wider society. The process will be illustrated using systems such as silvoarable agroforestry, the production of woodland eggs, and grazing in orchards.

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The environmental costs of high input agriculture

Paul Burgess

Financial and Economic Benefits of Integrated Crop-Livestock-Tree Systems in Europe

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Quantifying the environmental efficiency of integrated systems using life cycle assessment

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Introduction Life Cycle Assessment (LCA) is a popular approach to quantify the environmental efficiency of production systems, but generic process data from LCA databases are of limited value when comparing diverse farming systems. Furthermore, it is particularly challenging to compare the environmental efficiency of multi-output integrated farm systems with single-output conventional farm systems. We demonstrate application of consequential LCA (CLCA) to evaluate the environmental balance of integrated tree-bioenergy and arable-cropping farm systems in Sweden.

Material and Methods

A farm model was devised to represent the average ratio of arable land to stream length in the Skåne region of Sweden. The net environmental effect of introducing 50 m wide buffer strips planted with unfertilized short rotation coppice willow for bioenergy was quantified, using four pertinent impact categories: acidification potential (AP); eutrophication potential (EP); fossil resource depletion potential (FRDP); global warming potential (GWP). A willow tile-drain filter zone scenario (Filter), and a fertilized willow scenario (Yield-max) were also modelled.

Results and Conclusions

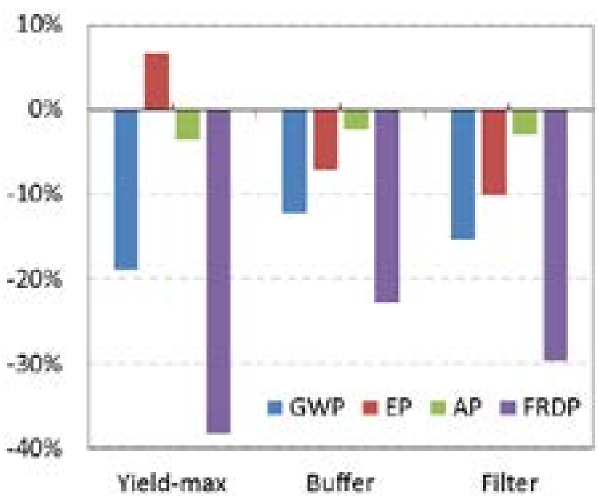

Figure 1. Farm-level change in environmental burdens for three scenarios of willow integration

Strategic integration of unfertilized willow along buffer strips or in tile-drain filter zones achieved significant reductions across all four impact category burdens, including a 10% reduction in EP burden achieved by retention of nutrient runoff from adjacent food production (Figure 1). Results account for burden "leakage" via displaced food production, and thus represent a net improvement in environmental efficiency of food and energy production. However, the GWP benefit was sensitive to indirect land use change assumptions. Non-strategic integration of willow to maximize bioenergy yield resulted in larger GWP and FRDP benefits, but a greater EP burden. Normalisation of results against European environmental loadings highlight the importance of EP reduction.

This study demonstrates how factors such as nutrient retention can be integrated into CLCA in order to quantify the potential environmental advantages of integrated farming systems. Additional factors, such as animal sheltering and soil improvement, must be similarly incorporated into CLCA of integrated systems to fully evaluate their environmental efficiency.

Acknowledgements

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The environmental costs of high input agriculture

David Styles

Quantifying the environmental efficiency of integrated systems using life cycle assessment

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Improving the water-use efficiency of Australian mixed farming systems

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Introduction The mixed crop-livestock belt of southern Australia comprises phases of wheat-based cropping sequences rotated with legume-based pastures grazed by sheep. The recent evolution of the farming system includes a 50% reduction in sheep numbers and an intensification of cropping under no-till systems, with the inclusion of oilseed (canola) and grain legumes. Two recent national R&D initiatives targeting whole-of-system synergies have generated significant improvements in WUE in the face of this evolution and a changing climate. The 5-year National WUE Initiative linked 17 regional grower groups with farming systems scientists and targeted a 10% increase in WUE predominately targeting the crop phase. The 10-year Dual-Purpose Crop Initiative developed and integrated the use of dual-purpose wheat and canola crops targeting both crop and livestock enterprises on mixed farms. We will present some of the key outcomes of these Initiatives and consider some key elements of success.

Material and Methods

The WUE Initiative linked 17 regional farmer groups across Australia with farming systems scientists to consider strategies to increase system WUE. The proposed strategies were grouped into 4 linked themes that included (1) cropping sequence (2) managing the summer fallow (3) in-crop canopy management and (4) overcoming subsoil constraints. Pre-experimental modeling predicted large improvements in yield and WUE from managing both the pre-crop and in-crop periods by combining good rotation, summer weed control and earlier sowing with appropriate varieties. Subsequent experiments tested these and other strategies across a range of environments over 5 years. The dual-purpose cropping Initiative investigated the potential to graze the vegetative biomass of early-sown wheat and canola crops to increase the winter carrying capacity and to spell pastures in winter, thereby generating simultaneous increases in crop and livestock production (and hence WUE) from the same farm. A feature of both Initiatives was grower involvement from the outset, the use of simulation modeling alongside on-farm experimentation, and multidisciplinary teams considering whole-of - system synergies.

Results and Conclusions

The WUE Initiative demonstrated numerous strategies to increase system WUE by well-in-excess of the 10% target (Kirkegaard et al., 2014). In particular the combination of break crops, complete summer weed control and early sowing of later-maturing wheat at lower plant density could increase whole-farm wheat yield and WUE by 11 to 47%. On mixed farms, early-sown wheat and canola crops could be grazed safely without yield penalties, and provide opportunities to increase both crop and livestock production on the same farm with related improvements in farm WUE (Bell et al., 2015). These Initiatives have demonstrated the potential for whole-of-system approaches involving synergies among management strategies on mixed farms to generate significant increases in system WUE, even in the face of drier and more variable seasons under climate change.

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We are grateful to Grains Research and Development Corporation (GRDC) for funding support of the National WUE Initiative (CSP00111), and the series of dual-purpose crop projects (CSP00075; CSP00132; CSP00160).

John Kirkegaard

Improving the water-use efficiency of Australian mixed farming systems

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Contribution of beneficial plant-associated microorganisms in crop-livestock-forest systems: how far can we go?

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Research funding and farmer use of inoculants to promote biological nitrogen fixation (BNF) have been inversely related to economic and logistic facilities to get N-fertilizers. In countries such as Brazil, where about 70% of the N-fertilizers are imported and quoted in foreign currency, research aimed at increasing the contribution of BNF to plant nutrition has been persistent and often very successful, in contrast to countries with low-cost N-fertilizers. However, a new horizon has been raised, relying on the global interest in mitigating greenhouse gases (GHG) emissions.

BNF with legumes used for pastures may be very successful, with examples including both temperate/subtropical species as alfalfa (*Medicago sativa*) and clover (*Trifolium* spp.) with reported annual contributions of up to 480 and 260 kg N/ha, respectively, and tropical species as *Stylosanthes* spp. and *Desmodium* spp.contributing with up to 260 and 380 kg N/ha, respectively (Ormeño-Orrillo et al., 2013). The challenge has been to introduce and maintain these legumes as pastures. There are encouraging reports of forage legumes mixed or not with grasses in temperate/subtropical regions, but they are rare in the tropics. However, a positive scenario for inputs of BNF in integrated crop-livestock-forest (ICLF) systems should increase the number of successful experiences.

In Brazil, an important component of many ICLF systems is the soybean (*Glycine max*). The soybean-*Bradyrhizobium* might be considered as the “perfect symbiosis”, adapted to a variety of edaphoclimatic conditions and reaching rates of 300 kg of N/ha, in addition to about 30 kg N/ha left over for the following crop (Hungria & Mendes, 2015), which in ICLF is often maize or *Brachiaria* spp. Considering the prices in Brazil, this “leftover” implies in an economy of about US$ 30/ha, besides the mitigation of 135 kg CO_2eq (considering 4.5 kg of CO_2eq/kg of N-fertilizer). The economic and environmental impacts in millions of hectares of pastures in Brazil can be easily realized. Another important contribution of BNF in ICLF can come from legume trees and may reach hundreds of kg of N/ha, e.g. with *Gliricidia* spp., but the adoption by farmers is still modest.

Relevant results can also be achieved with the use of other plant-growth promoting rhizobacteria (PGPR), encompassing contributions by a variety of mechanisms including BNF, production of phytohormones, increased stress tolerance, antibiosis against pathogens, among others. The use of *Azospirillum* spp. with the maize crop, also a component of many ICLF systems is increasing exponentially in Brazil. Finally and probably even more exciting are the results that have been obtained by our group with PGPR applied to *Brachiaria* spp., resulting in impressive increases in plant biomass production and nutrient content.

How far can we go with microbial inoculants in ICLF systems? Here we gave some few examples that can be expanded to several other annual and perennial crops and forest species used in ICLF systems. All can be benefited—in lower or higher degree—by microbial inoculants. Apparently, we are reaching an era of “microgreen revolution”, with deep impacts on sustainable food production.

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Acknowledgements

To Embrapa and CNPq.

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Nitrogen use and balances in smallholder crop-livestock production systems

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Introduction
Various methods are used to describe smallholder crop-livestock production systems. Smallholders are usually described as farmers that manage small land areas and raise few livestock. Stocking rate refers to livestock numbers or mass per unit land area. Some smallholders may raise few livestock on very large land areas (low stocking rates), and some raise few livestock on very small land areas (high stocking rates). Nitrogen use efficiency (NUE) is the percent of applied nitrogen (N) incorporated into products, such as the relative amount of consumed feed N incorporated into milk N (feed-NUE), the amount of applied fertilizer N or manure N taken up by crops and pastures (fertilizer-NUE, manure-NUE), or the relative amount of total N inputs incorporated into product N (whole-farm NUE). Nitrogen balance refers to the difference between N inputs (e.g., fertilizers, feed) and N outputs (crops, meat, milk) on a whole-farms basis. Negative N balances often occur at low stocking rates and low crop-livestock productivity due to inadequate replenishment of the N removed during extensive grazing of pastures/rangelands. Positive N balances occur at high stocking rates and high crop-livestock production due to high use of imported fertilizers and feed.

Material and Methods
Stocking rates, NUE, and N balances were determined for small-holder dairy farms in various location of West Africa, China, Australia and USA. Face-to-face interviews with dairy producers provided general ‘snap-shots’ of fertilizer, feed, and manure management and milk production.

Results and Conclusions
Stocking rates, NUE and N balances depend on the type and amount of N purchased and used to produce feed, milk and meat. On one end of a continuum, smallholder dairy farms with very low stocking rates (such as the extensive, pasture/rangeland, multipurpose cattle systems of West Africa) also have low productivity, low NUE and negative N balances because fertilizers and feed supplements are unavailable. On the other end of this continuum, smallholder dairy farms having high stocking rates (such as confinement dairy systems of China and USA where cows are fed in barns) have relatively high productivity, high NUE and positive N balances because fertilizers and feed are imported. Approximately 37% of global lactating cows have feed-NUE of <10% (most in smallholder multipurpose cattle systems of Africa) and these low efficient cattle account for 10% of the milk production globally. Approximately 30% of global lactating cows have feed-NUE of between 21 to 25% (most in USA, Western Europe and Oceania) and these cows account for 53% of the milk production globally. Relatively short, face-to-face interviews with farmers can provide accurate, general ‘snap-shots’ of fertilizer, feed and manure management. This can be a valuable source of information about actual and potential NUE and N balances on smallholder dairy farms.

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Mark Powell
Nitrogen use and balances in smallholder crop-livestock production systems
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Soil organic carbon sequestration and greenhouse gas emission

Alan Franzluebbers

Do integrated crop-livestock-forest systems promote soil C accumulation more than monocultures or continuous pasture?

http://www.wcclf2015.com.br/program/works/alan-franzluebbers.pdf

Do integrated crop-livestock-forest systems promote soil C accumulation more than monocultures or continuous pasture?

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Abstract

Soil organic carbon stock and its change with time and depth are key indicators of agricultural productivity potential and environmental health. This is because soil organic matter is a reservoir of biologically derived nutrients, a mediator of soil structural development, and a regulator of nutrient fluxes to the atmosphere and to receiving water bodies. Perennial agricultural systems of pastures and woodlands often contain greater soil organic carbon than annually cultivated cropping systems. Simultaneous integration of crops, pastures, and/or trees may have benefits for soil organic carbon accumulation and dynamics, but the relationships among components vary in space and time. Synergies among crop, livestock, and forest systems could allow tighter nutrient cycling, conservation of soil and water resources, greater reliance on renewable natural resources, improvement in the inherent functioning of soils, and diversity and dependability of income for farms with an abundance of labor. This presentation will explore the dynamics of soil organic carbon under simple and complex agricultural systems based on available literature. Forthcoming research on integrated crop-livestock-forest systems will add greatly to the relative dearth of information available, especially considering the large diversity of climatic and soil conditions where such integrated systems will be developing.

Intensification of livestock productivity in ICLF systems: The impact on GHG emissions

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Pasture degradation is a critical problem in Brazil as a result of excessive grazing and N losses, which leads to soil organic matter depletion and CO_2 emissions to the atmosphere. Integrated crop-livestock (ICL) systems are recommended as best practice to replace nutrients to the soil while the investment can be covered by the sale of grain. Existing experience shows that pasture carrying capacity increases from 0.5 AU (450 kg LW) ha^{-1} under degraded condition to 2.5 AU ha^{-1} in ICL. The improved pasture production increases soil C stocks, but the impact of the system on N_2O and CH_4 emissions should also be accounted for. Here we present a carbon footprint analysis for meat production from degraded pasture and an ICL system, together with possible compensation by introducing a forest component (C in eucalyptus biomass) and by the soil C stock change. The herd composition was defined considering specific performance indices for each pasture condition obtained from literature and expert knowledge. The IPCC *Tier 2* guidelines were used to calculate CH_4 and N_2O emissions for each herd. Fossil CO_2 from supplements, vaccines etc., were also included. With the respective stocking rates it was possible to estimate emissions on a per hectare basis. Carcass production (CWE) was 43 % higher with the ICL system compared to the degraded conditions. The area required to rear the herd under ICL was 80 % lower. The C-footprint for 1 kg CWE was reduced by approximately 45 %. The C accumulated in the soil and tree biomass would help to compensate emissions for about 10 to 20 years. Full emission neutralization could be realized by using the timber for energy production, which will require further studies.

Bruno José Rodrigues Alves

Intensification of livestock productivity in ICLF systems: The impact on GHG emissions

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Impacts of integrating crop and livestock production systems on GHG emissions from fertilizers and animal manure

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Crop and livestock production systems have increasingly developed apart, in agglomerations of specialized systems, because of the economic benefits of specialization, intensification and up-scaling. The specialization of crop and livestock production is fueled by cheap exogenous energy, and driven also by suppliers, processing industries and retail, who preferably act with large producers who are able to meet certain quality and quantity criteria. The processes of specialization and agglomeration are especially occurring in developed countries, and more recently also in peri-urban areas of rapidly developing countries. These are dominant trends and one of the reasons why the nominal prices of most food products have decreased over time.

The main drawback of the specialization and agglomeration of crop and livestock production is the disruption of the natural cycling of organic residues and nutrients to the soil where the feed was produced. As a result, cropland may become depleted in organic carbon and nutrients, while livestock production areas become enriched with organic matter and nutrients. Another drawback is the increased need for transport, storage, refrigeration, and processing/treatment capacity, and hence exogenous energy. These drawbacks create subsequently series of environmental impacts.

Here, we review and assess the impacts of separation versus integration of crop and livestock production systems on the emissions of the greenhouse gases methane (CH_4), carbon dioxide (CO_2) and nitrous oxide (N_2O). We examined comparative studies reported in literature and analyzed integrated assessment and life cycle analysis reports. A first conclusion is that only few studies have examined specifically the aspect of separation versus integration on GHG emissions. A second conclusion is that neither separation nor integration by definition leads to relatively low (or high) emissions per unit of livestock product. For all, the GHG emissions per unit of livestock product in current practice depend on crop and animal productivity, husbandry and management practices, the manure management system, environmental conditions and on the time horizon. However, integrated systems have lower potential GHG emissions than separated crop and livestock systems, provided that crop and animal productivity and management practices, manure management and environmental conditions are similar or near optimal in both type of systems. Modeling studies suggest that N_2O emissions from soils, fertilizers, and manure management, CO_2 emissions related to land use change, transport and electricity, and CH_4 emissions from manure management are lower in integrated systems than in specialized and separated systems.

Our review includes estimates of GHG emission profiles of crop and livestock products in Europea, Africa and Latin America at country and continent levels. These assessments show indirectly the effect of having different crop and livestock production systems and integration. Our estimates indicate that the emission profiles per product may differ more than a factor of two between countries. A complication is that some countries import and export significant amounts of feed and animal products and the emissions related to these imports and exports are not easily allocated to the animal products in an accurate and transparent manner. Integration of crop and animal production systems also has positive effects on nutrient use efficiency, and these have a range of beneficial ecological and human health impacts.

Acknowledgements: to the EU projects AnimalChange, Biorefine, ReUseWaste

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PLENARY SESSION 7

Going all the way - integration of crop, livestock and forest

Manuel Macedo

CLFIS: an overview of the brazilian experience

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CLFIS: AN OVERVIEW OF THE BRAZILIAN EXPERIENCE

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Introduction

The total pastureland in Brazil is estimated at 174 million ha, with 122 million ha of exotic species and 52 million ha of native species. Annual crops and planted forest, on the other hand, would be 59 and 7.6 million ha, respectively (IBGE. 2010, 2011; SNIF, 2015). Pasture degradation is by far the most important problem in Brazilian livestock systems. In the major annual crops areas some of the constraints are: decrease of soil quality (falling of soil organic matter content, less water infiltration rate, lower soil biodiversity, and increasing of soil compaction), attack of pests and diseases, new and aggressive weeds, etc. These problems have stimulated other approaches in how to conduct new farming systems in Brazil. Conventional continuous soil preparation systems, with the lack of crop rotation, negative levels of nutrient reposition are not sustainable. No-till in soil preparation, associated with integrated crop-livestock, crop-livestock-forest and forest-livestock systems appear to be sustainable alternatives. In this presentation, we report general aspects and some beneficial results of CLFIS adopted in different regions of Brazil in response to this new approach of farming systems.

Results and some remarks

Statistics about area of CLFIS in use are scarce. Some sources indicate a total of 3 million ha with CLFIS in Brazil. Crop-livestock combination (CLIS) is by far the largest area in use, over 80% of all. Farmers use simultaneously planting a long time, combining rice or corn with forages as some sort of CLIS. More recently, adjustment in agronomical practices, as plant density and row arrangement with new planting machinery has increased the effective use of CLIS as a long run system of crop-pasture rotation in the same area and location. Cycles of crop and pasture duration depends on local farming systems, economics, knowledge of practices and techniques, etc. Annual crops such as: soybeans, corn, sorghum, cotton, wheat and rice can be used on CLIS, but again, it depends on Brazil´s region and local farming systems. The tree, which is the component that completes CLFIS or LFIS is the new way nowadays of integrated system. Many questions still remain in their regard. Physical production of timber, efficient land use, and economic returns should be determined by research and local evaluation. Some results of research institutions and farmers have shown advantages of CLIS and CLFIS over conventional systems. Rotational systems of annual crops and pastures, with no-till associated to CLFIS increase soil fertility, the efficient use of nutrients, soil carbon sequestration, soil biodiversity, interruption in cycles of pests, diseases and weeds. More entries of income, employment and labor efficiency are due to CLIS and CLFIS. Government policies such as ABC Plan (low carbon agriculture policy) are helping farmers do adopt these systems. It is also expected less GHC emissions by area under use of CLIS and CLFIS. Brazil is increasing the efficiency of land use adopting this technology as alternative to recuperate degraded pasture, avoiding the opening of new areas of native forests in Amazon and Cerrado regions.

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To Embrapa, CNPq, FUNDECT-MS, for funding and support.

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Developing integrated crop-tree-livestock systems in China

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Introduction

China has been experiencing three decades of exceptional economic growth, but not without great environmental consequences. The result is a vicious circle of deteriorating air and water quality from animal waste and overuse of antibiotics, deforestation and declining biodiversity, soil and land degradation, and increasingly frequent catastrophic natural disasters. Yet in the meantime, China's improved standards of living caused a rise in demand for a more diversified diet. Will integrated crop-tree-livestock systems allow China to restore its degraded landscapes, reduce its soil and water pollution and greenhouse gas (GHG) emissions while improving dietary quality and farmland productivity? We examine how land-sharing and nutritional and nutrient flow at farm and landscape level helps balance ecosystem services and food production.

Materials and methods

Our case studies include the following:

a) Veterinary antibiotics in the soil: we gauged the impact of antibiotics on alfalfa's N-fixing symbiosis. The alfalfa seeds were inoculated with *Sinorhizobium meliloti*, and the soil was mixed with pig manure spiked with three different antibiotics treatments.
b) Fodder trees for animal nutrition and landscape restoration: we conducted a literature review on the traditional/ethnobotanical use of tree fodders, and projected those fodder species into different agroecological zones according to geo-referenced specimens.
c) Study on rubber seed for livestock feeds: we investigated the potential of rubber (*Hevea brasiliensis*) seed oil as an additive to livestock feeds to increase α-linolenic acid (ALA) in dairy cow milk.

Results and conclusions

a) The results of our initiative show that antibiotics in the soil significantly decrease the Alfalfa's N-fixation capacity. There is potential for phytoremediation to restore soils contaminated with antibiotics, particularly through the use of agroforestry systems.
b) There is an imperative to incorporate fodder trees into large-scale afforestation and landscape restoration projects, as they directly enhance smallholders' livelihoods and environmental services.
c) The results indicate that the supplement of rubber seed oil and flaxseed oil both increase milk production and the functional fatty acids content (ALA, VA, and CLA) in milk fat, while decreasing the content of saturated fatty acids.

Three case studies demonstrate the virtual cycle of material, nutrition and nutrients through integrated crop-tree-livestock systems. Reducing antibiotics inputs, restoring degraded agropastoral systems through fodder trees, and recycling agroforestry products can significantly improve the productivity and efficiency of such systems.

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Acknowledgements

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world congress on integrated crop-livestock-forest systems

3rd International Symposium on Integrated Crop-Livestock Systems

Trees as components of integrated crop-livestock systems: where land sharing means land sparing at farm and landscape scale

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Introduction

Grazing on fallows, in forests and parts of the landscape too wet or too dry to grow crops is as old as agriculture. Trees as a source of green fodder in dry periods are important in many landscapes, while they provide shade and shelter that reduces exposure to harsh climates. Mixed tree-crop-livestock systems, however, may appear to show 'yield gaps' when compared with specialized single-commodity enterprises. Yield gaps imply a land equivalent ratio below 1.0, and indicate that 'land sparing' would be feasible if the yield gap were closed, requiring less land to produce the same amount. On the other hand, overyielding and land equivalent ratios above 1.0 are common for intercropping, when compared to current-practice sole component systems. This might imply that 'land sharing', in multiple component systems is superior to any form of sole-crop 'land sparing'. We will review current models that allow specific tree-crop-livestock systems to be analyzed at farm (WaNuLCAS, APSIM) and landscape (FALLOW) level, using data on soil, climate, characteristics of crops, trees and livestock and management practices that specify how time and space are shared among components.

Material and Methods

As a case study a catchment in densely populated Java (Indonesia), as analyzed for its crop-livestock-forest interactions by Lusiana et al. 2012, will be compared with drier and less intensively used landscapes in Kenya (de Leeuw et al., 2014) and the parkland agroforestry of the Sahel (Bayala et al., 2015), to explore the robustness and applicability of existing models.

Results and Conclusions

Model comparison	Time Step	Spatial	Component libraries	Producti-vity	Water & NPK	Sharing/ sparing	Reference
APSIM	Day	Zoning	Extensive	Direct	Full	Indirect	www.apsim.info
WaNuLCAS	Day	Zoning	Partial	Direct	Full	Indirect	http://www.worldagroforestry.org/our_products/models
FALLOW	Year	Mosaic	Limited	Indirect	Limited	Direct	

A combination of models is recommended, combining strengths and avoiding gaps.

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Research needs and challenges for producer adoption of ICLF

Henry Neufeldt

Research needs for the advancement of ICLF

http://www.wcclf2015.com.br/program/works/henryneufeldt.pdf

Research needs for the advancement of ICLF

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Summary

Integrated crop-livestock-forest systems consist of three functionally and ecologically different elements: annual crops, animals and trees. Such systems can offer great opportunities to generate additional income and environmental sustainability through diversification of marketable products, higher resilience to climate and other shocks and enhanced ecosystem services such as from carbon sequestration, higher biodiversity and improved water and nutrient management.

At the same time, the system complexity rises in many, often unpredicted, ways. This can pose challenges on farmers to adopt such systems. While mono-cropping practices are relatively simple in terms of their need for technical capacity, market connectivity through supply and value chains, the challenges of integrating different production cycles, supply and value chains, provision of services and, last but not least, state regulations, rises considerably with every additional functionally different element that needs to be considered.

This system immanent increase in management complexity requires the integration of much more knowledge and can, to some extent, be considered among the barriers to adoption and scaling up. Other important factors may include, but are certainly not limited to, lower returns on investment during transition periods, the potentially higher context specific nature of the possible crop, livestock and tree components and a lacking enabling environment.

Research is required to fill these knowledge gaps. In particular, there is dire need to extend our understanding of the complex interactions of ICLF and how to scale up these systems effectively in order to develop social-ecological systems that are socially, economically and environmentally sustainable long term. Only if ICLF can convincingly respond to ever growing challenges such as increasing demand for food, fuel and feed as populations grow and diets change with rising affluence and urbanization, whereas climate change and resource mining continuously diminish the world's capacity to sustain its provisioning capacity long term, will these systems be of more than niche relevance.

This talk will address some of these questions and will try to synthesize answers based on, next to other sources of information, results presented at this conference.

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Research needs and challenges for producer adoption of ICL/ICLF

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Introduction

From the commitments to reduce greenhouse gas emissions made by Brazil in Copenhagen in 2009, It was implemented the National ABC Program (Low Carbon Agriculture emission) which includes among other technologies the adoption of Integrating Crop Livestock and Integration Crop Livestock Forest. This presentation will show the status of adoption of ICL/ICLF since 2010, the main trends, needs and constraints that must be overcome to increase the adoption of ICL/ ICLF in Brazil.

Material and Methods

The information contained in this summary comes from the work of the Getúlio Vargas Foundation ABC Observatory, the Department of Strategic Actions of the Presidency of the Republic and Cooperative Development Department of the Ministry of Agriculture. This is information relating to contracts made by the year 2014, which include the recovery of pastures, the ICLF and their main constraints for technology adoption. Important notes are made to improve search and research needs to enhance the adoption of ICLF in Brazil.

Results and Conclusions

The current situation indicates that 75% of ABC plan contracts are for recovery of pastures and another 25% primarily for ICLF or ICL (GVces 2104). Whereas a 10-year interval would be possible to achieve the average difference between the carbon storage in degraded pastures and integrated systems or recovered, and that 45 of the 60 million hectares of degraded pastures could be recovered and transformed into 15 million systems integrated, you can avoid emissions by 143 million tCO2e / year. Thus, only with the recovery of pastures and the ICL and ICLF systems can offer bolder mitigation targets that go beyond those recommended by the ABC Plan. For this it is necessary to overcome some difficulties, including: expanding the regional studies on environmental sustainability and economic and financial profitability for ICL/ICLF Systems ; Develop zoning of pastures and forests to identify priority areas for implementation of ICL/ICLF technologies; Strengthen and expand long-term GHG emission reduction monitoring networks; Encourage research in developing inoculants to grasses, to enhance the efficiency of emission reduction of ICL/ICLF systems.

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Research needs and challenges for producer adoption of ICLF

Eduardo Assad

Research needs and challenges for producer adoption of ICL or ICLF

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Integrated crop-livestock-forestry systems as potential carbon sinks

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Introduction Mixed farming systems have great potential to combine food production with environmental services, including climate change mitigation and biodiversity preservation. This study contributed to the evaluation of integrated crop-livestock (ICL) and crop-livestock-forestry (ICLF) production systems from the point of view of their potential for carbon (C) sequestration in the soil and in the production system as a whole.

Material and Methods The studies focused on the Cerrado biome of Brazil and area considered as transition zone between the Cerrado and the Amazon. The partial C balance was assessed through the net ecosystem exchange of nitrous oxide (N_2O) and carbon dioxide (CO_2). The soil C stock was assessed to 1 m depth, measuring total C and N and $\delta^{13}C$. Soil microbial community structure was evaluated based on PLFA analysis.

Results and Conclusions The main findings were that pasture in rotation with annual crops (soybean, dryland rice and maize) in integrated systems had a net negative balance of CO_2 emission, resulting in net C accumulation in the system. This is in contrast to the partial balance of the grain production phase of ICL, which emitted C to the atmosphere. Thus, the introduction of forage grasses and planning the duration of grain crop cultivation within the integrated system, may offset CO_2 emissions during the annual crop phase. This balance is partial because it was still not possible to assess the contribution of methane (CH_4) emission or removal by the production system. In the ICLF systems, trees showed a significant effect, not only on biomass, but also in the accumulation of total soil organic C. Carbon stocks of soils under the tree rows increased at 1-m depth compared to the time zero reference (degraded pasture). Results of the isotopic signature of the soil C showed that the forest component in ICLF had a significant effect in the soil organic matter build-up in a short term (3 years). The artificial increase of biological diversity above ground, using exotic or native species, affected the functional diversity of microorganisms in the soil. In contrast to the soil under continuous degraded pasture, soils under ICLF showed an increased ratio of fungi to bacteria indicating ecosystems of lower organic matter mineralization rates. Thus, soils under ICLF may have a larger capacity for C retention than soils under simple production systems. The positive net accumulation potential for C in ICL and the accumulation of soil C under ICLF even in a short time, are additional evidences that support integrated systems as a way towards a more sustainable agriculture (soil C enhances soil fertility) with lower C emissions (C sink) in tropical ecosystems. On the bases of the results of the study it will also be possible to make adaptations in integrated systems to improve or optimize their performance in removing C from the atmosphere.

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Beata Emoke Madari

Integrated crop-livestock-forestry systems as potential carbon sinks

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Making it Real: Operationalizing Soil C Sequestration and GHG Mitigation on Agricultural Lands

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Introduction

Land use and management account for roughly one-quarter of total anthropogenic greenhouse gases (GHGs) about half of which comes from managed agricultural lands and half from land clearing and deforestation often tied to expansion of agricultural land use. Within this larger category of land use, soils play a significant role not only as a GHG source but also as a potential sink, through storing C in soil organic matter. However, there has previously been relatively little engagement of agriculture, particularly with regards to soil management, in policies and programs for GHG mitigation. Now, that appears to be changing and there is increasing interest in 'bottom-up' strategies to incentivize agricultural management practices that sequester C in soils and reduce non-CO^2 soil emissions. These incentives range from GHG offset projects to inclusion of GHG emission reductions in 'green labeling' of agricultural products for consumers. A critical need for implementation of agricultural GHG mitigation strategies are rigorous quantification systems that are operational at the scale where mitigation practices are being implemented – on the farm!

Material and Methods, Results and Conclusions

The COMET-Mondial tool is designed to meet this need. COMET-Mondial is an integrated, multi-lingual, web-based platform for quantification and assessment of whole farm GHG emissions, using state-of-the-art computation methods in an environment that enables farmers (industry and agency personnel) to manage their data and produce high-quality estimates and reports of their emissions. COMET-Mondial is based on the COMET-Farm system (http://cometfarm.nrel.colostate.edu) which is already operational in the USA. The system includes three estimation modules: soil and biomass related emissions, livestock emissions and energy use, to produce a full-GHG budget at the farm scale. The system includes a full spatial graphic user interface that allows management details to be specified for individual fields and pastures and overlays management system with spatially-distributed soil and climate attributes. Empirical as well as process-based models are included in the system to calculate baseline as well as projected emission reductions with implementation of GHG mitigation practices. The COMET-Mondial tool is currently being implemented for countries in the EU, Brazil and Australia with plans for a pilot version of the system available in late 2015.

Marlen David Eve

Making it real: operationalizing soil C sequestration and GHG mitigation on agricultural lands

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Methane emission efficiency on integrated crop- livestock- systems at southern Brazil

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Introduction Methane (CH_4) emissions related to rumen fermentation is an important contributor to anthropogenic greenhouse gas (GHG) emissions into the atmosphere. Recent studies have demonstrated that reducing GHG emissions are related to the optimization of feed efficiency, this is to improve the quantity of product output while reducing environmental footprint (Hristov et al., 2013). On Integrated Crop-Livestock Systems (ICLS), in areas with the presence of trees, the shade-response in grass communities could be considered an emergent propriety. Shading may increase the N use efficiency of the understory plant leading to higher crude protein content in the dry matter and, when ingested, to a better conversion into the rumen, which would allows less CH_4 emission.

Material and Methods

We investigated the effects of the i) presence of trees and ii) N fertilization rate over the enteric methane emission of cattle grazing cool-season pastures on ICLS systems, over three grazing cycles corresponding to 2012,2013 and 2014in a long-term ICLS protocol. The field experiment was a complete randomized block design, with four treatments [(i) presence or absence of trees and, (ii) Nitrogen fertilization rates -90 and 180 kg per ha] three replications (12 paddocks of 0.99±0.231 ha) carried out at the Agronomic Institute of Paraná at Ponta Grossa-PR (25°07'22''S; 50°03'01''W). The mixed tree component - eucalyptus (*Eucalyptus dunnii),* pink pepper (*Schinus molle)* and silver oak (*Grevillea robusta*)- was planted in 2006 (237 trees/ha), on six paddocks. The forages were black oats + annual ryegrass (*Avena strigosa* + *Lolium multiflorum*), sown annually, and grazed by Purunã beef breed heifers (total of 24 animals- LW, 313.2 ± 41.57 kg). The forage was managed maintaining post grazing sward height at 20 cm. Gas collections were performed in each grazing cycle, over 5 consecutive days, by SF_6 technique, on two animals per paddock.

Results and Conclusions

CH_4 emission rate per kg live weight gain was calculated to study the relationship between the methane emission per unit animal product and the proposed treatments. There wasn't difference between treatments (P>0.05) with a mean CH_4 emission efficiency of 249.1 ±115.6374 g CH_4 kg ADG^{-1}. Other analysis and modelizations must be done, aiming to estimate CH_4 balance and other approaches using life cycle assessment, for example. Furthermore, on ICLS, single productivity doesn't must be considered due to the huge potential to mitigate CH_4 emissions by C fixed in soil, tree and forage components. Therefore, these integrated systems could be a key form of sustainable intensification needed for achieving future food security.

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Raquel Santiago Barro

Methane emission efficiency on integrated crop-livestock systems at Southern Brazil

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Influence of agricultural production systems in C and N stocks in Cerrado soils

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Introduction A large area (180 Mha) of central Brazil is occupied by a savanna biome known as the Cerrado. This region is regarded as an agricultural frontier and there is a steady growth in the area dedicated to permanent cropping. Owing to the dearth of long-term experiments, the impact of continuous cropping on soil carbon stocks remains unclear. In this present study, we investigated the effect of cropping or pastures, or integrated crop/livestock systems under different tillage systems in an experiment established in 1990 in the Cerrado region on soil C and N stocks.

Material and Methods

The field experiment was installed in an area of native vegetation (15°35' S, 47°30'W, 1200 m asl) at the Embrapa Cerrados Research Centre, Planaltina-DF. In 2014 the soil profile of 16 treatments and a native vegetation area (Cerrado) were sampled. These treatments included grazed pastures of *Brachiaria brizantha* in monoculture or in mixed grass/legume sward, continuous cropping under no-till or plough-till and integrated 4-yr crop/4-yr livestock systems. Soil samples were taken to 100 cm depth for analysis of total N and C. The soil C and N stocks were calculated on a basis of a mass of soil equal to that under the native vegetation as described by Sisti et al. (2004).

Results and Conclusions

Over a 20-year period no management system showed accumulation of soil C above that present under the original Cerrado vegetation, but unfertilized continuous pasture and continuous cropping under plough till showed significantly lower soil C stocks. The differences in soil N stocks followed the same trends but were proportionately greater which we attribute to a high and non-uniform distribution of charcoal at this site originating from natural and anthropic fire.

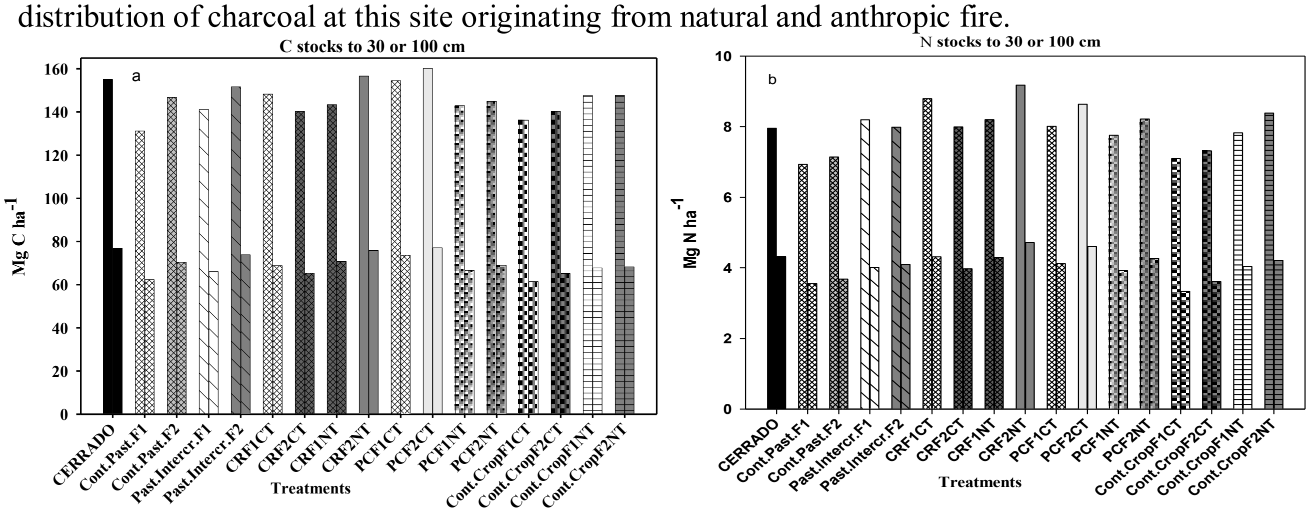

Fig. 1. Soil C (a) and N (b) stocks to 100 cm depth under different crop and pasture systems 24 years after establishment. Data are means of 4 replicate plots/paddocks.

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Robert Michael Boddey

Influence of agricultural production systems in C and N stocks in Cerrado soils

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A procedure to monitor nitrous oxide emissions from bovine excretions deposited on pastures

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Introduction
The success of strategies to mitigate greenhouse gases needs to be measurable, reportable and verifiable (MRV). In Brazil, the 200 million head cattle herd is mainly grown on extensively managed pastures of low productivity. The improvement of pasture production in 15 million ha is one of the nationally proposed actions to mitigate GHG emissions committed by the Country at the United Nations COP 15. An economic program called ABC (Low Carbon Agriculture) was created by the Government to offer credit at low interest rates to farmers willing to improve their pastures. One of the GHGs that should be monitored is N_2O, which originates mainly from the excreta deposited on pastures. Any direct N_2O monitoring system is unfeasible in view of the large area under the ABC program. The team at Embrapa Agrobiologia devised a strategy based on N_2O emission factors applied to estimates of N excreted by cattle partitioned between urine and dung.
Materials and methods
The emission factors (EFs) for cattle excreta were measured in field experiments. Plots were delimited in a fenced-off area and sorted in a completely randomized block design. Fresh cattle urine and dung were applied as individual treatments together with a control plot. The N content in the excreta was quantified and the amount of excreta put in place was controlled. N_2O fluxes were monitored on a daily basis for the first three weeks and then twice a week. The amount of N returning to the field as urine and dung of a cattle herd of a farm/ranch was estimated from information such as body weight (BW), live weight gain (LWG) and diet composition. In general, the animal diet was only forage and mineral salt. A composite sample of the pasture on offer for the analyses of protein content is required. Forage consumption was calculated as 2.5 % of BW and the ingested N is estimated based on the N content in forage consumed. The partitioning of the consumed N into urine and dung is obtained from the equation Ru/f (Ratio of N in urine to N in dung) = [1.2725 * (%N in diet)] – 1.09 (Xavier et al. 2014).
Results and discussion
Two trials were carried out in two different years in the same location of the Brazilian Cerrado. In the rainy season (summer), the EF for urine was estimated at 1.9 and 2.5 % for the first and second trials, respectively, while for dung it was 0.14 % and 0.35 %, respectively. The means were calculated as 2.2 % for urine N and 0.25 % for dung N. The emission factor for urine agrees with that of the IPCC guidelines (IPCC, 2006) in the summer season, but it overestimates N2O emission for the whole year as emissions in the dry season were close to zero. However, the IPCC EF of 2% is not appropriate to estimate N_2O emissions from cattle dung. The cattle BW averaged 350 kg and the acquired forage was 11 % protein content meant a daily forage consumption of 87 kg dry matter and a daily N intake of 1.5 kg. Hence, the N in urine should be 0.7 kg N and dung 0.8 kg. The N_2O emissions for the herd would be estimated at 17.4 g N-N_2O head^{-1} for the evaluated pasture. The model requires further validation by measuring urine-N and dung-N. This strategy is to be applied to estimate changes in N_2O emissions in pastures undergoing improvement on many ranches over large areas/regions.
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Xavier et al. 2014. Nutrient Cycling Agroecosystems 99: 45-62 (DOI 10.1007/s10705-014-9617-x)

Robert Michael Boddey

A procedure to estimate nitrous oxide emissions from bovine excretions in extensively managed pastures

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Time of *Urochloa* sowing intercropped with soybean

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Introduction

The crop-livestock integration system is an important strategy for maximizing the use of water, light, nutrients, machines and hand labor. In Brazil, the cultivation of fodder grass species between two soybean cropping seasons has been an important component of this system. The fodder grass sowing can be performed at soybean vegetative phase, accelerating the formation of the pasture after the soybean harvest (Franchini et al., 2014). In this presentation, we report the soybean grain yield and shoot mass of two *Urochloa* species affected by two soybean cultivars and two times of fodder grass sowing.

Material and Methods

The field experiment was carried out at Embrapa Soja Research Centre, Londrina, Paraná State, southern Brazil (23°11'S; 51°11'W; altitude 620 m) during the 2014/2015 cropping season. Treatments included two soybean cultivars (BRS 359 RR and BMX Potência RR), two *Urochloa* species (*U. brizantha* cv. BRS Piatã and *U. ruziziensis*) and two times of fodder grass sowing between soybean rows (at V2 and V5 stages). The soybean yield, grain moisture and shoot dry mass of fodder species at soybean harvest were evaluated. The soybean yield values were corrected to 13% moisture content.

Results and Conclusion

Tab. 1. Soybean yield, grain moisture and shoot dry mass of fodder grass at soybean harvest in two *Urochloa* species and two sowing times. Data are means of two soybean cultivars and four replicates

Treatments	Soybean yield (kg ha^{-1})	Grain moisture (%)	Shoot fodder grass (kg ha^{-1})
Soybean without fodder grass	2,786 a[1]	15,4 b	-
Soybean + *U. brizantha* cv. BRS Piatã sowed at V5 stage	2,600 a	15,8 b	303 b
Soybean + *U. ruziziensis* sowed at V5 stage	2,879 a	15,8 b	240 b
Soybean + *U. brizantha* cv. BRS Piatã sowed at V2 stage	2,074 b	19,2 a	1,581 a
Soybean + *U. ruziziensis* sowed at V2 stage	1,822 b	19,7 a	2,361 a
CV(%)	17,2	16,1	30,7

[1] Means followed by the same letter within a column do not differ significantly by Scott-Knott test ($p > 0.05$)

The sowing of *U. brizantha* cv. BRS Piatã or *U. ruziziensis* at V2 soybean stage allowed adequate grain yield and fodder grass establishment. This represents a significant innovation to improve the crop-livestock system in Brazil.

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Franchini et al. (2014) Pesq. Agropec. Trop., v.44, n.2, p.119-126.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Alvadi Antonio Balbinot Jr

Time of Urochloa sowing intercropped with soybean

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Yield of soybean in integrated crop-livestock-forest system

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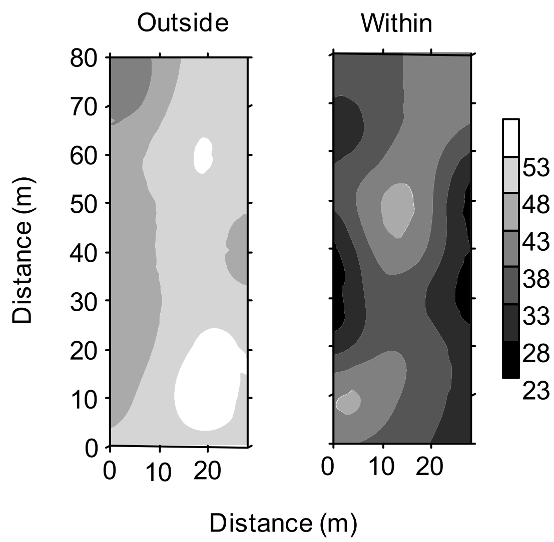
Introduction The integrated crop-livestock-forest system (CLFS) can enhance the production of soybean, meat and wood in regions characterized by sandy soils and warm climate as the Northwestern region of Paraná State, Brazil. The tree component in CLFS can provide water conservation, carbon sequestration, wood production, and improved animal welfare. On the other hand, it is necessary to evaluate the tree component effects on annual crops performance. This study aimed to evaluate the yield of soybean within and outside eucalyptus rows.

Material and Methods
The experiment was established in the municipality of Santo Inacio, (latitude 22°45'56" S, longitude 51°50'30" W and altitude 386 m). The soil was classified as Typic Haplustox according to USDA Soil Classification System. The eucalyptus specie used was *Corymbia maculata*, planted in single rows spaced 28 m, with a spacing of 4.2 m between trees in a row. In 2014/15 growing season – when eucalyptus had five years old - the soybean was sown in November using a row spacing of 0.5 m and 250,000 plants ha^{-1}. Soybean yield was assessed in 64 samples of 3 m^2 collected within and outside tree rows. The soybean yields were subjected to geostatistical analysis.

Results and Conclusion
Fig. 1. Maps of soybean yield (bags of 60 kg ha^{-1}) from areas within and outside the tree rows in an integrated crop-livestock-forest farming system. Santo Inácio, PR, Brazil



In the 5th growing season after eucalyptus establishment, the soybean yield losses caused by the trees were 27.0% on average, being more intense near the trees rows (Fig. 1). None of the positions between eucalyptus rows presented higher soybean yield when compared with the non-forested area. This result demonstrates that the eucalyptus plants induce high soybean yield loss, mainly due to high competition for water, light and nutrients.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Henrique Debiasi

Yield of soybean in integrated crop-livestock-forest system

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3rd International Symposium on Integrated Crop-Livestock Systems

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Carbon Neutral Brazilian Beef: a sustainable concept for beef production

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Introduction

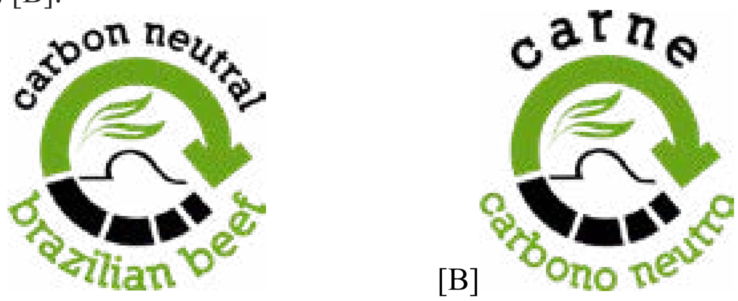
Currently the livestock systems in Brazil are under pressure to attend demands for beef. Environmental compliance in the production process is strongly requested. In this context, integrated farming systems are enabling diversified production, with more efficient use of resources and less environmental impacts, besides considering the mitigation of greenhouse gases (GHG) emissions in beef production. The objective of this paper is to introduce a brand concept for sustainable beef production.

Material and Methods

Technological concept: Carbon Neutral Brazilian Beef (CNBeef) is a brand concept which aims to certify meat production having their GHG emissions volumes neutralized within the production system. The presence of trees is required, as on integrated silvopastoral systems (livestock-forest, ILF) or agrosilvopastoral (crop-livestock-forest, ICLF), through established processes parametrized and audited by regulations and representatives from the value chain, along with technical support from Embrapa. *Requirements of Carbon Neutral Brazilian Beef*: (1) adoption of ILF and ICLF systems based on the "Low Carbon Agriculture" National Plan (ABC Plan) and the use of Embrapa guidelines; (2) assessment of the farm production system baseline GHG emissions based on data from the IPCC (2007) and PECUS Network (www.cppse.embrapa.br/redepecus); (3) carbon content estimates for the forest component according to Embrapa recommendations; (4) calculations for GHG neutralization based on PECUS Network; (5) concession of use for the brand concept to partners legally authorized by Embrapa and (6) systems audited by independent auditors linked to companies accredited for public or private agencies.

Results and Conclusions

Fig.1. Carbon Neutral Brazilian Beef seal in English (CNBeef) [A], and in Portuguese (Carne Carbono Neutro, CCN) [B].



[A] [B]

The brand concept CNBeef/CCN was developed by Embrapa and it is registered with the National Institute of Industrial Property (INPI) for services and products under the protocols 907078982, 907079156 and 907079270, with versions in Portuguese and English (Fig. 1). It is expected this brand concept to become an important tool to support sustainable beef production systems in Brazil.

Acknowledgements

Confederation of Agriculture and Livestock of Brazil (CNA), Embrapa, Grupo Mutum.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Roberto Giolo Almeida

Carbon neutral Brazilian Beef: a sustainable concept for beef production

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Implementing a Technological Reference Unit (TRU) of integrated Crop-Livestock-Forrest system (iCLF) as a model for socioeconomic and environmental adjustment of rural establishments.

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Introduction

The integrated management of rural establishments is an imperative tool in the reconciliation of economic effectiveness and efficiency with social and environmental parameters. In this presentation, we investigate the impacts of implementing integrated Crop-Livestock-Forest systems (iCLF) on the protagonist role of farmers as managers of rural areas.

Material and Methods

BioAtlântica Institute (IBIO), in partnership with *Embrapa Gado de Leite* and the State Forest Institute (IEF-MG), coordinates the implementation of a technological reference unit (TRU) of an iCLF system in a family production unit (FPU). The receiving FPU has 22.13 ha, with dairy farming as the main source of income. It is located in the Ribeirão do Boi watershed, within the Rio Doce basin, and the municipality of Caratinga - MG. The UPF's performance was evaluated through Agro-ecosystem Sustainability Indicators (ASI) (Ferreira et al, 2012).

Results and Conclusions

The calculated ASI for the selected FPU was 0.51 in October 2014, below the suggested sustainability threshold of 0.7. This result suggested that the FPU displayed inadequate conditions for sustainability, which led to the adoption of better productive and environmental practices by the owners, with the support of partner institutions. The model sought an increase in forest cover integrated with a change in the management and design of the unit's agro-ecosystems. In November and December 2014, 3.5 ha were allocated for the implementation of iCLF, 0.71 ha of riparian forest were fenced and planted with native species and a fragment of 7.9 ha of native forest was fenced to reduce grazing impact and induce natural regeneration. These practices intend to improve the property's economic, social and environmental performance, bringing the sustainability index up to 0.53 in the first year. The *Ribeirão do Boi* watershed has 35 thousand hectares of which 35.8% are covered by Atlantic Forest fragments and 35.3% by pastures in similar conditions to those found in this reference FPU, thus below an ideal sustainability parameter. This suggests a great potential for replication of iCLF systems in the basin.

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To our supporting teams at Embrapa Gado de Leite, IBIO and IEF; to Mr. Sebastião Rocha, Mrs. Neusa de Fátima and his sons and to all partners of Ribeirão do Boi's Sustainable Land Use Project.

Thomás Lopes Ferreira

Implementation of TRU of ICLF as means of socioeconomic and environmental suitability of rural establishments

AP4Z

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Sustainability indicators in integrated coconut-dairy production

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Introduction Integrated production is assumed to favor agricultural sustainability, whatever its conformation. A peculiar example of livestock-tree integration has been constructed in a dairy-coconut farm, which through smart management has been obtaining productivities among the highest registered, for both products simultaneously. In order to check the advantages of this integrated system beyond the economic dimension alone, an integrated sustainability assessment was carried out, under a project aimed at fostering ecological intensification in fruit production in Northeastern Brazil.

Material and Methods This illustrative case study was carried out at *Grangeiro Farm* (Ceará State), a 207 ha establishment where 100 ha of irrigated coconut orchards are combined with approximately 07 ha of Tifton pastures to feed a herd of ~60 Holstein dairy cows. Heifers and dry animals share the understory of the orchards for feeding, while all organic residues are stabilized and applied as fertigation. A field survey was carried out to analyze the performance of the farm with the set of 62 multi-attribute indicators included in the 'System for weighted environmental impact assessment of rural activities' (APOIA-NovoRural, Rodrigues et al., 2010).

Results and Conclusions Apart from soils characterized by very low bases saturation, implying a lower performance index, all sustainability dimensions studied resulted in performances well above the conformity level modeled in the indicators system (0.7 in a 0-1 utility scale, Fig 1). Besides observing of all aspects of the national forest code, and warranting excellent conservation status for natural habitats and other landscape ecology criteria, the establishment maintains excellent water quality, attesting a good status for the environmental quality dimension. Also, all indicators in the socio-cultural and the economic values dimensions resulted positive, confirming an excellent business position.

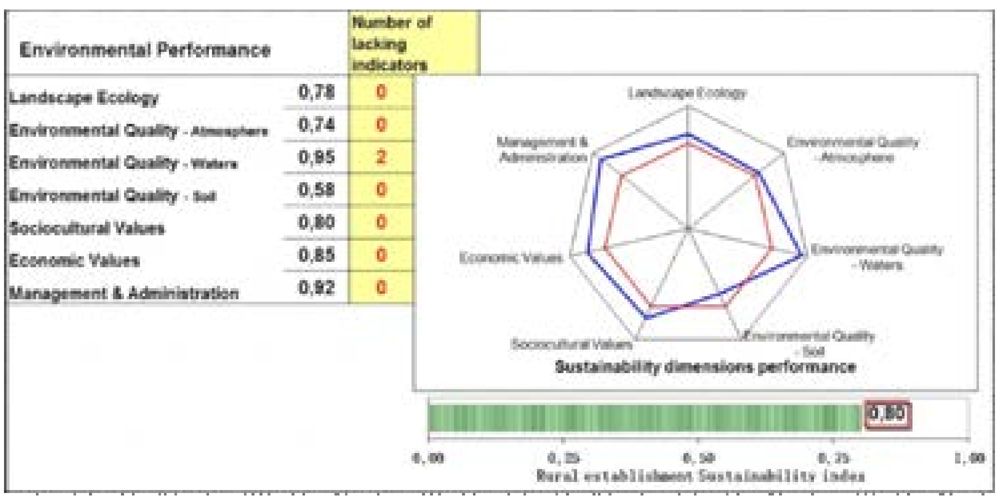

Fig. 1. Multi-attribute environmental performance indices observed in the coconut-dairy production system

An explanation for this success is shown in the good situation of the Management and administration dimension, a confirmation of the valuable decision of integrating tree-livestock for both productive and environmental performances, a gain for the sustainability of the farm.

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Geraldo Stachetti Rodrigues

Sustainability indicators in integrated coconut-dairy production

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Air temperature variation in an agroforestry system

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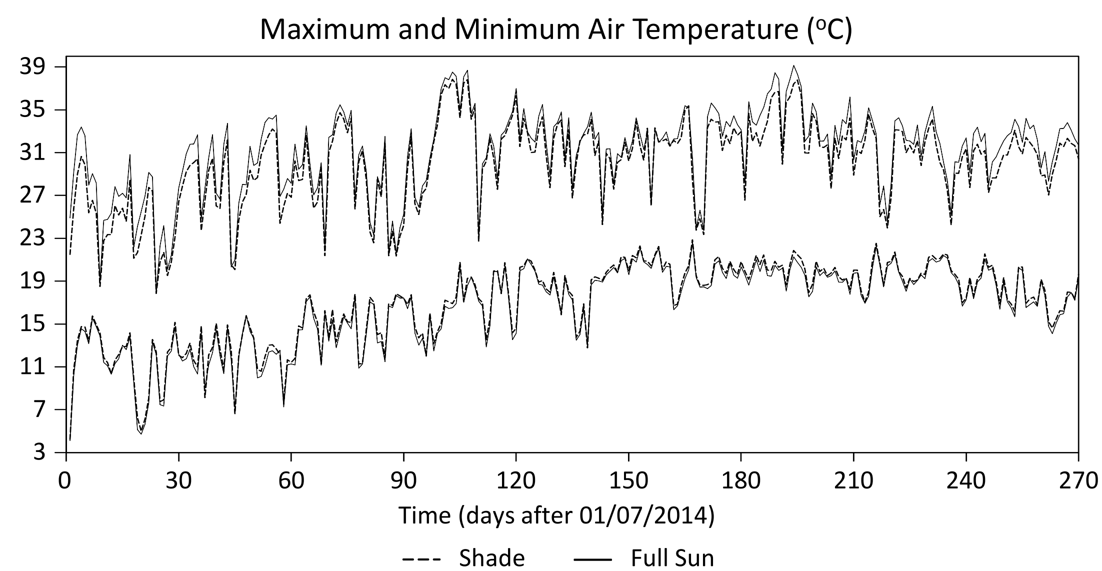
Introduction
There is little information on air temperature in agroforestry systems compared to absence of trees. The temperature can affect plant growth and development, soil attributes and the animal welfare (Colambari et al., 2010). In the present work, we report the temperature fluctuation between rows of *Eucalyptus grandis* compared to the temperature in absence of trees.

Material and Methods
The field work was carried out in Londrina, Paraná State, southern Brazil (23º48'S; 50º98'W; altitude 500 m) during the 2014/2015 soybean cropping season, from July and March. The daily maximum and minimum air temperature were measured in between single rows of five years old *E. grandis*, spaced 20 m (shade) and compared with air temperatures in absence of trees (full sun).

Results and Conclusion
The largest differences were found between the extreme maximum air temperatures. In the absence of trees the average of extreme maximum air temperature was 1.3 ºC hotter than in between tree ranks (Fig 1.). The maximum air temperatures were recorded in October, 2014 and in January, 2015. The extreme minimum temperatures were less affected by the presence of the ranks of trees. The average of the extreme minimum air temperatures in absence of trees was 0.3 ºC cooler than in between tree ranks (Fig. 1). Our results indicate that the presence of trees alleviates temperature effects in agroforestry systems.

Fig. 1. Maximum and minimum air temperatures between single rows of *Eucalyptus grandis* (shade) and in absence of trees (full sun). Londrina, PR, Brazil



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Soil humidity variation in an agroforestry system

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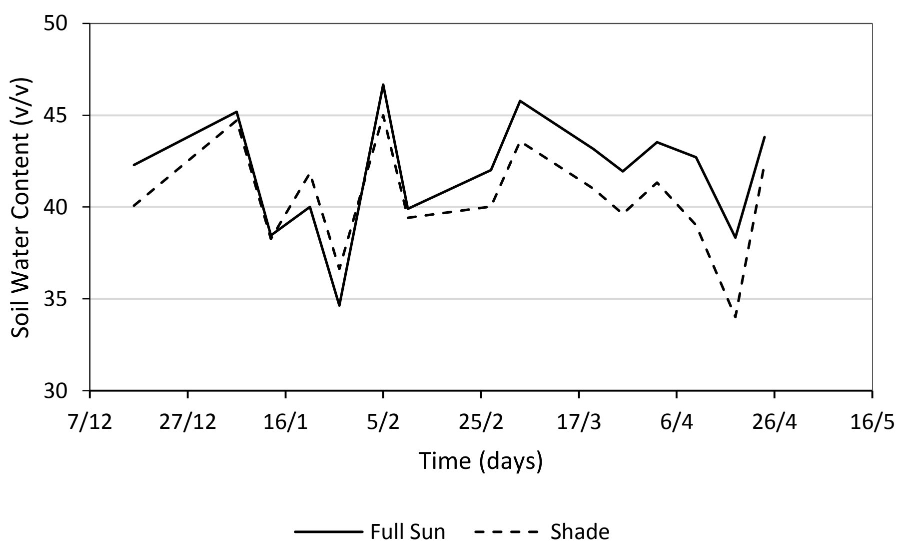
Introduction
Information on the soil water content in agroforestry system in relation to absence of trees is scarce. Soil water content can affect plant growth and soil behavior interfering with yield potential. In this study, we report fluctuating soil water content between *Eucalyptus grandis* ranks compared with the water content in absence of trees.

Material and Methods
The field work was carried out in Londrina, Paraná State, southern Brazil (23º48'S; 50º98'W; altitude 500 m) during the 2014/2015 soybean cropping season, from December to April. During that period volumetric water content in the 0.2 m soil layer was recorded weekly in the soybean crop growing between single rows of five years old *E. grandis*, spaced 20 m (shade), and compared with the soil water content of soybean growing in the absence of trees (full sun).

Results and Conclusion
On the average of the entire assessment period the soil water content in absence of trees was 43 mm higher than in the presence of trees (Fig. 1).

Fig. 1. Volumetric soil water content in soybean growing between single rows of *Eucalyptus grandis* (shade) and in the absence of trees (full sun). Londrina, PR, Brazil.



The data suggest that during the soybean cropping season, in the integrated crop-livestock-forest system, the presence of trees poses a higher water demand.

Impact of integration on nutrient and water-use efficiency

Julio Cezar Franchini

Soil humidity variation in an agroforestry system

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Spatial and temporal variation of near surface soil moisture and soil temperature in integrated crop-livestock system

Leandro BORTOLON[1]*, Alan O. LIMA[2], Elisandra S. O. BORTOLON[1], Pedro H. F. ROCHA[2], William S. S. CONCEIÇÃO[2], Jéssica P. SOUZA[2], Rodrigo E. M. ALMEIDA[1], Francelino P. CAMARGO[1]
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Introduction Soil moisture and soil temperature acerbates and important role to soil function that affects seed germination, soil gases dynamics, soil nutrient dynamics, root development, and plant development. Soil management affects directly spatial variation of soil properties mainly in systems with employ animals in the production systems, and the variability might be higher in near soil surface. Spatial variations of soil moisture and soil temperature due to soil management are well known; however, temporal and spatial variations at near soil surface in integrated crop-livestock systems is not well studied and there is a gap of information that must filled out to improve the understanding of the impact of soil and crop management on soil moisture and soil temperature over time. The objective of this study were to evaluate the spatial and temporal distribution of near surface soil moisture and soil temperature over a growing season in soybean/corn and grass under integrated crop-livestock systems.

Material and Methods

Transects were established in January 2015 in two fields under integrated crop-livestock systems in Pedro Afonso, TO, Brazil since 2006. In field one, transect was established when soybean was at R1 stage (DOY 23). In the field two, transect was established in grass (*Urochloa* Syn. *Brachiaria*) right after animals were removed to another field (DOY 23). In field two, animals returned every 28 days and grazed for 3 days, and then animals were relocated to another part of the field. Positions of the sampling points were located along transects. Sampling points were positioned every 5 m for a total distance of 100 m along the slope. Soil moisture and soil temperature were sampled with POGO Hydra Probe II sensor (Stevens Water, Portland, OR). Data were collected at the same time in both fields from 08:00 to 10:00 AM. At each sampling point, soil samples were taken at depth of 0-5 and 5-10 cm and analyzed for pH, clay, silt, and sand content, soil organic carbon and soil bulk density. Data of soil moisture and soil temperature were analyzed considering different dates using regression analysis, correlation and T-test.

Results and Conclusions

Near soil temperature and soil moisture vary over time. The grazing cycles and soybean harvest affected the amount of soil moisture and soil temperature. Near surface soil temperature increased right after animals were removed, and increased during the corn planting. The reason of increased temperature in field one was probably due to the reduction in the amount of residue in the soil surface after soybean harvest and corn planting. In the field two the same tendency was observed that soil temperature increased after forage consumed by animals. Both soil temperature and soil moisture changed spatially; however, soil moisture showed more spatial variation compared to soil temperature

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Acknowledgements

We are grateful for efforts of Fazenda Brejinho to give us access to the fields. Trade names and company names are included for the benefit of the reader and do not imply any endorsement or preferential treatment of the product by the authors or the EMBRAPA.

Leandro Bortolon

Spatial and temporal variation of near surface soil moisture and soil temperature in integrated crop-livestock system

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Relative water content in two grass cultivars in crop-livestock system in the State of Tocantins, Brazil.

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Introduction

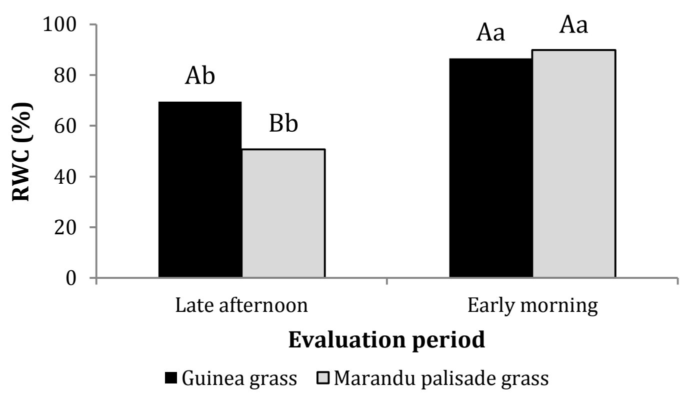
Difficulties in obtaining forage or straw to areas under no-tillage system are related mainly to the low forage production in the off season and the accelerated decomposition of the plant residues. In this presentation, we report the results of two grasses on Integrated Crop-Livestock System in the Tocantins Cerrado.

Material and Methods

The field experiment was installed in an area of native vegetation (11º43'S and 49º04'W, 280 m) at Federal University of Tocantins. Treatments included cut pastures *Brachiaria brizantha* (marandu palisade grass) and *Panicum maximum* (guinea grass) in successive legume/grass sward, in two evaluation periods, in early morning and late afternoon. Leaves samples were taken to 20 tillers per experimental unit and the relative water content of leaves were calculated based in mass of leaves adapted from Barrs and Weatherley (1962).

Results and Conclusions

Fig. 1. Relative Water Content (RWC) in two grass cultivars in successive legume/grass sward in two evaluation periods.



[Aa] Means followed by the same letters, uppercase in evaluation period and lowercase in cultivars, are not different ($p > 0.05$).

Owing to the lower water loss of guinea grass compared to marandu palisade grass (RWC= 16% and 40%) and higher moisture in leaves of guinea grass than marandu palisade grass (RWC= 70% and 51%), this cultivar may be more tolerant to water stress presented in the dry season.

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Acknowledgements

To Embrapa, UFT and CNPq who support the experiment, financially and technically.

Pedro Henrique Alcântara

Relative water content in two grass cultivars in crop-livestock system in the state of Tocantins, Brazil

ANXS

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How much of nitrogen from fertilizer is absorbed by palisadegrass when intercropped with corn?

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Introduction Intercropping corn (C) and palisadegrass (P) is used in Crop-livestock integration system (CLI). In this technique the P. is cropped together with C. without affecting C. yield. After C. harvest the P. grows in order to form a pasture. Studies with nitrogen use efficiency in C. intercropped with P. are scarce, and it is unknown how much of nitrogen (N) from fertilizer applied is uptake by the P. And if is necessary increase N rate in this production system. The study evaluates the influence of P. in the use of N fertilizer, according to forms of implantation of P. intercropped with C. in Brazil.

Material and Methods

The field experiment was installed in Piracicaba-SP. Treatments were: P. broadcasted before sowing C. (P. before); P. sowed in furrow between C. rows (P. row); P. seeds mixed with fertilizer at C. sowing (P. fertilizer); P. seeds broadcasted after corn sowing (P. broadcast after); P. seeds sowed in furrow at center of C. rows, after C. sowing (P. furrow after). N from fertilizer in P. was evaluated with labeled fertilizer (^{15}N-urea) with amounts of ^{15}N in aboveground P at the C. harvest. N rate applied in C. intercropped with P. was 80 kg ha^{-1}.

Results and Conclusions

N from fertilizer absorbed by palisadegrass was only 4% or 3.1 kg ha^{-1} of 80 kg ha^{-1} applied as urea in P. before, P. row, P. fertilizer and P. furrow after. For P. broadcast after ^{15}N recovery was 0.1% or 0.1 kg ha^{-1} of N-fertilizer.

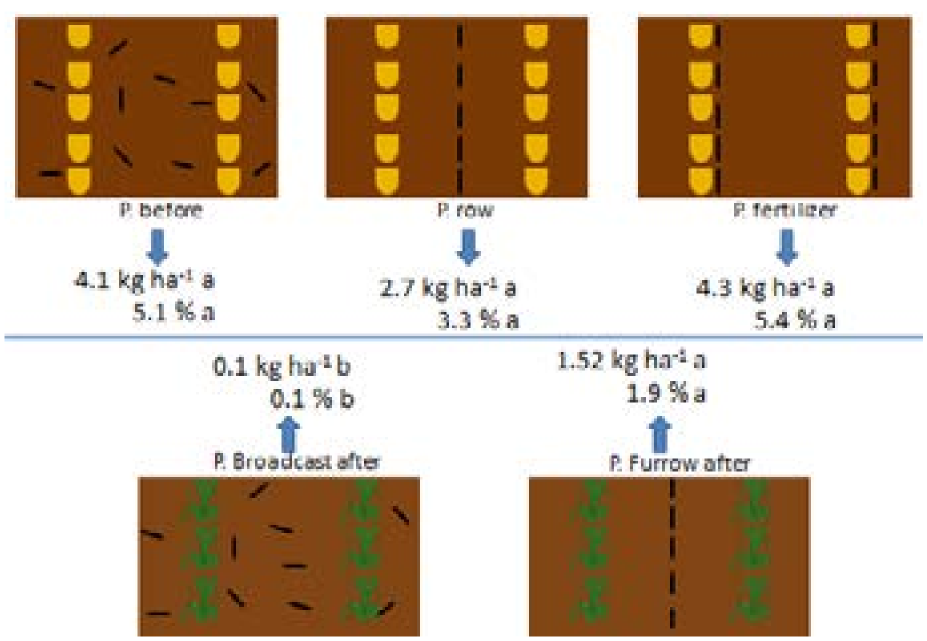

Figura.1- N from fertilizer recovered by palisadegrass

The palisadegrass in any form of implantation does not affect the N uptake by corn. It is not necessary increase nitrogen rate on corn intercropped with palisadegrass, because palisadegrass absorb at most 4.3 kg ha^{-1} or 5.4% of N-fertilizer.

Rodrigo Estevam Munhoz Almeida

How much of nitrogen from fertilizer is absorbed by palisadegrass when intercropped with corn?

AKGA

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world congress on integrated crop-livestock-forest systems

Nitrous oxide emissions from UK grasslands - measurements and mitigation

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Introduction. Grasslands are the most important source of direct nitrous oxide (N_2O) emissions from UK agriculture. A number of factors contribute to emissions, including the prevalence of grasslands in areas of higher rainfall leading to increased soil wetness and water filled pore space, higher nitrogen fertiliser, manure and urine inputs, and higher levels of soil organic carbon. However, there is considerable uncertainty in the effects of management and climate on the magnitude of emissions. There is also a debate about whether improved measurement of emissions and emission factors would help identify regional emission factors within an IPCC Tier 2 reporting framework. The study investigated the effect of varying fertiliser nitrogen (N) form and rates, timing of application, and the use of nitrification inhibitors on N_2O emissions in an intensive year long experimental programme.

Methods. Experiments took place in SW Scotland, Wales, SW England and N. Ireland between March 2011 and March 2013. Over a 1-year period for each experiment, direct N_2O emissions from different forms of inorganic N fertiliser were measured using static chambers. Treatments consisted of a control (0 kg N ha^{-1}), AN/CAN application rates of 80, 160, 240, 320, and 400 kg N ha^{-1} (all of which were split into four applications) an application of 320 kg N ha^{-1} split into 6 applications and a urea application rate of 320 kg N ha^{-1} in 4 applications. To study N_2O mitigation, the nitrification inhibitor dicyandiamide (DCD, at a rate of 10 kg ha^{-1}), was applied as 320 kg ha^{-1} AN/CAN with DCD, 320 kg ha^{-1} urea with DCD and in DCD only treatments. Measurements were taken regularly throughout the experimental period following a standard joint experimental protocol.

Results and Conclusions. Both site and treatment differences in cumulative annual N_2O emissions were demonstrated. There was also a general increase in emissions associated with increasing inputs of N at all sites, with the highest annual emissions (12.5 kg N_2O-N ha^{-1}), observed from the English site. At the two sites with lowest emissions (N Ireland and Wales) there was a linear relationship between N input and annual emissions. However, at the two sites with highest emissions the relationship between N input and emissions was non linear, with a sharp increase in N_2O emissions at higher N application rates. DCD was highly effective in reducing N_2O emissions from urea (89% $P<0.01$ in N Ireland) but did not significantly reduce N_2O emissions from AN/CAN. Splitting fertiliser applications into a larger number of smaller applications had no significant impact on reducing cumulative emissions. Grass yields responded strongly to increases in fertiliser N application at rates below 320 kg N ha^{-1}, but above this level responses were not significant. As a consequence, yield-scaled emissions of N_2O increased at the highest rates of fertiliser N application. The N_2O emission factors for most treatments at the Welsh, Scottish and N Irish sites were generally at or below the IPCC default emission factor of 1%. Higher emission factors (up to 2.9%) were observed at the English site and some treatments at the Scottish site. This study highlights the importance of both site and management in controlling emissions of N_2O from UK grasslands.

Bob Rees

Nitrous oxide emissions from UK grasslands - measurements and mitigation

AN6G

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Landscape stratification approach in agroecosystem studies

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Introduction The landscapes have several spatial and temporal scales (Huggett 1995), but in the agroecosystems context the climate, rocks and relief are structural factors, and the soils and biotic are dynamic factors. Agroecosystems have properties of natural systems and technologies applied in agricultural production processes (Mattson et al. 1997). This research presents a landscape stratification approach applied to agroecosystems studies.

Material and Methods The study area was the Cerrado biome characterized by ecoregions defining plateaus and depressions developed on high parent material diversity and long term tropical prominent seasonality climate. We have integrated public database for landscape stratification: Climate intensity (Embrapa); Weathering index of parent material (Geobank CPRM); and Relief (SRTM-90). The new approach has combined these datasets with the concept of Earth spheres applied to agroecosystems.

Results and Conclusions In the landscape stratification approach the Geomorphic represents the structural factors comprising the Atmosphere, Hydrosphere and Lithosphere in broader spatial and temporal scales (Tab. 1).

Tab. 1 – Landscape hierarchy synthesized by Spherical relations connecting environmental factors and landscape units with spatial and temporal scales.

Environmental Factor	Landscape Unit	Spatial scale (km^2)	Temporal scale (years)	Spherical relations* (∩)
Geomorphic	*Structural Provinces*	$> 10^8$	10^6 to 10^9	L, A, H
	Morphoclimatic Domains	10^6 to 10^8		LA, LH, AH, LAH
Geomorphic/ Biomorphic	*Biomes*	10^5 to 10^6	10^4 to 10^6	
Biomorphic	*Ecoregions*	10^4 to 10^5		B, AB, HB, LB, LAB, HAB, LHB, LAHB
	Hydrographic Basins	10^{-1} to 10^8		
Pedomorphic	*Catenas*	10^{-1} to 10^2	10^{-4} to 10^4	
Anthropomorphic	*Mesoregions*	10^3 to 10^5	10^{-4} to 10^3	All
	Microregions	10^2 to 10^5		
	Municipalities	10^1 to 10^5		

**Keys*: L: Lithosphere; A: Atmosphere; H: Hydrosphere; B: Biosphere; LA: Lithosphere-Atmosphere, LH: Lithosphere-Hydrosphere; LB: Lithosphere-Biosphere; AH: Atmosphere-Hydrosphere (climate); LAH: Lithosphere-Atmosphere-Hydrosphere (relief); LAB: Lithosphere-Atmosphere-Biosphere; HAB: Hydrosphere-Atmosphere-Biosphere; LHB: Lithosphere-Hydrosphere-Biosphere; LAHB: Lithosphere-Atmosphere-Hydrosphere-Biosphere (Pedosphere).

The Relief (LAH) emerges from the structural factors and plays important role in environmental studies as multiscale integrator. The Biosphere interactions have been expressed landscape functional domains associated to lower scales environmental factors. From the present approach, the Relief of the Cerrado has carved six plateaus suitable to high yield agriculture that are already occupied. The agroecosystems sustainability should consider the ecological intensification (Mattson et al 1997) based on landscape systemic view and promotion of integrated production systems.

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Acknowledgements
To Embrapa (Bioma Cerrado Project) and University of Brasília.

Eder de Souza Martins

Landscape stratification approach in agroecosystem studies

APM2

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Nitrous oxide fluxes in an integrated crop-livestock-forest system in Sinop-MT

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Introduction The objective of this study was to evaluate the mitigation potential of crop-livestock-forest integration system (ICLF) or monoculture forest, farming and grazing, check the seasonal differences in emissions between them and the effect of management operations of cultures on N2O fluxes.

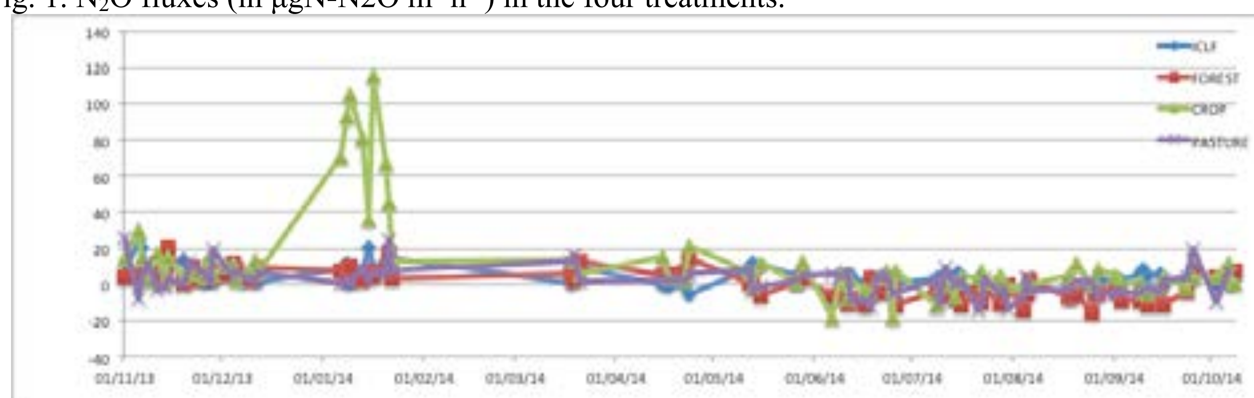
Material and Methods

The study was conducted at Sinop-MT (Embrapa Agrosilvopastoral) and consisted of monoculture forest (F) with the hybrid Eucalyptus urograndhis (H13), farming (L) with soy crop in and corn with *Brachiaria brizantha* cv. Marandu in the second crop, pasture (P) with *Brachiaria brizantha* cv. Marcandu the system of ICLF with triple rows of Eucalyptus hybrid urograndis (H13) and soy in yield and corn with Brachiaria brizantha cv. Marandu in the off-season. Nitrous oxide samples were taken from November 2013 to October 2014 by the closed static chamber technique and the fluxes were calculated.

Results and Conclusions

The N_2O fluxes are higher in the rainy season than in the dry season. It is recommended to perform daily collections to assess the fluxes in crop management operations. The fluxes of the areas F, L, ICLF have smaller values than L, thus, by integrating the three components in the same area and the influence of the reduction of forest component flows, ICLF system has great potential for mitigating N_2O emissions.

Fig. 1. N_2O fluxes (in µgN-N2O $m^{-2}h^{-1}$) in the four treatments.



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Renato de Aragão Ribeiro Rodrigues

Nitrous oxide fluxes in an integrated crop-livestock-forest system in Sinop - MT

AP64

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Mixed beef and cereal systems – choices of intensity of beef production system and implications for beef and cereal food outputs and emissions

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Introduction There is considerable debate about the challenges of producing food and reducing net greenhouse gas emissions in ruminant livestock systems. Land has potential for production of livestock products, for livestock feed, for direct human food or for alternative non-food products. Land and it's various uses all provide different opportunities for further ecosystem services provision. Land is not uniform in terms of capability and potential uses. Farmers make choices of use according to land type and further integrate use across land types within the farm.

Materials and Methods

To investigate the relationships between choices in use of land of different types and choices of intensity of management a series of simulated UK style upland beef and cereal farming systems and were used to model inputs/outputs and greenhouse gas emissions. A bespoke model for calculating emissions from the animal and its waste products was combined with an existing whole farm carbon calculator (SAC-C Calculator) to calculate land-based nitrous oxide, emissions for machinery use and embedded emissions from main inputs. A farm profile based around a baseline beef system of 100 breeding cows was established with 269 ha. of rangeland of native pastures and 69 ha. of lowland ploughable enclosed filelds, which were available for livestock grazing, fodder conservation or cereal production. Cereal production was directed towards feeding the cattle during winter and for cattle finishing and to providing straw for feeding and bedding. Surplus cereal was sold. Feed protein was imported into farm as maize dark grains, a distillery by-product. Herd sizes and land allocation were optimised by a non-linear program. A series of contrasting farm profiles were created around a series of paired choices; focussing the breeding herd upon rangeland typeland use versus. focussing the breeding herd on improved grassland grazing with low utilisation of rangeland; finishing the cattle rapidly (using intensive cereal diets) in 14 months or more slowly over 24 months using grazing and conserved silage; and use of a hardy hill cattle breed versus a more intensive and efficient cattle genotype.

Results and Conclusions

Each of the system combinations had different proportions of land use and different inputs and different outputs of meat and cereals (combined as human-edible protein) and different net greenhouse gas emissions. The systems were ranked differently depending upon which metric was chosen. The systems differed markedly in terms of total food production with systems using range grassland having the greatest potential producing most human food, but also having highest net emissions per farm. Systems making fullest use of rangeland, though had lowest emissions per kg human protein produced, whilst increasing the speed of finishing cattle for slaughter or using more efficient breed also reduced emissions per kg human protein produced. The rangeland area did not use fertiliser and so the nitrous oxide emissions by the cattle herd was reduced but needed good animal performance to be successful. Combining an extensive system for the breeding component and a more intensive system for the growing component of beef systems provided the best solution for lowest greenhouse gas emissions per kilogram of human food produced.

Tony Waterhouse

Mixed beef and cereal systems – choices of intensity of beef production system and implications for beef and cereal food outputs and emissions

ANW4

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Intensification for sustainable regional development: can the food-energy-water-environment 'nexus' approach deliver at the catchment scale?

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Introduction The context for sustainable agricultural intensification is one of enabling food security while contributing to sustainable economic development and welfare. Such intensification, which occurs at the plot scale, must not jeopardise other regional socioenvironmental demands and processes, and ideally articulate with short and long term goals, restrictions and potentialitities at different scales. Such an ambitious target requires an integrated, multi-level, multi-stakeholder, transectorial and interdisciplinary research approach to support decision and policy making. The food-energy-water-environment 'nexus' approach is considered herein for its potential to do just that, in a framework of sustainable intensification of smallholder family farming. The paper describes an ongoing project involving natural and social scientists, governmental practitioners and managers, policymakers, civil society and rural communities, aimed at developing a conceptual model and provisional operational guidance for participative governance and integrated, collaborative and adaptive management of natural resources at the catchment scale.

Material and Methods

The study has been structured with an interdisciplinary/transdisciplinary research ethos and approach to interconnect and integrate different ways of working, disciplines, sectors of society, and specialised and local knowledge as relevant to investigating the 'nexus' at a catchment-scale. Theory and practice and the overarching contextual themes provided by the 'nexus', sustainable intensification of agriculture and rural poverty reduction are being reviewed to allow the construction of an analysis framework and identify suitable indicators for quantifying key aspects and processes. This involves selected pilot catchments in Brazil and England for exploratory research, to collect primary and secondary data describing their environmental, economic, social, ethnic, political and governance characteristics. At each catchment, this includes interviews with key informants, focus groups, surveys of farmer knowledge, attitudes and practices, and workshops with governmental practitioners, stakeholders and community representatives. The two way transferability of lessons between catchment scale investigation and governance in Brazil and the UK's Catchment-Based Approach (CaBA) will be explored to assist in agri-environment challenges and implementation of the EU Water Framework Directive. Periodical exchanges with other researchers will assist in evaluating project progress and performance in respect to its use of technical, interdisciplinary and participatory approaches. A web tool (www.participationwater.net) aids the operationalisation of collaborative networks and is used for project management and communication among its participants.

Results and Conclusions

The key expected outcome of the partnership project is a conceptual model, including sustainability indicators, for decentralised participative governance and integrated, collaborative and adaptive catchment management aimed at sustainable intensification and economic and social development.

References cited

Acknowledgements

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Multi-scale Methods for Monitoring Mixed Cropping Systems in support of Low Carbon Agriculture Program: No-tillage and Crop Livestock and Forest Integration. GEO-ABC Project

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Introduction Agricultural powers have launched ambitious programs, such as GAP (Good Agricultural Practice) guidelines or the Low Carbon Agriculture Program (Program ABC). Those programs give a special role to multifunctional landscapes in the process to establish a sustainable agriculture.The purpose of this work is to present the Geo-ABC Project, an innovative project aiming at developing methods to monitoring, at local scale, sustainable cropping system (practices), such as: crop-livestock-forest integration and, at regional scale, *cropland sustainable system* (landscape patterns) in order to provide spatial indicators to support the ABC Program.

Material and Methods

A mixed of different methodological approaches will be applied to study how the local variables are scaled-up to the regional scale, and what spatial, temporal and textural indicators derived from coarse-resolution satellite images can be used to represent *cropland system* at landscape level. Crop specific distribution modelling, traditional up-scaling and new methods approaches based on indirect satellite-derived variables (temporal, spectral, spatial indicators) will be applied and tested in study cases at Tocantins state (Matopiba Region) and at crop-livestock-forest integration sites.

Results and Conclusions

The complete set of methodological approach constitutes one of results of this work, establishing methodological protocols to obtain systematic *spatial* indicators, at multi-scale level providing metrics to the ABC Program. At the political context, GeoABc will provide spatial-temporal metrics that can be used as inputs for: the monitoring the ABC Program goals ***(How much?)***; the survey of information about the adoption of the ABC Program ***(Where?)***; the planning of monitoring GHGs within the Sectoral Plan of Climate Change Mitigation and Adaptation ***(Where to go?)***; the processes of political decision-making in the assessment of ABC Program ***(What to do?).*** At the scientific context, those methods will provide inputs for scientific studies: on the dynamics of land use related with the adoption of low carbon agricultural production systems, for assessment of trends and establishment of future scenarios ***(land use dynamics)***; on the dynamics of land use, based on the expansion of low-carbon agriculture production related to the *mitigation of environmental impacts* ***(environmental impacts)***; on the dynamics of land use, based on the expansion of low-carbon agriculture production related to the *mitigation of* the greenhouse effect: (a) carbon stocks in soil and biomass; (b) reduction of GHGS; (c) water balance-*ecosystem services*; (iv) on the dynamics of land use, based on the expansion of low-carbon agriculture production and the relation with *Climate Change* ***(climate change).***

Acknowledgements: CAPES/COFECUB; UERJ/PPG-MA; EMBRAPA; INPE; INPA, UMR TETIS/Cirad-IRSTEA-Univ. AGroParisTech, IRD/UMR Espace-Dev, Maison de la Télédétection.

Margareth Simoes

Multi-scale methods for monitoring mixed cropping systems in support of low carbon agriculture program: no-tillage and crop livestock and forest integration. Geo-ABC Project

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The risk analysis use supporting decision-making process on crop-livestock systems in Tocantins State, Brazil.

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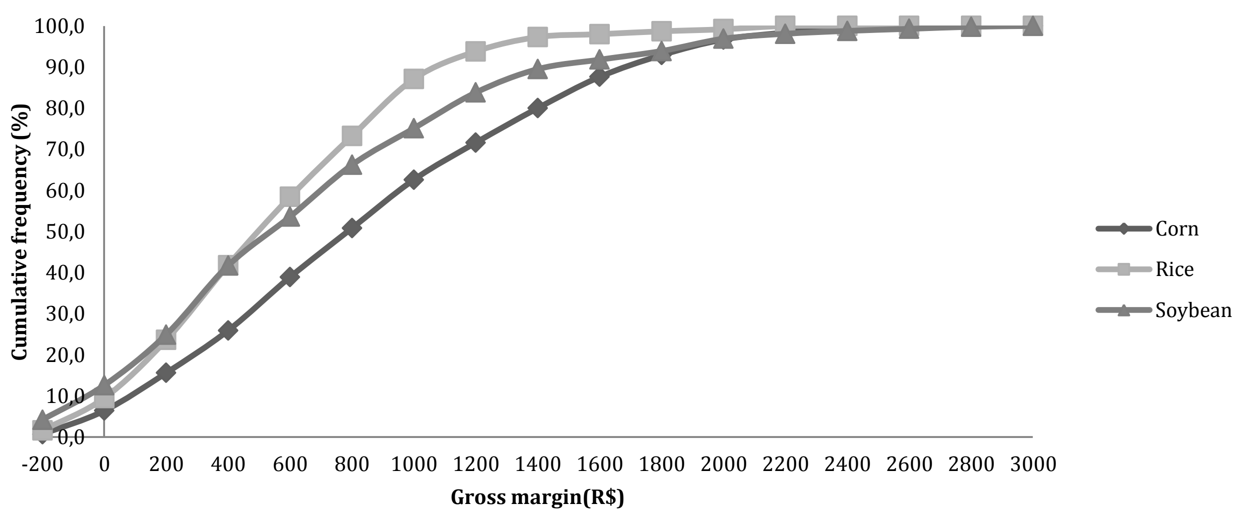
Introduction Decision-making about which crops will compose the crop-livestock system is an extremely important process for success integrated production. This case study aims to present the Monte Carlo (Boyle, 1977) risk analysis as a tool to support this process.

Material and Methods
This case study was based on data from Trigueira Farm, located in Pium, Tocantins (22 L 49.121149W, 10.437507S). The risk analysis was performed for the Tocantins three main grain crops: rice, corn and soybean. The operating cost of each culture was defined from reference technical coefficients and local values. Tocantins market prices for rice, corn and soybean on the from 2009 until 2014 had been adjusted and their frequency determined. The productivity and the selling prices were the variables used in analysis by Monte Carlo method. The each culture risk was determined as the percentage of simulations which the gross margin was negative.

Results and Conclusions
Fig. 1. Gross margin frequency estimated for rice, corn and soybean in Tocantins.



Risk analysis showed that corn, rice and soybean had negative gross margin probability of 6.4, 9.5 and 12.6%, respectively.

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To the extension workers and Trigueira farmers.

Scope for Earth Observation to Provide Activity Data for GHG Accounting

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Introduction
Monitoring of emissions and removals of greenhouse gasses (GHG) from the land based sectors is required under the United Nations Framework Convention on Climate Change. Estimates are produced by combining emissions factors with ‘activity data’ on management activities that impact GHGs. Although standard emissions factors have been derived from international literature, high quality ‘activity data’ is not always available to compliment this. In general ‘activity data’ is compiled via survey techniques. Whilst well designed surveys provide a valuable source of information on agricultural activity, they can be time consuming for farmers to complete, and may be limited in spatial coverage. A previous assessment by the GRA Inventories and Monitoring group has highlighted the availability of such data as a critical issue for developed and developing economies: For countries at an early stage of inventory development, lack of infrastructure and resource can act as a barrier to on the ground survey techniques. For developed countries, particularly those with higher tier inventory accounting systems, the complexity of activity data requirements may make survey approaches prohibitively expensive, or introduce unacceptable levels of burden for farmers to complete. Here we investigate the scope for Earth Observation (EO) to augment or provide an alternative to traditional survey based techniques for activity data.

Material and Methods
We undertook a web based survey of activity data needs across 11 countries participating in the Global Research Alliance Inventories and Monitoring Group to assess activity data needs. We also surveyed existing experiences of the use of Earth Observation to address these needs. Needs were classified under four themes: “”Land Area and Biomass”, “Long Term Land Improvement”, “Short Term Land Management” and “Land Degradation”. We also collated a number of case studies to highlight opportunities for EO to contribute to regional to national scale GHG emissions assessments from the responses.

Results and Conclusions

- A wide range of data requirements were identified, with all respondents highlighting a need for improved activity data. A common theme was that precise data needs were clearly defined, but respondents did not have access to such data.
- In general priority data activities focused on “land area and biomass” and “short term land management” - including data on rotations, stocking density, pasture quality etc.
- Use of EO was reported for all four themes. 30% of respondents were either already using EO data or developing methodologies for the “land area and biomass” theme, whereas uptake was lower (10%) for “short term land management”. Barriers to application in “short term land management” indicated that complexity and accuracy were issues. Geographic coverage was seen as the principal benefit of EO across all of the themes considered.
- Case studies highlight a strong potential for EO to assist with GHG accounting systems. More work is required to overcome perceived barriers and facilitate greater use of EO.
- The GRA may have a role in facilitating this development via method and experience sharing and the development of standardised methodologies and verification techniques.

Practical quantification of greenhouse gas emissions and removals across ICLF systems

Brian McConkey

Scope for earth observation to provide activity data for GHG accounting

ANWP

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Toward a guidance for monitoring carbon stocks in grasslands

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Introduction: Worldwide and in Canada, carbon stocks in permanent grasslands are important. However, due to poor information and difficulties associated with their quantification, grassland C stocks and stock changes are generally not included in national greenhouse gas inventory or environmental indicator programs. To address this gap, the Global Research Alliance on Agricultural Greenhouse Gases (GRA) identified as a priority the development of a guidance to assist designing appropriate measurement strategies for quantifying carbon stocks and stock changes in grasslands. The first step toward this objective is to summarize current state of knowledge on C variability associated with various grassland types and examine the detection ability of general measurement strategies based on experience in scientific literature.

Methodology: We first reviewed worldwide the scientific literature on quantifying C stocks on heterogeneous landscapes. From this basis we are developing a typology of grasslands and documenting their associated C stock variability. Finally, we aim at estimating C stock detection ability of different grassland types and propose appropriate sampling strategies.

Results and Conclusions: Two thousand (2000) citations were identified for evaluation. Of these, 795 have been identified that characterize and/or discuss SOC variability and measurement strategies. Of those, 270 studies from 27 countries specifically deal with measurement of C stocks of grassland. Overall in our database, temperate grasslands were the most widely represented type of grassland and mountain grasslands the least represented. With regards to sampling depth, about half of the studies sampled only the surface soil (less than 30 cm), and about 25% went down to 80 cm or deeper. Most of the publications use classical random sampling strategies whereas about 15% use a geostatistical approach to model or account for structure of heterogeneity. Preliminary examination of the studies also suggests that C stocks in grasslands are generally more heterogeneous in space than cropland likey due to interactions between vegetation community patterns, accumulation of C in perennial vegetation and litter, livestock behaviour and management, and/or variation in underlying soil landscapes. Our next step will be to examine differences in C variability between grassland types and propose appropriate sampling strategies that will be considered in the development of the guidance.

Denis Angers

Toward a guidance for monitoring carbon stocks in grasslands

ANTQ

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GHG fluxes in African agricultural soils: Implications for programming and policy

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Summary
According to FAOSTAT, 41% of land-related greenhouse gases (GHGs) in Africa are related to soils. However, there have only been a total 21 studies assessing soil GHG fluxes on the entire African continent. The majority of these studies were conducted on research farms and based on a small set of management practices in just 12 countries, ie they were not representative of farming practices. Most of these studies also lasted for less than a year and measurements took place at infrequent intervals, which means that emission peaks may have been missed. Based on this limited body of evidence it is fair to say that we know very little about African agricultural GHG fluxes.

This limited set of experiments stands in stark contrast to the huge variance in climates, soils and farming systems in Africa and the urgent and growing need for a better understanding of GHG fluxes from African soils in order to contribute to low emissions development pathways of African economies (ie 'green economies'), climate finance and global climate negotiations. We also need to be better able to set priorities for agricultural research in Africa through spatially explicit information, for instance to quantify the effects of government fertilizer subsidies on N_2O fluxes. Similarly, there is growing recognition that IPCC Tier 1 and 2 emission factors may be consistently overestimating gas fluxes at low fertilizer dosage rates, which is the case for most of African agriculture. The potentially wrong numbers from emission factors are then multiplied with limited information on the extent of different management practices and are likely going to produce erroneous results which in the end lead to bad decisions.

Ultimately, we need more and better data from many different management systems across the African continent. These data gaps could be closed cost effectively through innovative sampling designs and protocols (eg gas pooling), better linkages between emission factors and activity data and improved modeling capacities.

Whereas the costs of large-scale measurement approaches may appear high initially, the investments made in the collection of this information will pay back quickly in the form of more carbon market related funds and more robust national climate and development policies.

Practical quantification of greenhouse gas emissions and removals across ICLF systems

Henry Neufeldt

GHG fluxes in African agricultural soils: implications for programming and policy

ATKK

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Opportunities to work within the Global Research Alliance on Agricultural Greenhouse Gases for improving national quantification of integrated agricultural production systems

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Introduction The Global Research Alliance on Agricultural Greenhouse Gases has expanding list of country members. Currently there are 45 member countries including Brazil and 8 other countries of South America, 15 countries in Europe, 7 in Central&North America, 3 in Africa, 9 in Asia, and 2 in Oceania. The mission of GRA is to provide a framework for voluntary action to increase cooperation and investment in research activities to help reduce the emissions intensity of agricultural production systems and increase their potential for soil carbon sequestration, and improve their efficiency, productivity, resilience and adaptive capacity, thereby contributing in a sustainable way to overall mitigation efforts, while still helping meet food security objectives. Within the GRA, the mission of the Inventory and Monitoring Cross-Cutting Group within the GRA is to foster research and knowledge sharing to improve broad quantification of GHG emissions and removals. All signatories to the United Nations Framework Convention on Climate Change are obligated to prepare annual national inventory of greenhouse gas (GHG) emissions for countries in Annex I or periodic national communications containing a GHG inventory otherwise. Generally, these inventories become an important measure of progress towards more GHG-efficient agricultural production systems. Researchers investigating GHG emissions and removals for integrated agricultural production systems need to understand how to target their work so that improvements in GHG-efficiency. The GRA Inventory and Monitoring Group can facilitate collaboration among countries to improve GHG quantification.

Material and Methods

A stock take of activities to improve inventories of member countries of the GRA was undertaken. The data was analyzed to identify understand what inventory improvements are being done or considered. Opportunities were identified for better activity data and country-specific Tier 2 or Tier 3 emission factors for integrated systems.

Results and Conclusions

Generally there is often poor connection between biophysical scientists doing GHG research and the practitioners who produce national inventories. The researchers need to familiarize themselves with the basic structure of national inventories if they want their research applied. One strategy being done by some countries is to improve the consistency of activity data for different sources such as having livestock data for methane and N_2O emissions match the manure input and pasture utilization for estimating carbon stock change on agricultural land. For new emission factors derived from research to be adopted, it is important that there be a way to quantify the amount of activity and also show the new emission factors reliably estimate emissions and removals for activity categories. For example, for new emissions and removals for agroforestry systems to be included, there needs to be 1) a suitable method for estimating the amount of agroforestry system types and 2) documentation that the new emission factors provide good estimates of GHG emissions and removals for the range of actual system within the amount of each agroforestry type. The GRA Inventory and Monitoring Cross-Cutting Group can facilitate collaboration with scientists and practitioners in other countries with similar production system countries to adopt Tier 2 or Tier 3 GHG inventory methods.

Practical quantification of greenhouse gas emissions and removals across ICLF systems

Jan Verhagen

Opportunities to work within the global research alliance on agricultural greenhouse gases for improving national quantification of integrated agricultural production systems

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Greenhouse Gas Quantification Methods and Tools for Managers of Integrated Production Systems in the U.S.A.

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Introduction

Emerging environmental markets have the potential to incentivize additional conservation on the land. Land managers require tools that will enable them to quickly and easily assess these opportunities across their integrated activities and under various management scenarios. USDA enlisted the help of nearly 100 scientists to develop a set of technical methods for estimating greenhouse gas (GHG) emissions and carbon storage at the local farm, ranch and forest scale. The methods and the scientific basis contained in the report were submitted to four rounds of review by federal and academic experts as well as public comment to ensure rigor and transparency. The report is being used to provide land managers with standardized and vetted GHG assessment tools.

Material and Methods

The objective was to create a standard set of GHG quantification methods for USDA, and then to integrate those methods into a user-friendly tool that will help landowners estimate the GHG impacts of their management decisions. The methods presented in the report address GHG emissions and carbon storage for the integrated farm, ranch and forest operation, and also provide the opportunity to assess individual practices or management decisions. Following the technical guidance of the methods report, the tool will aid: (i) Landowners and other stakeholders in assessing increases and decreases in GHG emissions and carbon storage associated with changes in land management, (ii) USDA in assessing GHG and carbon storage increases and decreases resulting from current and future conservation programs and practices, and (iii) USDA and others in evaluating and improving national and regional GHG inventory efforts. The report must reflect the highest level of scientific rigor and transparency. It is critical that the tool demonstrate accuracy, completeness and ease of use. In the process of developing the report, the authors noted many significant areas where research and/or available data are lacking. Filling these research and data gaps will enhance our ability to provide reliable farm-scale estimates of changes in GHG emissions and carbon sinks.

Results and Conclusions

Crop, grazing land and livestock management influence greenhouse gas emissions. Often emissions can be reduced, or carbon storage increased, by adopting new management or implementing conservation practices. An example of an integrated production system in the U.S.A. is evaluated using the COMET-Farm tool and following the methods in the USDA report. The example clearly shows how COMET-Farm is able to estimate changes in GHG emissions and carbon storage due to altered management. The results help to empower the manager to assess the benefits and engage with environmental market opportunities. The example presented demonstrates the usefulness and user-friendliness of the COMET-Farm tool and highlights the completeness, rigor and transparency of the GHG methods report. Also presented are some of the strategic research and data gaps that need to be addressed to allow for more complete and accurate local-scale GHG inventory.

Practical quantification of greenhouse gas emissions and removals across ICLF systems

Marlen David Eve

Greenhouse gas quantification methods and tools for managers of integrated production systems in the USA

ANVR

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Climate change mitigation potential of Japanese agricultural soils estimated by country-scale simulation of soil carbon stock change and CH_4 and N_2O emissions

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Introduction Better agricultural soil management has big potential to mitigate greenhouse gas emissions. Increasing carbon inputs to soils may enhance soil C sequestration but it may increase other GHG (CH_4 and N_2O) emissions. It is therefore important to evaluate total GWP (Global Warming Potential) for each management options by taking above-mentioned trade-off into account. We have developed country-scale simulation system of GHGs including soil carbon which link mechanistic models to simulate GHGs and country-scale datasets for model inputs such as weather, soil, landuse, agricultural activities to evaluate GWP of agricultural soil management.

Material and Methods
Soil carbon was calculated by the system developed by Yagasaki & Shirato (2014) which was based on the Japanese- modified versions of Rothamsted soil carbon turnover model (RothC: Shirato *et al.*, 2004, 2005). N_2O was calculated from CO_2 emission calculated by the RothC, C/N ratio of soils and the amount of N fertilizer inputs by using empirical equation, which relates N_2O to mineral N in soils, proposed by Mu *et al.* (2008). CH_4 emissions from paddy soils were calculated by emission factors derived from DNDC-Rice model (Fumoto *et al.*, 2008). Fossil fuel consumption by agricultural machineries, plastic films, fertilizers, pesticides etc. were calculated, too.

Results and Conclusions
Among several agricultural management scenario analysis, 10%- increasing- carbon (C) input to soils resulted in higher amount of soil organic carbon (SOC) (i.e. lower CO_2 emission from SOC) but increased both of CH_4 and N_2O. Other mitigation options such as extending mid-season drainage for CH_4 and decreasing N inputs of chemical fertilizer for N_2O, however, could offset these increased GHGs by increasing C inputs to soils. We conclude that increasing C inputs to soil is effective for enhancing soil C sequestration, and accompanying increment of other GHGs (i.e. trade-off) can be offset by other options such as better paddy water or chemical fertilizer managements.

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Acknowledgements
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Yasuhito Shirato

Climate change mitigation potential of japanese agricultural soils estimated by country-scale simulation of soil carbon stock change and CH4 and N2O emissions

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3rd International Symposium on Integrated Crop-Livestock Systems

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Advances in technology transference: the experience of integrated crop-livestock-forestry (ICLF) adoption in Tocantins State.

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Introduction

In 2010 the Brazilian Government established a goal to reduce the emissions of greenhouse gases (GHG) by agriculture from 36.1 up to 38.9% in ten years (2010 -2020). To contribute for reaching part of this purpose in Tocantins State, Embrapa and other research and extension services partners have been conducting a project of technology transference on sustainable agricultural practices, including integrated crop-livestock-forestry (ICLF), since 2012.

Material and Methods

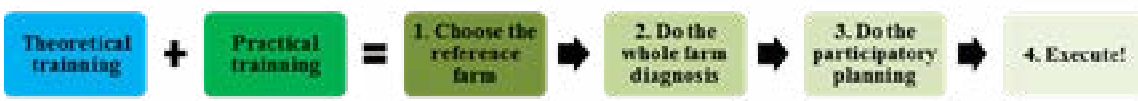

Figure 1. The basic steps proposed by the methodology.

The approach used was based on the combination of Training & Visit (Domit et al., 2007) and Reference Network (Miranda and Doliveira, 2005) sharing the theoretical and practical knowledge with extension workers. It is expected to enhance the adoption of low carbon emission technologies by farmers through the improvement of extension workers' technical knowledge in sustainable agriculture, including ICLF.

Results and Conclusions

The approach has been succeeded in the improvement of the adoption of ICLF by farmers from Tocantins so far. The extension workers who take part of the project have put in practice the knowledge shared during the theoretical part through the establishment of 13 reference farms, encompassing an area of more than 1,400 hectares. The main technology applied was crops for pasture recovering (Barreirão, Santa Fé and São Mateus Systems). The strengthening of extension services and the maintenance of the reference farms network applying ICLF´s technologies can increase the adoption of sustainable agriculture in Tocantins and surrounding areas of Cerrado, especifically in Maranhão, Piauí and Bahia States (MATOPIBA), the Brazilian agricultural frontier.

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Deivison Santos

Advances in technology transference: the experience of integrated crop-livestock-forestry (ICLF) adoption in Tocantins state

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Development and occurrence of dairy cattle damage in *Eucalyptus grandis* x *E. camaldulensis* in silvipastoral system

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Introduction

The silvopastoral systems are essential in the optimization of the animal production and in the diversification of the small farms, including the wood and others products in the productive system of the same area. This work aimed to evaluate the growth of the Eucalyptus hybrid *Grancam* planted in silvopastoral system and the damage levels caused by the dairy cattle to the trees.

Material and Method

In experimental area of the UTFPR Câmpus Dois Vizinhos–PR, in October/2012, were planted clonal seedlings of the hybrid Grancam (*E. grandis x E. camaldulensis*) in one silvopastoral system. The oats grazing started in 12 months of age of the trees (8 animals/ha). Were measured, in February/2015, the trees in 04 double lines (3x2 m), with distance of 23 m each other (considered treatments, because the distance of the place of entrance of the animals in the area: L1: 10 m; L2: 25 m; L3: 50 m; L4: 75 m), about the DBH (diameter at breast height); total height (Ht), occurrence and damage level caused by dairy cattle (low (little or without damages), average (peeling slight) and high (peeling to the wood) e mortality (%).

Results and Discussion

The DBH, Ht, number of trees and low mortality were featured in the L2, not differing of the L4 to DBH and Ht and to the L1 to Ht. In the L3, DBH and Ht were lower, not differing of the L4, because the higher level of damages in this lines, which caused debility in the trees. In the L3 and L4 occurred higher mortality, because the severe ants attack in the initial phase and posterior damage by cattle. Higher levels of cattle damage, as in the case, indicate the necessity of control to the cattle input and/or the protection of the trees lines with fences until the growth is more advanced. Was not significant correlation between the distance of cattle entrance in the area and the level of damage (Pearson (r): -0.15). It is concluded that the elevation of damage level influenced negatively the growth of the trees, in DBH (r: -0.76) and Ht (r: -0.92). The trees with higher damages should be priority to harvest in the next thinning.

Table 1: Development and occurrence of dairy cattle damage in silvopastoral system with Eucalyptus hybrid "Grancam" with 28 months of age. Dois Vizinhos, PR. 2015.

Treatment / Double line	Nº Trees	DBH (cm)	Ht (m)	Mortality (%)	Damage level (%) by dairy cattle		
					High	Medium	Low
L1	47.0	18.3 b*	10.9 a	53 b	70	10	20
L2	100.0	21.4 a	11.2 a	0 a	10	40	50
L3	25.0	18.8 b	10.2 b	75 c	100	0	0
L4	27.0	20.2 ab	10.6 ab	73 c	80	10	10
Average	49.8	19.6	10.7	50	65	15	20

* Averages not follow by the same letter, in the vertical, differ by Tukey test at 5% of error probability.

Enabling conditions for integrated crop and livestock systems in the United States, Brazil, and New Zealand: A comparative analysis of incentives and barriers across three regions.

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Introduction

In this study we examine the institutional environment for sustainable agriculture in the United States, Brazil, and New Zealand. In particular we ask whether or not the overall policy context is enabling or inhibitory of integrated crop and livestock systems (ICLS) and which policy changes are likely to have the most enabling influence on the adoption of ICLS.

Material and Methods

We use the existing literature and expert interviews to construct an accounting matrix that illuminates current tradeoffs between economic and ecological outcomes of five different agricultural practices in each country: 1) specialized corn production with synthetic fertilizers, 2) specialized beef cattle production using pasture only, 3) corn production using liquid manure as fertilizer, 4) beef cattle production using crops and crop byproducts as feed, and 5) a fully integrated crop and beef production system with a rotation of the area under pasture, and crops, but no additional use of manure and crop products on the farm. We then undertake a thorough review of all existing agricultural, environmental, labor, food safety, and energy policies relevant for agricultural management in these three countries and quantify the impact of each of these policies on economic and ecological outcomes associated with the five different agricultural systems. Finally, we assess the quantitative impact of changes from the current policy conditions on the economic and ecological outcomes associated with each system.

Results and Conclusions

[PRELIMINARY!] We find that existing federal policies are more conducive to integrated crop and livestock systems in Brazil and New Zealand than in the United States. Further financial support for the investment costs associated with transitions to integrated systems in the form of low interest loans coupled with insurance on those loans would substantially help farmers transition to integrated systems in these countries, given the absence of other policy barriers. In the United States insurance programs and a lack of water quality regulations are the largest policy barriers associated with integration, since the returns to specialized systems with insurance are higher than the returns of integrated systems. Changes in the insurance programs and water quality regulations would go a long way toward improving the economic competitiveness of integrated systems in the United States.

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Rachael Garrett

Enabling conditions for integrated crop and livestock systems The United States, Brazil, and New Zealand: a comparative analysis of incentives and barriers across three regions

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Integrated production systems revealing antagonistic fungi biodiversity in Cerrado/Amazon ecotone

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Introduction

The antagonism and diversity of fungi have been studied in several environments, including agricultural soils. Nevertheless, information regarding fungi able to control *Fusarium* sp., *Rhizoctonia* sp. and *Sclerotium rolfsii* in cerrado/Amazon ecotone soils is restricted.

Material and Methods

During the rainy and dry season 10 treatments were assessed, including monoculture, integration of Crop/livestock/Forest, fallow and native forest. Classical and molecular tools were used to select and indentify antagonistic fungi species.

Results and Conclusions

The results showed that colony forming units (CFU) were higher at integrated systems in rainy season. Fungal isolates as *Penicillium*, *Talaromyces*, *Eupenicillium*, *Trichoderma*, *Aspergillus*, *Chaetomium*, *Acremonium*, *Curvularia*, *Purpureocillium*, *Bionectria*, *Paecilomyces*, *Plectospharella*, *Clonostachy*, *Mucor*, *Fennellia* and *Metarhizium* were able to control *Rhizoctonia* sp., *Fusarium* sp. and *Sclerotium rolfsii.* This is the first report to describe culturable fungi species from Cerrado/Amazon ecotone able to control pathogens. Furthermore, we suggest that integrated systems can be an strategy for increasing fungal biomass and the rainy and dry season can modulate the density of soil fungi also, mainly in Cerrado/Amazon ecotone.

Acknowledgements

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Anderson Ferreira

Integrated production systems revealing antagonistic fungi biodiversity in Cerrado/ Amazon ecotone

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Microclimate dynamics in simple and integrated production systems

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Introduction
Different arrangements have been deployed in integrated systems aiming higher return than simple systems. The microclimate is among the factors of great importance, suffering changes caused by integration. It is considered as of fundamental understanding to have right decisions in the development of crops. This study relates temperature (T) and relative humidity (RH) measured in different production systems.

Materials and Methods
The study was conducted in an experimental area of Embrapa, located at Ponta Porã, MS, Brazil (22°32'55" S; 55°38'53" W). Eight large plots were evaluated from 20 March to 24 June 2014: corn in no-till system (NT) and in conventional system (CS); eucalyptus forest (5 years old and spaced 2x3 m) (F); crop-livestock integration with pasture of *Brachiaria brizantha* cv. Xaraés (ILP Pasture) and with corn (ILP Corn); crop-livestock-forest integration with spacing between eucalyptus trees of 25 m and intercropping of Xaraés pasture (ILPF Pasture 25m); crop-livestock-forest integration with spacing between eucalyptus trees of 12.5 and 25 m, with intercropping of corn (ILPF Corn 12.5m and ILPF Corn 25m, respectively). One termohigrometer was installed in the center of each plot to measure air T and RH. They were regulated to stay about 50 cm above the interim crop, and on the forest plot it stayed 2 m above the ground. Measurements were taken every 30 minutes. Reference weather data were obtained from a National Institute of Meteorology (INMET) station near to the experimental area.

Results and Conclusions
On systems with corn, in situations of maximum T, ILPF Corn 12.5m and 25m maintained 0.8 and 0.4 °C lower than NT, respectively. When INMET recorded T equal to or higher than 30 °C, ILPF Corn 12.5m showed 1.5 °C lower than ILP Corn. Minimum T were 0.4 °C higher in ILPF Corn 12.5m and 0.2 °C in ILPF Corn 25m, relating them with NT. It was also observed that when the lowest T was recorded in INMET (6.5 °C), only the systems with forestry component did not exceed this T, while all the others were below 6 °C. ILPF Corn 12.5m showed 0.5 °C lower amplitude than ILPF Corn 25m. CS, NT and ILP Corn had close amplitudes with each other. The average of minimum RH was 2.6% higher on ILPF Corn 25m, when compared to ILP Corn. When INMET recorded RH lower than or equal to 45%, ILPF Corn 25m was 2% higher compared to the NT and 3.3% compared to the ILP Corn. ILPF Corn 12.5m showed 2.8% higher RH as compared to NT and 4% higher than ILP Corn. In critical times the difference between ILPF Corn 12.5m and ILP Corn reached 6.6%. In pasture treatments, ILPF Pasture 25m showed average of maximum T 0.6 °C lower than ILP Pasture and similar minimum. When INMET registered daily average of 25 °C, ILP Pasture had average amplitude of 11.9 °C, while ILPF Pasture 25m don't pass from 11.4 °C. In this same consideration, on cold days, with average of 11.3 °C in INMET, ILP Pasture had amplitude of 7.5 °C and ILPF Pasture 25m of 7.2 °C. The average of minimum RH was 1.1% greater in ILPF Pasture 25m, reaching up to 5.7%. All ILPF systems proved to be capable of improving the microclimate over the interim crop as compared to ILP and simple systems.

Acknowledgements
To Embrapa and CNPq for funding.

A free electronic spreadsheet to calculate shade parameters of single trees and tree strips

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Introduction

The tree shade effects on crops, pasture and animals grown in integrated systems has been widely studied. For some crops and livestock there are estimates of tree shade amount which allows optimizing the consortium benefits. Therefore, knowing shade parameters, such as area and orientation, is important for planning the spatial arrangement of components in integrated system areas as for production as for scientific research. In this paper, we present a free electronic spreadsheet to assess tree hade parameters for planning agroforestry implementation.

Material and Methods

The spreadsheet was developed to return the following final results: shade area, shade length, shade width, shade dislocation from the trunk and shade orientation (azimuth). The parameters were estimated from equations proposed by Silva (2006) for trees with cylindrical-shaped canopies. The spreadsheet was developed in LibreOffice Calc 4.3, but saved in .xlsx format for due its compatibility with other spreadsheet programs. For validation, field measurements were taken from 21 single trees and 4 tree strips (with 4 rows of 33 plants each, in 3x3 m spacing), except for azimuth. Data form in loco measurements and from spreadsheet estimations were compared by the paired t-test at the 5% significance level.

Results and Conclusions

Table 1. Comparison between averages of the estimated and measured shade parameters of 21 single trees and 4 tree strips (with 4 rows of 33 plants each, in 3x3 m spacing). Means followed by the same letter in the column do not differ significantly by the paired t-test at the 5% level.

	Single trees				Tree strips (with four rows of trees			
	Length (m)	Width (m)	Dislocation (m)	Area (m²)	Length (m)	Width (m)	Dislocation (m)	Area (m²)
Estimated	7.52a	6.67a	7.26a	44.02a	102.89a	11.10a	5.45a	1040.51a
Measured	6.02b	5.17b	6.82b	37.58a	98.98b	12.60a	5.77a	1135.72a
Difference ± standard error	1.50 ±0.39	1.50 ±0.46	0.44 ±0.14	6.44 ±5.90	3.91 ±0.42	-1.50 ±1.24	-0.32 ±1.95	-95.21 ±112.77

The difference between estimated and measured shade areas for single trees was not significant. Also, no differences were found between measured and calculated shade width, dislocation and area for the tree strips. The spreadsheet tended to overestimate shade length, shade width and shade dislocation from the trunk of individual trees and shade length of tree strips. These differences, however, were relatively small. Thus, it is recommended the use of the spreadsheet for estimation of tree shade parameters, especially shade area. The spreadsheet can be downloaded from: https://www.embrapa.br/documents/1354309/1529241/C%C3%A1lculo+Sombra+V1/56460a8f-fbe9-4a39-a67e-f2854fc59aa4.

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Henrique Nery Cipriani

A free electronic spreadsheet to calculate shade parameters of single trees and tree strips

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Potential use of Lidar (light detection and range) to planning agrosilvopastoral systems in degraded lands in Amazon observing the Brazilian forest low and minimizing carbon emissions

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Introduction: The use of Lidar to biomass and carbon stocks estimative in native and planted forests is well known and has increased in the last decade. Recently, Lidar was used to planning and monitoring forests operations and to estimate volume and biomass in the Antimary State Forest in the western Amazon. The use of this technology allowed the elaboration of high resolution 3D surface and canopy digital terrain models. These models information are essentials not only to forest companies but to the adequate planning of any land use. In this work we propose a methodology to agrosilvopastoral systems (ASPS) implementation through the use of Lidar which by the previous identification of the permanent preservation areas (PPA), forest cover and relief, guarantee the observance of the Brazilian forest low and minimize carbon emissions.
Material and Methods: A 50 ha area of degraded pastures in the Rio Branco municipality was selected to the study. Inside this area an ASPS implementation planning simulation was performed. The methodology followed three phases: i. topographic and drainage description; ii. micro-zoning and iii. ASPS model definition. In the first phase topography and drainage were described through a 3D surface model. In the micro-zoning phase the PPA were defined following the prescriptions of the Brazilian low and the need of PPA restoration verified. Also, a digital survey of the remaining vegetation was performed through the use of a 3D canopy model, determining the forest cover and defining the vegetation to be preserved (e.g. big trees) and to be removed (e.g. weeds and shrubs).
Results and Conclusions: i. the total PPA area was calculate as 11,2 ha and 6.0 ha of this area demand restoration; ii. the area has 4.9 ha covered by trees higher than 10m and to the establishment of the ASPS 2.0 ha of these trees (out of the PPA) were removed; iii. 13.1 ha of secondary vegetation, composed by trees lower than 5m need to be removed to the ASPS implementation (vegetation inside the PPA was preserved) and iv. the final area to the ASPS was 38.9 ha and considering a 20 x 4 m spacing a total of 4860 trees will be planted. The spacing was defined taking in consideration the machinery which will be used to the crops.

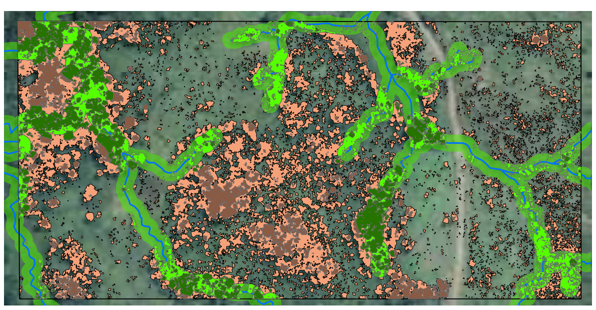

Figure 1. ASPS selected area image presenting: i. permanent preservation areas (striped green areas); ii. remaining above 10m height (dark green) and below 5m (light green) vegetation; iii. to be removed vegetation (light and dark brown areas) and iv. drainage (blue lines)

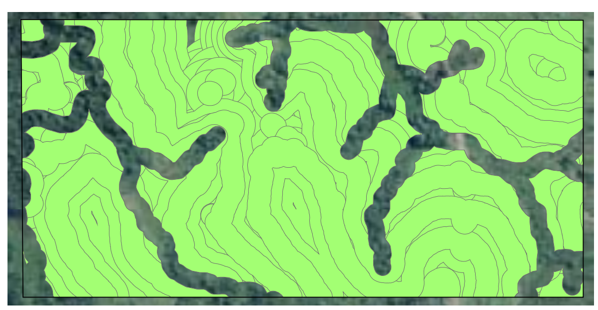

Figure 2. ASPS final area presenting the planting lines according to the defined spacing (20m) and following the area topography.

Resilience of mixed systems to climatic change and the impact of integrated systems on microclimate and biodiversity

Marcus V. N. D'Oliveira

Potential use of LIDAR (Light Detection and Range) to planning agrosilvopastoral systems in degraded lands in Amazon observing the Brazilian forest low andminimizing carbon emissions

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Economic results of the integrated crop-livestock systems implementation in degraded pastures in Pium, TO, Brazil

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Introduction

In Pium, Tocantins state, Brazil, in 2012 Embrapa developed a technology transference project in partnership with the state's rural extension service for the consolidation of low carbon emissions agriculture. The goal was to recover the degraded grasslands of the Trigueira farm (49°1'37.44"W and 10°24'58.84"S) with low cost using a crop-livestock system (ICL).

Material and Methods

After the socioeconomic and environmental assessment on this reference farm, before the crop seasons 2013/2014, extension workers, farmers and the Embrapa team choosed a system named "Barreirão" (Oliveira et al., 1996). This technology was developed to recover/renew degraded pasture in Cerrados's areas. Seeds of the perennial grasses are sowed simultaneously with annual crop, or after its harvest. The chosen crop to precede the new pasture of the grass Brachiaria brizantha, variety BRS Piatã, was the upland rice, variety BRS Sertaneja. According to analysis of soil, the fertility correction was recommended based on Sousa, Djalma M. G. & Lobato, Edson (2004). The rice sowing was in 2012 and of the grass in 2013. The fertilizer used for planting was 5-25-15 and for nitrogen topdressing was urea. All mechanized services were done with own machinery of the farm, except the rice harvest and its drying. Also, every data were registered to figure out the costs of the implemented activities.

Results and Conclusions

Table 1. Calculation of gross margin per hectare on the Farm Trigueira using integrated crop-livestock system in the harvests 2012/2013 and 2013/2014.

Operation / Service	Cost (R$/ha)	Percentage %
Liming (1)	212,375	8,81
Soil preparation (2)	186,52	7,73
Soil Fertility correction (3)	347,01	14,39
Planting (4)	993,22	41,18
Cultivation (5)	284,85	11,81
Harvest (6)	85,00	3,52
Postharvest (7)	214,67	8,90
Rural extensionist's service (8)	25,50	1,06
EFFECTIVE OPERATING COST (1+2+3+4+5+6+7+8)	**R$2.411,63**	**100,00**
GROSS INCOME - Rice sale	**R$2.683,33**	
GROSS MARGIN	**R$271,70**	

The adoption of crop- livestock integration system at the Trigueira farm positively influenced the gross margin of the farmer, paying the grassland reform.

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To Embrapa researchers, Ruraltins extensionists and Trigueira's farmers.

Claudio França Barbosa

Economic results of the integrated crop-livestock systems implementation in degraded pastures in Pium, TO, Brazil

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Trees implantation costs in a silvopastoral system with *Peltophorum dubium* in Southwest region of Parana State

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Introduction

The implantation costs in silvopastoral production systems tend to be more elevated, in comparison with traditional livestock systems, because demand of higher initial investments. Therefore and because the limited initial income in some farmers, usually this activity are not implanted, also for demand of more time to obtainment of gross income. This work aimed to show the implantation costs of the silvopastoral system with native forest specie.

Material and Methods

The implantation of the silvopastoral system occurred in Dois Vizinhos/PR, in 2160 m² of area, with four double lines every 10 m, spaced 2 x 1.5 m in the lines, using 200 seedlings of *Peltophorum dubium* with average height of 1.2 m. Were realized mechanized of tillage (mowing in total area and scarification in the lines) and manuals practices of plantation, with application of hydrogel and fertilization with NPK, according to the soil analysis, and the control of cutting ants. Were considered the following costs components: hour machine of the mechanized operations, according to the tractor model and agricultural implement utilized and the cost of hour machine payed in the region for each operation; manual operations: necessary days to realize the activities of implantation of the system, considering R$ 65.00 to each day, according to the price used in the region at the time study; agricultural inputs: average prices used in the region at time of the study. Were not considered the spending with the acquisition of the machines and equipment's because the mechanization level of the systems vary according with the area and the farmer.

Results and Discussions

The effective total cost to the implantation of the tree component in the silvopastoral system was R$ 19,487.09/ha, equivalent to R$ 32.14/seedling. The agricultural inputs totalizing R$ 13,514.39, representing 69.35% of the effective total cost by hectare. The participation of the manual and mechanized operations in the total cost were of 19.25% e 11.40%, respectively (Figure 1).

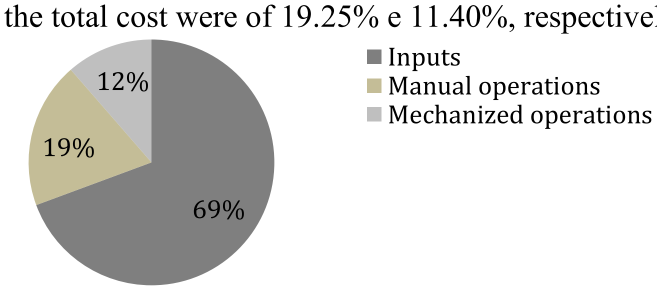

Figure 1 – Percentage distribution of the implantation cost items of the tree component in one silvopastoral system with canafístula. Dois Vizinhos-PR. 2014.

It should be highlighted the higher value considered in the seedlings acquisition, R$ 12,950.00 or 95.8% of the total cost of the agricultural inputs. This fact can be justified by the use of big seedlings, with relative higher price, but with advantages like rusticity and larger speed of shading and, with that, will be possible to input animals in the system relatively early.

Eleandro José Brun

Tree implantation costs in a silvipastoral system with peltophorum dubium in Southwest region of Parana state

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Impact assessment for integrated crop-livestock-forest technology transfer

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Introduction An environmental impact assessment method has been proposed to test and promote integrated crop-livestock-forest (ICLF) strategies adopted in *technology reference units* (TRU), established under the scope of a 'National Technology Transfer Network'. The approach was tried out in a TRU set up in Paragominas in collaboration with Embrapa Eastern Amazon, as a demonstration of the procedure to be adopted in all TRU associated with the Network in Brazil.

Material and Methods The illustrative case study was carried out at a large scale ranch, whose ICLF system was implemented as a response to productive decline (caused by *Urochloa brizantha* cv Marandu death syndrome). The field study surveyed observable changes attributed to ICLF (typically, 20m-apart eucalyptus lines, rows sown to soybean in biannual rotation with pasture), as compared with the former pasture condition. The observable changes were registered in the set of socio-environmental indicators, organized in the multi-criteria impact assessment method (Ambitec-Agro, Rodrigues et al., 2010).

Results Due to its usual intensification effect, as compared with extensive pasture, ICLF caused increases in input use, a negative index that represent a trade-off for environmental performance (Fig. 1). Even then, due to important improvements in environmental quality (all compartments), the integrated index for this dimension resulted positive.

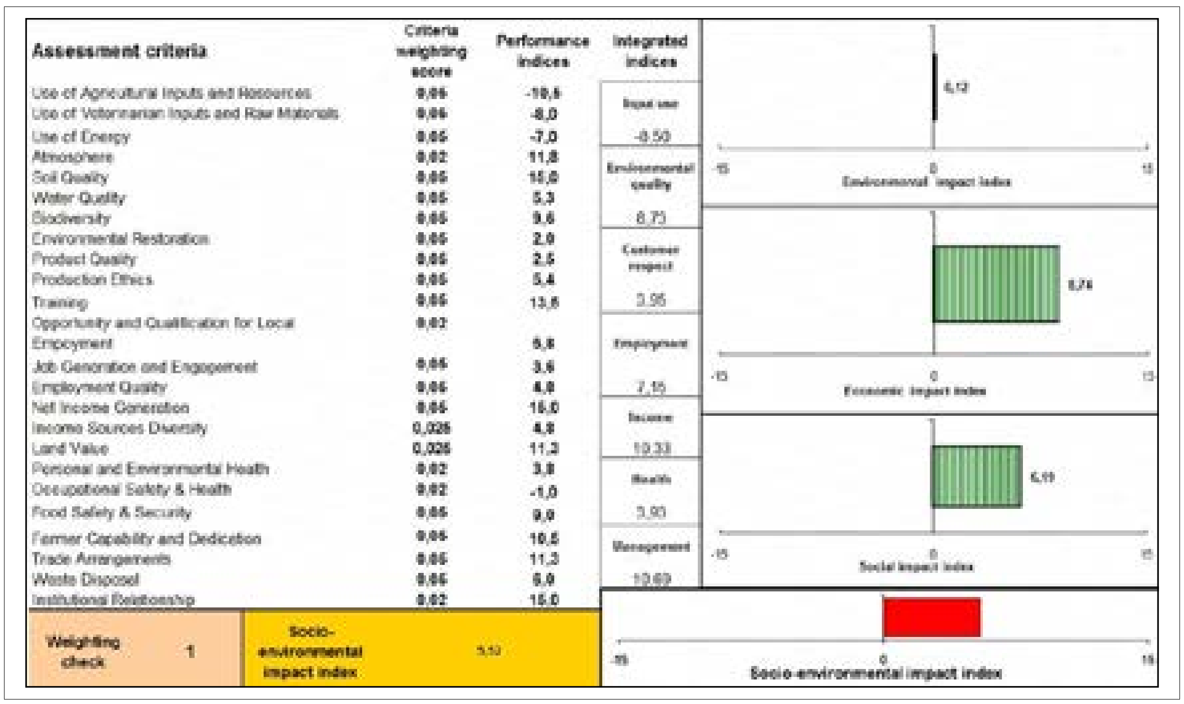

Fig. 1. Multi-criteria performance indices observed in an ICLF system in Paragominas (PA, Brazil).

Positive results were observed also for the economic and the social dimensions of sustainability, attesting to the valuable contributions of ICLF for the general performance of the farm.

Conclusion The replication of this environmental assessment procedure is one of the technology transfer mechanisms adopted by Embrapa and its partners in the National ICLF Network.

Reference cited Rodrigues et al. (2010) JOTMI 5(4):38-56.

Socio-economic benefits and impacts of change to diversified systems

Geraldo Stachetti Rodrigues

Impact assessment for integrated crop-livestock-forest technology transfer

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Evolution and analysis of integrated crop-livesdtock systems on Fazenda Dom Bosco, Cristalina-GO

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Introduction After clearing a light cerrado vegetation in 1974, on a Red-Yellow Latossol, this 3200 ha farm initially pioneered soybeans and cattle, separately. Soybean yields started at about 2200 kg/ha, rising to a current 3450 kg/ha. but winter carrying capacity of the *Brachiaria decumbens* pastures, established after one upland rice crop, dropped from an initial 0.7 AU/ha in winter to an unsustainable 0.4 AU/ha after 8-10 years. Even after converting to *B.brizantha,* this picture changed little.

Material and Methods

In 1998, Eng. Agr. Sebastião Conrado decided to use a crop phase with soybeans and maize planted after pasture, benefitting from its good soil physical properties. He applied all the recent soil fertility recommendations and established a 4-year soybeans, 4-year pasture rotation. In 1999, three new rotations were devised with the objective of improving pasture carrying capacity and maximizing overall profit:

Rotation 1. *Maize with supplemental pivot irrigation undersown with B.ruziziensis/Irrigated Phaseolus Beans - 330 ha plus 470 ha in Rotation 3;*

Rotation 2: *Rainfed Phaseolus Beans /Forage Sorghum /Sorghum for Silage/Pasture – 800 ha;*

Rotation 3: *Rainfed Soya/Millet/Maize/Pasture – 800 ha.*

These systems bought in weaned calves at 120-135kg carcase weight equivalent and sold the stores at 180-195kg carcase weight equivalent to a fattening operation, to which the sorghum for silage was sold. The pasture grass was undersown in the last maize crop in the arable phase and the established pasture divided into 10 ha paddocks. Recently, in order to face the inordinately high weaner price in 2014, all cattle were sold, pastures in rotation with crops were desiccated and planted to crops (2/3 soya and 1/3 maize), lime and gypsum were applied on 400ha of permanent pastures on marginal land, then planted to soya or maize. With favourable weaner prices, pastures will be re-established on improved nutrient status soils. A 20-year financial farm model of the three rotations introduced in 1999 was carried out, using internal rate of return (IRR) and net present value (NPV).

Results and Conclusions

The model indicated IRRs of 15.19%, 9.2% and -4.1% for rotations 1 to 3, compared to >-5% for the without project case. NPVs were respectively : R$1,015,201, R$-123,071, R$-1,694,297 and R$-2,806,222 without project. All the new rotations were better than the old one, but only Rotation 1 was profitable under both IRR and NPV measures at the commodity prices projected. In this model, the irrigated area was 330 ha and the rest of the cropped area was under rotation 3. Land use intensification (LUI) in crops can be conservatively estimated as equal to the yield increase of 57% in soybeans (proxy for all annual crops) from the original 2200 to 3450kg/ha (equal for all rotations), but this is mostly due to genetic improvement and is not included in this analysis. However, comparing the overall stocking rates of 1.93, 1.74, 1.49 with the pre-ILPD stocking rate of 0.93 AU/ha gives the following LUI estimates in per cent 107,53, 87.1 and 60.2 for rotations 1, 2 and 3 respectively.The model indicates the potential for this system to stem Amazon de-forestation by absorbing national cattle herd growth in renovated pastures and empowering government command and control efforts. **Lessons learnt were**: better soil management improves profit and sustainability for both cattle and crops; these systems need to be flexible; zero tillage has been the salvation of the Cerrado; LUI on degraded tropical pastures (ca. 50 million hectares) should be the solution for zero de-forestation.

John Nicholas Landers

Evolution and analysis of integrated crop-livestock systems on Fazenda Dom Bosco, Cristalina-GO

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PISACOOP Program - Promoting Sustainable Agriculture and Rural Development in Southern Brazil through Integrated Crop Livestock Systems

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Introduction

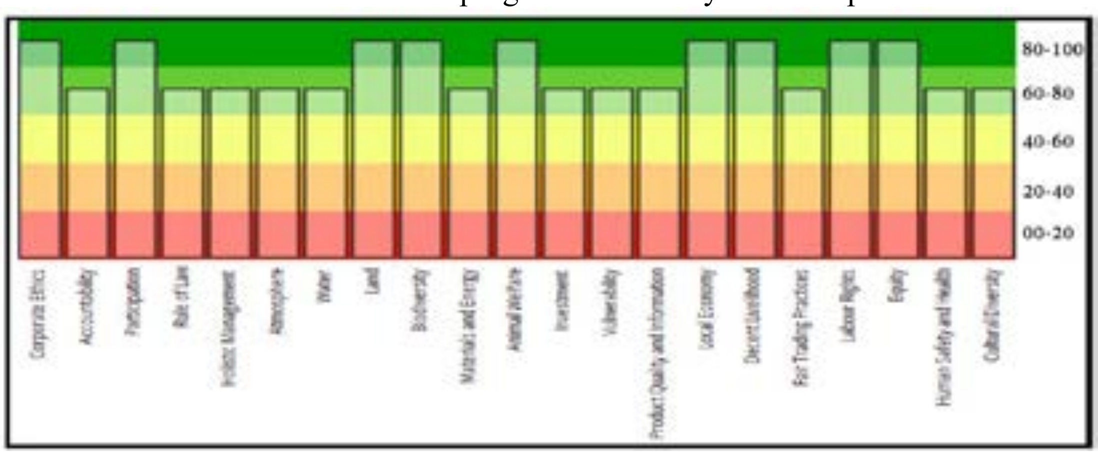
The global state of food insecurity is associated to the obstacles faced by the small farmers on what regards the sustainable food production. The integrated crop livestock systems (ICLS) play an important role in developing countries. It contributes to local food sovereignty, employment and natural resource conservation. Envisaging concrete opportunity for promoting sustainable agriculture and rural development (SARD) at farm and landscape level within low Human Development Index territories, the think-tank group represented by Brazilian Ministry of Agriculture and Livestock (MAPA), Federal University of Parana (UFPR) and Federal University of Rio Grande do Sul (UFRGS) designed and implemented in 2008 the ICLS whole-farm management model in southern Brazil called PISACOOP (Programa de Produção Integrada de Sistemas Agropecuários em Microbacias). In this presentation, we report the acquired SARD obtained results of 7 yr of integrated crop livestock systems program completion.

Material and Methods

The research was carried out on the participant program properties located on the states of southern Brazil (Rio Grande do Sul, Paraná and Santa Catarina) amid January 2014 to end of March 2015. The evaluation tool used was the Sustainability Assessment of Food and Agriculture systems (SAFA) designed by FAO in 2013 complemented with an adapted semi structured questionnaire. A total of 110 personnel involved on the different program stages from its design to the final beneficiary public were consulted. This research aimed to verify the potentiality of the PISACOOP program on effectively support sustainable food and agriculture production (SARD).

Results and Conclusions

Fig. 1. Illustrates the results of PISACOOP program over its 7 years of implementation.



About 42, 85% of the indicators evaluated have presented a "Best" status and 57, 14% of the remaining features achieved a "Good" score under the 4 dimensions of sustainability defined on the SAFA instrument. It can be concluded that the southern Brazilian PISACOOP arrangement can effectively contribute to local SARD demanding just a small amount of institutional adjustments.

Raquel Rejane Negrelle

PISACOOP Program - Promoting sustainable agriculture and rural development in Southern Brazil through ICLS

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Expected investment of Tocantins farmers, Brazil, to apply integrated crop-livestock system during Embrapa's technology transfer

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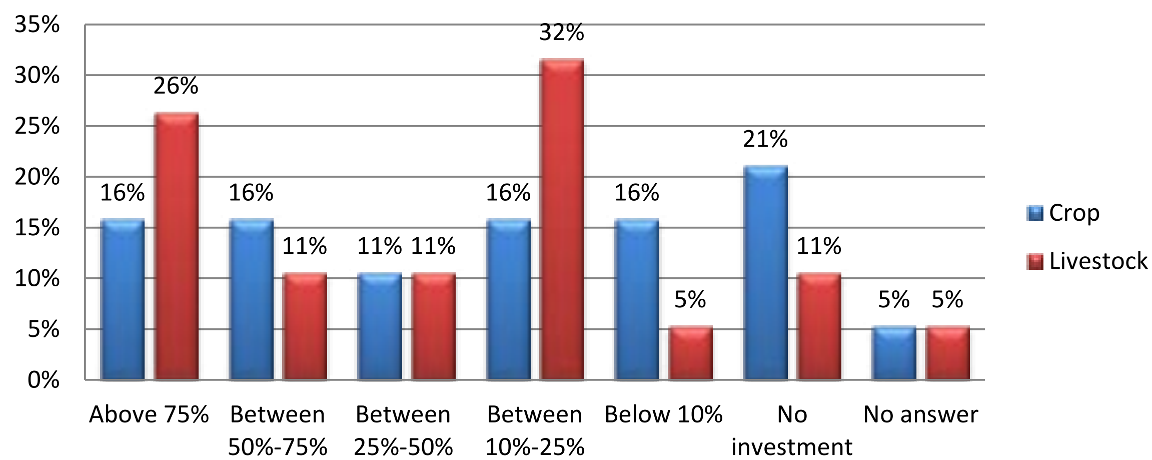
Introduction In 2012, Embrapa started the project named "Technology transfer for the consolidation of low carbon emissions agriculture in Tocantins" that aims to train rural extension professionals of the region on techniques in integrated crop-livestock (ICL) systems. The training of these professionals has resulted in transfer of new technologies to many farmers of Tocantins. The project monitors the results of some of these farmers for further impact assessment of applied technologies. In this presentation, we report the data of these farmers collected in the beginning of the project to analyze their current conditions and expectations regarding the implementation of the new integrated system.

Material and Methods

A questionnaire was given to 19 farmers that started the implementation of the ICL techniques in Tocantins. Tocantins is a state in the Brazil's northern region and it has Cerrado (Savanna) and Amazon Forest as biome. Social and economic data were collected of these farmers from which it was possible to analyze the current condition and expectations regarding the implementation of ICL. Besides, these data allowed measuring the socioeconomic background of the farmers.

Results and Conclusions

Fig. 1. Annual investment expected in agriculture and in livestock to apply ICL over the annual revenue before using the new system.



The results show that 79% of farmers have more than 10 years of experience in rural activities, which is a positive point for the successful implementation of ICL system. Before applying ICL system, one third of farmers produced only one culture, mainly corn. This fact indicates that although savvy, they need to adapt the farms to the new system. About investment expectations for the implementation of ICL, Fig. 1 shows that farmers intend to invest more in livestock than in crop. 26% of them expect to invest yearly in livestock more than 75% of the annual revenue of the farm. On the other hand, 21% of farmers do not intend to invest in any additional crop, indicating that they will only maintain the production of the current culture and add after livestock in the system.

Roberto Manolio Valladão Flores

Expected investment of Tocantins farmers, Brazil, to apply integrated crop-livestock system during Embrapa's technology transfer

AJXS

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How effective is a field day for technology transfer in integrated crop-livestock systems with dual-purpose wheat?

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Introduction

The use of Field Days as a tool for technology transfer in agriculture is widely known and used, as Miller and Cox (2006) have pointed out. In order to evaluate the effectiveness of this kind of method for Integrated Crop-Livestock Systems (ICLS) using dual-purpose wheat (DPW), a survey was conducted in one of the largest field days on Rio Grande do Sul (RS) state, at the Librelotto Farm in Boa Vista das Missões, RS. It was also needed to understand the profile of the attendees at the event. We present in this paper the results of our findings.

Material and Methods

The Librelotto Farm field day was chosen for this research for two reasons: a) it is a big field day, with approximately a thousand visitors each year; b) the importance that the organizers place in the DPW. The survey was conducted in the 2013 and 2014 field days, using both closed and semi-structured questions. Only farmers were interviewed, and only one questionnaire per farm. Descriptive statistics were used, as well as content analysis for the semi-structured questions. This led to 164 farms being surveyed in 2013, and 160 in 2014, but with 140 and 138 valid questionnaires in each year, respectively.

Results and Conclusions

In 2013, approximately 77% of the farmers said that they use integrated systems, and 74% in 2014. Most farms use the soybean (summer) - milk production system, as well as dual-purpose wheat (68.6% and 56% in each years, respectively). In order to estimate if this practice is effective, the respondents had to already have visited the event in previous years. The amount of people that already went to that particular field day was close to 58% in 2013, and 35% in 2014. Of those, 89% in 2013 and 83% in 2014, use some kind of technology that they learned about it, in this particular event. The technologies that were most cited were crop rotation, pasture cultivars and management technics. The users of DPW use it mostly for pasture (55.2% in 2013 and 67.5% in 2014), followed by pasture and grain (42.7% and 29.9%), and finally only grain production (2.1% and 2.6%).
Although the study was able to indicate that the Librelotto Farm field day is highly effective in technology transfer of ICLS, it was not possible to estimate if DPW has any kind of differentiation if compared to other forms of technology in this regard.

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Acknowledgements

To Embrapa, the Librelotto Farm organizers, as well as all the Universidade Federal de Santa Maria (UFSM) students that helped in the data gathering.

Alvaro Augusto Dossa

How effective is a field day for technology transfer in integrated crop-livestock systems with dual-purpose wheat?

AJYK

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The use of technological reference units (TRU) on smallholder farms as a techonology transfer tool of crop and livestock integration in southern Brazil

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Introduction

Embrapa (Brazilian Agriculture Research Corporation) and Emater (Extension Agency) are using family farms as reference units to transfer technologies and key technical knowledge to small milk and beef producers. The TRUs were conducted as production system models, and technological meetings were carried out during the entire year. In this presentation, we report the results of two years of winter and summer annual forages integrated on commercial enterprises.

Material and Methods

The TRUs were chosen by Emater. It represented the average smallholder farms of Rio Grande do Sul, and were managed as production systems for at least 3 years, during winter and summer. In each TRU, winter and summer forages are managed in plots of 500 to 5000 m^2. On the beginning of each cropping season, the extension agents responsible for each TRU were trained on forage establishment and management, and also received a “kit” containing seeds and technical information of each technology. The technology transfer was carried out through the formation of multipliers, and the realization of field days in these TRUs for crop and livestock producers, other extension agents, and regional leaderships.

Results and Conclusions

Table 1: Average green matter (GM) production and number of TRUs of winter and summer forages established in 2013 and 2014 (winter averages), and 2012/2013 and 2013/2014 (summer averages).

Winter Forages	Avg. GM (kg/ha)	Number of TRUs	Summer Forages	Avg. GM (kg/ha)	Number of TRUs
Ryegrass BRS Ponteio	33.550	16	Forage Sorghum BRS 802	56.394	17
Rye BRS Serrano	31.796	12	Silage Sorghum BRS 655	58.632	13
Oat BRS Centauro	26.411	13	Sudangrass BRS Estribo	49.072	12
Wheat BRS Tarumã	23.650	16	Pearl Millet BRS 1501	50.405	17
Control*	19.943	8	Corn BRS Missões*	35.347	9

*** Control and corn BRS Missões – average of 2013;**

The two year forage production data showed that the winter and summer cultivars present opportunities for greater forage production than the control-forage in use by the producer (Table 1). Additionally, the use of TRUs proved to be an important technology transfer tool to promote adoption of reliable technology and knowledge among family farmers.

Acknowledgements

To the extension agents of Emater/RS from Água Santa, Agudo, Almirante Tamandaré do Sul, Alpestre, Benjamin Constant do Sul, Boa Vista das Missões, Caseiros, Ciríaco, Cristal do Sul, David Canabarro, Erechim, Gaurama, Gentil, Herval Seco, Iraí, Jaboticaba, Marau, Mariano Moro, Mormaço, Nova Alvorada, Nova Boa Vista, Paim Filho, Palmitinho, Passo Fundo, Ponte Preta, Restinga Seca, Rodeio Bonito, Rondinha, Santa Cruz do Sul, São José do Ouro, São José das Missões, São Pedro das Missões, São Sepé, Sertão, Silveira Martins, Soledade, Tapejara, Taquaruçu do Sul, Vale do Sol, Vila Maria and Vista Alegre who diligently maintained the TRUs and registered the forage production data presented in this abstract.

Giovani Stefani Faé

The use of technological reference units (TRU) on smallholder farms as a techonology transfer tool of crop and livestock integration in Southern Brazil

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The role of woodlands in the small ruminant production in northeast Portugal

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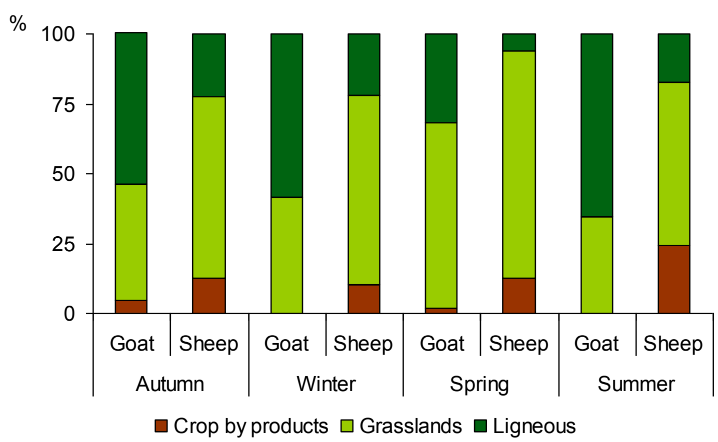
Introduction Small ruminant production is a very extensive activity in the northeast of Portugal, mainly based on use of spontaneous vegetation. Driven by shepherds, goat and sheep flocks use several daily itineraries, crossing over a highly diversified landscape; composed by a mosaic of diverse land uses (Forestlands, scrublands, pastures, and annual and perennial croplands).

Material and Methods

The present study is part of a research project which deals with vegetation-herbivore interaction of silvopastoral systems. Fieldwork was conducted over the territory of Morais village (52.16 km²) located near Bragança, (N41° 29' 23" W6° 46' 44"; 600m above sea level), northeast Portugal. Three herds of goats and three herds of sheep were monitored along their journeys every three months for a year in order to record the grazing circuits and diet composition. Diet composition was determined by direct observation method in pre-set intervals of 15 minutes during the day. For each observation point, herbaceous communities, shrubs and tree species consumed were recorded. Diet selection was estimated by Krueger's preference index and the degree of overlap between diets was estimated using the Kulczynsk is similarity index.

Results and Conclusions

Fig. 1: Goat and sheep flocks diet composition along the year.



The results showed that the diet of goats had a significantly higher content of shrubs (27% vs. 6%) and trees species (24% vs. 10%) than sheep. Sheep showed a higher content of herbaceous species in their diets (84% vs. 49%). The average of diets' overlap was higher during the winter and lower in summer.

Marina Meca Ferreira de Castro

The role of woodlands in the small ruminant production in Northeast Portugal

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Adoption of crop-livestock-forest systems: What comes next?

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Introduction

The integrated crop-livestock-forest system (ICLFS) is a rational way of use and manage natural resources. It integrates trees, field crops and animals in a scientifically way, being ecologically desirable, operationally feasible and socially acceptable by farmers (Macedo et al., 2010; Balbino et al., 2011; Pacheco et al., 2013). It enables several benefits through ecological and economic interactions resulting from intercropping different species (Macedo et al., 2010). In this sense, a combination consisting of soybeans, corn, eucalyptus, brachiaria grass and beef cattle has been tested in an ICLFS in Southern Goiás state. This paper presents technical coefficients of the tree or animal components, because they represent economic activities that last longer in the system, in order to support decision making on ICLFS for potential future adopters, based on a six years' experience.

Material and Methods

The ICLFS was implemented at Boa Vereda farm (Cachoeira Dourada, Goiás State, Brazil) in the 2008/2009 harvest, in a degraded pasture where only extensive livestock was being practiced. The system setup started with the cultivation of soybean integrated with eucalyptus (645 trees/ha of *Eucalyptus urophylla* clone). In the following year a corn and *Brachiaria brizantha* cv. Marandu intercropping was used. Pacheco et al. (2013) carried out an economic viability analysis of setting up this system. Therefore, after the corn harvest, the pasture was already established and eucalyptus had grown enough to bear the beef cattle in the system. Since then, the pasture is fertilized every start of the rainy season (November), to maintain the carrying capacity. From this system, animal weight gain and increase the volume of wood are annually recorded.

Results and Conclusions

Even without having a specific race, the beef cattle shows remarkable performance in weight gain per occupied area. Productivity has been of 270 kg carcass weight/ha/year, with slaughter age from 2 to 2.5 years. It is emphasized that well done extensive traditional livestock provides an average of 105 kg carcass weight/ha/year, with slaughter age between 3 and 4 years. The average wood increase has been 40 m^3/ha/year, using only 36% of the area. This is close to the national average of monocultures with 1,667 trees/ha (Anuário, 2014). Tree component should provide extra income to farmer, hitherto focused on livestock only. A partial cut is expected at 6 years of age, obtaining wood for energy, and final cut at age 14, obtaining wood for sawmill. These indicators show the viability of the integration livestock-forest system (ILFS), resulting from the adoption of ICLFS.

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world congress on integrated crop-livestock-forest systems

3rd International Symposium on Integrated Crop-Livestock Systems

IMPACT OF BOVINE EXCRETA AND SEASONALITY ON MICROBIOL SOIL PROPERTIES IN AN INTEGRATED CROP-LIVESTOCK SYSTEM

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Introduction

In crop-livestock integration system (iCL) microbiological soil properties tend to change gradually with the development of pasture. The objective of this study was to evaluate the effect of bovine excretas and seasonality of its application in some chemical and microbiological soil properties in areas under pasture conducted in iCL system.

Material and Methods

Fourty eight plots were established in four randomized complete block in a split-plot design with three treatments (urine, faeces and control), two areas with pastures (Área 1- Three years of pasture with *Urochloa ruziziensis* e Área 2 – One year of pasture with *Urochloa brizantha* cv. Piatã), two periods of excreta application (dry and wet seasons) repeated in time (two years of applications). Soil samples for microbial biomass analysis were performed at thirty days after the application of bovine excretas and were collected at 0-0,1 m depth to determine microbial biomass carbon and nitrogen (MBC and MBN), soil total carbon (STC) and soil total nitrogen (STN), basal respiration, ratio MBN:STN, microbial quotient (MBC:STC) and metabolic quotient (qCO_2). Data were subjected to analysis of variance and means were compared by Tukey test at 5% probability.

Results and Conclusions

Area 1 in the dry season showed an inverse relationship between microbial biomass carbon and metabolic quotient after applications, which according to Frazão et al (2010) and Diniz et al. (2014) suggests a higher stability of the system. Microbiological soil properties tend to gradually increase with the development of pasture at iCL system, associated with bovine excreta applications. The cattle faeces in pastures under iCL system had higher effect than urine on the microbiological soil properties, when they were evaluated at thirty days after the application on the soil. The greatest effect on the soil microbiological properties was observed in the dry season.

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Acknowledgements

To UnB, Embrapa, Capes, CNPq and all research scientists, technicians and field workers at Embrapa Arroz e Feijão and UnB who helped to carry out this experiment.

Adriana Rodolfo da Costa

Impact of bovine excreta and seasonality on microbiol soil properties in an integrated crop-livestock system

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Forage production and corn grain yield as affected by intercropping and corn population

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Introduction

Intercropping cash crops with perennial forage species such as *Urochloa ruziziensis*, enables the use of grain production to recover the forage yields of degraded pastures, which represent approximately 80 million hectares of arable land in Brazil (Kluthcouski et al., 2003). In addition, the introduction of perennial forage grasses in cash crop areas may benefit the subsequent cash crop (i.e., increase yields) by providing straw for the no-till system, breaking pest cycles and improving the fertility and physical quality of soil (Nascente et al., 2013). Therefore, this intercropping technique increases the level of food production without requiring new cropping areas. Identifying the correct density for intercropped corn plants is very important and can help to increase the accumulation of forage plants biomass, without negatively affecting corn grain yield. So, this study aimed at evaluating the effect of corn plants densities in the cropping performance, intercropped or not with *U. ruziziensis*.

Material and Methods

The experimental design was randomized complete blocks, in a 4x2 factorial scheme. Treatments were the combination of corn plants populations (20000, 40000, 60000 and 80000 plant ha^{-1}) with cropping systems (single and intercropped corn x *U. ruziziensis*). Corn yield, yield components and forage biomass were evaluated.

Results and Conclusions

Statistical analysis of the data revealed a significant effect of corn plant population on all variables, except for the number of grain rows ears^{-1} and mass of 100 grains. No effect of cropping system and not the interaction of factors. Therefore, corn grain yield was not affected by the intercropping with *U. ruziziensis*. Increasing corn plants densities (up to 80,000 plants ha^{-1}) provided a reduction in the number of ears plant^{-1} and grains per ear row^{-1}, however, resulted in a higher grain yield (Figure 1A). The forage biomass decreased when *U. ruziziensis* was intercropped with corn in the off-season as we increased the corn plant density up to 80,000 plants ha^{-1} (Figure 1B). In the absence of water restriction, the density of 80,000 corn plants ha^{-1} was the best recommendation.

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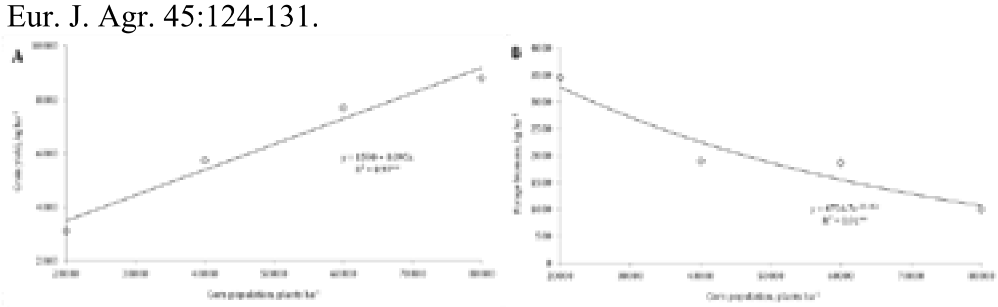

Figure 1. Corn grain yield (A) and forage biomass production (B) as a function of corn plant population.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Adriano Stephan Nascente

Forage production and corn grain yield as affected by intercropping and corn population

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Performance of soybean crop in a crop-livestock-forest system in the southwestern of Brazilian Amazon

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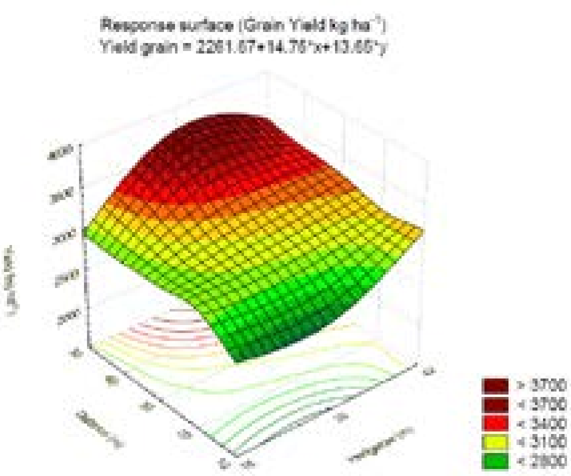
Introduction Nine billion people is expected to inhabit our planet by 2050. That is the most important and unprecedented challenge of the humanities, all the time. One solution of this equation is to improve the agricultural land use efficiency, especially in the tropics. So, the exploitation of the forest, cash crops and livestock in the same area at the same time can be a sustainable practice to boost the efficiency of the agricultural land.

Material and Methods
In order to evaluate the influence of the eucalyptus trees (hedgerow), planted in 2013, in the grain yield of soybean plants, a long term experiment has carrying been out in the southwest of the Amazon, in Porto Velho, Rondonia (Passos et al., 2013). The spatial arrangement of the trees comprehends hedgerow of four rows of eucalyptus plants spacing in 18, 32 and 42 meters among them. Between the hedgerows the soybean in the summer was grown. The treatments were three distances of the hedgerow versus four proportions of distances from trees (10, 20, 30 and 45%). The treatments were laid out in a randomized complete block design (RCBD) with eight replicates.
Results and Conclusions
Fig. 1. Response Surface of grain yield of soybean plants intercropped with eucalyptus plants.



The higher grain yield was observed in the middle of the largest hedgerow (42m). The average of this hedgerow (3,321.6 kg ha^{-1}) boosted the grain yield in 15,6% in relation to the smallest one (2,874.1 kg ha^{-1}). That difference (7.5 bags ha^{-1}) could represent a significant effect on the profitability of the farmer. The medium hedgerow presented the average of 3,083.4 kg ha^{-1}. Into the smallest and largest hedgerows, the evaluated distances, from the trees to the soybean plants, did not effected the grain yields. This factor only significantly influenced the productivity of soybean plants in the medium hedgerow (30 meters). In this case, the grain yield is explained by the linear equation Y (kg ha^{-1}) = 98.6*meters + 2,307.3 (R^2=97.7%); up to the middle of the hedgerow (15 meters). In that distance from the trees, the yield (3,785 kg ha^{-1}) was about 47.4% higher than the closest row of soybean (2,568 kg ha^{-1}). The two years old eucalyptus hedgerow affected the average grain yield from 30 meters wide.

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Acknowledgements
Embrapa and CNPq

How does integrating cropping-livestock-forest systems influence sustainability issues?

Alexandre Martins Abdão dos Passos

Performance of soybean crop in a crop-livestock-forest system in the Southwestern of Brazilian Amazon

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Soil density of a clayey Oxisol under different ICLF systems in the Cerrado region of Brazil

Alexandre R. ARAÚJO[1*], André D. FERREIRA[1], Manuel C. M. MACEDO[1], Roberto G. ALMEIDA[1], Ademir H. ZIMMER[1].
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E-mail address of presenting author*: alexandre.araujo@embrapa.br

Introduction

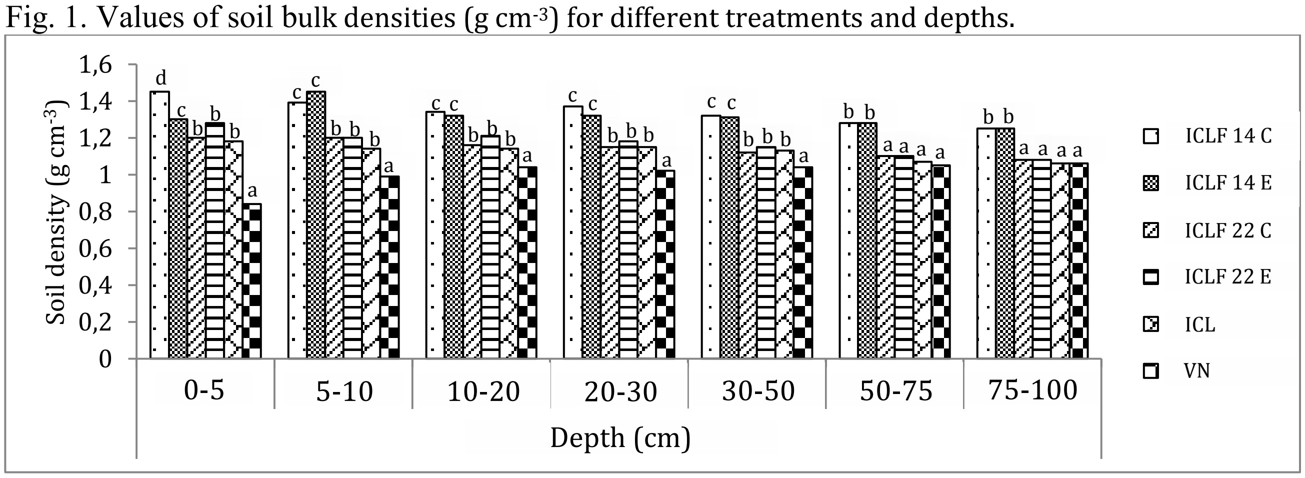
It is consensus that soil physical conditions may be restrictive for plants development, reducing production of crops and pastures, and their sustainability over time. Identify soil constraints are a main objective in soil physics studies in order to provide better plant growth. The goal of this trial was to evaluate soil density at different depths and distances from tress of *Eucalyptus urophylla* x *Eucalyptus grandis* (clone H13), planted in single line rows, as ICLF (integrated crop-livestock-forest) systems, in the Cerrado region of Brazil.

Material and Methods

The experiment was carried out at Embrapa Beef Cattle Research Center (20° 26' S, 54° 43'W, 530 m asl), in a complete randomized block design, with four replications. Soil samples were collected at depths: 0-5, 5-10, 10-20, 20-30, 30-50, 50-75 and 75-100 cm. Treatments were: ICLF 14 C (spatial arrangement with 357 trees/ha, spaced 14 x 2, soil samples collected in the center between two single rows of eucalyptus); ICLF 14 E (same spacing as before, samples collected at 1m from the eucalyptus plant); ICLF 22 C (spatial arrangement of 227 trees/ha, samples collected at same position as ICLF 14C); ICLF 22 E (samples collected at 1 m from the eucalyptus plant); ICL (crop-pasture, no trees) and VN (natural vegetation close to the experimental area). The tree component of the ICLPF was planted in January, 2009 and soil sampling in December, 2014. Soil density was calculated in accord to the Manual of Soil Analysis Methods (EMBRAPA, 1997). Forage grass, established between trees and under grazing, was *Brachiaria brizantha* cv. BRS Piatã.

Results and Conclusions

Fig. 1. Values of soil bulk densities (g cm^{-3}) for different treatments and depths.



The largest values of soil densities, regardless of soil depth, were observed in ICLF 14 treatments: in the center between two single rows of eucalyptus (C) or close to eucalyptus plant (E).

References cited

EMBRAPA (1997) Manual de métodos de análise de solo.212p.

Acknowledgments
To EMBRAPA, CNPq and FUNDECT for funding.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Alexandre Romeiro Araújo

Soil density of a clayey oxisol under different ICLF systems in the Cerrado region of Brazil

ANY2

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Influence of different spatial arrangements of the tree component in ICLF systems on the soil total pore volume

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Introduction

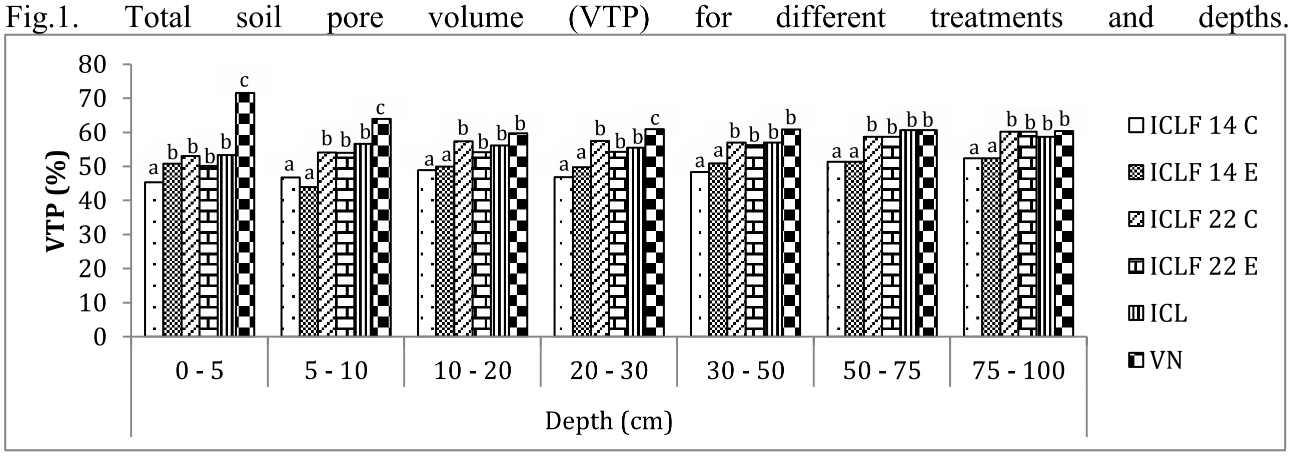
It is estimated that total porosity in soil varies from 0.30 to 0.70 m^3 m^{-3} and this characteristic or attribute is greatly influenced by use and management (FERREIRA, 2010). Study of the porous soil system is important for several features, among them, storage and water movement, root system development and soil resistance. This study aimed to assess the total soil porosity (VTP) at different depths and distances from the eucalyptus plant, established as single rows in ICLF systems in the Cerrado region of Brazil.

Material and Methods

The trial was carried out at Embrapa Beef Cattle Center (20° 26' S, 54° 43'W, 530 m asl), Campo Grande, MS, in a randomized block design, with four replications. Soil samples were collected at depths: 0-5, 5-10, 10-20, 20-30, 30-50, 50-75 and 75-100 cm. The treatments were: ICLF 14 C (spatial arrangement with 357 trees ha, spaced 14 x 2, , soil samples collected in the center between two single rows of eucalyptus); ICLF 14 E (same as before, samples collected at 1m from the eucalyptus plant); ICLF 22 C (spatial arrangement of 227 trees/ha, samples collected in the center between two single rows of eucalyptus); ICLF 22 E (same as before, samples collected at 1 m from the eucalyptus plant); ICL (crop-livestock and no trees) and VN (natural Cerrado vegetation close to experimental area). The tree component was established in January, 2009 and the evaluations of total porosity (VTP) in December, 2014. VTP was calculated in accord to the Manual of Soil Analysis Methods (EMBRAPA, 1997). Forage grass, established between trees and under grazing, was *Brachiaria brizantha* cv. BRS Piatã.

Results and Conclusions

Fig.1. Total soil pore volume (VTP) for different treatments and depths.



The smaller VTP values were observed in ICLF 14 C and ICLF 14 E treatments, while the highest values in the natural vegetation (VN), especially in the upper layers.

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Acknowledgments

To EMBRAPA, CNPq and FUNDECT for support and funding.

Alexandre Romeiro Araújo

Influence of different spatial arrangements of the tree component in ICLF systems on the soil total pore volume

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3rd International Symposium on Integrated Crop-Livestock Systems

Performance of soybean cultivars in agroforestry system in Southern Brazil

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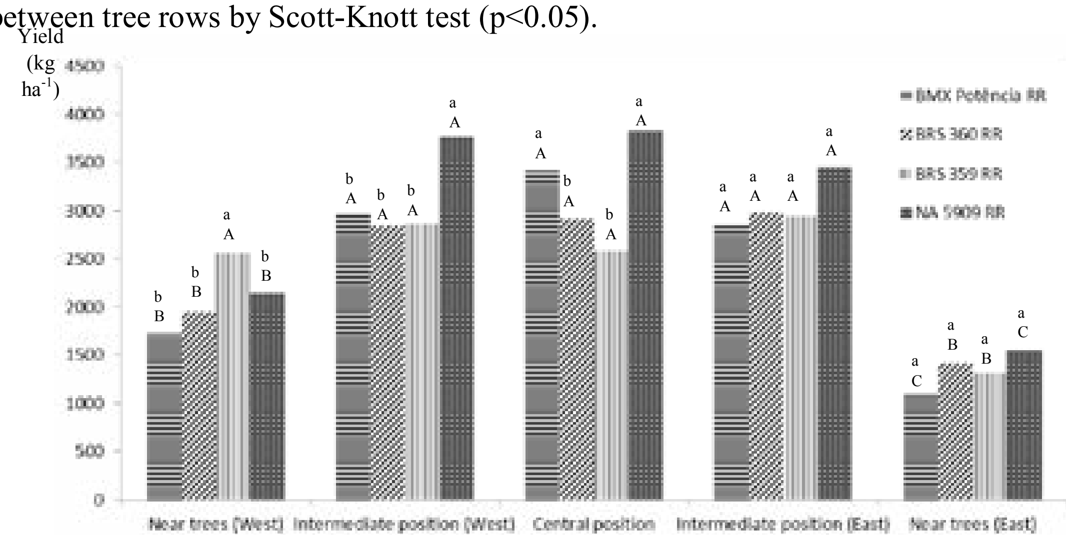
Introduction There is lack of information about the performance of modern soybean cultivars in agroforestry system. The competition for water, light and nutrients imposed by the trees can significantly reduce soybean yield (Franchini et al., 2014). In the present work, we report the grain yield of four soybean cultivars in different positions between rows of *Eucalyptus grandis.*

Material and Methods
The field experiment was carried out at Londrina, Paraná State, southern Brazil (23º48'S; 50º98'W; altitude 500 m) during the 2014/2015 cropping season. The treatments were allocated in a randomized complete block with split plot design with three replications. Treatments included four modern soybean cultivars in the plots (BMX Potência RR, BRS 360 RR, BRS 359 RR and NA 5909 RR) and five positions between *E. grandis* single rows, spaced 20 m in the subplots. Each subplot measured 10 x 20 m. *E. grandis* plants (approximately 250 plants ha^{-1}) were five years old and 15 m height. The soybean grain yield was evaluated.

Results and Conclusion
Fig. 1. Grain yield of four soybean cultivars in different position between *Eucalyptus grandis* single rows, spaced 20 m. Lowercase letters compare cultivars and capital letters compare positions between tree rows by Scott-Knott test ($p<0.05$).



The lowest yield was observed near the trees for all cultivars, due to competition for environmental resources imposed by *E. grandis* (Fig.1). In general, in the central position between the tree rows, the cultivar NA 5909 RR showed the highest yield. On the other hand, near the trees - west position - the BRS 359 RR exhibited the best performance. This indicates that there is interaction between soybean cultivars and levels of competition caused by the tree component.

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How does integrating cropping-livestock-forest systems influence sustainability issues?

Alvadi Antonio Balbinot Jr

Performance of soybean cultivars in agroforestry system in Southern Brazil

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Principal component analysis of soil quality indicators after a short-term evaluation in different no-till integrated crop-livestock systems in Brazilian lowland

Amanda P. MARTINS[1]*, José B. M. BORIN[1], Thiago BARROS[2], Taise R. KUNRATH[2], Felipe C. CARMONA[2], Ibanor ANGHINONI[1], Paulo C. F. CARVALHO[2].
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Introduction

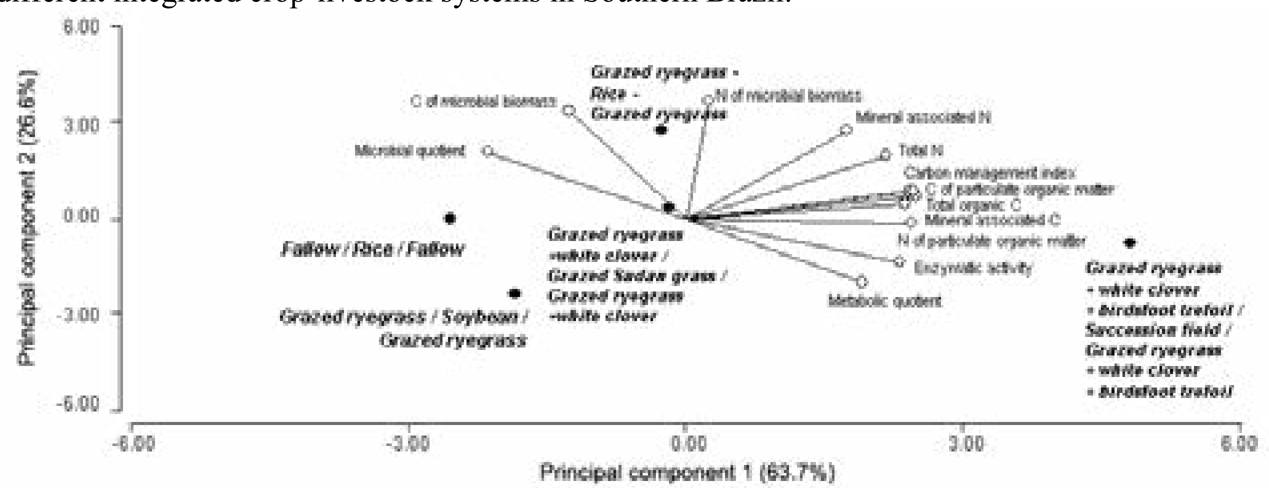
The adoption of no-till, crop diversity and integration between crop and livestock (ICLS) are alternatives that are being proposed to increase agriculture sustainability in the rice paddy fields of Brazilian lowlands. Since soil is considered as the central compartment where management modifications can be measured, our study aimed to evaluate which ICLS system are more associated to soil quality indicators by principal component analysis, 18 months after its adoption.

Material and Methods

An experiment was established in March of 2013 at the Corticeiras Farm, Cristal, in Southern Brazil (30º97'S, 51º95'W, 28 m asl). Treatments consisted in ranging vegetation diversity and rice crop intensity over time, distributed in a randomized block design with three replicates. Soil (Albaqualf) sampling was performed in September of 2014, up to 10 cm depth, after one summer season and two winter seasons. All ICLS treatments were under no-till but because some have lower rice crop intensity, two of them are characterized only as livestock systems. The main soil quality indicators according to Souza et al. (2014) were analyzed, excluding soil aggregation and including enzymatic activity (fluorescein diacetate hydrolysis) and microbial and metabolic quotients.

Results and Conclusions

Fig. 1. Principal components analysis of soil quality indicators after 18 months of the adoption of different integrated crop-livestock systems in Southern Brazil.



The system more associated with soil quality indicators was the one that is characterized by slow crop rotation and low diversity (grazed ryegrass+white clover + birdsfoot trefoil / succession field) (Fig. 1) and was sowing with rice every five years. However, additional studies are needed to validate the adequate indicators of soil quality status in a long-term approach.

References cited

Souza et al. (2014) Soil Till. Res. 139: 28-36.

Acknowledgements To Agrisus, CNPq and CAPES for the financial and scholarship support.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Amanda Posselt Martins

Principal component analysis of soil quality indicators after a short-term evaluation in different no-till integrated crop-livestock systems in Brazilian lowland

AJZA

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Soil microbial biomass stocks of short-term no-till integrated crop-livestock systems in a lowland of Southern Brazil

Amanda P. MARTINS[1]*, José B. M. BORIN[1], Filipe S. CARLOS[1], Luiz G. de O. DENARDIN[1], Maurício de AZEVEDO[2], Flávio A. O. CAMARGO[1], Ibanor ANGHINONI[1].
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Introduction

Soil microbial biomass (MB) is an effective indicator of short-term changes that occurred due to modifications in agricultural management (Balota and Auler, 2011). Thus, the present study aimed to evaluate soil MB stocks and some quotients related to it of different paddy farming systems, including integrated crop-livestock systems (ICLS) under no-till, after 18 months of its adoption.

Material and Methods

The experiment, established in March of 2013 at the Corticeiras Farm, Cristal, in Southern Brazil (30º97'S, 51º95'W, 28 m asl), test different production systems that range vegetation diversity and rice crop intensity over time, distributed in a randomized block design with three replicates, being (described as 1st winter-1st summer-2nd winter): 1) fallow-rice-fallow; 2) grazed annual ryegrass (AR)-rice-grazed AR; 3) grazed AR-soybean-grazed AR; 4) grazed AR+white clover (WC)-grazed Sudan grass-grazed AR+WC; and 5) grazed AR+WC+birdsfoot trefoil (BT)-succession field (native pasture species)-grazed AR+WC+BT. All ICLS treatments were under no-till but because some have lower rice crop intensity, two of them are characterized only as livestock systems. Soil (Albaqualf) was sampled in September of 2014 (0-10 cm soil layer). The MB determinations were performed according to Mendonça and Matos (2005). The metabolic quotient (qCO_2) was calculated by dividing the basal respiration and the microbial C content; and the microbial quotient (qMic) was calculated as the ratio of microbial C by total soil organic C.

Results and Conclusions

Table 1. Soil C and N stocks of MB stock, qMic and qCO_2, 18 months after the adoption of different paddy farming systems and in a reference area (native forest) in Southern Brazil

Paddy farming system	C-MB	N-MB	qMic	qCO_2
	------------kg ha^{-1}	-----------	------%------	-----mg CO_2-C g MB-C^{-1} day^{-1}-----
1	358 ab	30.0 ab	1.8 a	18.4 ab
2 – ICLS	443 ab	57.7 a	1.8 a	12.2 b
3 – ICLS	251 ab	25.3 b	1.4 ab	18.6 ab
4 – Livestock	344 ab	43.3 ab	1.6 ab	14.6 b
5 – Livestock	211 b	33.0 ab	0.7 b	22.7 a
Native forest (NF)	620 a	29.0 ab	1.4 ab	12.3 b

Means followed by the same letter in the column do not differ by Tukey test (p>0.05).

The N-MB stock, qMic and qCO_2 were affected by the different paddy farming systems (Table 1). Regarding N-MB, only *System 2* and *System 3* were different between them, with higher and lower values of immobilized N, respectively. The lowest qMic value observed for System 5 occurred because it is the only system that did not present similar value to the NF. The highest qCO_2 of this system also indicates its higher microbial activity.

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Acknowledgements To Agrisus, CNPq and CAPES for the financial and scholarship support.

Amanda Posselt Martins
Soil microbial biomass stocks of short-term no-till integrated crop-livestock systems in a lowland of Southern Brazil
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3rd International Symposium on Integrated Crop-Livestock Systems
towards sustainable intensification • brasília • brazil • 2015

Mechanical resistance to penetration of an Ultisol in livestock-forestry system at Northeast of Brazil

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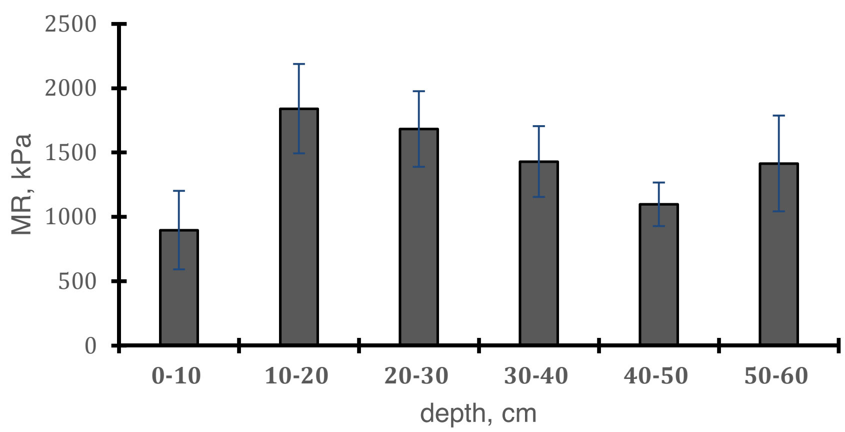
Introduction Soil mechanical resistance is a good soil physical indicator of its compaction. The animal component of the livestock-forestry system may make some pression on soil surface due to the trampling, which may lead the soil compaction and then negative impacts on its productive capacity. Identifying the occurrence of this process in livestock-forestry systems is crucial to their sustainability. In this presentation, we report the results of short-term livestock-forest systems on mechanical soil resistance in the Ultisol at Atlantic forest biome - Northeast of Brazil.

Material and Methods

The field experiment was installed in an area with some degree of degraded grass (07º24' S, 35º10'W, 180 m as') at the Agronomic Institute of Pernambuco on Experimental Station of Itambé-PE in April 2011. The plots, with three replicates, had about 1 ha and were grazing along three years. Mechanical soil resistance to penetration was measured after three years, October 2014, at central line of the livestock-forest system with mixed grass/legume (*Brachiaria decumbens*/*Gliricidea sepium*) at 0.00-0.10; 0.10-0.20; 0.20-0.30; 0.30-0.40; 0.40-0.50 and 0.50-0.60 m soil depths using an electronic devices PenetroLOG® PLG1020 (Falker, 2013).

Results and Conclusions

Fig. 1. Mechanical soil resistance (MR) at different depths under livestock-forest system in Itambé-PE, Brazil. Data are means of 3 replicate/depth, bars represents confidence interval (p<0,05).



After three years time, the livestock-forestry system kept the MR below 2000 kPa until 0.60 m soil depth, which is considered the limit to adequate plant roots development (Fig. 1). Mixing legume trees and grass pasture seems to be positive on MR, which could be included as an indicator about this system. The monitoring of soil attributes should be ongoing to evaluate the response of system at Atlantic Forest biome.

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FALKER. PenetroLOG PLG1020, Available in <http://www.falker.com.br/download.php>. Acess: 2013. 14th feb.

Acknowledgements

To IPA, UFRPE, Embrapa, CNPq, FACEPE and all research scientists, technicians, students and field work that establishment and maintain this work possible.

Spatial dependence of pH in a crop-livestock system in the southwest of Amazon

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Introduction

The high level of precipitation observed in the Amazonia and the original material of the soil are conducive to the high level of acidity on the soils. This edaphic attribute is responsible to low integrity and sustainable productivity in agrossystems in Brazil. In this work, we report the geostatistic analysis and results 8 years of cropping under no till and integrated crop/livestock systems on soil pH in the Brazilian Amazon.

Material and Methods

The experiment is located at the research station of Embrapa (406440 S; 9027781 W and 406700 S, 9027357 W) in soil types are dystrophic red-yellow oxisol, under no tillage (crop and livestock system) since 2008 (Passos et al., 2013). The clime is humid tropical (well-defined dry and rainy season) according to Köppen's Climate Classification. In 2012, the soil was sampled at a depth of 0 – 10 cm, in a grid of 30m x 30m, totaling 128 sampling points in intersect lines. The data were analyzed by descriptive statistics, normality test, trend analysis and verification of spatial dependence by means of experimental semivariograms and adjusted the variables presenting spatial dependence. Finally performing ordinary kriging of data, generating maps of prediction of the variables under study, and analyzed quality with cokriging.

Results and Conclusions

The pH values for asymmetry and kurtosis revealed is not normal distributions. The data set with coefficient of variation (CV) equal to 4,8%, are considered low-variance (<10%). The semivariance were adjusted using the Circular, adjustment method presented better performance, with parameters: *nugget effect* (C_0) of 0,04, *sill* (C_0+C_1) of 0,07 and *range (a)* of 136 meters. The semivariograms revealed moderate spatial dependence $(C_0/(C_0+C_1)x100)$ indicate 64% (*nugget effect* between 26-75% of the *sill*). Despite adequate yields achieved in last years in the area (Passos et al., 2013); above the state average; the area presents pH values consider highly acidic that are agronomically inappropriate for the most cash crops.

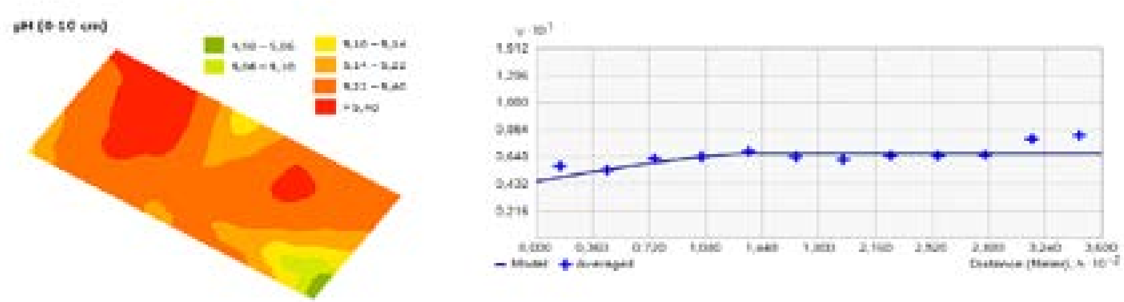

Figure 1 – Map of pH estimated by the kriging and adjust semivariogram.

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How does integrating cropping-livestock-forest systems influence sustainability issues?

Andréia Marcilane Aker

Spatial dependence of PH in a crop-livestock system in the Southwest of Amazon

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3rd International Symposium on Integrated Crop-Livestock Systems

Effects of grazing management and crop rotation strategies on *Conyza bonariensis* on Integrated Crop-Livestock System after 11 years continuous glyphosate use

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Introduction Continuous use of glyphosate caused a strong selection pressure for glyphosate-resistant weeds along the years. *Conyza Bonariensis* L. Cronq. (flaxleaf fleabane) is an increasing problem in no-tillage agriculture and is a cosmopolitan species distributed globally in fields. Research on implication of agricultural practices in *Conyza* spp. field occurrence has not been conducted on Integrated Crop-Livestock System (ICLS). This work assessed the effects of crop rotation, stocking methods or grazing intensities on aboveground seedling of *C. bonariensis* in ICLS. The study was conducted over a time span of 11 years.

Material and Methods

This work is part of an long-term experimental protocol of no-till ICLS in the south of Brazil (30˚05' S; 51˚39' W) and consists in four replicates of a 2 × 2 balanced factorial design with two stocking methods (continuous and rotational) and two herbage allowances (moderate and high) During the summer, each paddock was divided into two summer crop systems (soybean summer crop and maize–soybean summer crop rotation), under a no-till system. In each plot, the C. *bonariensis* seedling was determined on winter grazing and summer crop seasons in the central area of each sub plot (4 x 52 m) were taken on the intersections of a 4 x 10 m grid (10 squares per sub plot) with on metallic square 50-50 cm were counted all emerged seedlings.

Results and Conclusions

Table 1 - Mean values and treatment effect on aboveground seedling of *Conyza bonariensis* (individual m^2) at the winter grazing and summer crop seasons. Treatments included stocking method (continuous/rotational), grazing intensity (low/moderate) and summer crop system (soybean/maize-soybean rotation).

Season	Summer crop system	Continuous		Rotational		PM	PG	PC	PMxC	PGxC
		Low	Moderate	Low	Moderate					
Winter grazing										
	Rotation	2.8a	12.8ab	5.2ab	6.0ab	0.248	0.031	0.645	0.501	0.337
	Soybean	1.1a	24.6b	2.4a	6,9ab					
Summer crop										
	Rotation	2.3a	27.8ab	4.2ab	12.8b	0.471	0.000	0.984	0.829	0.361
	Soybean	0.2a	19.2ab	2.1a	17.1b					

PM, p-value for stocking method treatment; PG, p-value for grazing intensity treatment; PC, p-value for summer crop system.

Over a 11-year period the continuous grazing with low pressure showed less occurrence of *C. bonariensis* (Fig. 1). Wu et al. (2007) showed that *C. bonariensis* is photoblastic and germination was greatly stimulated under light. Low grazing intensity improved the straw amount on the area restricting the level of light sufficiently during a fallow situation thus reducing the germination ability of C. *bonariensis* (tab.1).

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How does integrating cropping-livestock-forest systems influence sustainability issues?

Anibal de Moraes

Effects of grazing management and crop rotation strategies on conyza bonariensis in an integrated crop-livestock system after 11 years continuous glyphosate use

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3rd International Symposium on Integrated Crop-Livestock Systems towards sustainable intensification • brasilia • brazil • 2015

Effects of crop rotation strategies and grazing management on Italian ryegrass sward height in integrated crop-livestock systems

Armindo BARTH NETO[1,2,*], Jean Victor SAVIAN[2], Ian M. CEZIMBRA[2], Olivier J. F. Bonnet[2], Chantal LOYCE[3], Michel BERTRAND[3], Paulo César de Faccio CARVALHO[2]
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Introduction

Studies in Integrated Crop Livestock System (ICLS) mainly focused on isolated factors of either the grazing (i.e. grazing intensity) or the crop phase (e.g. soil compaction, impact on crop yield). We assumed that both phases cannot be disconnected, and that management of one phase will affect the next one. This will be particularly true in Italian ryegrass pastures where the pasture re-establishes itself by self-seeding each year. The management strategies (i.e. crop rotation; grazing management) can affect herbage production and persistence in the system. The objective of this study was to focus on the transition phase as a critical link between pasture and crop phases. In this study, we used sward height as a parameter indicating the effects of crop and livestock management on the pasture.

Material and Methods

The experiment was conducted in Southern Brazil at the Federal University of Rio Grande do Sul, (30°05' S; 51°39' W), in a subtropical humid region (Cfa classification). The ICLS protocol, initiated in 2003, consists in the rotation of two summer crops managed under no tillage, either a soybean monoculture or a soybean-maize rotation. In the winter, Italian ryegrass pastures, established each year by self-seeding, were grazed by sheep, managed under two grazing intensities (low and moderate, give numbers of grazing intensity here) and two stocking methods (continuous and rotational). Sward height was measured with a sward stick in 75 random points per experimental unit (0.1 ha) in two occasions (just before the entering of the animals and at the end of the stocking period) in 2010, 2011 and 2012.

Results and Conclusions

Grazing intensity did not significantly affect sward height in 2010 (P =0.1788 and P =0.1845 for the two measurement occasions). Later on, in 2011 and 2012, grazing intensity significantly affected sward height in both phases, with an increase in the significance of the effect from 2011 (P =0.0288 and P =0.0057) to 2012 (P =0.0061 and P =0.0001). It seems from this result that grazing intensity had an accumulative effect on sward height across the years. Pasture managed at moderate grazing intensity had lower sward height at the beginning of grazing phase than pasture managed at low grazing intensity (17.95 and 20.96 cm, respectively). Higher grazing intensities (e.g. lower sward height) could have negative consequences on the seed head production, affecting the ability of the pasture to re-establish itself by self-seeding for the following years. In conclusion, managing pasture under moderate grazing intensity could result in the necessity of mechanical reseeding in addition to the natural processes of self-seeding.

Armindo Barth Neto

Effects of crop rotation strategies and grazing management on italian ryegrass sward height in integrated crop-livestock systems

ANXW

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Growth the African mahogany (*Khaya ivorensis*) in Oxisol yellow in the integrated Crop-Livestock-Forest system in eastern Amazon

Arystides R. SILVA[1*], Agust SALES[2], Carlos A. C. VELOSO[1], Eduardo J. M. CARVALHO[1]
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Introduction

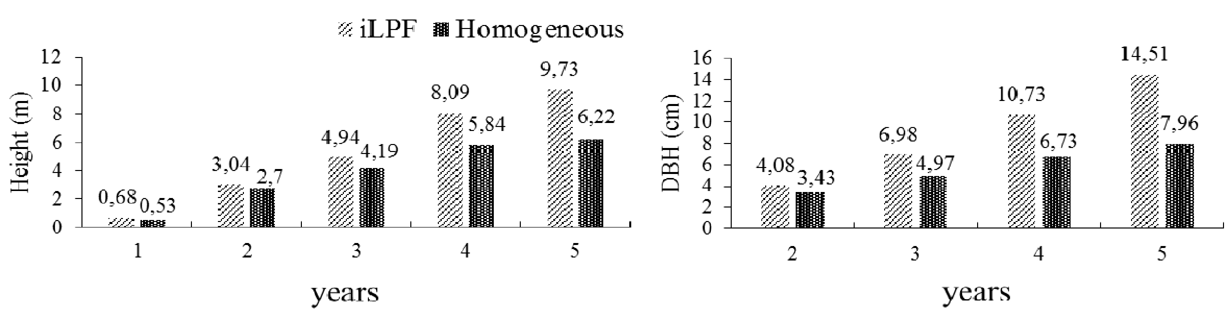
One of the major challenges in the Amazon is to promote the recovery of degraded areas by adjusting the improvement on the quality of life to ecosystem carrying capacity. The integrated Crop-Livestock-Forest system (ICLF) allows the recovery of these areas in a sustainable manner and with a production per area (Balbino et al., 2011). This study aimed to evaluate the growth of African Mahogany (*Khaya ivorensis*) in integrated Crop-Livestock-Forest system in the eastern Amazon.

Material and Methods

The experiment was conducted on the farm Vitória (02 ° 57'29,47 "S, 47 ° 23'10,37" W, 89 metros de altitude), located in the municipality of Paragominas-PA. The treatments consisted of two cultivations of African Mahogany: in iLPF system (consortium with corn BRS 1030 and Brachiaria ruziziensis) in an area of 4.05 ha, where was held the planting of trees in rows, each with 2 lines, in the spacing 5x5 m, being distance between rows 20 m, which totaled 28% of the area occupied by the track of rows and density of 200 trees.ha^{-1} and homogeneous system (1.35 ha) in the spacing 5x5 m. We evaluated the plant height in both systems from first to fifth year and the diameter at breast height (DBH) of the second to fifth year.

Results and Conclusions

Fig. 1. Height and DBH (Diameter at breast height) plant of the African Mahogany (*Khaya ivorensis*) cultivated for five years in integrated Crop-Livestock-Forest system, farm Vitória, Paragominas-PA



The Plants African mahogany in the system ICLF presented higher values of height (m) and DBH (cm) compared with homogeneous system due to the spacing between the rows reduce competition for nutrients favoring the development of trees (Fig. 1). This demonstrates that the African Mahogany (*Khaya ivorensis*) has good development in these systems, and assists in the recovery and maintenance of productive capacity of the soil.

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Balbino et al. (2011) Pesq. Agropec. Bras. 46; p. i-xii

Acknowledgements

To EMBRAPA Eastern Amazon, the project iLPF, project PECUS and the Bank of the Amazon by the financing of the search.

Arystides Resende Silva

Growth the African mahogany (khaya ivorensis) in oxisol yellow in the integrated crop-livestock-forest system in Eastern Amazon

AJYF

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Productivity of corn in Oxisol yellow in the integrated Crop-Livestock-Forest system in northeastern Pará

Arystides R. SILVA[1*], Agust SALES[2] , Carlos A. C. VELOSO[1], Eduardo J. M. CARVALHO[1]

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Introduction

There is a large need to turn into productive areas natural resources degraded in northeastern Pará, with sustainable economic potential, by adjusting the improvement on the quality of life to ecosystem carrying capacity. The system integration Crop-Livestock-Forest (ICLF) allows the recovery of these areas in a sustainable manner and with a production per area (Balbino et al., 2011). This study aimed to evaluate the productivity of corn (BRS 1030) in Crop-Livestock-Forest integration system in northeastern Pará.

Material and Methods

The experiment was carried out on the farm Victoria (02 ° 57'29,47 "S, 47 ° 23'10,37" W, 89 meters of altitude), located in the municipality of Paragominas-PA. The treatments consisted of two systems used a hybrid BRS 1030: in iLPF system, with spacing 0,6 m, in consortium with *Brachiaria ruziziensis* and intercalary with *Khaya ivorensis* in area of 4.05 ha. where was held the planting of trees in rows, each with 2 lines, in the spacing 5x5 m, being distance between rows 20 m, which totaled 28% of the area occupied by the track of rows and density of 200 trees.ha^{-1} and conventional system (3 ha). Corn evaluation was performed by sampling in two rows of 5 linear meters per track (area portion useful 7 m²), which were determined: the productivity of grains in kg.ha^{-1}; moisture content of the grain (%); plant stand (numbers of plant.ha^{-1}).

Results and Conclusions

Tab.1. Productivity of the corn BRS 1030 in integrated Crop-Livestock-Forest system and conventional system, farm Vitória, Paragominas-PA.

Treatment	Moisture harvest (%)	Productivity		Stand (plant.ha^{-1})	Straw production (kg.ha^{-1})
		(kg.ha^{-1})	(saca.ha^{-1})		
iLPF	23,97	5.764,41	96,07	58.333	4.849,89
Conventional	20,54	5.848,37	97,47	66.428	4.946,10

The ICLF system with the smallest population of the experimente (58.333 plant.ha^{-1}) obtained, in proportion, higher productivity grain (5.764,41 kg.ha^{-1} e 96,07 saca.ha^{-1}), compared to the conventional system. It can be seen that the system iLPF with population about 14% smaller than the conventional system, has provided highest production per individual, in other words, around 0,1 kg.plant^{-1}, being this production about 13% higher to obtained in the conventional system. The corn in consortium with *Brachiaria ruziziensis* not suffered reduced in the productivity and obtained gain in grain production per individual when compared to the conventional system.

References cited

Balbino et al. (2011) Pesq. Agropec. Bras. 46; p. i-xii

Acknowledgements

To EMBRAPA Eastern Amazon, the project iLPF, project PECUS and the Bank of the Amazon by the financing of the search.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Arystides Resende Silva

Productivity of corn in oxisol yellow in the integrated crop-livestock-forest system in Northeastern Pará

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Development of the Paricá *(Schizolobium amazonicum)* in Oxisol yellow in the Crop-Livestock-Forest integration system in eastern Amazon

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Introduction

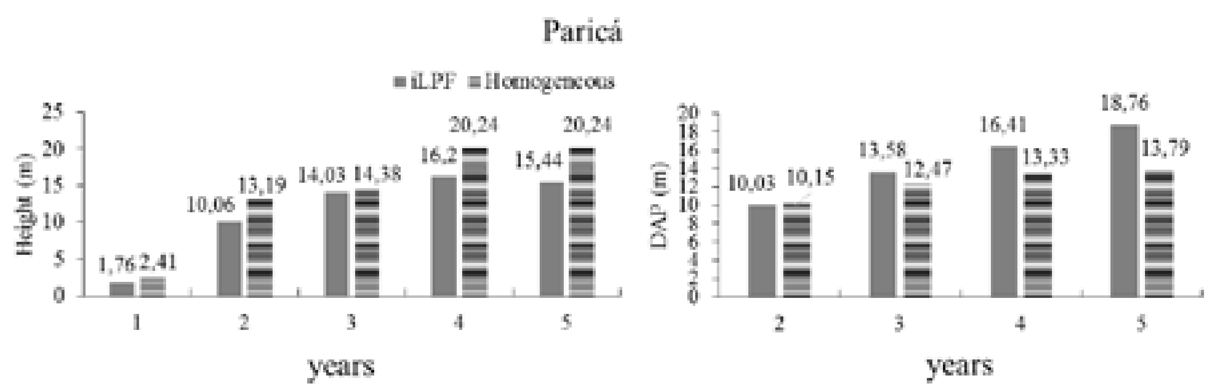
Cattle ranching in the Amazon generated an environmental liability of millions of hectares of degraded pastures, associated to economic decay due to low productivity and overall conjuctural factors. The system integration Crop-Livestock-Forest (iLPF) allows the recovery of these areas in a sustainable manner and with a production per area (Balbino et al., 2011). This study aimed to evaluate the performance of the paricá (*Schizolobium amazonicum*) in Crop-Livestock-Forest integration system in the eastern Amazon.

Material and Methods

The experiment was conducted on the farm Vitória (02 ° 57'29,47 "S, 47 ° 23'10,37" W, 89 metros de altitude), located in the municipality of Paragominas-PA. The treatments consisted of two cultivations of paricá: in iLPF system (consortium with corn BRS 1030 and Brachiaria ruziziensis) in an area of 4.05 ha, where was held the planting of trees in rows, each with 2 lines, in the spacing 4x3 m, being distance between rows 21 m, which totaled 24% of the area occupied by the track of rows and density of 267 trees.ha^{-1} and homogeneous system (1.35 ha) in the spacing 4x3 m. We evaluated the plant height in both systems from first to fifth year and the diameter at breast height (DAP) of the second to fifth year.

Results and Conclusions

Fig. 1. Height and DAP of plant of the paricá (*Schizolobium amazonicum*) cultivated for five years in Crop-Livestock-Forest integration system, farmVitória, Paragominas-PA.



The paricá in the iLPF system presented numbers minors of height of plant (m), however, had higher numbers of DAP (cm) compared with homogeneous system due to the spacing between the rows reduce competition for nutrients favoring the development of trees (Fig. 1). This demonstrates that the paricá (*Schizolobium amazonicum*) has good development in these systems, rapid growth and cutting ages, and assists in the recovery and maintenance of productive capacity of the soil.

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Balbino et al. (2011) Pesq. agropec. bras.: sistemas de integração lavoura-pecuária-floresta, p.10.

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Carlos Alberto Costa Veloso

Development of the Paricá (schizolobium Amazonicum) in oxisol yellow in the crop-livestock-forest integration system in Eastern Amazon

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Fertility of a Oxisol yellow under cultivation of cultures in Crop-Livestock-Forest integration system in northeastern Pará

Carlos A. C. VELOSO[1*], Arystides R. SILVA[1], Eduardo J. M. CARVALHO[1], Agust SALES[2]
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Introduction

Cattle ranching in the Amazon generated an environmental liability of millions of hectares of degraded pastures. The inclusion of agriculture and forestry in these degraded areas is a form of economically viable recovery and reduce the pressure on natural areas. The system integration Crop-Livestock-Forest (iLPF) allows recovery of these areas in a sustainable manner and with a production per area (Balbino et al., 2011). In this paper, aimed to evaluate the Fertility of a Oxisol yellow under cultivation of cultures in Crop-Livestock-Forest integration system in northeastern Pará.

Material and Methods

The experiment was carried out on the farm Victoria (02 ° 57'29,47 "S, 47 ° 23'10,37" W, 89 meters of altitude), located in the municipality of Paragominas-PA. Treatment consisted of the cultivation of maize (BRS 1030) in consortium with Brachiaria ruziziensis and intercalary with paricá in area of 4.05 há. The evaluation of the soil was carried out before system deployment (zero reference) and after five through years by physical and chemical analysis, the depths 0-10, 10-20, 20-30 and 30-40 cm, using the methodology proposed by Embrapa (1997) except the organic matter (OM), which was determined by the method of Walkley & Black, described in Black (1965).

Results and Conclusions

In the soil after the five years of the system iLPF pH the values (4.0) and organic matter (2.05%) were suitable for cultivation. Phosphorus levels were suboptimal (6 mg / dm^3). The potassium and magnesium in the 0-10 cm depth submitt showed acceptable values during treatment (61 mg.dm3). Calcium values were comfortable (1,3 cmolc.dm^3). Soil fertility indicated by the base saturation (V%) was adequate (16.83%). Carbon showed a significant difference according in the depth 0-10 cm (18 g.dm3) compared to the depths 10-20, 20-30 and 30- 40 cm (13; 10; g.dm3 7, respectively). Physical characteristics (sand, silt and clay) showed no significant difference (55; 284; 660 g.kg-1, respectively). There recovery and maintenance of soil production capacity, reduce carbon, organic matter, content of phosphorus, saturation for bases and the aluminum content increases with increasing soil depth.

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To EMBRAPA Eastern Amazon, the project iLPF, project PECUS and the BASA - Bank of the Amazon by the financing of the search.

Carlos Alberto Costa Veloso

Fertility of a oxisol yellow under cultivation of cultures in crop-livestock-forest integration system in Northeastern Pará

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Short-term evaluation of soil chemical attributes in different integrated crop-livestock systems in lowland of Southern Brazil

Cezar A. G. DE TONI[1]*, José B. M. BORIN[1], Amanda P. MARTINS[1], Fernanda A. COSTA[1], Felipe C. CARMONA[1], Paulo C. F. CARVALHO[2], Ibanor ANGHINONI[1]
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Introduction

Integration between crop and livestock (ICLS) and no-till system are been used in Brazil aspiring to reach sustainability in the rice paddy fields of South Brazilian lowlands. The soil chemical attributes indicate relations with the productivity of the crop nutrient levels and also with other soil properties. The study intents to compare different chemical attributes in an Albaqualf, in layers from 0 to 10cm of different paddy farming systems, 18 months after its adoption.

Material and Methods

An experiment was established in March of 2013 at the Corticeiras Farm, Cristal, in Southern Brazil (30º97'S, 51º95'W, 28 m asl). The treatments were distributed in a randomized block design with three replicates, being (described as 1st winter/1st summer/2nd winter): Rice-monocrop – fallow/rice/fallow; ICLS-Rice – grazed annual ryegrass (AR)/rice/grazed AR; ICLS-Soybean – grazed AR/soybean/grazed AR; Livestock-CP - grazed AR+white clover (WC)/grazed Sudan grass/grazed AR+WC; and Livestock-CNP – grazed AR+WC+birdsfoot trefoil (BT)/succession field (native pasture species)/grazed AR+WC+BT. All ICLS treatments were under no-till but because some have lower rice crop intensity, two of them are characterized only as livestock systems. The sampling was performed 18 months after the establishment (end of 2nd winter season).

Results and Conclusions

Table1. Soil chemical attributes in the 0 to 10 cm layer in an Albaqualf after 18 months of adopting different paddy farming systems and in a reference area (native forest) in Southern Brazil

Paddy farming system	pH-H_2O	Organic matter	Available P	Available K	Exchangeable Ca	Exchangeable Mg	Exchangeable Al	Cation exchange capacity
		--g kg^{-1}--	-----mg kg^{-1}-----		---mmol$_c$ kg^{-1}---			
Rice-monocrop	6.3 a	25.7 bc	22^{ns}	130 b	48^{ns}	28^{ns}	0 b	114^{ns}
ICLS-Rice	6.2 a	31.4 bc	31	190 a	49	33	0 b	136
ICLS-Soybean	6.2 a	22.6 c	44	132 b	46	27	0 b	103
Livestock-CP	6.1 a	27.2 bc	51	153 ab	53	30	0 b	114
Livestock-CNP	6.0 a	33.6 b	58	189 a	50	31	0 b	118
Native forest	5.3 b	54.2 a	48	40 c	47	22	12 a	176
Mean	6.0	32.4	42	159	49	29	2	127
CV	4.2%	17.7%	18.3%	16.1%	11.4%	22.3%	38.5%	23.2%

Rice-monocrop: intensive monocropping of rice. ICLS-Rice: Rice-beef cattle integration. ICLS-Soybean: Soybean-beef cattle integration. Livestock-CP: Livestock of beef cattle in cultivated pastures. Livestock-CNP: Livestock of beef cattle in cultivated and natural pastures. CV: coefficient of variation. Means followed by the same letter in the column do not differ by t test (p>0.05). ns = not significant.

The exchangeable Al and pH showed the same behavior, with no differences among the treatments. Soil exchangeable Ca and Mg did not show differences among any of the evaluated areas. Among paddy farming systems, no differences were observed for available K contents. Additional studies are needed to validate the adequate indicators of Soil chemical attributes in a long-term approach.

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Acknowledgements To Agrisus, CNPq and CAPES for the financial and scholarship support.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Cezar Augusto Gama de Toni

Short-term evaluation of soil chemical attributes in different integrated crop-livestock systems in lowland of Southern Brazil

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Short-term evaluation of soil physical attributes and moisture in different integrated crop-livestock systems in lowland of Southern Brazil

Cezar A. G. DE TONI[1]*, Amanda P. MARTINS, José B. M. BORIN[1], Felipe C. CARMONA[1], Thiago BARROS[2], Dânia V. B. OZÓRIO[1], Ibanor ANGHINONI[1]
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Introduction

Integration between crop and livestock (ICLS) and no-till system are been introduced in Brazil aspiring to reach sustainability in the rice paddy fields of South Brazilian lowlands. The physical attributes have great importance in soil characteristics such as structure, aeration, water retention. And associated with the others characteristics show influences in plant development. Thus, this study aimed to compare different ICLS regarding its physical attributes in an the 0 to 10 cm layer of an Albaqualf.

Material and Methods

An experiment was established in March of 2013 at the Corticeiras Farm, Cristal, in Southern Brazil (30º97'S, 51º95'W, 28 m asl). The treatments were distributed in a randomized block design with three replicates, being (described as 1st winter/1st summer/2nd winter): Rice-monocrop – fallow/rice/fallow; ICLS-Rice – grazed annual ryegrass (AR)/rice/grazed AR; ICLS-Soybean – grazed AR/soybean/grazed AR; Livestock-CP - grazed AR+white clover (WC)/grazed Sudan grass/grazed AR+WC; and Livestock-CNP – grazed AR+WC+birdsfoot trefoil (BT)/succession field (native pasture species)/grazed AR+WC+BT. All ICLS treatments were under no-till but because some have lower rice crop intensity, two of them are characterized only as livestock systems. The sampling was performed 18 months after the establishment (end of 2nd winter season). The physical attributes were determined according to Embrapa (1997).

Results and Conclusions

Table 1. Soil physical attributes and moisture at soil sampling in the 0 to 10 cm layer after 18 months of adopting different paddy farming systems and in a reference area (native forest) in Southern Brazil

Paddy farming system	Density	Porosity			Moisture at sampling	
		Macropores	Micropores	Total	Absolute	Proportion of FC
	---Mg m^{-3}---	--------------------m^3 m^{-3}--------------------			--m^3 m^{-3}--	----------%----------
Rice-monocrop	1.43 a	0.14^{ns}	0.45^{ns}	0.59^{ns}	0.38^{ns}	84^{ns}
ICLS-Rice	1.38 a	0.11	0.50	0.61	0.31	62
ICLS-Soybean	1.49 a	0.15	0.47	0.62	0.25	53
Livestock-CP	1.49 a	0.16	0.45	0.61	0.35	78
Livestock-CNP	1.34 a	0.13	0.46	0.59	0.24	52
Native forest	1.06 b	0.14	0.40	0.54	0.23	58
Mean	1.36	0.14	0.46	0.59	0.29	65
CV	10.1%	13.4%	12.3%	5.8%	32.4%	25.2%

FC: field capacity. CV: coefficient of variation. Means followed by the same letter in the column do not differ by t test ($p>0.05$). ns = not significant.

Soil bulk density was the only soil physical attribute that differed among the paddy farming systems and native forest. The native forest presented the lowest soil bulk density and differed of all paddy farming systems which did not differ among them. Complementary studies are needed to evaluate the paddy farming systems soil physical attributes.

References cited Embrapa (1997) Handbook of Soil Method Analyses

Acknowledgements To Agrisus, CNPq and CAPES for the financial and scholarship support.

Cezar Augusto Gama de Toni

Short-term evaluation of soil physical attributes and moisture in different integrated crop-livestock systems in lowland of Southern Brazil

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world congress on integrated crop-livestock-forest systems

3rd International Symposium on Integrated Crop-Livestock Systems

Bulk density in different CLF systems after three years of establishment

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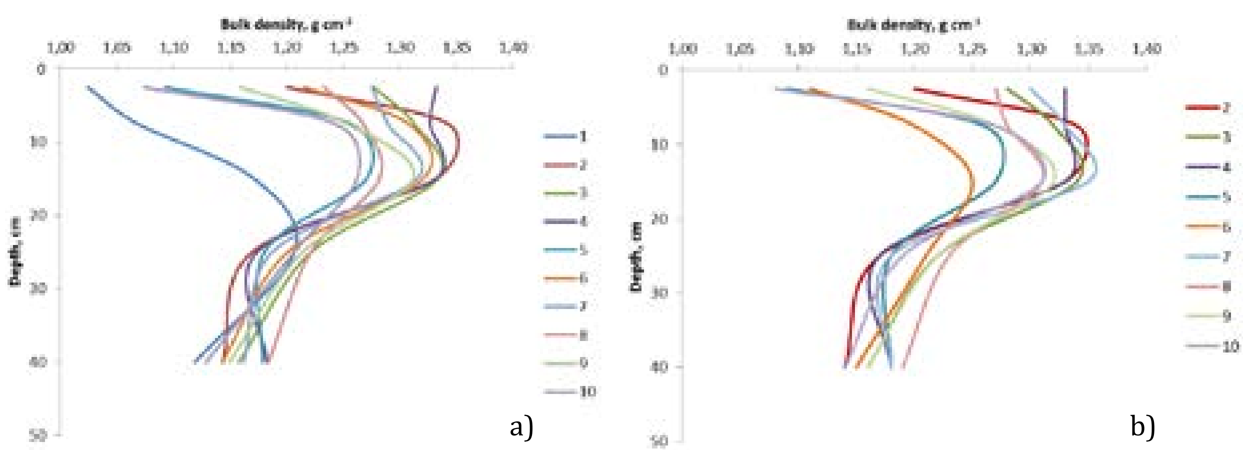
Introduction Integrated crop-livestock-forest systems can affect soil attributes in different ways. In this regard, one important attribute that needs to be taking into account is bulk density (BD). Higher values of BD cause decrease on water infiltration rates and soil volume explored by the roots, resulting in soil erosion, and loss of crop yield. This work presents results of determinations BD measures from 10 different integrated production systems after three years of establishment.

Material and Methods

The experiment was established in a randomized block design with four replications. The production systems evaluated were: 1-Forest with eucalyptus; 2-Crop no till system with soybean crop followed by corn intercropped with *Brachiaria brizantha*; 3-Livestock with *Brachiaria brizantha*; 4-Crop-Livestock (2 years each); 5-Livestock-Crop (2 years each); 6-Livestock-Forest; 7-Livestock-Forest; 8-Crop-Livestock (2 years each)-Forest; 9-Livestosck-Crop (2 years each) - Forest; 10-Crop+ Livestosck-Forest. It was collected rings volumetric (100 cm³) in the 0-5; 5-10; 10-20; 20-30 and 30-50 cm of soil layer. The soil samples were placed in a drying oven (105 ° C) and the BD determined.

Results and Conclusions

Fig. 1. Bulk density in the CLF systems after three years of establishment, a) general average; b) means of crop and pasture areas only.



Treatments 1, 5, 9 and 10 showed lower BD in the 0-5 cm layer (Fig. 1a). In the 5-10 and 10-20 cm layers, treatment 1 showed lower value, and in the other layers there were no significant differences after three years of implementation. If we consider only samples from crop and pasture areas, soils under pastures had higher BD values than those under crop systems in the 0-5 cm layer. (Fig. 1b). To this is attributed to sowing operation amending the soil surface layer. Therefore, after three years of establishment, bulk density was little affected by different CLF systems.

Acknowledgements
To Embrapa, CNPq, and all research scientists, technicians and field workers at the Embrapa Agrossilvipastoril Research Center who diligently maintained this large experiment.

Cylindrical volume of *Peltophorum dubium* (Sprengel) Taubert in an Silvipastoral System depending of the age and planting density

Débora M. HEID[1]*, Flavia A. MATOS[1], Vadim CARBONARI[1], Rafael P. de CARVALHO[2], Alex M. MELOTTO[3], Natália A. SALLES[1].
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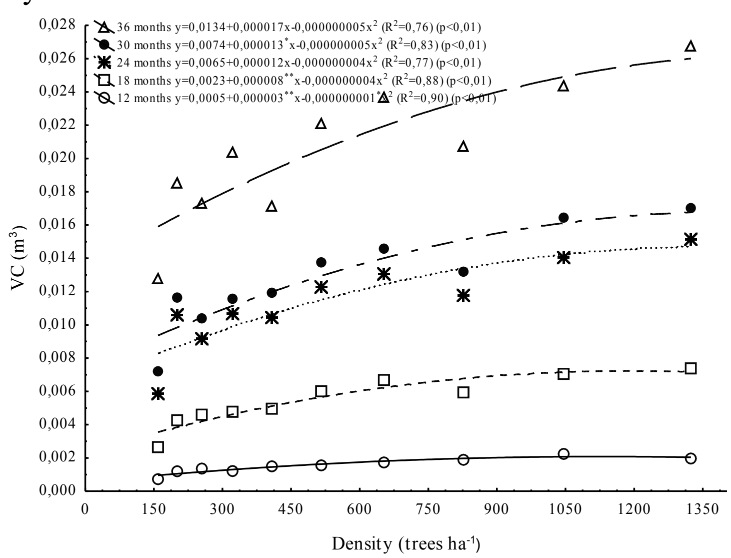
Introduction The choice of appropriate trees for the establishment of silvipastoral systems (SSP) is crucial to the success of these systems. In addition to the species to be used, the definition of appropriate planting density should be well planned (Carvalho, 2003). In this presentation was evaluated the canafistula volumetric growth in different planting densities

Material and Methods

This study was conducted in the experimental area of Embrapa Agropecuária Oeste, in Ponta Porã-MS (22º33'07"S and 55º38'37"W; 496 m). Were studied ten canafistula densities: 1324; 1046; 827; 653; 516;, 408; 322; 255; 201 and 159 tree ha^{-1}. The trees were measured at 36 months after planting, to obtain the cylindrical volume (VC = ((pi x DAP^2/4) x ALT). We opted for the cylindrical volume because is not yet defined the form of canafistula in silvipastoral systems (SSP), making it impossible to calculate the real volume.

Resultados e Conclusões

Fig. 1. Cylindrical volume (VC) of *Peltophorum dubium* in an silvipastoral system depending of the age and planting density.



The VC, at all ages, was higher with the increase in the density of trees. In the ages 12, 24 and 36 months, the maximum tree densities that result in maximum estimated cylindrical volume of trees are above the highest measured density (1324 trees ha^{-1}), especially at 36 months (1700 trees ha^{-1}), showing again that until the third year, under the conditions of this study, canafistula has increased in cylindrical volume in denser plantings.

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Volumetric estimate of *Peltophorum dubium* (Sprengel) Taubert at 36 months in two Silvipastoral Systems

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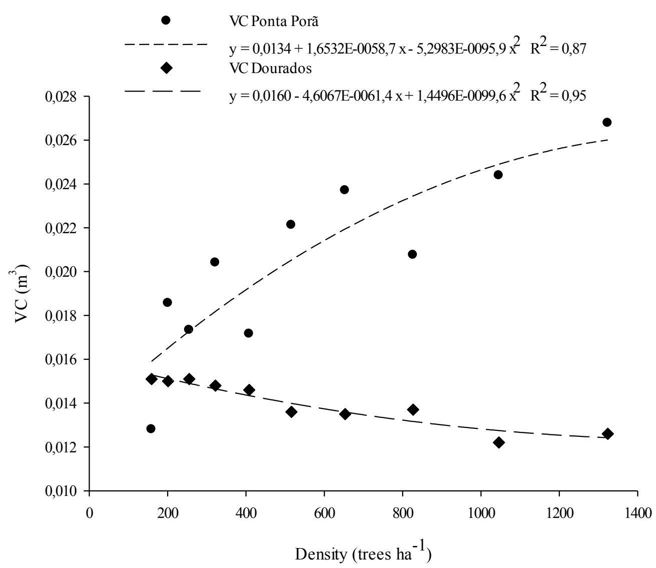
Introduction The variation in tree management in function of the planting density is important for understanding adaptive differences of species (Berger, 2002). In this work was rated the cylindrical volume of canafístula (*P. dubium*) in different planting densities with two management situations: without the bole pruning and with pruning up to 26 months old.

Material and Methods

This study was conducted at experimental farm of the Universidade Federal da Grande Dourados (22º 13' 18.54"S and 54º 48' 23.09"O; 412 m), in Dourados-MS and in the experimental area of Embrapa Agropecuária Oeste, in Ponta Porã-MS (22º33'07"S and 55º38'37"W; 496 m). The treatments included to study ten canafistula densities: 1324; 1046; 827; 653; 516;, 408; 322; 255; 201 and 159 tree ha^{-1}. The trees were measured at 36 months after planting, to obtain the cylindrical volume (VC = ((pi x DAP^2/4) x ALT). We opted for the cylindrical bole volume because is not yet defined the form of canafístula in silvipastoral systems (SSP), making it impossible to calculate the real volume.

Results and Conclusions

Fig. 1. Development of canafistula trees, with and without bole management, in an SSP.



Canafistula trees presented different growth, according to the management practices used in each area. When there was no bole management, the largest cylindrical volume values were found in the lower planting densities. The inverse occurred in the area where the bole was conducted until 26 months, showing higher VC values in the largest planting densities.

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Débora Menani Heid

Volumetric estimate of peltophorum dubium (sprengel) taubert at 36 months intwo silvipastoral systems

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Black oat leaf temperature in a long-term integrated crop-livestock system in Southern Brazil

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Introduction

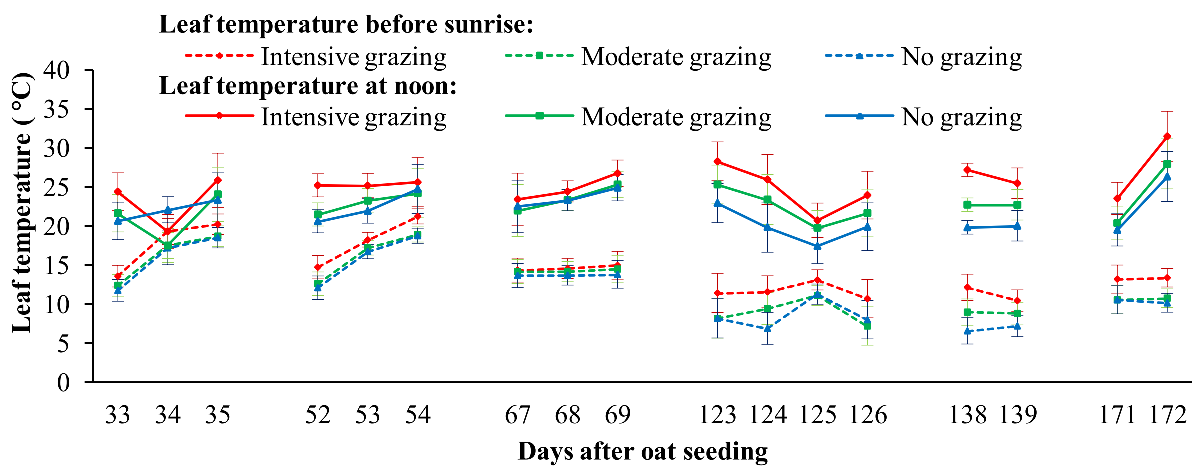
Integrated crop-livestock systems aim to achieve the synergy between the crops used in the rotation system. The grazing changes root development dynamics and water absorption due to the continuous pasture development (Vadez et al., 2013). To maintain plant temperature, hydration is required. Thus, the aim of this study was to evaluate black oat water status through leaf temperature (LT) measurement.

Material and Methods

The long-term integrated clop-livestock system trial has been conducted since 2001, in a Rhodic Hapludox, in Southern Brazil (29°03'10" S, 53°50'44" W, 465 m asl), which has a warm humid summer (Cfa) climate according to the Köeppen classification. The average temperature is 19°C, and the yearly average precipitation is 1850 mm. Treatments consisted of grazing intensities during the winter, which were determined by the grazing pasture height: 10, 20, 30 and 40 cm, with an additional reference treatment (non-grazed), organized in a randomized block design with three replications. For this study, intensive grazing (10 cm pasture height), moderate grazing (20 cm pasture height) and no-grazing were considered. Samplings were performed only in the first experimental block. Black oat LT was evaluated at two periods: from 04:00 am to 06:30 am (LT_B) and from 11:30 am to 1:30 pm (LT_N). There were four replicates (plants) of each treatment, and LT was obtained from the mean of three readings from the same plant, using an infrared thermometer. The evaluations were only performed in the leaves of the upper third that were receiving solar radiation, ensuring uniform measurements.

Results and Conclusions

Fig. 1. Black oat leaf temperature: (a) before sunrise and (b) at noon, along the pasture cycle.



The adequate pasture management performed with moderate grazing intensity allows pasture crop to keep similar LT of non grazed condition

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Diego Cecagno

Black oat leaf temperature in a long-term integrated crop-livestock system in Southern Brazil

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Black oat leaf water potential in a long-term integrated crop-livestock system in Southern Brazil

Diego CECAGNO[1]*, Sérgio E.V.G.A. COSTA[1], Taíse R. KUNRATH[2], Amanda P. MARTINS[1], Ibanor ANGHINONI[1], Paulo C.F. CARVALHO[2]
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Introduction

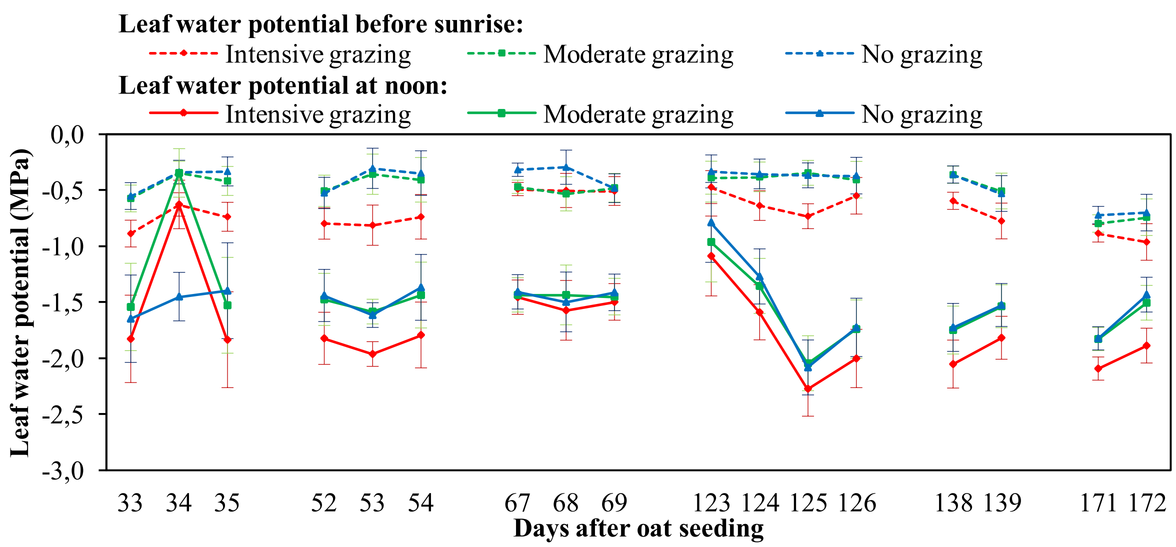
Integrated crop-livestock systems (ICLS) aim to achieve the synergy between crops in the food production system. Leaf water potential (Ψ_{LW}) has highlighted as a tool for plant water content assessment and, consequently, to measure the impact of different managements in the equilibrium of these systems. Thus, the objective of this study was to evaluate black oat Ψ_{LW} during a pasture season of an ICLS under different grazing intensities.

Material and Methods

The long-term integrated clop-livestock system trial has been conducted since 2001, in a Rhodic Hapludox, in Southern Brazil (29°03'10" S, 53°50'44" W, 465 m asl), which has a warm humid summer (Cfa) climate according to the Köeppen classification. The average temperature is 19°C, and the yearly average precipitation is 1850 mm. Treatments consisted of grazing intensities during the winter, which were determined by the grazing pasture height: 10, 20, 30 and 40 cm, with an additional reference treatment (non-grazed), organized in a randomized block design with three replications. For this study, intensive grazing (10 cm pasture height), moderate grazing (20 cm pasture height) and no-grazing were considered. Samplings were performed only in the first experimental block. Black oat Ψ_{LW} was evaluated at two periods: from 04:00 am to 06:30 am (Ψ_{LWB}) and from 11:30 am to 1:30 pm (Ψ_{LWM}). There were four replicates (plants) of each treatment. The evaluations were only performed in the leaves of the upper third that were receiving solar radiation, ensuring uniform measurements. The Ψ_{LW} was measured in the field using a Scholander pressure chamber.

Results and Conclusions

Fig. 1. Black oat leaf water potential: (a) before sunrise and (b) at noon, along the pasture cycle.



The adequate pasture management performed with moderate grazing intensity allows pasture crop to keep similar Ψ_{LW} of non grazed condition.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Diego Cecagno

Black oat leaf water potential in a long-term integrated crop-livestock system in Southern Brazil

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The original landscape cover dynamics is the functional reference for agroecosystem design and management

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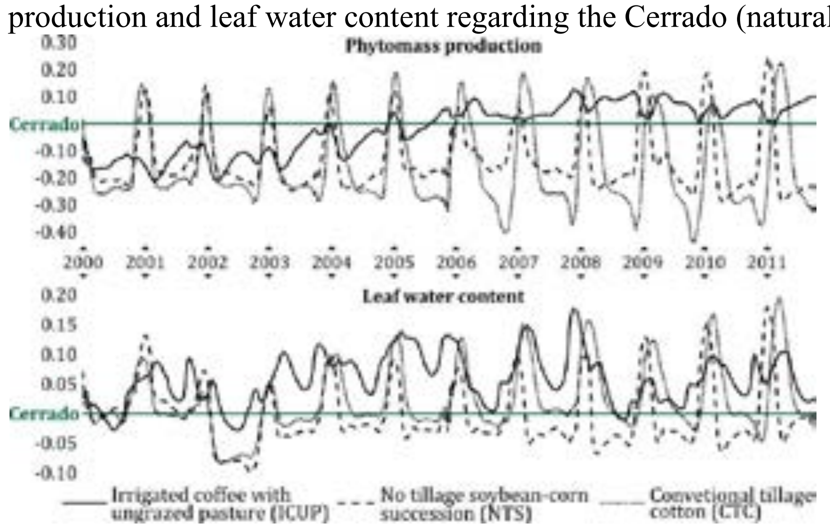
Introduction The biosphere's productivity can be quantified as a cascading series thanks to our improved understanding of photosynthetic metabolism (Smil 2013). This comprehension allows the agroecosystems design based on natural analogies and mimics the ecological processes (Altieri 1999). Hence, this study aimed to evaluate agroecosystems productivity regarding natural reference.

Material and Methods The study area was located in the Cerrado biome marked by vast plateaus with gentle relief, poor fertility and deeper soils, and prominent seasonality. Its original vegetation cover has been the Cerrado *stricto sensu* characterized by tree-shrub proportion from 10% to 60% arboreal coverage and regarded the functional reference. There were evaluated the phytomass production and leaf water content of 12-years period from MODerate Imaging Spectrometer (MODIS) dataset of three agroecosystems regarding Cerrado: irrigated coffee with ungrazed pasture (ICUP), no tillage soybean-corn succession (NTS) and conventional tillage cotton (CTC).

Results and Conclusions The ICUP showed the lowest amplitude between the seasons, even during its establishment from 2000 to 2004, considering both parameters (Fig. 1). Other assessed systems have had lower performance regarding functional reference.

Fig. 1. Phytomass production and leaf water content regarding the Cerrado (natural reference).



During the dry season, the leaf water content of the ICUP has regarded the natural reference and has achieved higher levels over the wetter season (Fig. 1). Altieri (1999) highlighted that a key strategy in sustainable agriculture is to restore functional biodiversity agroecosystems. In the Cerrado, the sustainability of the agroecosystems should consider the design of integrated systems that imitate the natural patterns of tree-shrub proportion.

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Acknowledgements

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Eder de Souza Martins

The original landscape cover dynamics is the functional reference for agroecosystem design and management

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Agronomic evaluation of maize crop in crop-forest system in the Roraima savannah

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Introduction

Mixed farming systems are more sustainable than specialized systems for grain and fiber. Interest in these models comes from the benefits of synergy between annual and tree crops (Balbino et al., 2011). This paper presents the results of maize crop for 2 years in single and double alleys of *Eucalyptus urograndis*.

Material and Methods

The experiment was conducted on native savannah area in the Campo Experimental Água Boa, from Embrapa Roraima (02º15'00' N and 60º39'38' W, 90 masl). Treatments included the cultivation of corn in single alley (3 meters between plants) and doubles alleys (3 meters between plants and rows) of eucalyptus. The alleys were spaced 12 m where corn in rotation with soybean were grown. Corn was planted for two years, with density of 40,000 plants ha^{-1}, used Bandeirante variety. Samples were collected at 2.5; 5.0; 7.5 and 10m from eucalyptus. The design was a randomized complete block with split plot and four repetitions.

Results and Conclusions

There was no effect on the sample distance and the lines eucalyptus number on the height, productivity and residual straw in the year 2013. In 2014 observed better productivity in single lines and high plants between the alley (Tab. 1). Similar results are observed by Macedo et al. (2006). In the first year, there is no influence of intercropping eucalyptus (little plants). In the second year, the eucalyptus plants presented five meters and begins the interference, affecting the maize growth.

Tab. 1. Plant height, grain yield and residual straw coming from corn cropped between single and double alleys of eucalyptus, sampled at different distances. Boa Vista / RR / BR (2013-2014).

Distance (m)	Plant height (cm) 2013	Plant height (cm) 2014	Grain yield (Mg ha^{-1}) 2013	Grain yield (Mg ha^{-1}) 2014	Residual straw (Mg ha^{-1}) 2013	Residual straw (Mg ha^{-1}) 2014
2.5	194.25a[1,2]	197.18 b	2.82 a	4.14 a	8.05 a	5.43 a
5.0	204.75a	209.37 a	3.30 a	3.48 a	8.26 a	5.23 a
7.5	199.88 a	218.06 a	3.25 a	3.92 a	9.54 a	5.43 a
10.0	194.13 a	176.12 b	3.27 a	3.92 a	9.41 a	5.38 a
Eucalyptus alleys						
1	196.38 a	195.41 a	2.96 a	4.26 a	8.41 a	5.36 a
2	200.13 a	204.97 a	3.36 a	3.48 b	9.22 a	5.38 a
CV1	6.15	7.54	12.60	10.88	38.88	7.08
CV2	5.35	6.91	23.73	14.66	38.39	8.49

[1]Means followed by the same letters in the column, for each factor under study, are not significantly different in the level of 5% by Scott-Knot test. [2]Data represent mean of 4 replicates.

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How does integrating cropping-livestock-forest systems influence sustainability issues?

Edmilson Evangelista da Silva

Agronomic evaluation of maize crop in crop-forest system in the Roraima Savannah

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Agronomic evaluation of soybean crop in crop-forest system in the Roraima savannah

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Introduction

Mixed farming systems are more sustainable than specialized systems for grain and fiber. Interest in these models comes from the benefits of synergy between annual and tree crops (Balbino et al., 2011). This paper presents the results of soybean crop for 2 years in single and double alleys of *Eucalyptus urograndis*.

Material and Methods

The experiment was conducted on native savannah area in the Campo Experimental Água Boa, from Embrapa Roraima (02º15'00' N and 60º39'38' W, 90 masl). Treatments included the cultivation of soybean in single alley (3 meters between plants) and doubles alleys (3 meters between plants and rows) of eucalyptus. The alleys were spaced 12 m where soybean in rotation with corn were grown. Soybean was planted for two years, with density of 300,000 plants ha^{-1}, used Tracajá variety. Samples were collected at 2.5; 5.0; 7.5 and 10m from eucalyptus. The design was a randomized complete block with split plot and four repetitions.

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There was no effect on the sample distance and the lines eucalyptus number on the height, productivity and residual straw in the year 2013. In 2014 observed better productivity in single lines (Tab. 1). Similar results are observed by Macedo et al. (2004). In the first year, there is no influence of intercropping eucalyptus (little plants). In the second year, the eucalyptus plants presented five meters and begins the interference, affecting the soybean growth.

Tab. 1. Plant height, grain yield and residual straw coming from soybean cropped between single and double alleys of eucalyptus, sampled at different distances. Boa Vista / RR / BR (2013-2014).

Distance (m)	Plant height (cm)		Grain yield (Mg ha^{-1})		Residual straw (Mg ha^{-1})	
	2013	2014	2013	2014	2013	2014
2.5	68.00 a	65.43 a	3.44 a	2.26 a	2.59 a	2.43 a
5.0	64.75 a	66.56 a	2.93 a	2.13 a	2.54 a	2.16 a
7.5	66.12 a	69.25 a	3.26 a	2.23 a	2.96 a	2.93 a
10.0	66.87 a	66.56 a	3.96 a	2.18 a	3.30 a	2.34 a
Eucalyptus alleys						
1	65.06 a	66.22 a	3.59 a	2.42 a	2.91 a	2.40 a
2	67.81 a	67.73 a	3.21 a	2.13 b	2.80 a	2.61 a
CV1	8.59	1.66	16.81	9.37	9.45	8.80
CV2	7.53	6.91	13.01	6.20	21.20	16.19

[1]Means followed by the same letters in the column, for each factor under study, are not significantly different in the level of 5% by Scott-Knot test. [2]Data represent mean of 4 replicates.

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How does integrating cropping-livestock-forest systems influence sustainability issues?

Edmilson Evangelista da Silva

Agronomic evaluation of soybean crop in crop-forest system in the Roraima Savannah

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Tillering of marandu grass in integrated crop-livestock-forest of Eucalyptus

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Introduction Pasture degradation is a serious problem and has increased considerably in recent years, putting at risk the sustainability of animal production. The agroforestry systems are a promising alternative. The successful use of pastures in integrates crop-livestock-forest depends on the understanding of morphophysiological mechanisms and their interaction with the environment and management. The adaptation of forage in shading conditions is important and *Urochloa* can be used under conditions of natural shading. The objective was to evaluate the tillering of marandu grass intercropped or not with maize in an agrosilvopastoral system with one or three rows of eucalyptus distanced at 4 and 10 meters from the tree component.

Material and Methods
The experiment was conducted at APTA Polo Regional Extremo Oeste, Andradina (20°53'46" S, 51°22'46" W and 405 m altitude). The experiment was arranged in a randomized block design with factorial arrangement (2x2x2), 2 types of trees arrangements de integrated crop-livestock-forest, single line of eucalyptus (200 trees ha^{-1}) and triple lines of eucalyptus (500 trees ha^{-1}), two types of integration of pasture with eucalyptus (with and without corn) and two distances of trees (4 and 10 m), in plots of 50 m² and 4 replications. Tillers of *Urochloa brizantha* were identified in the area known (0,08m²) since the establishment of the corn crop and pasture and, approximately 160 days after sowing pasture and corn, the period of harvest corn crop, was evaluated total count of the number of tillers. Statistical analyzes were performed using the statistical program R.

Results and Conclusions
Table 1. Density of tillers (m^{-2} number) of marandu grass in 2 distances (4 and 10 m) of the eucalyptus trees, intercropped or not with maize agrosylvopastoral system.

	Number of tiller.m^{-2}	
	4 m	10 m
Maize	88Aa	119Ba
Without maize	133Ab	613Aa

Lowercase letters in line and uppercase letter in columns differ in Tukey test (p<0,05).

There was effect of systems in number or tillers. When the tillering of pasture with corn was evaluated there were no differences between the distances of 4 and 10m. However, in absence of corn, there were differences between the distances, with higher tillering to 10m of the trees, indicating that the highest incidence of light in pasture benefitted tillering of marandu grass, as well as no competition for nutrients and water. In the distance of 4m of trees the tillering no exhibt differences in the presence or absence of corn. However at 10m of the trees, the absence of corn allowed greater tillering to the grass in relation to treatment with corn, featuring the competition with the culture limited tillering of marandu grass, probably due to lower light present, competition for water and nutrients and also the occupation of spaces in the soil by corn. The largest tillering in the initial phase of marandu grass occurs in absence of maize crop in the distance of 10m.

Erikelly Aline Ribeiro Santana

Tillering of marandu grass in integrated crop-livestock-forest of eucalyptus

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Soil fertility levels in the process of recovery of degraded pasture by iCL in the western Brazilian Amazon

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Introduction:
Pasture degradation is one of the environmental problems of the Amazon region, with about 60% of pasture areas in the Amazon in some degree of degradation. Thus, there are losses not only to the environment but also the sustainability of livestock, since livestock production in degraded pasture is lower than in recovered or in good condition pastures. The low soil fertility levels are one of the main reasons of the degradation. Integrated systems as iCL are considered the most economically and technically viable way to proceed the recovery of soil fertility. Thus, this study aimed to compare the soil fertility levels in degraded pastures and in the recovery process with iCL.

Materials and methods:
The work was conducted at the Experimental Station of Embrapa Western Amazon, located at km 54 of BR 174 highway. The soil is a Xanthic Ferralsol (FAO, 1990) with clayey texture. The object of the study was a system implemented in 1991, made up of six paddocks of 3000 m^2 each, with pasture associated with Mahogany (*Swietenia macrophylla*), arranged in two central lines. That pasture was reformed through corn cultivation associated with *Brachiaria brizantha* CV Xaraés. Three paddocks were cultivated with corn only in the first year (Cult1) and the other three were cultivated for two years in a row (Cult2). After de corn harvest, the pasture was grazed by sheeps. In the first year it was applied 3Mg/ha of limestone to raise the sum of bases to 40%. In each planting were applied, in the groove, the equivalent to 350 kg/ha of 4-28-20 formula, plus 100 kg/h of urea and 75 kg/ha of KCl for cover. After de second year six soil samples were collected at a depth of 0–20 cm in each paddock to analyze pH in water, organic matter (OM), available phosphorus (P) and potassium (K), sum of the bases (SB) and base saturation (V%) according to the Embrapa Methods Manual (2011). The variance analysis was performed and means were compared using the Tukey test.

Results:
OM levels increased gradually among treatments ($P < 0.0021$) going from 28,1g/kg in degraded pasture (DP), to 35,3g/kg in Cult1 and 41,5g/kg in Cult2, demonstrating the benefits of corn cultivation can bring soil fertility. In relation to P ($P < 0.0129$) and K ($P < 0.0688$) a similar trend occur, but whit the levels at DP lower than Cult2, being respectively 3.6 and 14.2 mg/dm^3 of P and 17.5 and 21.7 mg/dm^3 of K, but with the Cult1, not differing from any of the two treatments (7.7 mg/dm^3 of P and 20.2 mg/dm^3 of K). For the SB ($p < 0.0005$), the response was the opposite, since only the DP values were low; 0.48 cmolc/dm^3. In Cult1 or Cult2, the values have stabilized in the range of 1.55 cmolc/dm^3. The V% ($P < 0.0007$) showed a gradual increase, going from 8.5% in DP, to 17.1% in Cult1 and 23.1% in Cult2.

Conclusions:
In general, the introduction of maize crop in successive years by iCL, was an effective way to restore fertility levels of the degraded pasture soil, since all fertility parameters increased with the crops sequence.

Felipe Tonato

Soil fertility levels in the process of recovery of degraded pasture by ICL in the Western Brazilian Amazon

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Seed banks during three year on integrated crop-livestock-forest system under different shading levels in Sinop, Mato Grosso, Brazil

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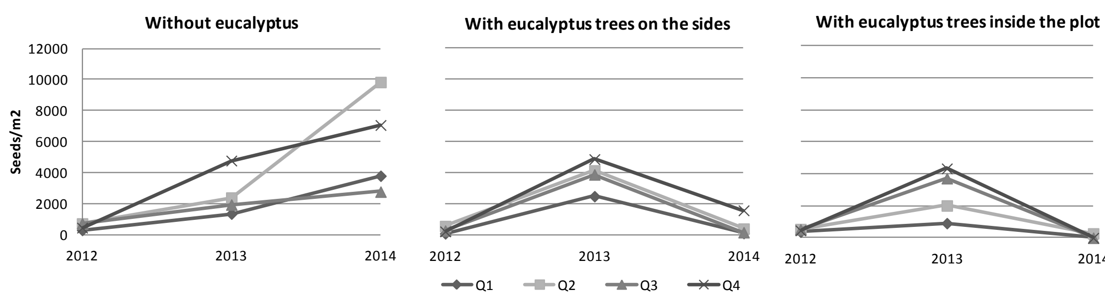
Introduction - The integrated systems can provide shading in many situations, be it through the shading provided by pastures, either by soil cover with straw, or even with the shading of trees on crops when the forest component is inserted (Ikeda & Cavalieri, 2015). Considering that many weed species present seeds considered photoblastic positive, it is believed that integrated systems can reduce weed infestation. Therefore, the aim of this study was to evaluate the seed banks size in integrated production system with dairy cattle and different shading levels during three years of long-term experiment, carried out at Embrapa agrosilvopastoral, Sinop-MT.

Material and Methods

The experiment was conducted in four quadrants, constituted of: Q1: pasture of first year (*Urochloa ruziziensis* cv. Ruziziensis) followed by pasture of second year (*U. brizantha* cv. Piatã) and after by crop of first year; Q2: crop of second year (corn silage and cowpea) followed by pasture of first year and after by pasture of second year; Q3: crop of first year (corn silage and cowpea) followed by crop of second year and after by pasture of first year; Q4: pasture of second year followed by crop of first year and after by crop of second year. The quadrants were subdivided into three shading levels (without eucalyptus, with double rows of eucalyptus trees on the sides of the plot and triple rows of eucalyptus trees inside the plot). Six samples composed of three sub-samples in layer 0 to 0.10 m depth in each shading level of the four quadrants were collected. The samples were evaluated in greenhouse and irrigated daily. The emerged seedlings were counted, identified and discarded every two weeks for three months. The identification of the best model to fit the curves was made with the CurveExpert 1.3 program.

Results and Conclusions

Fig. 1. Seedbanks size at 0-10 cm depth during three years on integrated crop-livestock-forest system under different shading levels in Sinop, Mato Grosso, Brazil



The areas without trees tended to increase the seed bank size over the years (Fig. 1), while in areas with trees there was an increase in seed density in 2013 with a reduction in 2014 to levels close to the year 2012. The curves were adjusted to quadratic models ($y=a+bx+cx^2$).

References cited

Ikeda & Cavalieri (2015). Sistemas integrados de produção para o manejo preventivo da resistência de *Amaranthus* spp. In: Inoue et al. Manejo de *Amaranthus*. São Carlos: Rima, 2015. p. 183-194.

Acknowledgements

To CNPq and Embrapa.

Fernanda Satie Ikeda
Seed banks during three year on integrated crop-livestock-forest system under different shading levels in Sinop, Mato Grosso, Brazil
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Seed banks size during three years on single and integrated cropping systems in Sinop, Mato Grosso, Brazil

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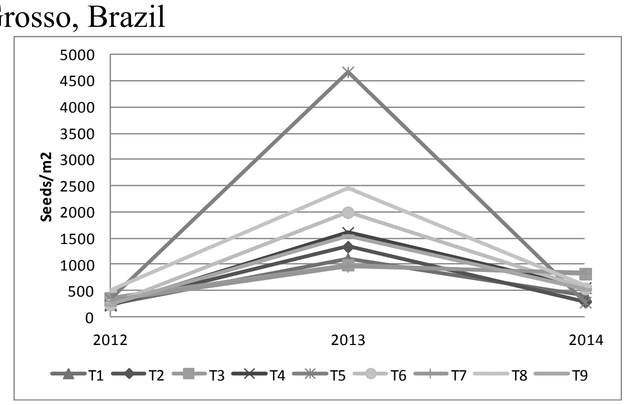
Introduction - The integrated cropping systems are considered more sustainable than single crops in many aspects, but many studies must be conducted with the objective of know more about the problems and benefits of each one. One of the benefits is related with the weed infestation suppression with integrated cropping systems (Ikeda & Cavalieri, 2015). Therefore, the aim of this study was to evaluate the seed banks size in single and integrated cropping systems during three years of long-term experiment, carried out at Embrapa agrosilvopastoral, Sinop-MT.

Material and Methods

The experimental design was a randomized block with four replications and ten treatments [1) single forest; 2) soybeans/corn-pasture association; 3) single pasture; 4) integrated crop-livestock with two years of cropping, followed by two years of pasture; 5) integrated livestock-crop with two years of pasture, followed by two years of cropping; 6) integrated crop-forest system, with forest and cropping between the lines; 7) integrated livestock-forest system, with forest and pasture between the lines; 8) integrated cropping-livestock-forest (ICLF) system, with forest and four years of cropping, followed by four years of pasture between the lines; 9) ICLF system, with forest and pasture four years, plus four years of cropping between the lines. Four samples composed of five sub-samples in 2012 and two sub-samples in 2013 and 2014 in layer 0 to 0.10 m depth in each plot. The emerged seedlings were counted, identified and discarded every two weeks for three months. The identification of the best model to fit the curves was made with the CurveExpert 1.3 program.

Results and Conclusions

Fig. 1. Seed banks size at 0-10 cm depth during three years on single and integrated cropping systems in Sinop, Mato Grosso, Brazil



The seed banks size increased in 2013 and after were reduced in 2014 to levels close to the year 2012 for almost all treatments. The treatment 5 in 2013 showed the highest density during the three years of evaluation, while the treatment 3 and 7 presented similar density in 2013 and 2014. The curves were adjusted to quadratic models ($y=a+bx+cx^2$).

References cited

Ikeda & Cavalieri (2015). Sistemas integrados de produção para o manejo preventivo da resistência de *Amaranthus* spp. In: Inoue et al. Manejo de *Amaranthu*s. São Carlos: Rima, 2015. p. 183-194.

Acknowledgements
To CNPq and Embrapa.

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Influence of *Peltophorum dubium*(Sprengel) - Taubert densities on photosynthetically active radiation, in livestock-forest system.

Flavia A. MATOS[1]*, Débora M. HEID[1], Luciano S. de REZENDE[1], Felipe L. G. BORGES[1], Thais CREMON[1], Ítalo M. ROMAN[1]
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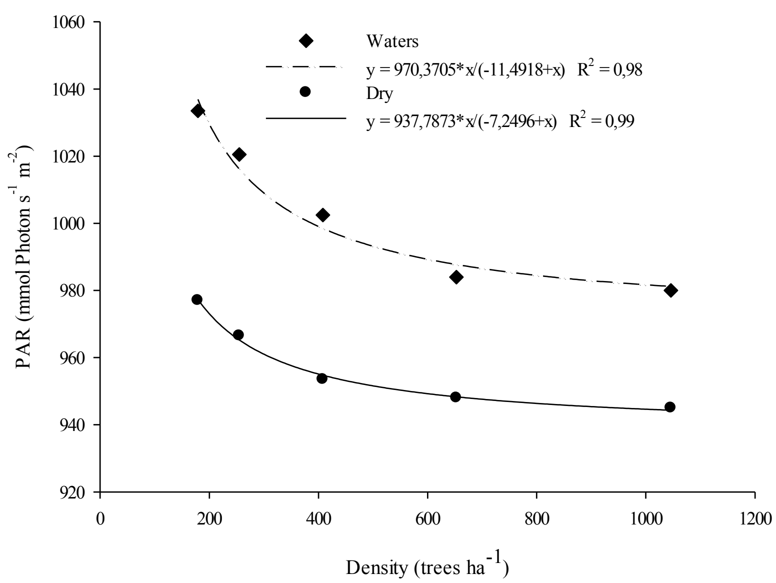
Introduction With the growth of trees in livestock-forest system there is a progressive decrease of light available for plant growth below the trees, it may influence negatively and decrease the biomass accumulation of forage (Paciullo et al., 2011). This study evaluated the influence of *Peltophorum dubium*(Sprengel) tree density on photosynthetically active radiation(PAR).

Material and Methods

The experiment was carried out at the Experimental Farm of Universidad Federal da Grande Dourados, with geographic coordinates 22° 13 '18:54 "S, longitude 54°48'23.09" and average altitude of 412 m. The PAR was taken in the summer and winter season in five planting densities of *Peltophorum dubium*(Sprengel) (179, 255, 408, 653 and 1046 trees ha^{-1}).

Results and Conclusions

Fig. 1. Photosynthetically active radiation indices (PAR) for *Peltophorum dubium*(Sprengel) trees.



The PAR was little influenced by the density of *Peltophorum dubium*(Sprengel) trees. The lowest values of PAR, observed at higher density, indicate a situation very common in livestock-forest system, where the entry of light in the canopy is reduced due to presence of trees. However, the difference among the values was considered small among the summer and winter season (Fig.1) being 5.5 and 4% respectively, and 4.5% between seasons.

References cited

Paciullo et al. (2011) PAB 46:1176-1183.

Acknowledgements

To Universidad Federal da Grande Dourados and *In memoriam* teacher PhD. Omar Daniel.

Flavia Araujo Matos

Influence of peltophorum dubium(sprengel) - taubert densities on photosynthetically active radiation, in livestock-forest system.

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Biomass accumulation of *Urochloa brizantha* cv. Piatã in a silvipastoral system

Flavia A. MATOS[1]*, Débora M. HEID[1], Valdemir A. LAURA[2], Alex M. MELOTTO[3], Natália A. SALLES[1], Mizael TERRA[1]
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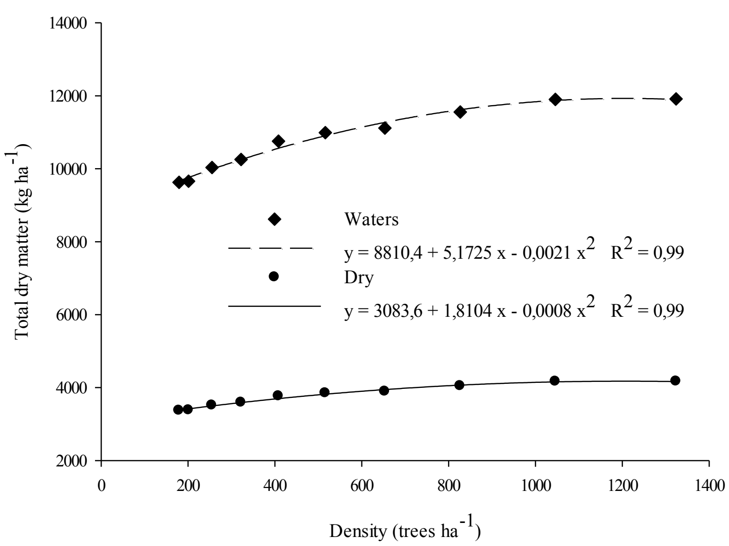
Introduction With the trees growth in silvipastoral system (SSP), there is a progressive decrease of light available in the understory that can influence and compromise the forage accumulation, according Paciullo et al. (2011). In this presentation, we evaluated the influence of canafistula tree density (*Peltophorum dubium*) on biomass accumulation of capim-piatã.

Material and Methods

This study was conducted at experimental farm of the Universidade Federal da Grande Dourados (22º 13' 18.54"S and 54º 48' 23.09"O; 412 m), in Dourados-MS. The collect of capim-piatã samples was realized during the dry season (July) and the rainy (January) of 2012 and 2013, in ten tree densities (ha^{-1}).

Results and Conclusions

Fig. 1. Biomass accumulation of capim-piatã according to the canafistula population densities in the rainy and dry seasons, in Dourados - MS.



The contribution of the highest population densities of canafistula trees for SSP was positive, because there was an increase of approximately 20% in the rainy season and 7% during the dry when compared to less studied density, considering the system age of 36 months. The lower biomass accumulation during the dry was due to low rainfall indices in the period.

References cited

Paciullo et al. (2011) PAB 46:1176-1183.

Acknowledgements

To Universidade Federal da Grande Dourados and *In memoriam* to teacher Ph.D. Omar Daniel.

Flavia Araujo Matos

Biomass accumulation of urochloa brizantha cv. Piatã in a silvipastoral system.

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Macronutrient levels for sorghum regrowth in consortium with forage and/or pigeon pea dwarf in Integrated Crop-Livestock Farming System

Gilmar C. LIMA[1*], Sanderley S. CRUZ[2], Marcelo ANDREOTTI[3], Isabô M. PASCOALOTO[1], João V. F. LATTARI[1], Caroline A. SOARES[4], Ana C. A. R. PAZ[1]
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Introduction

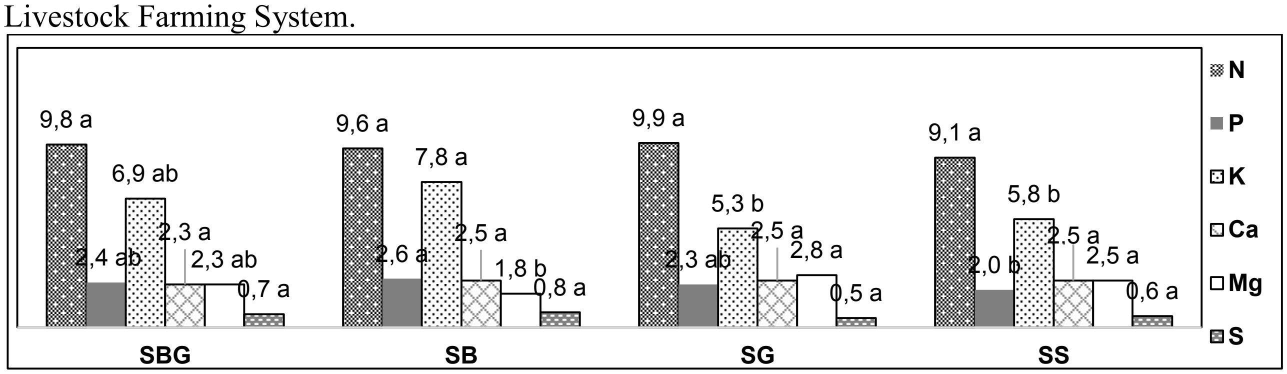
Information about nutrient extraction by sorghum in different productivity levels should be taken as a reference for defining the management of soil fertility in order to better exploit the potential of crop yield.

Material and Methods

The experiment was conducted in the agricultural year of 2013/14 in Selvíria city, Brazil. The experimental design was a randomized block design with 6 treatments and 4 replications. The treatments were: sorghum (cv. Volumax) monocrop (SS); sorghum in consortia with U. brizantha cv. Marandu (SB); sorghum with P. maximum cv. Mombaça (SP); sorghum with pigeon pea dwarf (Cajanus cajan) (SG); sorghum with Marandu grass and dwarf pigeon pea (SBG); and sorghum with Mombaça grass and pigeon pea dwarf (SPG), cut down to 0,30 m for silage (May 2014). The sorghum and forage were mechanically sown on the same line and pigeon pea was sown between rows, spaced 0,50 m. In sowing fertilization was used 300 kg ha^{-1} of the formulated 08-28-16 and in side dressing it was used 120 kg ha^{-1} N (ammonium sulfate). To assess the macronutrient levels (Malavolta et al., 1997) and the sorguhm dry matter production, it was collected 1 m² of material (3 replicates/portion).

Results and Conclusions

Picture 1. Levels (g kg^{-1}) of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sulfur (S) of sorghum in consortium with forage and pigeon pea dwarf in Integrated Crop-Livestock Farming System.



**different letters in the same column differ in 5% by Tukey test.

In the Picture 1 it can be seem that the consortium that provided the highest and the lowest content of macronutrients was sorghum with pigeon pea dwarf, with 9.9 g kg^{-1} of N and 0.5 g kg^{-1} S, respectively. There was not sorghum regrowth in consortium with Mombaça grass and and/or pigeon pea dwarf.

References cited

MALAVOLTA, E. et al. **Avaliação do estado nutricional das plantas:** princípios e aplicações. 2.ed. Piracicaba: Associação Brasileira para Pesquisa da Potassa e do Fosfato, 1997. 319p.

Acknowledgements

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Gilmar Cotrin de Lima

Macronutrient levels for sorghum regrowth in consortium with forage and/or pigeon pea dwarf in integrated crop-livestock farming system

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Macronutrients determination in tropical forage resulting from the consortium with sorghum regrowth in lowland Cerrado

Gilmar C. LIMA[1*], Sanderley S. CRUZ[2], Marcelo ANDREOTTI[3], Isabô M. PASCOALOTO[1], João V. F. LATTARI[1], Caroline A. SOARES[4], Isabela M. D. M. Fernandes[1]
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E-mail address of presenting author*: gilmar_palmeirense@hotmail.com

Introduction

The consortium plants compete for production factors, among which we highlight the macronutrients. After the plant material harvested for silage, the regrowth of intercropping plants may have their nutritional content changed, reflecting the quality of forage produced. The purpose was to evaluate the macronutrient of grasses Marandu and Mombasa installed in consortium with sorghum and / or dwarf pigeon pea after the regrowth of plants harvested for silage production in cerrado conditions.

Material and Methods

The experiment was conducted in the agricultural year of 2013/14 in Selvíria city, Brazil. The experimental design was a randomized block design with 6 treatments and 4 replications. The treatments were : sorghum (cv. Volumax) in monocrop (SS); sorghum in consortia with *U. brizantha* cv. Marandu (SB); sorghum with *P. maximum* cv. Mombaça (SP); sorghum with pigeon pea dwarf (*Cajanus cajan*)(SG); sorghum with Marandu grass and dwarf pigeon pea (SBG); and sorghum with Mombaça grass and pigeon pea dwarf (SPG), cut down to 0,30 m for silage (May 2014). The sorghum and forage were mechanically sown on the same line and pigeon pea was sown between rows, spaced 0,50 m. In sowing fertilization was used 300 kg ha^{-1} of the formulated 08-28-16 and in side dressing it was used 120 kg ha^{-1} N (ammonium sulfate). To evaluate the levels of macronutrients (N, P, K, Ca, Mg and S) in forage was harvested 1 m² of the material (3 replicates/portion), according to Malavolta et al. (1997).

Results and Conclusions

Table 1. Macronutrient levels in tropical forage in consortium with sorghum and/or pigeon pea dwarf in Integrated Crop-Livestock Farming System in the Cerrado.

Treatments	N	P	K	Ca	Mg	S
	g kg^{-1}					
SBG	17,0 a	2,6 a	18,7 a	3,4 c	3,8 b	1,3 a
SB	15,6 ab	2,7 a	17,3 a	2,9 c	3,6 b	1,1 a
SPG	12,3 bc	1,8 b	9,3 b	6,0 b	4,7 a	1,1 a
SP	10,9 c	1,9 b	6,7 b	7,3 a	5,4 a	1,3 a
CV (%)	9,93	11,54	32,73	34,02	14,33	17,12

CV (%) = coefficient of variation; different letters differ at 5% by Tukey test.

It is observed in Table 1 that the macronutrient absorbed in higher quantities was the K and the absorbed in lower quantities was the S in the tested consortium. The nutrient content showed the following descending order N>K>Ca>Mg>P>S.

References cited

MALAVOLTA, E. et al. **Avaliação do estado nutricional das plantas:** princípios e aplicações. 2.ed. Piracicaba: Associação Brasileira para Pesquisa da Potassa e do Fosfato, 1997. 319p.

Acknowledgements

Thanks to FAPESP and CNPq for granting research fellowships to the authors.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Gilmar Cotrin de Lima

Macronutrients determination in tropical forage resulting from the consortium with sorghum regrowth in lowland Cerrado

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Carbon dynamics in different pasture managements in Atlantic Rainforest biome

Paulo Roberto da ROCHA JUNIOR[1], Guilherme Kangussú DONAGEMMA[2]*, Lucas Santos SATIRO[1], Felipe Vaz ANDRADE[1], Raphael Bragança Alves FERNANDES[3], Eduardo de Sá MENDONÇA[1]
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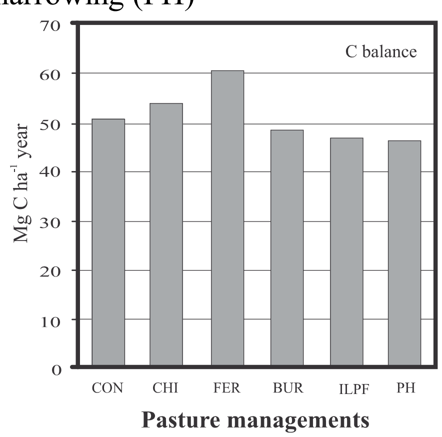
Introduction
Few studies in Brazil have shown that C storage in grassland soils has a crucial importance, because tropical conditions usually improves oxidation of the organic matter and increases C-CO_2 emissions. This storage is dependent of soil management in the pastures. The objective of this study was to evaluate the C balance in different systems of pastures managements.

Material and Methods
The experiment was carried out at experimental farm of Universidade Federal do Espírito Santo (22° 44' E, 41° 21' W, 120 m) located in Alegre – ES. The experiment was evaluated from September 2013 to August 2014, coinciding with the first year after pasture plantation. Different pasture managements were studied: pasture control (CON); pasture chisel (CHI); pasture fertilizer (FER); pasture burned (BUR); pasture on integrated crop-livestock-forest (iCLF); and pasture on plowing and harrowing (PH). *Eucalyptus* was planted on pasture iCLF, and in all treatments was planted *Brachiaria brizantha*. The C inputs and outputs were monitored and the C balance was considered the difference between inputs and outputs in each treatment. The inputs considered were the C present in plant aerial part, litter, soil (0-20 cm) and roots (0-20 cm). The outputs were the C from C-CO_2 emissions and eroded sediments.

Results and Conclusions
Figure. 1. Carbon Balance in different pasture managements. pasture control (CON); pasture chisel (CHI); pasture fertilizer (FER); pasture burned (BUR); pasture on integrated crop-livestock-forest (iCLF); and pasture on plowing and harrowing (PH)



All pastures management exhibit positive C balance after one year. The best results was verified at pastures FER, followed by CHI. The practice of plow and harrow promoted the less carbon balance result. The sequence of C balance between the managements found were FER > CHI > CON > BUR > ILPF > PH.

Acknowledgements
To FAPES, CAPES, farmers and the field work collaborators.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Guilherme Kangussu Donagemma

Carbon dynamics in different pasture managements in Atlantic Rainforest biome

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Water losses in different pastures management in Atlantic rainforest biome

Paulo Roberto da ROCHA JUNIOR[1], Guilherme Kangussú DONAGEMMA[2]*, Lucas Santos SATIRO[1], Felipe Vaz ANDRADE[1], Raphael Bragança Alves FERNANDES[3], Eduardo de Sá MENDONÇA[1]
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[2]Embrapa Solos, 22460-000, Rio de Janeiro, RJ, Brazil.
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E-mail address of presenting author*: guilherme.donagemma@embrapa.br

Introduction

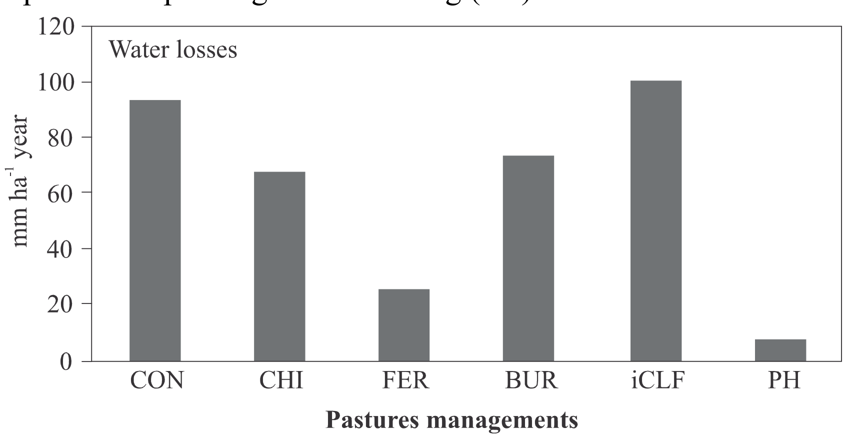
Water availability in agriculture and, generally, for society is a global problem, and studies to improve it better use are essential. Extensive pastures are common in various countries, and these areas can contribute to increasing this resources, however it is required their best use and management, aiming to promote the increase of infiltration and the reduction of water losses by runoff. In this context, the objective of the present study was to evaluate the effects of different pasture managements of pastures on water losses.

Material and Methods

The experiment was carried out at experimental farm of Universidade Federal do Espírito Santo (22° 44' E, 41° 21' W, 120 m) located in Alegre – ES. The experiment was evaluated from September 2013 to August 2014, coinciding with the first year after pasture plantation. Different pasture managements were studied: pasture control (CON); pasture chisel (CHI); pasture fertilizer (FER); pasture burned (BUR); pasture on integrated crop-livestock-forest (iCLF); and pasture on plowing and harrowing (PH). *Eucalyptus* was planted on pasture iCLF, and in all treatments was planted *Brachiaria brizantha*. The water losses were determinate after each considered erosive rainfall event. Treatments were implanted on plots for water losses estimation with dimensions of 3.5 x 11 m (35 m^2).

Results and Conclusions

Figure. 1. Water losses in different management systems of pasture. pasture control (CON); pasture chisel (CHI); pasture fertilizer (FER); pasture burned (BUR); pasture on integrated crop-livestock-forest (iCLF); and pasture on plowing and harrowing (PH).



The highest water losses were found in the managements of iCLF followed by CON, BUR, CHI, FER, PH (Figure 1). Data obtained in the first year of implementation showed that pasture after plowing and harrowing and pasture fertilizer produce less water losses. This can be associated to the higher roughness of soil, mainly in the plowing and harrowing management, that was made in contour and that provide the water infiltration in the soil avoid the water losses.

Acknowledgements

To FAPES, CAPES, farmers and the field work collaborators.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Guilherme Kangussu Donagemma

Water losses in different pastures management in Atlantic Rainforest biome

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Grain Yield of Mayze as a consequence of a crop rotation with a second crop, forage, green manure and lie fallow

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Introduction

Among the numerous benefits of Crop-Livestock-Forest Integration are: the restoration of soil fertility, the establishment of pastures with low costs, the improvement in physical, chemical and biological properties of the soil, the control of pests, pathogens and weeds, the recycling of nutrients from the soil, the increase in grain yield. The Crop-Livestock-Forest systems can increase job opportunities, the efficiency in the use of machinery, equipment and manpower, and also productivity and profitability. Quantify these benefits should be role of the research to support public policy actions.

Material and Methods

The experiment was conducted on the 2010/11 growing season. The soil is a Rhodic Hapludox located in Botucatu-SP. The experimental design was a randomized block with four replications. The plots consisted of four crop systems (I. "Mayze crop - forage" II. "Mayze crop – Second crop", III. "Mayze crop - Fallow", IV. "Mayze crop - Green Manure nt "). The hybrid 2B433 of Mayze was sown on november 18 of 2010. It were determined the yield components of the plants in two lines of 5 meters and the grains yield using all the plants in the plots of 52 m² each. Data were subjected to the analysis of variance, and means were compared by the t test (LSD), at 5% probability.

Results and Conclusions

Only the plant population and ear index were not affected by treatments. For all other treatments, the fallow system was less efficient in agronomic terms. The efficiency of crop rotation systems, especially those involving the green manure and the forage (Crop-Livestock Integration) is linked to the multiple benefits that these practices provide to production systems. Encourage more efficient systems is the most sustainable way to promote agronomic and social gains to Brazilian agriculture, which will be more charged every day by their efficiency and sustainability.

Table 1. Yield components and grain yield of mayze as a function of the crop rotation in a no tillage system. Botucatu, São Paulo State, Brazil, 2010-2011.

Tratamentos	Yield components					
	Dry matter	Population	Ear index	Grains per ear	Mass of a hundred grains	Grain Yield
Systems	kg ha^{-1}	plants ha^{-1}	----------------nº--------------		g	kg ha^{-1}
Fallow	9803d	60000a	1.1a	500c	28.58b	8339c
Second Crop	12574c	61000a	1.1a	538b	32.99a	11665b
Green Manure	14901a	60000a	1.1a	587a	32.50a	12527a
Forage Crop	14014b	60750a	1.1a	583a	33.07a	12800a
DMS (0,05)	880	3050	0,18	37,02	1,52	741
CV(%)s	7.4	11.0	3.5	7.3	5.2	16.9

Acknowledgements

The authors thank the São Paulo Research Foundation (FAPESP) for financial support (Registry numbers: 2006/01705-4, 2009/10232-0, and 2009/05066-4) and the National Council for Scientific and Technological Development (CNPq) for an award for excellence in research to the second, third, and fourth authors.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Gustavo Spadotti Amaral Castro

Grain yield of mayze as a consequence of a crop rotation with a second crop, forage, green manure and lie fallow

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Spatial variability in the productivity of maize intercropped with Tachi (*Sclerolobium paniculatum*) in the Amapá savanna - Brazilian Amazon

Gustavo S. A. CASTRO[1]*, Luis W. R. ALVES[1], Daniel M. de F. ARAÚJO[1]
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Introduction
Crop-livestock-forest systems can enable Brazilian agriculture, increasing the profit of the farmer and rancher, in addition to providing nutrients for plants, improve soil fertility, stimulates crop rotation, decrease the incidence of pests and diseases and increases jobs. In the northern region, stands out the need of search for rational exploitation of wood, being the recent research with intercropped agriculture-forest recently evaluated an alternative system of grain production.

Material and Methods
The experiment was carried out in 2013, but forest specie Tachi-white (*Sclerolobium Paniculatum*) was planted in 2010. The spacing between plants was 2 m x 12 m. In leading the Tachi was seeded maize, in the 0.80 m spacing with five plants per linear meter, seeking population of 60 000 plants per hectare. In full flower were conducted evaluations in 10 plants per plot, contemplating the dry matter production and plant height. It was also evaluated the productivity of corn grains. Data were subjected to the analysis of variance, and means were compared by the t test (LSD), at 5% probability.

Results and Conclusions
It is observed in Figure 1 large variation in all components evaluated, being that the agronomic depletion zone of productive components of maize focuses on two lines closest to the Tachi. For plant height and dry matter production, this variation is even greater, with only the central line (line 5) stands out on the other, indicating great potential for competition of this culture. On the other hand, to the grain yield, the 5 centerlines had similar results. For recommendation, according to soil and climatic conditions in the Amapá savanna and the spacing used, the planting of grains can be done until the third year in-between Tachi.

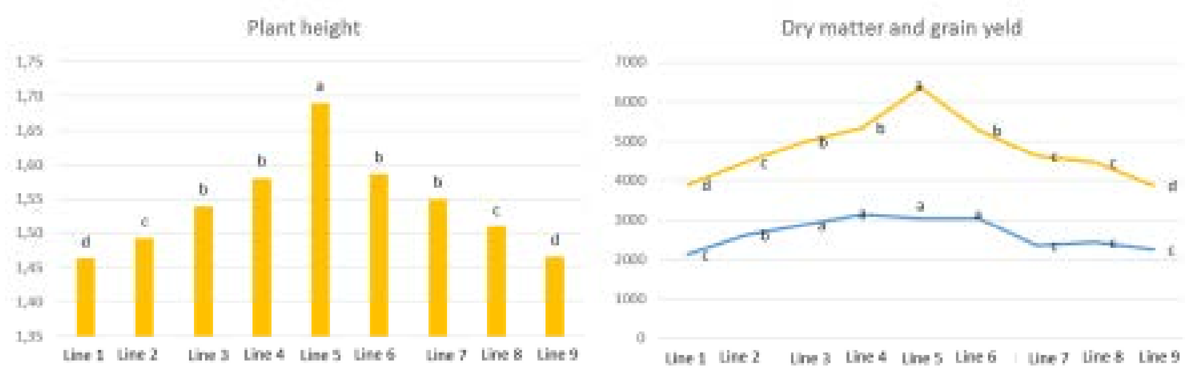

Figure 1. Maize plant height, dry matter and grain yeld as affected by distance from the Tachi.

Acknowledgements
To Embrapa and all technicians and field workers at Embrapa Amapá.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Gustavo Spadotti Amaral Castro

Spatial variability in the productivity of maize intercropped with tachi (sclerolobium paniculatum) in the Amapá Savanna - Brazilian Amazon

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BIOMASS ALLOCATION IN EUCALYPTUS IN MONOCULTURE AND SILVIPASTORAL SYSTEM

Helio TONINI[1], Marina MORALES[2], Vanderley PORFÍRIO da SILVA[2], Jorge LULU[1] Austeclinio L.FARIAS NETO[1], João L.P. MENEGUCI[3]
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Trabalho apoiado financeiramente pelo Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPQ)

Introduction

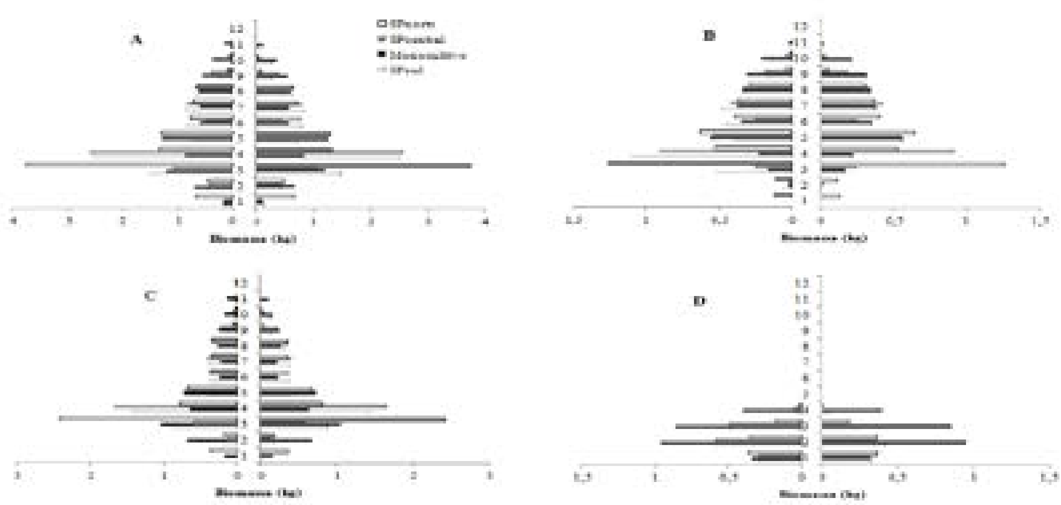
Este trabalho foi desenvolvido com o objetivo de comparar a alocação da biomassa arbórea, a conicidade do tronco e a relação altura e diâmetro, ao longo do fuste de árvores de eucalipto implantadas em sistema silvipastoril em diferentes faces de exposição solar e em monocultivo.

Material and Methods

Os dados foram coletados no campo experimental da Embrapa Agrossilvipastoril em Sinop (MT) nas coordenadas 11°52'18.99"S e 55°35'51.76"O. A espécie florestal avaliada foi o clone de híbrido *Eucaliptus grandis x Eucalyptus urophylla* (clone H13) plantado em espaçamento 3, 5 m x 3 m no monocultivo e em faixas de linhas triplas, no sentido leste-oeste, com espaçamento de 3,5 m x 3 m x 30 m no sistema silvipastoril. Foram coletados dados de biomassa arbórea aérea, conicidade do tronco e relação h/d em 13 árvores médias distribuídas em sistema silvipastoril face norte, central e sul e monocultivo.

Results and Conclusions

Fig. 1 Total biomass in the crown (A), leaves (B), live branches (C) and dead branches (D) in one meter segments of a *Eucalyptus* grown in monoculture and in silvopastoral system to 27 months.



No sistema silvipastoril, não houve efeito da posição da árvore na faixa de plantio sobre a produção total de biomassa na parte aérea, porém, árvores com face de exposição norte foram mais baixas e cônicas e produziram mais galhos e folhas nas partes inferiores da copa.
O sistema de plantio não teve influência sobre o a biomassa do tronco individual, porém na comparação com o monocultivo, as árvores plantadas em sistema silvipastoril apresentaram menor altura total, maior conicidade e biomassa na copa.

Helio Tonini

Biomass allocation in eucalyptus in monoculture and silvipastoral system

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Energy conversion of crop production systems with winter annual pastures under no-tillage

Henrique Pereira dos SANTOS[1]*, Renato S. FONTANELI[1], Anderson SANTI[2], Ana M. VARGAS[3], Amauri C. VERDI[3]
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Introduction

Production systems without crop rotation, based on agrochemicals, cause reduction in energy efficiency due to the small cover crop, coupled with the heavy reliance on external inputs. Management practices that reduce the problems outlined can be alternative to increasing the efficiency of crop production systems, especially by the use of crop rotations and management of species for green manure, cover crop, fixing N and carbon sequestration (Santos et al, 2011).

Material and Methods

The field trial was carried out at the Embrapa Trigo Research Center, in Coxilha county, RS state, for a period of 2009/10 to 2012/13. Treatments consisted of six crop-livestock production systems (CLPS): System I: wheat (W)/soybean (S) and common vetch (V)/corn (C) ; II: W/S and black oat pasture (BO)/C; III: W/S and BO/S; IV: W/S and pea (P)/C; V: W/S, dual-purpose triticale (T)/S and V/S; and VI: W/S, dual-purpose white oat (WO)/S and dual-purpose wheat (Wd)/S. Energy obtainable was considered from grain yield, dry matter yield, amount of N in the dry matter and crop residues. Energy consumed was estimated based on amount of energy coefficients corresponding to the limestone, fertilizers, seeds, fungicides and insecticides used in each CLPS and spent energy of operations (sowing, fertilizing, spraying and harvest). Energy conversion results of the energy consumed by the division obtainable in each CLPS. Data were processed in MJ (kcal x 1,000 x 4.186).

Results and Conclusions

Table 1. Energy Conversion of six integrated crop-livestock production systems under no-tillage.

Production Systems	Energy conversion-livestock production systems (Mj/ha)				
Year	2009/10	2010/11	2011/12	2012/13	Average
System I (W/S e V/C)	75.77 a	80.17 a	45.66	58.10 a	64.92 a
System II (W/S e BO/C	51.42 b	52.00 c	34.92	46.50 ab	46.21 b
System III (W/S e BO/S)	45.53 b	45.23 c	31.94	32.64 b	38.84 b
System IV (W/S e P/C)	73.98 a	72.08 ab	39.75	55.99 a	60.45 a
System V (W/S, T/S e V/S)	52.98 b	61.60 bc	32.31	36.46 b	45.84 b
System VI (W/S, WO/S e Wd/S)	46.21 b	48.76 c	35.20	33.24 b	40.85 b
Average	56.50 A	59.29 A	36.62 B	43.82 B	49.51
C.V. (%)	29	31	30	35	-
Significance level	**	**	ns	**	**

Values within a column followed by the same lower case letter or in the same row followed by the same capital letter, are not different (*P>0.05*) by Tukey. Ns: not significant; ** Significant at the 0.01level.
W=wheat; S=soybean; V=common vetch; C=corn; BO=black oat pasture; P=pea; T=dual-purpose triticale; WO=dual-purpose white oat; Wd= dual-purpose wheat.

Corn crop stood out as greater energy return, compared to other grain crops and winter pastures. Among the soil cover crops and green winter fertilization and vetch was the most efficient in energy conversion. Systems I and IV were the most efficient in energy conversion. Integration of crop livestock production systems, under no-tillage was feasible and show positive energy conversion.

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How does integrating cropping-livestock-forest systems influence sustainability issues?

Henrique Pereira dos Santos

Energy conversion of crop production systems with winter annual pastures under no-tillage

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Energy balance of crop production systems with winter annual pastures under no-tillage

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Introduction

Inputs and services used in crop rotation or crop production systems represent energy costs. Depending on these components and grain or dry matter yields, the energy expenditure will determine the efficiency of energy conversion of production systems. If the energy produced is less than the energy consumed, the energy balance is negative (Santos et al., 2010).

Material and Methods

The field trial was carried out at the Embrapa Trigo Research Center, in Coxilha county, RS state, for a period of 2009/10 to 2012/13. Treatments consisted of six crop-livestock production systems (CLPS): System I: wheat (W)/soybean (S) and common vetch (V)/corn (C); II: W/S and black oat pasture (BO)/C; III: W/S and BO/S; IV: W/S and pea (P)/C; V: W/S, dual-purpose triticale (T)/S and V/S; and VI: W/S, dual-purpose white oat (WO)/S and dual-purpose wheat (Wd)/S. Energy obtainable was considered from grain yield, dry matter yield, amount of N in the dry matter and crop residues. Energy consumed was estimated based on amount of energy coefficients corresponding to the limestone, fertilizers, seeds, fungicides and insecticides used in each CLPS and spent energy of operations (sowing, fertilizing, spraying and harvest). Energy balance is the difference between the power obtainable and consumed in each CLPS. Data were processed in MJ (kcal x 1,000 x 4.186).

Results and Conclusions

Table 1. Energy balance of six integrated crop-livestock production systems under no-tillage.

Production System	Energy balance of crop-livestock production systems (MJ/ha				
Year	2009/10	2010/11	2011/12	2012/13	Average
System I (W/S e V/C)	194.194 ab	201.651 ab	148.319 bc	196.011 ab	185.044 b
System II (W/S e BO/C)	217.294 a	212.772 a	164.148 ab	230.440 a	206.164 a
System III (W/S e BO/S)	166.882 bc	164.972 c	156.323 abc	170.070 b	164.562 c
System IV (W/S e P/C)	184.054 bc	184.503 bc	128.601 c	194.836 ab	172.998 bc
System V (W/S, T/S e V/S)	160.367 c	180.843 bc	146.308 bc	172.554 b	165.018 c
System VI (W/S, WO/S e Wd/S)	169.353 bc	181.039 bc	182.999 a	176.472 b	177.466 bc
Average	182.024 A	187.630 A	154.450 B	190.064 A	178.542
C.V. (%)	15	14	19	19	-
Significance level	**	*	**	**	**

Values within a column followed by the same lower case letter or in the same row followed by the same capital letter are not different (*P>0.05*) by Tukey. * Significant at the 0.05 level. ** Significant at the 0.01 level.

W=wheat; S=soybean; V=common vetch; C=corn; BO=black oat pasture; P=pea; T=dual-purpose triticale; WO=dual-purpose oat; Wd= dual-purpose wheat

Crop corn stood out as greater energy return, compared to other grain crops and winter pastures. System II (wheat/soybean and black oat pasture/corn) was the most efficient in energy balance. Integration of crop and livestock production systems, under no-tillage was feasible and show positive energy balance.

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Henrique Pereira dos Santos

Energy balance of crop production systems with winter annual pastures under no-tillage

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Predicting Carbon Dynamics in Integrated Production Systems in Brazil using the CQESTR Model

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Introduction: Soil can be a source or sink of atmospheric CO_2 depending on the agriculture management practiced. Process-based C models are research tools to predict management impact on soil organic carbon (SOC) and options to increase SOC stocks and reduce atmospheric CO_2. The CQESTR model was used to examine the effect of different soil management practices, including integrated crop-livestock system (iCLS), and various scenarios on soil C dynamics over time and to validate its use for tropical ecosystems.

Material and Methods: The study was conducted at Embrapa Rice and Beans Research Center, in a tropical savannah ecosystem (climate Aw, 16°28" S, 49°17" W; 803 m asl.). The land was under native vegetation until 1950s and has been in iCLS since 2000. Crop rotations included corn (*Zea mays* L.) as summer crop and 3.5 or 4.5 years in pasture (*Urochloa sp.*) in Paddock 4 (P4), and 2.5 years crop phase [soybean (*Glycine max* L.), dryland rice (*Oryza sativa* L.) and corn] followed by 2.5 or 3.5 years in pasture (*Urochloa sp.*) in Paddock 5 (P5). Soil bulk density and organic matter were determined for the 0-10 and 10-30 cm depths in 1999, 2007, 2010, 2013 and 2014. The CQESTR model was calibrated with P5 data and validated with P4 data. Model performance was evaluated as described by (Liang et al., 2009) using regression analysis and mean square deviation (MSD) statistics.

Results and Conclusions: The CQESTR model was calibrated for Cerrado by adjusting the basic decomposition rate coefficient, k, from 0.0004 to 0.0003 which improved the accuracy of the simulated SOC values for these soils. The measured and simulated values for relatively small number of observed data were significantly ($P = 0.001$) correlated (r = 95.5%) with an MSD of 2.11 indicating that the model captured spatial-temporal dynamics of SOC in the topsoil (0-10 cm) for the iCLS very well despite limited SOC data. However, CQESTR did not predict SOC accumulation trend for the 10-30 cm layer. This underestimation could be due to lack of site specific grass or crop root biomass and root distribution under tropical conditions. Additional data are required to develop suitable coefficients and parameters to calibrate the model to improve the CQESTR prediction of SOC stabilization process in the subsoil layers of tropical soils.

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Acknowledgements:
The study was financially supported by Embrapa (02.11.05.001; 01.11.01.002) and CNPq (562601/2010-4). The authors gratefully acknowledge CAPES for scholarship funding number: 14318/13-00 and the Agricultural Research Service of the U.S. Department of Agriculture.

Janaina de Moura Oliveira
Predicting carbon dynamics in integrated production systems in Brazil using the cqestr model
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Mineralogical alteration under integrated crop–livestock production system

Vanessa BERTOLAZI[1,2], Jessica OLIVEIRA*[1], Laurent CANER[2], Alberto V. INDA[1], Israel MACHADO[1], Estefane CHAVES[1], Tatiele SOARES[1].
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Introduction The integrated crop–livestock system (ICLS) can provide a more resilient and sustainable option for food production (Russelle et al., 2007). That system significantly influence the soil system, but knowledge about the effects on the mineralogy of subtropical soils is limited.

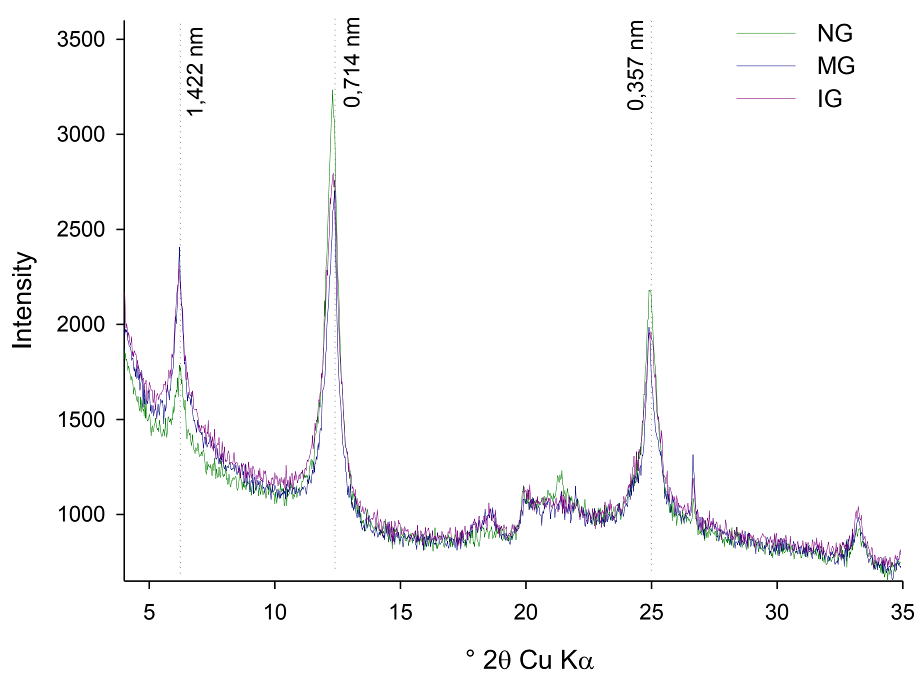
Material and Methods

This work was conducted on a long-term ICLS trial (since 2001) located in São Miguel das Missões in Rio Grande do Sul State, Brazil (28°57'23''S, 54°21'22''W). The soil, a Rhodic Hapludox, is cultivated with soybean (summer) and a mix of black oat + Italian ryegrass (winter) succession. Treatments consisted of different grazing intensities during the winter season: intensive grazing (IG), moderate grazing (MG), and no-grazing (NG). To evaluate soil chemical and mineralogical attributes, soil was sampled up to 40 cm, in November 2013.

Results and Conclusions

After 12 years under an integrated crop–livestock system (soybean–beef cattle) a similar mineralogy was observed (Fig. 1) with kaolinite (0,714 and 0,357 nm) and 2:1 minerals (1,422 nm), however the area under no grazing (NG) presented lower intensity for 2:1 minerals. The areas with intensive grazing (IG) and moderate grazing (MG) presented similar behavior.

Fig. 1. X-ray diffraction patterns from 3 to 35° 2θ, corresponding to reflections of the (00l) plane, ofthe <2 µm fraction of soil from the 0 to 0.05 m layer saturated with Caunder different grazing intensities 12 years after establishment.



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How does integrating cropping-livestock-forest systems influence sustainability issues?

Jessica Souza de Oliveira

Mineralogical alteration under integrated crop–livestock production system

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Teak growth in monoculture and integrated livestock-forest system in Figueirópolis D´Oeste - MT, Brazil

Hudson S. SOUZA[1], Antonio de A. TSUKAMOTO FILHO[1], Diogo G. S. VENDRUSCOLO[1], Reginaldo A. MEDEIROS[2], Raiane S. SILVA[3], Jhonny P. V. M. MOURA*[1], Leone D. MEDEIROS[4]
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Introduction

The Teak (*Tectona grandis* L.f.) is tropical forests native of Southeast Asian monsoon, and is currently being tested its establishment in integrated livestock-forest (iLF) systems. The iLF system is characterized in that it comprises the planting of trees with animal breeding can be simultaneous or staggered in time.

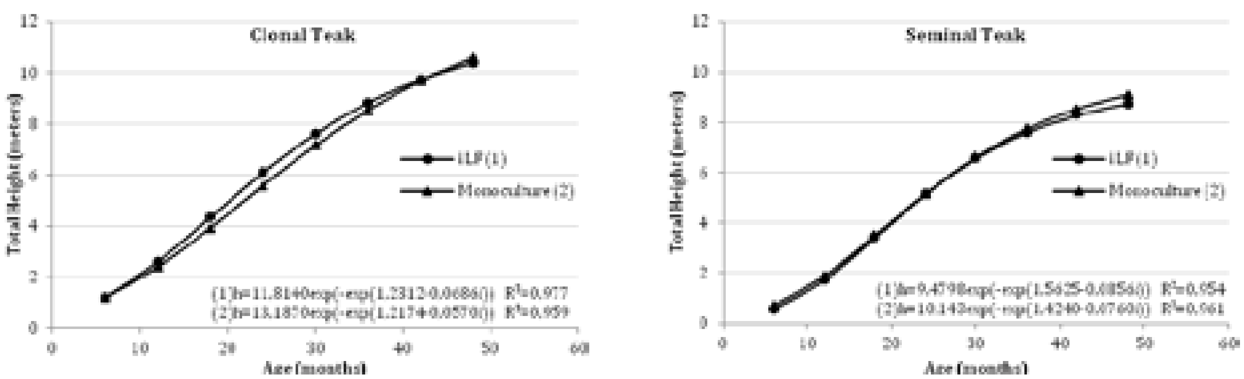
Material and Methods

The experiment was conducted in the municipality of Figueirópolis D'Oeste, Mato Grosso (15°24'27" S, 58°45'56" W) at an altitude of 344 m. The iLF system (*Tectona grandis* L.f. + *Brachiaria brizantha*) and monoculture were established in January 2010 with seminal Teak and clonal Teak. The plant spacing was 4 m x 2 m in both settlements. Data collection regarding the overall height was performed every 6 months for 48 months long. To describe growth Teak, the Gompertz model was adjusted for estimated height (h) as a function of age (i). The "t" test for homogeneus variances at the level of 95% significance was applied to verify if there was difference in height growth between the cultivation systems at the 48 months.

Results and Conclusions

The Figure 1 presents the growth of Teak at 6 to 48 months of age for the clonal and seminal material in both systems.

Fig. 1. Growth curve for *Tectona grandis* L. f. in monoculture and iLF system.



The comparison between the monoculture and iLF system by the "t" test demonstrated no significant difference, denoting that the iLF system did not affect height growth of Teak to 48 months, demonstrating the economic viability of integration compared to monoculture. According to Embrapa (2003), the iLF system emerge as a promising alternative because it is more diverse, potentially more productive and sustainable than traditional livestock systems.

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Acknowledgements

To FAPEMAT, Univ. Federal de Mato Grosso (UFMT) and IFMT – Cáceres.

Jhonny Moura

Teak growth in monoculture and integrated livestock-forest system in Mato Grosso - Brazil

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Spatial and temporal variations of soil water in an integrated crop-livestock-forestry system

João C. MEDEIROS[1]; Beáta E. MADARI[2]; André L.R. SILVEIRA[3]; Pedro L.O.A. MACHADO[2]; Luís F. STONE[2]; Mellissa A.S. SILVA[2]; Flávio J. WRUCK[2]

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Introduction The reduction in water availability in soil adversely affects the growth and development of plants. Thus, the productivity of an integrated crop-livestock-forestry system (iCLF) is also directly influenced by available soil water (Sinclair et al., 1986). This study aimed to monitor the spatial and temporal variations of water tension in the soil in an iCLF in the Cerrado.

Material and Methods The study was conducted in a iCLF deployed in a clayey Rhodic Ferralsol (Oxisol) located within the city limits of Cachoeira Dourada, GO, Brazil (18°27'43"S, 49°35'58"W). The period of Dec. 2012 to July 2013, including part of the rainy and dry seasons, was evaluated when the system was in its 4th year of establishment, having trees (*Eucalyptus urograndis*) and pasture (*Urochloa brizantha*). The iCLF was established planting the trees in triple rows spacing 2 m between plants and 3 m between rows. The spacing between the triple rows was 14 m. To monitor the water tension in the soil three tensiometer sets were used in three monitoring sites. Water tension was measured in the tree line (0.0 m) and 3.0 and 6.0 m off this line towards the middle of the pasture at three depths (0.10, 0.40, and 0.80 m), totaling 27 tensiometers. Readings were taken every 48 hours using a digital tensiometer, until the tensiometer stopped working due to the drying of the water column in it. To monitor the rainfall a rain gauge was installed near the experiment.

Results and Conclusions Figure 1 demonstrates that from the beginning of December to the beginning of April (rainy season), the soil moisture did not vary with the position of the sampling points and the surface soil layer contained more water than the subsurface soil. From the month of April, there was a reduction in precipitation and, consequently, a reduction in soil moisture, which was more pronounced near the tree rows in all soil layers, which is explained by the different consumption of water by the trees and the pasture.

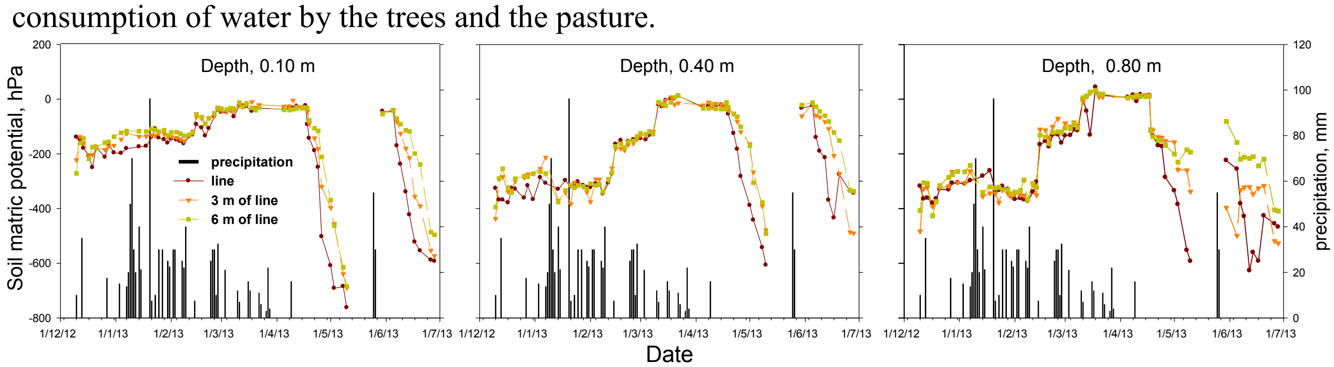

Figure 1. Soil matric potential and precipitation in an integrated crop-livestock-forestry system

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Acknowledgements to Embrapa (02.11.05.001), CNPq (562601/2010-4), CAPES and to Dr. Abílio Pacheco for making available the study site on his property, Boa Vereda farm.

João Carlos Medeiros

Spatial and temporal variations of soil water in an integrated crop-livestock-forestry system

AP26

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Soil moisture during the transition between rainy and dry seasons in a crop-livestock-forest integration area

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Introduction

In traditional systems of pasture monoculture, high temperatures result in large proportion of the absorbed water to be used to temperature control of plants, a condition that could lead to limiting water availability for biochemical and physiological processes and, consequently, negative impacts to herbage production. In crop-livestock-forest systems, modification of microclimate due to the presence of trees may result in changes on the availability of water in the soil and interfere with forage plant growth, minimising the negative effects on herbage production.

Material and methods

The experiment was carried out at Embrapa Agrossilvipastoril, Sinop, MT (11º51'S, 55º35'W and 384 m a.s.l.), from April to June 2014. The area was divided into three light regimes: (1) Piatã brachiariagrass cultivated in the absence of trees (*Eucaliptus* H13 clone) (full natural light; FL); (2) shade produced by a double row of trees on the edges of the paddocks (181 trees ha^{-1} - S1); and (3) shade produced by four triple rows of trees with pasture in between them (718 trees ha^{-1} - S2). The tree arrangements resulted in 18.1 and 55.0% reduction in photosynthetic active radiation (PAR) relative to the full natural light condition. In light regimes S1 and S2 shade strips were identified in relation to proximity to the tree lines (lateral – at 4 m from the tree line (closer to shade source), and central – positioned at the centre of the cultivated area in between tree lines (further away from the shade source)). Measurements of soil moisture were carried out through monitoring of soil water content using capacitance probes and were expressed in volumetric humidity (cm^3 cm^{-3}). Readings were taken every three days from 10 cm layers until 160 cm depth during 90 days, from the beginning of the transition between the rainy and the dry season (April 1) until the end of the experiment (June 30). Data were not subjected to analysis of variance, and are presented using descriptive statistics only.

Results and conclusions

Soil moisture remained between the soil field capacity and 50% of that level throughout the measurement period, following a descending curve typical of the transition period between the rainy and the dry seasons of the year for all light regimes, with small variation between them. Values for the 0-10 cm layer were around 12% higher than those of the 10-20 cm layer. For both layers, greater higher values were recorded for the central (0.235) relative to the lateral (0.260) strips, particularly during the drier period (June). For the 10-20 cm layer, the central strip of light regime S2 showed the highest and more stable values recorded throughout the measurement period, which were around 15% greater than those recorded for FL at the end of the experiment. However, seasonality of production at the FL regime was smaller than at S1 and S2 regimes, since shaded pastures showed a greater reduction in herbage accumulation, probably consequence of reduced root mass under those conditions (lower shoot-to-root ratio; Paciullo et al., 2010), which resulted in reduced capacity of water absorption.

References

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world congress on integrated crop-livestock-forest systems

3rd International Symposium on Integrated Crop-Livestock Systems

Carbon indexes after a short-term evaluation in different integrated crop-livestock systems under no-till in Brazilian lowland

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Introduction

Agriculture sustainability of Brazilian lowlands is a challenge for rice paddy fields. Alternatives to ameliorate this scenario, as no-till, crop diversity and integrated systems, are being proposed due to its positive effects, which can be measured in the soil organic matter (OM) dynamics. The evaluation of soil OM quantity and quality has been expressed by carbon management index (CMI) in a synergistic manner as a result of different soil management systems adoption. Thus our study aimed to evaluate the effect of short-term paddy farming systems and livestock integration on soil C indexes, 18 months after its adoption.

Material and Methods

An experiment was established in March of 2013 at the Corticeiras Farm, Cristal, in Southern Brazil (30º97'S, 51º95'W, 28 m asl). Treatments consisted in ranging vegetation diversity and rice crop intensity over time, distributed in a randomized block design with three replicates. Soil (Albaqualf) sampling was performed in September of 2014, after one summer season and two winter seasons. Treatments were consisted of (described as 1st winter-1st summer-2nd winter): 1) fallow-rice-fallow; 2) annual ryegrass (AR)-rice-AR; 3) AR-soybean-AR; 4) AR+white clover (WC)- Sudan grass-AR+WC; and 5) AR+WC+birdsfoot trefoil (BT)-succession field (native pasture species)-AR+WC+BT. All ICLS treatments were under no-till (except Rice-monocrop) but because some have lower rice crop intensity, two of them are characterized only as livestock systems. The CMI and its components, carbon stock index (CSI) and carbon lability index (CLI), were calculated according to Diekow et al. (2005), for the 0 to 10 cm soil layer.

Results and Conclusions

Table 1. Carbon indexes in the 0 to 10 cm layer in an Albaqualf, 18 months after the adoption of different paddy farming systems and in a reference area (native forest) in Southern Brazil

Treatment	Carbon stock index	Carbon lability index	Carbon management index
1	0.47 ab	0.34 b	17 c
2	0.58 ab	0.51 ab	31 bc
3	0.42 b	0.36 b	15 c
4	0.50 ab	0.52 ab	27 bc
5	0.62 a	0.71 a	49 b
Native forest	-	-	100 a

[1] Reference, with carbon management index = 100. Means followed by the same letter in the column do not differ by Tukey test ($p>0.05$, ns = not significant).

The CSI and CLI presented similar pattern. A higher value was observed under Livestock-CNP and lower values under Rice-monocrop and, especially, ICLS-Soybean (Tab. 1). Thus, Livestock-CNP that is characterized by slow crop rotation (with rice crop only every five years) and very high plant diversity showed the highest CMI among paddy farming systems. Even so, the CMI value was only 49, half of the native forest and similar to ICLS-Rice and Livestock-CP.

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Acknowledgements To Agrisus, CNPq and CAPES for the financial and scholarship support.

José Bernardo Moraes Borin
Carbon indexes after a short-term evaluation in different integrated crop-livestock systems under no-till in Brazilian lowland
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Carbon and nitrogen stocks and fractions after a short-term evaluation in different no-till integrated crop-livestock systems in Brazilian lowland

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Introduction

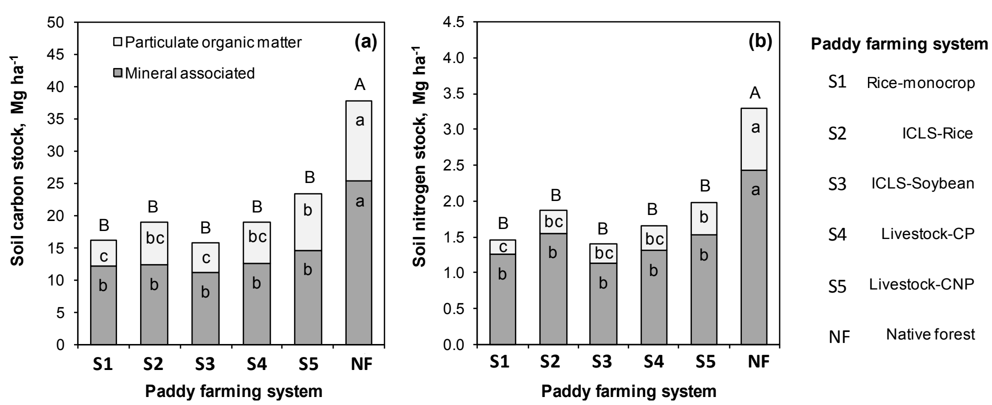
The adoption of no-till, crop diversity and integration between crop and livestock (ICLS) are being proposed to the irrigated rice fields of Brazilian lowlands, increasing agriculture sustainability in this region. Soil is considered as the central compartment where management modifications can be measured and the soil organic matter (SOM) as a key attribute to evaluate soil quality. Thus, our study aimed to evaluate the effect of short-term paddy farming systems and livestock integration on soil C and N stocks and fractions, 18 months after its adoption.

Material and Methods

An experiment was established in March of 2013 at the Corticeiras Farm, Cristal, in Southern Brazil (30º97'S, 51º95'W, 28 m asl). Treatments consisted in ranging plant diversity and rice crop intensity over time, distributed in a randomized block design with three replicates. Soil (Albaqualf) sampling was performed in September 2014, up to 10 cm depth, after one summer season and two winter seasons. Treatments were consisted of (described as 1st winter-1st summer-2nd winter): S1) fallow-rice-fallow; S2) annual ryegrass (AR)-rice-AR; S3) AR-soybean-AR; S4) AR+white clover (WC)- Sudan grass-AR+WC; and S5) AR+WC+birdsfoot trefoil (BT)-succession field (native pasture species)- AR+WC+BT. All ICLS treatments were under no-till (except Rice-monocrop) but because some have lower rice crop intensity, two of them are characterized only as livestock systems. Soil OM fractionation was performed according to Cambardella and Elliot (1992).

Results and Conclusions

Fig. 1. Carbon (a) and nitrogen (b) in different organic matter fractions 18 months of the adoption of different integrated crop-livestock systems in Southern Brazil.



Livestock-CNP that is characterized by slow crop rotation (with rice crop every five years) and very high diversity (grazed ryegrass+white clover + birdsfoot trefoil / succession field) showed higher particulate C and N stocks as compared to Rice-monocrop (Fig. 1). The only short-term differences in C and N stocks were provided in particulate OM fraction, with Livestock-CNP – that is characterized by slow crop rotation (with rice crop every five years) and very high diversity – showing higher particulate C and N stocks as compared to Rice-monocrop.

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Acknowledgements To Agrisus, CNPq and CAPES for the financial and scholarship support.

How does integrating cropping-livestock-forest systems influence sustainability issues?

José Bernardo Moraes Borin

Carbon and nitrogen stocks and fractions after a short-term evaluation in different no-till integrated crop-livestock systems in Brazilian lowland

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Soil physical attributes after conversion of degraded pasture into eucalyptus and integrated crop-livestock-forest systems in Minas Gerais State, Brazil

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Introduction

The establishment of different use and management systems causes changes in soil physical attributes. The preservation of soil properties is important to maintain the sustainability of production systems over time. In this study we evaluated the soil physical attributes after conversion of degraded pasture into eucalyptus and integrated crop-livestock-forest systems six years after establishment in Minas Gerais State, Brazil.

Material and Methods

The field experiment was installed in an area of degraded pasture (16º41'S, 43º50'W, 598m als) at Institute of Agrarian Sciences - Federal University of Minas Gerais (ICA/ UFMG) in 2009, in a completely randomized design with four treatments and four replications. Treatments included native vegetation (NAT) as the original condition of the soil, degraded pasture of *Panicum maximum* (DPA) as the as reference area before the conversion, monoculture of eucalyptus (*Eucalyptus urophylla* x *E. grandis*) (EUC) and integrated crop-livestock-forest system (ICLF). Soil samples were taken at 0-20 cm depth layer for determination of particle density, bulk density, total porosity, humidity and aggregate stability index (Embrapa, 1997).

Results and Conclusions

Table 1. Soil particle density (PD), bulk density (BD), total porosity (TP), humidity (SH) and aggregates stability index (ASI) under different systems six years after establishment. Data are means of four replicates (n=4).

Study areas	PD ($g.cm^{-3}$)	BD ($g.cm^{-3}$)	TP	SH (%)	ASI (%)
NAT	2.45 A	1.49 B	38.84 A	10.31 A	87.24 A
DPA	2.55 A	1.68 A	33.62 B	6.72 B	76.26 A
EUC	2.54 A	1.53 B	39.28 A	9.67 A	77.44 A
ICLF	2.52 A	1.53 B	34.63 B	8.52 AB	81.08 A

Means followed by the same letter in column are not different by the Tukey test ($p < 0.05$).

We found modifications on soil physical attributes six years after establishment of different land uses. Conversion of degraded pasture into eucalyptus and integrated crop-livestock-forest systems have contributed to decrease the bulk density and to maintenance of water in the soil. Areas under native vegetation and eucalyptus showed the higher soil total porosity as compared to degraded pasture. We found no differences on soil particle density, total porosity and aggregates stability index six years after establishment of integrated crop-livestock-forest system. Similar results were reported by Conte et al (2011) after seven years after establishment of integrated crop-livestock system in Rio Grande do Sul, Brazil. The sustainable use of soil can improve the physical attributes over time.

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Acknowledgements

To FAPEMIG (Fundação de Amparo à Pesquisa do Estado de Minas Gerais) for financial support. To UFMG by the maintenance of the field experiment over 6 years.

Leidivan Almeida Frazão

Soil physical attributes after conversion of degraded pasture into eucalyptus and integrated crop-livestock-forest systems in Minas Gerais state, Brazil

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Soil microbial attributes under different land uses in Minas Gerais State, Brazil

Luiz Henrique GOMES DE ABREU[1], Leidivan A. FRAZÃO[1], Fernanda V. de OLIVEIRA[1], Ariel D. P. LOPES[1], Luiz Otávio R. PINTO[1]; Regynaldo A. SAMPAIO[1]; Leonardo D. T. SANTOS[1]
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Introduction

The sustainability of the agroecosystems is important to maintain the soil quality aiming to agricultural production and the environmental preservation. In this sense, integrated production systems have many advantages that contribute to the establishment of more stable production models which can improve the needs found by agriculture. Soil microbial attributes is the main component of soil organic matter and is the more active part of the soil, so it is used as an important indicator of changes in soil quality. So, the aim of the present study was to evaluate the soil microbial attributes under different land uses in Cerrado of Minas Gerais State, Brazil.

Material and Methods

This study was carried out at Buritis Farm (16º42'33"S, 44º04'37" W), located in Montes Claros, Minas Gerais State, Brazil. We evaluate in a completely randomized design five different land uses: native vegetation (NAT) as the original condition of the soil, degraded pasture (DPA) and well managed pasture (MPA) of *Brachiria decumbens* cv. Marandu, monoculture of eucalyptus (*E. urophylla* x *E. grandis*) (EUC) and integrated livestock-forest system (ILF). Soil samples were taken at 0-5, 5-10 and 10-20 cm depth layers for determination of soil microbial carbon (Cmic), basal respiration (BR) and metabolic quotient (qCO_2) (Silva et al.2007a,b).

Results and Conclusions

Table 1. Soil microbial carbon (Cmic), basal respiration (BR) and metabolic quotient (qCO_2) at 0-5, 5-10 and 10-20 cm depth layers under different land uses. Data are means of four replicates (n=4). Means followed by the same letter in column are not different by the Tukey test ($p < 0.05$).

Study areas	Cmic (mg Cmic kg^{-1})			BR (mg C-CO_2 kg^{-1} h^{-1})			qCO_2 (mg C-CO_2.g^{-1}Cmic h^{-1})		
	Soil depth layer (cm)								
	0-5	5-10	10-20	0-5	5-10	10-20	0-5	5-10	10-20
NAT	183a	143b	168a	0.29a	0.19a	0.16a	1.90a	1.55a	0.94a
DPA	220a	148ab	148a	0.27a	0.24a	0.35a	1.26a	2.67a	2.89a
WPA	257a	175ab	171a	0.34a	0.21a	0.25a	1.35a	1.49a	1.49a
EUC	318a	288a	272a	0.31a	0.19a	0.24a	1.30a	0.88a	0.99a
ILF	187a	169ab	166a	0.27a	0.28a	0.26a	2.92a	1.99a	1.79a

We found differences on soil microbial carbon between the studied areas, since the higher values were observed in the monoculture of eucalyptus at 5-10 cm depth layer. This result can be explained due the high deposition of cultural residues after the harvesting which was performed before soil sampling. We found no differences for basal respiration and qCO_2 between the evaluated areas.

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Acknowledgements

To FAPEMIG (Fundação de Amparo à Pesquisa do Estado de Minas Gerais) by the financial support. To Buritis Farm by the availability of study areas.

Response of weed community to different agricultural systems with non-chemical management

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Introduction

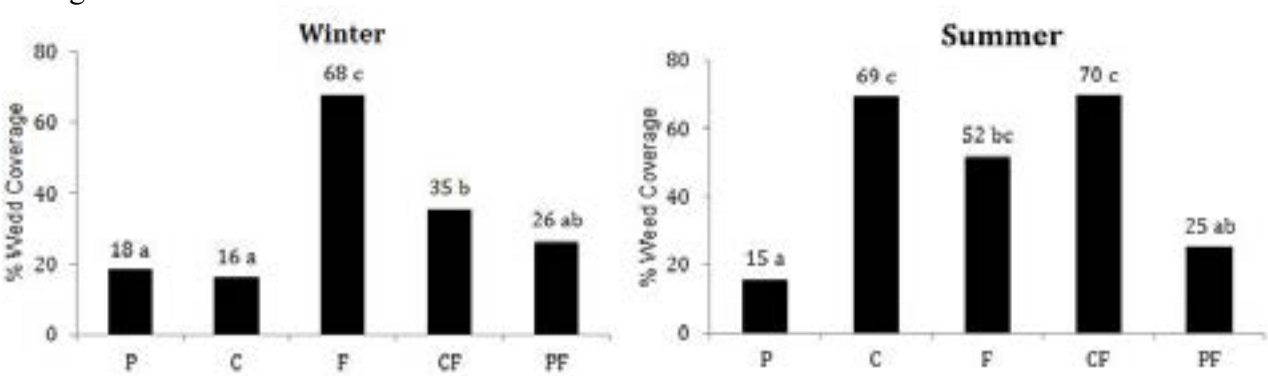
The search for alternative management of agricultural areas, improvement of environmental quality combined with the increase in production has led to the adoption of various integrated agricultural production systems (Lemaire et al. 2014). However, these diversity managements have generated changes in living community composition in agricultural ecosystems. The impacts caused by weeds can cost hundreds of billions of dollars annually through crop losses, management costs, and many other types of deleterious economic impacts. The purpose of this research was to analyze the occurrence of weeds under different production systems.

Material and Methods

The experiment was conducted at the experimental farm (25°26'S, 49°11'W, 900 m ASL) of the Federal University of Parana, located at the municipality of Pinhais, state of Paraná. The experiment consisted on randomized blocks with 3 replications in five production systems, as follows: crop (C), pasture (P), forest-forest (F), crop-forest (CF) and grassland-forest (PF) where the occurrence of weeds in winter 2014 and summer 2015 was evaluated. In each repetition were taken 21 samples divided into four transects of 14 m for each treatment, subsequently the percentage of coverage for each weed species was determined.

Results and Conclusions

Fig. 1. Weed coverage in pasture (P), crop (C), forest (F), crop-forest (CF) and pasture-forest (PF) during winter and summer.



In the winter period there was a higher occurrence of weeds on single forest system (F). in other hand, during summer the crop and crop-forest presented the highest incidence of weeds. The pasture was the system which had a lower prevalence of weeds for winter and summer.

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How does integrating cropping-livestock-forest systems influence sustainability issues?

Leonardo Silvestri Szymczak

Response of weed community to different agricultural systems with non-chemical management

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Litter comparison on two different crop-livestock-forest systems with different stages of development

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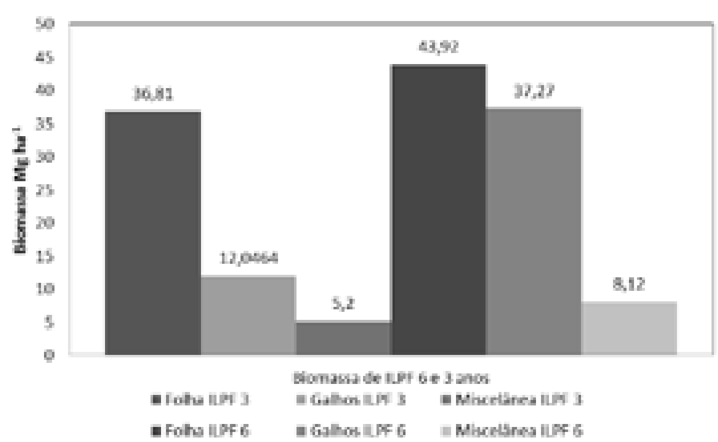
Introduction Litter is one of the most important components inside a forest ecosystem, because it is responsible for nutrients cycling and returning to system. According to Pereira et al. (2013),in crop-livestock-forest systems, litter has an important role in soil enrichment.

Material and Methods This study was conducted in Cachoeira Dourada county, south of Goiás, Brazil, in the following coordinates: 18 29’ 30’’S latitude and 49 28’ 30’’ W longitude. In studied area there are two crop-livestock-forest systems with *Eucalyptus urograndis* consorciated with a *Urochloa brizantha.* One of them has six years and the other three years. For litter collection, all the material accumulated over the soil was considered (leaves, branches, bark and miscellaneous), in different decomposition stages. A wooden frame with 0,0625 m² was used for litter collection. Samples were collect in two treatments: between rows of trees and between the trees. Fifty-four (54) samples were collected in each system. After dried in circulation oven with air exchange at 65ºC, all the material was weighed for determining the dry weight of each sample (tons/ha). Data were analyzed through factorial ANOVA with 95% of significance.

Results and Conclusions The six years crop-livestock-forest system showed the highest biomass production ($p<0,05$; Fig. 1). The comparison between trees and rows did not show difference among them. The component leaves showed the highest accumulation with 43,96 Mg/ha^{-1}, also in six years system. It can occur because a prune was conducted in the oldest system, and also bark is produced in older trees.



Acknowledgements Thanks to Fundação de Amparo à Pesquisa do Estado de Goiás (FAPEG) for sponsoring this study and also thanks to Dr. Abílio Pacheco, the owner of the experimental area, where this study was conducted.

Luanna Elis Guimarães

Litter comparison on two different crop-livestock-forest systems with different stages of development

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Productivity of maize intercropped with Gliricídia (*Gliricidia sepium*) in Amapá savanna - Brazilian Amazon

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Introduction

Crop-livestock-forest systems can enable Brazilian agriculture, increasing the profit of the farmer and rancher, in addition to providing nutrients for plants, improve soil fertility, stimulates crop rotation, decrease the incidence of pests and diseases and increases jobs. In the northern region, stands out the need of search for rational exploitation of wood, being the recent research with consortium agriculture-forest recently evaluated an alternative system of grain production.

Material and Methods

The experiment was carried out in 2013, but forest specie Gliricidia (*Gliricidia sepium*) was planted in 2010. The spacing between plants was 2 m x 12 m. In leading the Gliricidia was seeded maize, in the 0.80 m spacing with five plants per linear meter, seeking population of 60 000 plants per hectare, in nine rows of maize between the trees. In full flower were conducted evaluations in 10 plants per plot, contemplating the dry matter production and plant height. It was also evaluated the productivity of corn grains. Data were subjected to the analysis of variance, and means were compared by the t test (LSD), at 5% probability.

Results and Conclusions

There is great variation in the components evaluated (Figure 1), being that the agronomic depletion zone of productive components of maize focuses on two lines closest to the Gliricidia. Between the lines of Gliricidia showed better yields the central row and near the trees. This is possible since the formed shadow is not homogeneous, and corn can enjoy the organic waste produced by this fixing plant of N. For recommendation, according to soil and climatic conditions in Amapá savanna and the spacing used, the planting of grains can be done until the third year in-between Gliricidia.

Figure 1. Maize plant height, dry matter and grain yield as affected by distance from the Gliricidia.

Acknowledgements

To Embrapa and all technicians and field workers at Embrapa Amapá Research Centre.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Luis Wagner Rodrigues Alves

Productivity of maize intercropped with gliricídia (gliricidia sepium) in Amapá Savanna - Brazilian Amazon

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Carbon mineralization in no-till integrated crop-livestock systems in Brazilian lowlands

Luiz Gustavo de O. DENARDIN[1*], José Bernardo M. BORIN[1], Amanda P. MARTINS[1], Felipe de C. CARMONA[1], Filipe S. CARLOS[1], Flávio Anastácio de O. CAMARGO[1] and Jamir Luis S. da SILVA[2].
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Introduction

The adoption of no-till, crop diversity and integration between crop and livestock are alternatives that are being proposed to increase agriculture sustainability in the rice paddy fields of Brazilian lowlands. Soil chemical and microbial attributes are indicators of short-term changes in soil quality (Anghinoni et al., 2013). Thus, the objective of this study was to verify the carbon mineralization in different integrated systems in Brazilian lowlands.

Material and Methods

The field experiment was installed in 2013 at Corticeiras Farm, located in Cristal, Rio Grande do Sul State, Brazil. Treatments were consisted of (described as 1st winter-1st summer-2nd winter): 1) fallow-rice-fallow; 2) grazed annual ryegrass (AR)-rice-grazed AR; 3) grazed AR-soybean-grazed AR; 4) grazed AR+white clover (WC)-grazed Sudan grass-grazed AR+WC; and 5) grazed AR+WC+birdsfoot trefoil (BT)-succession field (native pasture species)-grazed AR+WC+BT. Mineralization of soil C was estimated with CO_2 evolved throughout 92 days at 25°C, from a 20 g fresh soil sample, with NaOH 0.05 mol L^{-1} extractions and HCl 0.05 mol L^{-1} titration (Alef and Nannipieri, 1995).

Results and Conclusions

Table 1. Mineralized C (C_m), potentially mineralizable C (C_0), C mineralization rate (k) and half-life of C mineralization ($t^{1/2}$) in the 0 to 10 cm layer in an Albaqualf, in Southern Brazil.

Treatment	C_m	C_o	k	$t^{1/2}$
	---------- mg C-CO_2 kg^{-1} ----------		------ $days^{-1}$ -------	----- days -------
1	541 ab	639 b	0.022 a	33 b
2	507 ab	557 b	0.026 a	27 bc
3	367 b	426 b	0.027 a	26 bc
4	447 ab	496 b	0.026 a	19 c
5	480 ab	520 b	0.025 a	28 bc
Native forest	670 a	1007 a	0.011 b	61 a

The C_m was very similar among the areas, but native forest and Treatment 3 differentiated from each other, with the lowest value for the last one (Table 1). However, the C_0 was not different among the paddy farming systems. Except for the C_m, all the values were lower when compared to the native forest. The k value did not show differences among the treatments except for the native forest value which was lower when compared to the other ones.

Since the experiment has been installed only one and a half year ago, it is important keep studying the changes and interactions that those systems can show when the soil is under those conditions in lowlands.

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Acknowledgements To Agrisus, CNPq and CAPES for the financial and scholarship support.

Enzymatic activity in no-till integrated crop-livestock systems in Brazilian lowlands

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Introduction

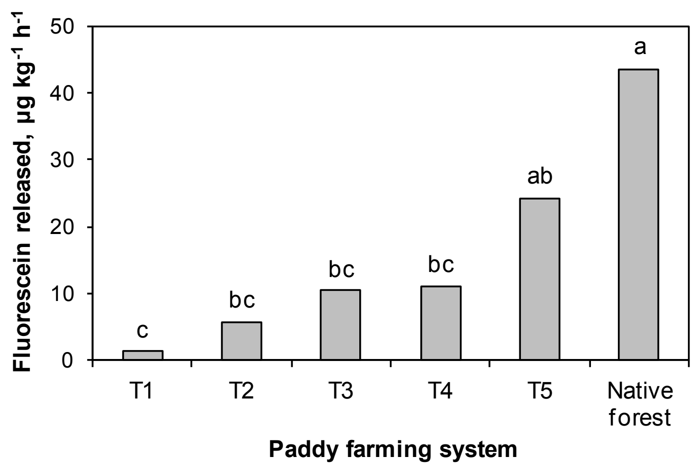
The adoption of no-till, crop diversity and integration between crop and livestock can affect physical, chemical and biological soil properties. Soil microbial attributes, as enzymatic activity and metabolic quotient are indicators of short-term changes in soil quality (Babujia et al., 2010). From this, the objective of this study was to verify the enzymatic activity in different integrated systems in Brazilian lowlands.

Material and Methods

The field experiment was installed in 2013 at the Corticeiras Farm, located in Cristal, Rio Grande do Sul State, Brazil. Treatments were consisted of (described as 1st winter-1st summer-2nd winter): 1) fallow-rice-fallow; 2) grazed annual ryegrass (AR)-rice-grazed AR; 3) grazed AR-soybean-grazed AR; 4) grazed AR+white clover (WC)-grazed Sudan grass-grazed AR+WC; and 5) grazed AR+WC+birdsfoot trefoil (BT)-succession field (native pasture species)-grazed AR+WC+BT. The enzymatic activity was measured by the hydrolysis of fluorescein diacetate, which is hydrolyzed by a range of soil enzymes (proteases, lipases, esterases) and then measured by spectrophotometer at a wavelength of 490 nm (Bandick and Dick, 1999).

Results and Conclusions

Fig. 1. Enzymatic activity after 18 months of the adoption of different integrated crop-livestock systems in Southern Brazil.



The Treatment 5 presented the higher enzymatic activity among the treatments, being similar to native forest. Among the paddy farming systems, Treatment 1 presented the lower values (Fig. 1). This treatment presented higher and lower shoot dry matter at sampling, respectively, which represents a readily decomposable material for microorganisms, reflecting in enzymatic activity.

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Bandick and Dick (1999) Soil Biol. Biochem.

Acknowledgements To Agrisus, CNPq and CAPES for the financial and scholarship support.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Luiz Gustavo de Oliveira Denardin

Enzymatic activity in no-till integrated crop-livestock systems in Brazilian lowlands

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SOCIOECOEFFICIENCY ANALYSIS OF INTEGRATED AND NON-INTEGRATED SYSTEMS OF CROP, LIVESTOCK AND FOREST IN THE BRAZILIAN CERRADO

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Introduction

The global increase in demand for food, fiber and energy is a challenge for the current agricultural production model. As a leading agricultural producer, Brazil can help meet this demand with the recovery of degraded areas. In this context, besides the recovery of degraded pastures, integrated farming systems emerge as an alternative to production intensification and land use optimization. The Brazilian Agricultural Research Corporation (EMBRAPA) led the development of Crop-Livestock integration (CLi) and Crop-Livestock-Forest integration (CLFi) systems in different regions of the country. It has been claimed that the adoption of integrated systems bring environmental, social and economic benefits. The aim of this project was to analyze the sustainability performances of CLi, CLFi systems in comparison to conventional methods of crop, livestock and forest production.

Material and Methods

The life cycle assessment cradle-to-gate approach was used to compare the integrated and non-integrated systems. All systems analyzed are located in the Brazilian Cerrado (Brazilian Savanna). The sustainability analysis was performed by means of the socio-eco-efficiency tool AgBalance™, developed by BASF and certified by independent global agencies such as DNV Business Assurance and NSF International. The study was developed based on primary data from Santa Brigida's farm (Unit of Technology Reference of EMBRAPA) and secondary data from literature for the agricultural inputs. The functional unit was the amount of soy, corn, sorghum, meat and eucalyptus (biomass for energy) to cover the average demand of 500 people in Brazil.

Results and Conclusions

Because each production system (CLFi, CLi, conventional) yields different products in different proportions, *arrangements* were composed, which are combinations of the production systems with equal output, i.e. the same functional unit. Each one of these arrangements has a dominating, protagonist system. The combinations having a higher contribution of CLFi system (followed by CLi system) presented the most eco-efficient alternatives as opposed to the arrangements built purely from conventional systems. Social sustainability indicators show better performance of CLFi and for CLi systems (concerning the occupied area); on the other hand, conventional systems score better with regard to rural employment. This result is linked to the food needs of the referenced population, and the assumption that a larger area occupied by the conventional method represents more job offers. The agricultural indicator results show better performance in those arranges with higher percentage of CLFi followed by CLi, e.g., adapted supply of organic matter to soil, higher crop rotation diversity and lower ecotoxicity impact. The most significant environmental advantages of adopting these integrated systems were lower energy use, lower emissions and lower land use. Resource depletion of integrated systems was higher due to zinc micronutrient used at cattle feed and fertilizers used for eucalyptus. The impacts of costs on the integrated systems were lower due to the higher yields.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Marcela Porto Costa

Socioecoefficiency analysis of integrated and non-integrated systems of crop, livestock and forest in the Brazilian Cerrado

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Taper equations for tree diameter and volume estimation in silvipastoral systems

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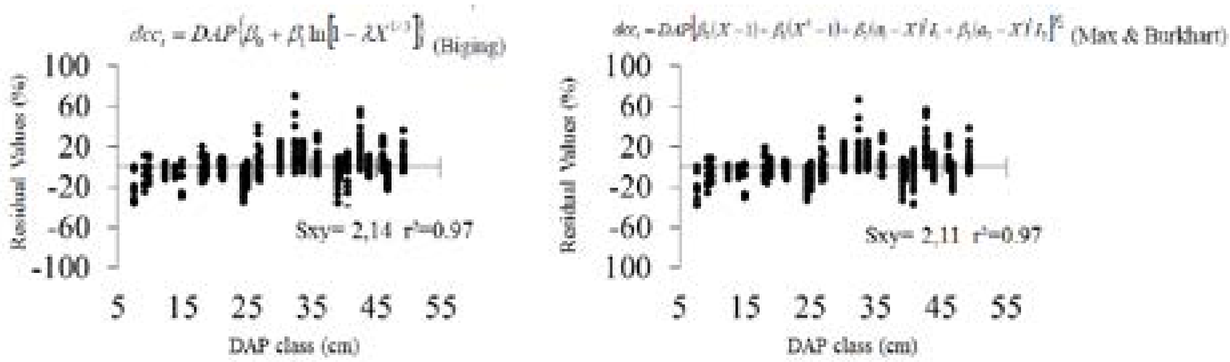
Introduction Several studies have been developed in order to define taper equations for different forest stands, species, sites, management systems, planting spacings, etc. However, specifically in silvopastoral systems, in which the spacings between tree rows are wider, the dendrometric behavior is different from that observed in pure stands. Studies for trees established in these systems are still scarce. The objective of this work was to select allometric models taper estimation of eucalypt trees established in a silvopastoral system.

Material and Methods
The data assessed were obtained from a 10-year-old mixed agrosilvipastoral system, established in a 4-ha mountainous area. Trees were arranged in 10-m wide strips of land, in contour lines, ntercalated with 30-m wide strips used for grazing. Segmented (Max & Burkhart) and non-segmented (Biging) models were evaluated for the taper equations in order to compare the accuracy of these in use in trees planted in iLPF systems as described by Müller at al (2014). Equation comparison was made by residue graphic analysis, standard error and R^2_{adj} (Kvålseth, 1985).

Results and Conclusions
Fig. 1. Graphs of residues (%) of the estimations of diameter of *Eucalyptus grandis* trees established in a 10 year-old silvopastoral system.



Despite the segmented model has shown a slightly better accuracy in the representation of the data, due to its lower standard error, the results of both models were satisfactory for use in silvopastoral systems.

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Marcela Venelli Pyles

Taper equations for tree diameter and volume estimation in silvipastoral systems

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Physic nut yield in different spacing planting and intercropping models

Marcelo D. MULLER[1], Marcela V. PYLES[2], Alexandre M. BRIGHENTI[1], Domingos S.PACIULLO[1], Carlos E. MARTINS[1], Wadson S.D. ROCHA[1], Fausto S. SOBRINHO[1]
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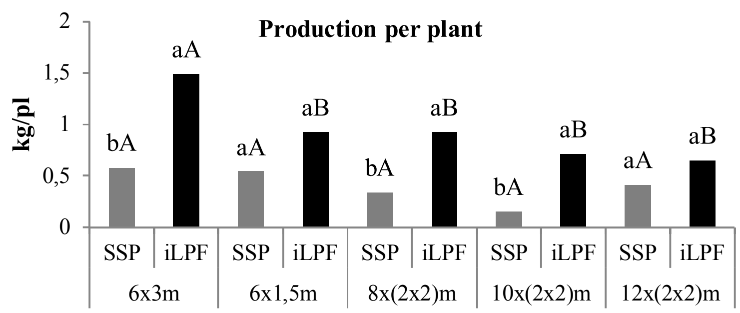
Introduction Physic nut is being considered as a potential alternative for biofuel feedstock production due to its high oil content, high yield potential and environmental adaptation. It is also an alternative for agroforestry systems as it can be intercropped with other activities. Than, the objective of this research was to evaluate the effect of different spacing plantings and intercropping models on physic nut trees yield in two harvest seasons.

Material and Methods The experiment was set up in 2009, in Coronel Pacheco-MG. The yield of physic nut trees established in two types of integrated systems (crop-livestock-forestry – iLPF, and livestock-forestry - SSP) and different spacing planting (6x3m; 12x(2x2)m; 10x(2x2)m; 8x(2x2)m; 6x1,5m), was evaluated. For this evaluation was accounted the number of branches with fruit, the number of curls in each branch, number of fruits per curls and number of seeds per fruit of a sample of 10 trees.

Results and Conclusions
Fig. 1. Scrolling effect of consortium type within each spacing yield (kg plant-1) of physic nut located in different spacing and types of systems. Lowercase letters: differences between spacings. Uppercase letters: differences between systems



Plants established in iLPF system showed significantly higher production values compared to those established in SSP system, which can be attributed to use of residual fertilizer from maize crop by tree component. Plants established in greater spacing (6x3m and 6x1.5m) had higher yields which shows that the production per plant increases significantly with spacing between plants, compensating thus the lowest population density. Therefore, we conclude that physic nut production is higher in iLPF systems and systems with fewer trees per area compared to SSP systems and denser (Müller et al., 2015).

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How does integrating cropping-livestock-forest systems influence sustainability issues?

Marcelo Dias Muller

Physic nut yield in different spacing planting and intercropping models

ANVG

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Prunning height influence on eucalyptus trees established in silvopastoral systems

Marcelo D. MULLER[1], Wadson S.D. ROCHA[1], Carlos E. MARTINS[1], Fausto S SOBRINHO[1], Alexandre M. BRIGHENTI[1], Marcela V. PYLES[2]
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Introduction The artificial pruning is a common silvicultural practice used in forest stands to produce high quality wood. Pruning may benefit plant growth and its dendrometric characteristics (Finger et al., 2001). It also has benefits to the understory growing pastures by reducing canopy closure (Fontan et al., 2011). Few pruning studies have been undertaken for intercropped crop-livestock-forestry systems related to intensity, frequency and age of pruning. This study aimed to evaluate the effect of pruning intensity on the growth of tree eucalyptus clones established in an intercropped crop-livestock-forestry system.

Material and Methods

The study was carried out in a 4 hectare area in Coronel Xavier Chaves-MG. The trees were established in rows composed by two lines of trees spaced by 3 meters between lines and 2 meters between plants. Each row was spaced by 24 meters (pasture área), totaling 370 trees per hectare.

The Basal Area, Tree height and Volume increases were evaluated under two ages of first prunning (12 and 18 months), and tree pruning intensities (25, 35 and 55% of tree high). The diameter at breast high (DBH) and total plant high (Ht) were measured from 12 to 30 months, each six months. After, the basal area per plant (BA) and the individual volume (IndVol) as well as its increases in the period (per month) were calculated.

These data were submitted to analysis of variance and the means were compared using the Scott-Knott test (P<0,05)

Results and Conclusions

Fig. 1. Increases in Basal Area (BA), Total Height (H) and Individual Volume (IndVol) of tree eucalypts clones under different pruning intensities and ages of first pruning.

Age (months)	Prunning height	BA(m^2/tree)	H (m)	Ind Vol (m^3/tree)
12	25%	0.0111 a	7.8 a	0.0592 a
12	35%	0.0108 a	7.8 a	0.0577 a
12	55%	0.0107 a	7.7 a	0.0585 a
18	25%	0.0112 a	8.2 a	0.0618 a
18	35%	0.0106 a	7.8 a	0.0574 a
18	55%	0.0107 a	8.2 a	0.0594 a

As it can be seen in Tab. 1, neither the age of first pruning or pruning intensity affected basal area, tree height and volume increases. It may be attributed to lower competition for resources in such systems have the largest spacing between trees. It also suggests that in silvopastoral systems, the intensity of pruning can be higher.

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Marcelo Dias Muller

Prunning height influence on eucalyptus trees established in silvopastoral systems

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world congress on integrated crop-livestock-forest systems

Setting management zones in a crop-livestock system from the soybean yield map

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Introduction A tool with great potential to use in Crop-Livestock System (CLS) is the Precision Agriculture (PA), which, when applied to livestock systems, is called Precision livestock Farming (PLF). The PLF allows managing the forage resources and animals efficiently. Thus, this study aimed to evaluate the relationship between the soybean crop productivity and the annual ryegrass biomass production within management zones (MZ) defined through the soybean crop map.

Material and Methods

The study was conducted in a consolidated CLS area at Bage – Rio Grande do Sul, in the agricultural year 2012/13, located between the geographic coordinates (WGS 84), 31 ° 19'09 "S and 53 ° 59'36" O, with an average altitude of 200 m. The experimental design was in randomized blocks, distributed as a factorial 3x2 with four replications. From the soybean yield data, in the next stage, the area of pasture was divided into three MZ: High (12.2% of the area); Low (17.2% of the area) and Medium productivity (70.6% area). To estimate the dry matter (DM) production of the forage over the cycle (130 days), four exclusion cages (EC) per MZ were installed to measure the differences on pasture yield within the different zones. The sum of the differences of cuts made inside and outside the EC in each MZ, resulted in the total pasture DM yield over the production cycle.

Results and Conclusions

There were no differences between the MZ, showing an amplitude of only 337 kg DM/ha. The total forage DM yields within the low, medium and high productivity areas were: 4310, 4123 and 4460 kg/ha respectively. Thus, it can be inferred that the MZ delimited from a single yield map of the previous crop (soybean) was not efficient to estimate the following forage production zones. These results agreed to those described by Guedes Filho et al. (2010), who studied the productivity of five grain crops in a rotational system for a period of eight years and proved that there was a high temporal variability between crop yields. In addition, these authors showed that crops resulted in different productivity distributions.

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Acknowledgements

To Embrapa, Stara and UFSM.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Marcelo Pilon

Setting management zones in a crop-livestock system from the soybean yield map

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Maize aboveground dry matter production under anticipated nitrogen fertilization cultivated in Crop-Livestock System

Marcieli MACCARI[1*], André B. SOARES[1], Tangriani S. ASSMANN[1], Marcos A. BORTOLI[1], Denise A. G. ALEJALDE[1], Daniel F. MIOTTO[1], Débora C. A. DA CRUZ[1].
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Introduction

In crop-livestock systems, nitrogen fertilization is the most important issue on the animal and maize production. N fertilization could be made at the pasture phase and its recycling and N-fertilizer storage in the soil promote increase in N availability for the subsequent period enhancing maize performance. This research aimed to evaluate the dry matter production of maize, subjected to nitrogen fertilization on pasture or grain crop.

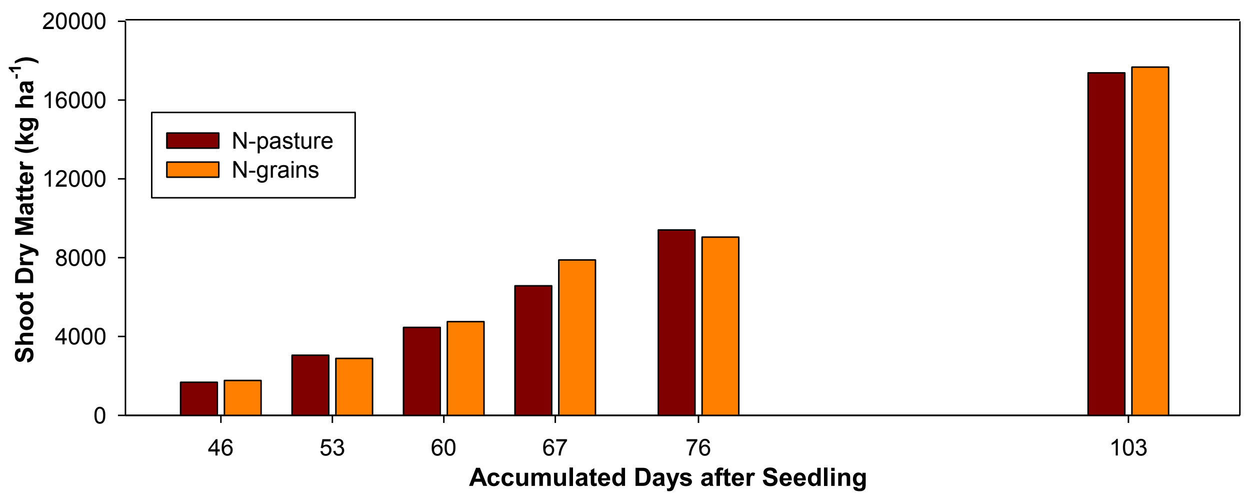
Material and Methods

The work was carried out from September, 2012 until now, in the county of Abelardo Luz, Brazil. The region's climate is subtropical humid with 1.800 mm mean annual rainfall. The soil at the experimental site was a Clayey Oxisol. The experiment was arranged complete randomized block design with four replications to compare application time of nitrogen fertilization: N fertilization time: in the treatment N-pasture, nitrogen (200 kg ha-1 N) was applied as urea in the pasture phase (2014). In the treatment N-Grains, nitrogen (200 kg ha-1 N) was applied in urea form just in the corn phase, stages 6 to 7 leaves (2013/2014). Corn hybrid 'Máximus' was sowed in 10^{th}October, 31 days after the removal of animals. Aboveground dry matter accumulation was evaluated by cutting 4.5 m lines of corn each plot at 46, 53, 60, 67, 76 e 103 days after corn sowing.

Results and Conclusions

There was no effect of N-fertilization in accumulated corn aboveground dry matter. The accumulated MS ranged from 1.6 to 17.7 ton DM ha^{-1} (Figure 1). In conclusion, the N-fertilization might be applied in grazing period, previously to the corn sowing to ensure greater use of cycling and nutrient providing high yields on maize.

Figure 1: Maize aboveground dry matter accumulated in relation to the days after sowing.



How does integrating cropping-livestock-forest systems influence sustainability issues?

Marcieli Maccari

Maize aboveground dry matter production under anticipated nitrogen fertilization cultivated in crop-livestock system

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Assessment of the nitrogen nutritional status of Maize under anticipated nitrogen fertilization cultivated in Crop-Livestock System

Marcieli MACCARI[1*], André B. SOARES[1], Tangriani S. ASSMANN[1], Marcos A. de BORTOLLI[1], Denise A. G. ALEJALDE[1], Joel T. SOUZA[1], Andressa C. BENDER[1].
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Introduction

Nitrogen nutrition index is management tool to make early diagnosis of nutritional status of plants during the development of culture and thus determine the actual need for additional application of nitrogen fertilizer. This research aimed to evaluate the nitrogen nutrition index of maize, subjected to nitrogen fertilization on pasture or grain crop.

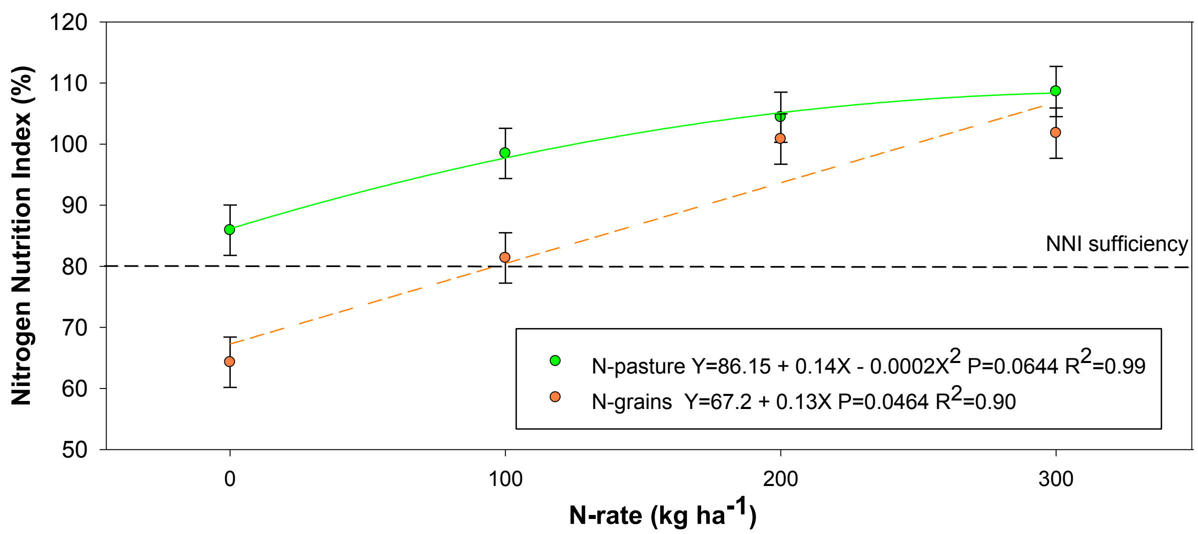
Material and Methods

The study was carried out in the city Abelardo Luz (SC) in a Clayey Oxisol. The experimental design was a randomized block design with three replications. The treatments were arranged in a 2 x 2 factorial arrangement. The first factor was **N Fertilization Time**: in the N-Pasture level, nitrogen (200 kg ha^{-1} N) and in N-Grains level, no nitrogen was applied. The second factor was the **Grazing Height**, characterized by two sward heights of oat at 15 cm (Low Height Pasture) and at 30 cm (High Height Pasture). Corn hybrid 'Maximus' was sowed in 10thOctober, 31 days after the removal of animals. In the twelve resulting plots from the combination of treatments on pasture phase (**N Fertilization Time x Grazing Height**) rates of N-fertilizer (0, 100, 200 e 300 Kg ha^{-1} of N) as urea were allocated in the split plot. The equation for determining the nitrogen nutrition index (NNI) was: $NNI = (100*N\%)/(3.4 *DM^{-0.37})$.

Results and Conclusions

Anticipated N-fertilizer (N-Pasture) resulted in better NNI and even when N was not applied in corn (0 N-rate) anticipated N-fertilizer kept NNI above the NNI sufficiency level. The plants in N-Grains plots have reached the same NNI observed in N-Pasture when it were applied 200 and 300 kg ha^{-1} N.

Figure 1: Nitrogen nutrition index of maize in relation to N-rates and N-fertilization rates



* To the bars that are not coincident, the averages differ by DMS test (minimum significant difference) at 5% probability

Marcieli Maccari
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Straw production of ryegrass under different managements in Crop-Livestock Integration system

André B. SOARES[1], Marcio PIGOSSO[2], Rafael A. G. OLIVEIRA, Luryan T. KAGIMURA[1], Angélica ZATTA[1], Anderson C. LIMA[1], Ricardo B. AIOLFI[1], Izabela GOMES[1], Bruno A. H. SCHMALZ[1].
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Introduction

The management of soil-covering within the crop-livestock integration system is a practice usually performed. The correct choice of the period of cover crop from desiccation evento is a key issue in the system, since it is well-planned, allows addition soil protection benefits, a strong initial growth of the subsequent cash-crop, weed suppression, reduction of nutrient and soil losses, problems of allelopathy and plantability and reducing the interval in which the soil is without any cultivation and there is more intensive exploitation of the land.

Material and Methods

The work was carried out on a farm in Renascença-Paraná-Brazil, between April 2013 and April 2014. Two experiments were conducted with the use of ryegrass, with or without grazing, both were set up in of randomized blocks with split plot with four replications design. The plots consisted of three intervals between desiccation and sowing of corn (IDS) (0, 15 and 30 days) and the subplots were composed of two levels of nitrogen fertilization of corn (0 and 150 kg ha^{-1}). The production of straw was evaluated by collecting two samples of 0.25 m² per plot, held on the corn sowing. Data from both trials were gathered and subjected to analysis of variance and F test. When found significance, the means were compared using the Tukey test at 5% error probability through the statistical software SAS Statistical Analysis System - SAS v. 9.0 (SAS Institute, 2002).

Results e Conclusions

Tabela 1. Interaction between production straw (kg DM ha^{-1}) and different intervals between desiccation and sowing (IDS).

	0	15	30
	Production of Straw (kg DM ha^{-1})		
Ryegrass ungrazed	6620,80 Aa	4927,85 Ab	4042,15 Ab
Ryegrass grazed	2621,25 Ba	2443,35 Ba	2213,80 Ba

* Means followed by the same uppercase letter in the column and lowercase on the line do not differ statistically among themselves by Tukey test (P<0.05).

There was interaction (P<0.05) between grazing/no grazing and intervals between desiccation and sowing for the production of straw. The experiment with no grazing was superior in straw production when compared to with grazing one, however, although the straw production is less when there is grazing, it still has, in any of the IDS, the ideal quantities ground cover recommended by no-till system. With these results is possible to affirm that a managed under integrated crop-livestock area is able to increase the producer's profits to animal production during the Winter season, increases nutrient cycling in the system while providing enough amount of straw for the cultivation of succeeding crops.

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Marcio Pigosso

Straw production of ryegrass under different managements in crop-livestock integration system

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Corn yield under desiccation effect of ryegrass single pasture or intercropped with vetch

André B. SOARES[1], Marcio PIGOSSO[2], Rafael A. G. OLIVEIRA, Luryan T. KAGIMURA[1], Angélica ZATTA[1], Bruno A. H. SCHMALZ[1], Ricardo B. AIOLFI[1], Izabela GOMES[1], Anderson C. LIMA[1].
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Introduction

The crop-livestock integration system provides diversification of agricultural and livestock activities within the rural property in the same area, which enables better use of environmental resources, resulting in higher yields of meat, milk and grains. In recent years, has searched to intensify agricultural production to ensure a better use of land and the lenght time between desiccation of winter pasture and sowing of grain crops in the system is one of the managements that has been studied in order to intensify land use, which would favor an exploration of areas during almost the whole year.

Material and Methods

The work was carried out on a farm in Renascença-Paraná-Brazil through four experiments with the use of ryegrass single and intercropped with vetch, with or without grazing, all of those were conducted through the design of randomized blocks, with split plot with four replications. The plots consisted of three intervals lenghts between desiccation and sowing of corn (IDS) (0, 15 and 30 days) and the subplots were composed of two levels of nitrogen fertilization of corn (0 and 150 kg ha^{-1}). For the evaluation of grain yield were collected the three central lines of each subplot at harvest. Data from four trials were analyzed togheter, subjected to analysis of variance and F test. When found significance, the means were compared using the Tukey test at 5% error probability through the statistical software SAS *Statistical Analysis System* - SAS v. 9.0 (SAS Institute, 2002).

Results and Conclusions

Tabela. 1. Grain yield (kg ha^{-1}) in each experiment with three periods of desiccation with and without application of 150 kg N ha^{-1} in coverage in corn.

Experiment	Productivity of corn grains (kg ha^{-1})
Ryegrass no grazed	9.410 BC
Ryegrass grazed	10.727 A
Ryegrass + Vetch no grazed	8.530 C
Ryegrass + Vetch grazed	9.857 AB
Nitrogen Level	
With N	9.333 B
Without N	9.929 A

*Means followed by the same letter are not statistically different by Tukey test (P<0.05).

No interaction was observed (P>0.05) between treatments. There was a higher grain yield in experiments with grazing, which can be explained by the animal effect on nutrient cycling. Considering nitrogen fertilization level, corn performed better when no N fertilized. It can be affirmed that the nitrogen fertilization is not necessary coverage in corn in grazed areas that have been fertilized during the grazing period.

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Intercropping of soybean with *Urochloa* species

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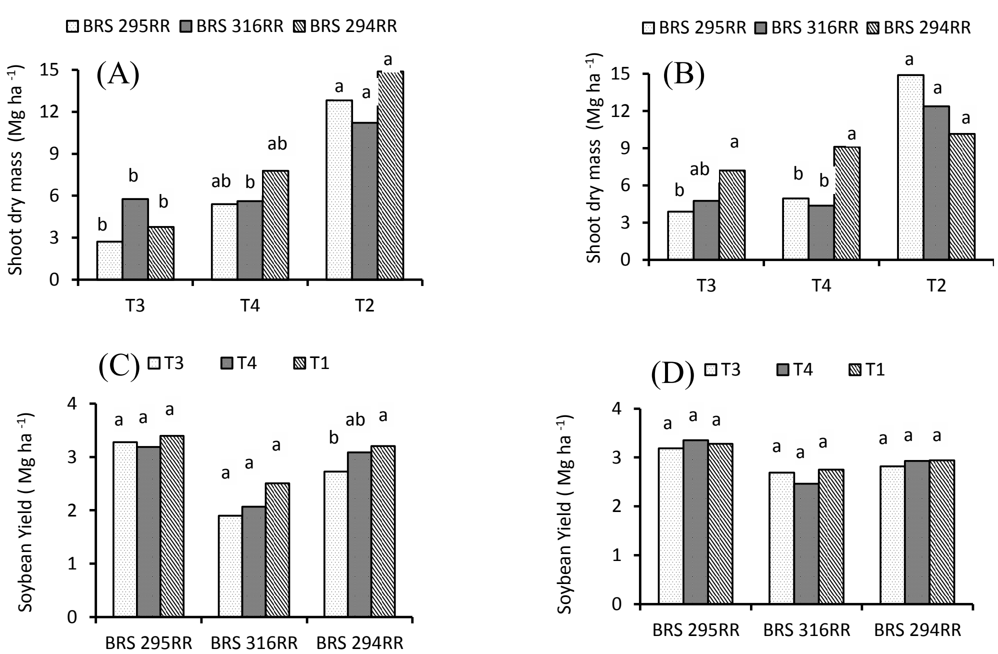
Introduction The fodder grass sowing can be performed at soybean vegetative phase, accelerating the formation of the pasture after the soybean harvest. Thus, this study aimed to evaluate the yield of glyphosate-resistant soybean cultivars intercropped with *Urochloa* species, under different fodder grass management.

Material and Methods

Six experiments, consisting of three soybean cultivars (BRS 295 RR, BRS 316 RR and BRS 294 RR) x two fodder grass species (*Urochloa ruziziensis* and *U. brizantha* cv. BRS Piatã) were carried out at Embrapa Soja Londrina, Paraná State, southern Brazil (23º11'S; 51º11'W; altitude 620 m). For each experiment, four treatments were evaluated: T1) soybean only; T2) fodder grass only; T3) soybean intercropped with fodder grass + glyphosate application (180 g a.i. ha^{-1}) to suppress the grass growth; and T4) soybean intercropped with fodder grass, without glyphosate application. The spacing between the soybean rows was 0.60 m and 200,000 plants ha^{-1}. Both fodder grass species were sown between soybean rows when the crop plants were V4 stage.

Results and Conclusions

Fig. 1. Shoot dry mass of *U. ruziziensis* (A) and *U. brizantha* (B) at soybean harvest, and yields of soybean intercropped with *U. ruziziensis* (C) and *U. brizantha* (D). Means compared by Tukey test (p>0.05)



The yields of the three soybean cultivars were not significantly affected by intercropping with the *Urochloa* grasses. The suppression of the growth of U. *ruziziensis* and *U. brizantha* with glyphosate was not necessary.

Osmar Conte
Intercropping of soybean with urochloa species
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Impact of cover crops on soil compaction for crop-livestock integrated systems in the southwestern of Brazilian Amazon

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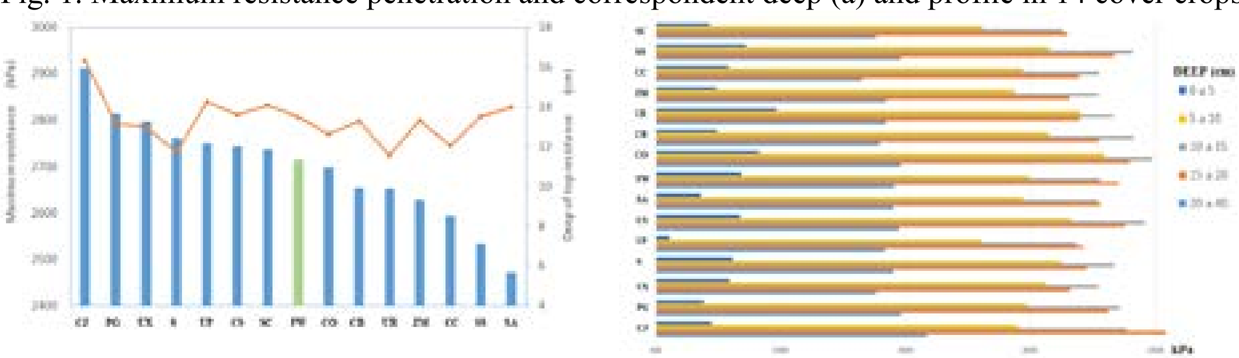
Introduction Soil compaction and its deleterious consequences are well known throughout the agricultural farming systens. Subsoil compaction has become a growing concern due to the increase of animals use pasture in cropping areas. Frequent and heavy animals traffic may modify the soil compaction in crop-livestock integrated systems (CLS), increasing soil density and soil resistance to penetration and reducing macro and total porosity with consequences to the growth and yield of crops. Cover crops can increase soil organic matter, improving physics soil quality, even breaking down previously compacted soil layers.

Material and Methods

In order to evaluate the response of several cover crops in a CLS under no tillage an experiment was carried out in the southwest of the Amazon, Rondonia. Fourteen cover crop [*Urochloa ruziziensis* (UR), *U. brizantha* cv Xaraés (UX), *U. brizantha* cv Piatã (UP), *Canavalia brasiliensis* (CB), *Cajanus cajan* (CC), *Crotalaria juncea* (CJ), *C. ochroleuca* (CO), *C. spectabilis* (CS), *Zea mays* (ZM), *Pennisetum glaucum* (PG), *Stizolobium aterrina* (SA), *Stizolobium cinereum* (SC), *Sorghum bicolor* (SB) *and Sorghum sudanense* (SS)] were sowed in March 2014. The control treatment consisted of natural fallow. In October 2014 the soil penetration resistance (0-40 cm deep evaluating each cm), the maximum resistance and the correspondent deep, in each treatment, were evaluate through an automated penetrometer (Lima et al., 2013).

Results and Conclusions

Fig. 1. Maximum resistance penetration and correspondent deep (a) and profile in 14 cover crops



The highest maximum resistance penetration were obtained from the *Crotalaria juncea*. The plants CO, CB, UR, ZM, CC, SS and SA provides maximum resistance penetration lower than the the control treatment (fallow). The average deep of the compact layer were 13,3 cm. The plants CJ, CS, CO,CB and SS provided the highest resistance to penetration in 0 to 15 cm deep in soil layer. The selection of appropriate cover crops can influence the soil compaction in a CLS under no-till.

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Pedro Gomes Cruz

Impact of cover crops on soil compaction for crop-livestock integrated systems in the Southwestern of Brazilian Amazon

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Relationship between the light intensity and the distance from eucalyptus strips in pasture

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Introduction

The recovery of degraded pastures can be done by integrated crop-livestock-forest systems (CLFS). Improving ambience for livestock without economically affecting production in this kind of system depends on orientation, length and surface area of shades projected by trees. Therefore, this study aimed to evaluate the shading of eucalyptus strips in the pasture.

Material and Methods

The experiment was conducted in the southwest of the Amazon, Porto Velho – Rondônia (Embrapa Rondônia). The experimental area is composed to 7 strips of 250 m long, with 4 rows of eucalyptus each with an average height 13 m. Distances between strips ranging 18-42 m, with the presence of pasture. For illuminance measurement is used a portable luximeter sensor, traversal being done in the morning and afternoon, lines perpendicular to strips, at points 30 meters equidistant from one another (in the direction of the rows length). Illuminance was raised one point at the center of each strip and 10 in pasture areas, corresponding one point to every tenth of the distance between two strips, totaling 61 points per transept and 1,342 points across the area. The relationship between variables was analyzed by Pearson correlation coefficient.

Results and Conclusions

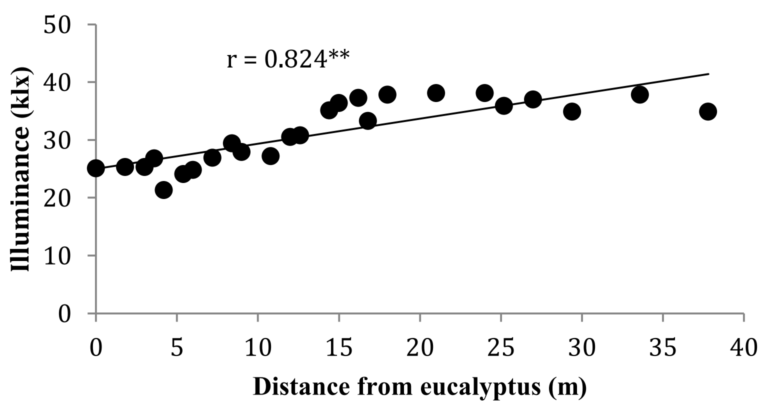

Figure 1. Correlation between the distance from eucalyptus strips and the illuminance on grassland. klx = 1,000 lux. ** Significant at the 1% level of significance.

There was a positive correlation between the distance from strips and the illuminance, showing that the closer the eucalyptus strips the lower the light intensity. So, the average illuminance under strips was 25.1 klx while on pasture the average was 31.5 klx. It concludes that the eucalyptus reduce the illuminance in pasture under strips by 25.5%. Further analyzes should be made to quantify this reduction and its effect on the development of pasture.

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Trees and grass contribution to soil organic carbon in agroforestry systems

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Introduction: Agroforestry systems have the potential to enhance carbon (C) sequestration in soil compared with treeless (agricultural) systems (Montagnini & Nair, 2004). When one type of vegetation is replaced with another, stable isotope contents (δ^{13} C) values can be used to identify soil organic carbon (SOC) derived from residues in the native vegetation and the new vegetation based on discrimination between C3 and C4 plants. The present study aimed to assessing the impact of difference land-use systems on C3 and C4 contribution to SOC.

Material and Methods: The experimental area is located inside the Cerrado biome. Soil samples were taken from six different land-use sites: (i) native local forest; (ii) Eucalyptus forest (EF) established in 1985 (OEC); (iii) EF established in 2004 (NEC); (iv) pasture of *B. decumbens*; (v) Agroforestry System (AF) established on 1994 (OAF); and (vi) AF established on 2004 (NAF). The establishment on AF was placed first with the eucalyptus planted and rice (*Oryza sativa*), soybean (*Glycine max*) and braquiaria grass (*B. Brizantha* cv. Marandu) in between trees rows. Soil was collected from four depths (0-10; 10-20; 20-50 and 50-100 cm). For stable C isotope analysis, whole soil was analyzed mass spectrometer. The percentage of SOC derived from the *Brachiaria* ssp., a C4 plant, or from the eucalyptus or native forest, a C3 plant, was estimated based on the equations: % C4-derived SOC = $(\delta - \delta_T)/(\delta_G - \delta_T) \times 100$ (1); % C3-derived SOC = 100 - % C4-derived SOC (2) Based on the equations 1 and 2 were calculated the contributions of each C3 and C4 species in SOC C-derived, as follows: C3-devived SOC (Mg ha^{-1}) = (% C3-derived SOC) x (SOC content, Mg ha^{-1}) (3); C4-derived SOC (Mg ha^{-1}) = (% C4-derived SOC) x (SOC content, Mg ha^{-1}) (4). A complete randomized design was used with Tukey's studentized. Statistical differences were considered significant at $p < 0.05$.

Results and Conclusions:

Table 1 – C4 and C3-derived soil organic carbon (SOC) in the whole soil in different depths of six different land-use systems in the Brazilian Cerrado, MG.

Depth (cm)	C4-devived SOC (Mg ha^{-1})					
	Site					
	Pasture	OEC	NEC	OAF	NAF	Forest
0–10	5.50 a	1.83 c	0.86 d	2.48 b	1.98 bc	0.97 d
10–20	4.99 a	2.39 b	1.14 c	2.59 b	2.21 b	1.43 c
20–50	4.61 a	3.17 b	1.04 d	2.96 b	2.13 c	1.78 c
50–100	3.65 a	2.98 ab	1.28 c	2.73 b	2.29 b	2.56 b
	C3-derived SOC (Mg ha^{-1})					
0–10	0.35 d	3.61 b	3.78 b	2.81 c	2.71 c	4.82 a
10–20	0.38 d	1.72 c	4.28 a	1.89 c	2.90 b	3.75 a
20–50	0.41 d	0.82 d	3.08 a	1.34 c	2.46 b	2.20 b
50–100	0.40 c	0. 58 c	2.50 a	0.88 bc	1.51 b	1.31 bc

Lowercase letters in the same row indicate significant differences in SOC at a given depth and site. OEC, old eucalyptus; NEC, new eucalyptus; OAF, old agroforestry; NAF, new agroforestry.

We conclude that most of the carbon in the cerrado soil came from grasses (C4) even when above ground vegetation is composed by trees (C3).

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Rafael Tonucci

Trees and grass contribution to soil organic carbon in agroforestry systems

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Soil chemical attributes for different land-use systems in semi arid region

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IntroductionThe evaluation of soil fertility in already placed agroforestry systems allows inferences of greater managements practices and nutrient cycling. In the semi arid region the use of integrated systems provides optimization of land and the efficient use of resources, thus becomes preponderant know soil chemical properties to assist in soil management. It aimed to evaluate soil chemical properties of agroforestry systems already placed.

Material and Methods

The experimental site was established in 1997 in the Caatinga Biome, at Luvisol area. We evaluated four different land-use (i) agrosilvopastoral system (agricultural crops: corn, sorghum with subsequent entry of goats and sheep in the area and native trees making light incidence of 80%); (ii) silvipastoral system (native pasture and native trees making light incidence of 60%); (iii) traditional (area under maize and bean intercropping without use of inputs and currently fallow for seven years); (iv) native forest (reference area - Caatinga vegetation), full descriptions can be checked in Araújo Filho and Silva (2008). Soil samples were collected in the first semester of 2013 (rainy season), at the 0-0.1 m layer. It was analysed pH; OM; P; K; Ca and; Mg as soil chemical properties.

Results and Conclusions

Fig. 1. Soil chemical properties at different land-use systems.

Land-use	OM	pH	P	K	Ca	Mg
	g dm^{-3}		--- mg dm^{-3} ---		--- $mmol_c$ dm^{-3} ---	
Agrosilvopastoral	17,1 b[1]	6,9 a	24 a	162 b	54 b	17 b
Silvipastoral	21,2 b	6,7 b	7 b	169 b	55 b	16 b
Traditional	16,5 b	5,9 c	5 b	62 c	37 c	9 b
Native Forest	26,9 a	6,8 ab	8 b	213 a	90 a	40 a

[1]Lowercase letters indicate differences (at the 0.05 probability) among land-use systems.

It was observed that native forest presented superiority to other land-use systems to the properties: soil organic matter, potassium, calcium and magnesium. Silvopasture shown greater pH values than any other land-use system. For phosphorus, the greater concentration was found at agrosilvopastoral. In general, the lower values for pH, P, K, Ca and Mg were observed for traditional land-use. The agrosilvopastoral and silvopastoral systems had better values for pH; Ca and; K when compared to traditional land-use.

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Acknowledgements

We would like to thank Embrapa for financial support.

Crop-Livestock Integration System as a sustainable production strategy in regions with climate risks

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Introduction

The crop-livestock integration system (ILP, in Portuguese) is a sustainable production strategy for climate regions with two issues that are important for crop yields and livestock: the dry spell and the dry fall and winter.

Material and Methods

To demonstrate the potential of ILP, in 2005 was installed at Embrapa Maize and Sorghum, located in the city of Sete Lagoas-MG, Brazil (19º28'S, 44º15'W) and 732 m altitude. The climate is Aw (Koppen), i.e., typical savannah with dry winter. The ILP system was implemented in four plots with area of 5.5 ha each, with no-till system, rotation and intercropping of soybean, maize-*Brachiaria* (*Urochloa brizantha*), sorghum-Tanzania (*Panicum maximum* cv. tanzania), and tanzania pasture.

Results and Conclusions

The dry spell occurred in all years except 2006/2007 and affected the crop yields (Table 1). However, they were always above the average observed in the region. In the first year it caused the loss of maize. Sorghum was the last crop to be planted and, even so, it was less affected by the water deficit, unlike soybean, which was the most affected crop. Pastures were more productive, especially during the dry season compared with pastures in the region. The use of crossbred cattle potentiated the meat gain in the ILP system, and these animals were finished in feedlots.

Table 1. Income of ILP from Embrapa Maize and Sorghum for ten years. Sete Lagoas, MG, 2015.

Year	Exploitation Type					Occurrence of Dry Spells
	Soybean	Maize Silage	Maize Grain	Sorghum Silage	Meat	
	....	Mg/ha	....		@/ha	
2005/2006	1.80	NE	0.00	31.00		Severe = S
2006/2007	2.43	NE	6.40	53.00	9.18	Absent = A
2007/2008	1.98	NE	8.17	41.40	9.38	Low = L
2008/2009	2.80	NE	8.07	40.30	NE	Low = L
2009/2010	2.20	NE	8.72	36.60	11.30	Low = L
2010/2011	2.37	NE	6.09	37.70	8.30	Medium = M
2011/2012	2.90	NE	7.15	20.08	NE	S
2012/2013	0.85	52,99	7.28	52.18	NE	Two (Nov = L and Jan = S)
2013/2014	NE	32,00	6.67	32.00	28.00	Two (Nov = L and Jan = SS)
2014/2015	in evaluation	39,00	in evaluation	43.20	in evaluation	S

NE = Not evaluated

In these ten years of experiments with ILP in the region, the results show that the rotation of crop with pasture is good strategy to increase both plant and animal productivity and enable at least reasonable harvests in the dry periods, which is a chronic problem. They also show that the crop-pasture intercropping may be conducted in order to maximize crop productivity without damages to pasture. These results were shared with farmers, technicians, and students through seminars and field days.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Ramon Costa Alvarenga

Crop-livestock integration system as a sustainable production strategy in regions with climate risks

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Pinus forest, "brachiaria" pasture and native savanna species as weeds: a conflict?

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Introduction. In this contribution the weed flora of an agroforestry trial established in the Experimental Station of the Forestry Institute in Moji Guaçu, state of São Paulo, Brazil, was surveyed and compared with the herbaceous "cerrado" vegetation (Brazilian savanna) of the surrounding area. Despite the expected buffering effect of *Urochloa decumbens* (known as "brachiaria") on the growth of weedy species , the results show a rich invading flora with a mxture of the native "cerrado" taxa and common weedies. The work also duiscuss some aspects and implications of the dispersal of the weed flora.

Material and Methods. The field observations were held at the Mogi Guaçu Experimental Station (22°15'S, 47°00'W, 570 m asl), in the state of São Paulo, Brazil, in an area of 19.2 ha divided in trials of 150X80m, correspondig to four spacing sets of *Pinus caribaea* (5X4, 4X3, 4X2, 3X2 m) with repetitions in random plots. Introduction of cattle took place after sowing of *Urochloa decumbens* grass in the ratio of 1.5 individuals per hectare. The presence of the weed flora was observed inside the plots (INT) and in the surrounding area (EXT, up to 5 meters from the limits). All species sampled have vouchers in the Herbarium Rioclarense (HRCB), at the UNESP University, campus of Rio Claro, state of São Paulo, Brazil.

Results and Conclusions. The list of "weed" species (i.e., invading species) shows 41 taxa inside the consortium pine-pasture-cattle (IN), whilst 29 are found in the surrounding area (EXT). Interestingly, the numbers are higher in the presence of the fodder used (*U. decumbens*), which is cited to buffer the occurrence of other species through the shading after the fast growth and expansion of the tufts. Although these invading species are here considered as weeds 21 have been listed as components of the herbaceous flora of the "cerrado". They were either part of the soil seed bank prior to the beginning of the experiment, or brought by animals (zoochory, birds mainly), wind (anemochory) of by the cattle itself through their movements for water consumption. The presence of their seeds mixed with the fodder seeds can also be discarded which is in fact another form of contamination. Furthermore, as no striking differences were found among the four spacing trials, and the presence of the cattle did not decrease the numbers of weed species, we strongly support the use of this consortium in large scale as it brings many aspects of sustainability through the principles of ILPF.

Reinaldo Monteiro

Pinus forest, "brachiaria" pasture and native savanna species as weeds: a conflict?

ANZC

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Energetic balance for grain, meat and biofuel production in specialized and mixed agricultural systems in the Cerrado region

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Introduction We assessed the energetic efficiency of the agricultural system, and the energetic balance of the biofuel produced, in a long term experiment (20 yrs) with specialized and mixed agricultural systems.

Material and Methods

The energetic efficiency of the agricultural system and the energetic balance of the biofuel produced were calculated from data obtained in a long-term experiment conducted in area at Embrapa Cerrados in Planaltina – DF, Brazil. The treatments evaluated were: continuous grass pasture; continuous grass-legume pasture; crop-livestock integration; and continuous grain production under no-till and conventional soil management system. The inputs of fossil energy used in consumables in each production system were evaluated as function of the grain and meat production.

Results and Conclusions

The agricultural products from integrated systems with more number of grazing cycles for animal production presented the most positive energy balance and greater renewable energy production density per year than the continuous pasture system, in both grass-alone or grass legume pastures. The energetic balance of soybean biodiesel presented a higher value in the no-till system compared to conventional soil management, reaching a value of 2:1. Among the biofuels, the highest energetic balance was obtained for maize bioetanol, reaching a value of 3.2:1. The biofuel produced in all production systems presented a positive energy balance, which can be considered sustainable from an energetic point of view.

Acknowledgements

To FAPERJ for research grants "Cientista do Nosso Estado" awarded to BJRA, SU, CPJ and RMB. We gratefully acknowledge the dedication of research scientists, technicians and field workers at the Embrapa Cerrados Centre who maintained this large experiment for over 20 years and provided the data and information.

Robert Michael Boddey

Energetic balance for grain, meat and biofuel production in specialized and mixed agricultural systems in the Cerrado region

APKM

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Organic inputs and soil cover effects on seedlings establishment in the formation of an agroforestry system in degraded soil in the Caatinga biome

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Introduction: The use of organic inputs and/or soil cover promotes beneficial effects, mainly for crops, and this is one way to alleviate the problem of environmental degradation in the Brazilian semiarid region. The objective of this study was to evaluate the use of organic fertilizers and soil cover, in degraded soil, on the surveillance and variables of development of cashew (*Anacardium occidentale*) and "Sabiá" (*Mimosa caesalpiniifolia*) seedlings in the establishment of an agroforestry system in the Brazilian Semiarid.

Material and Methods: The experiment was conducted in a degraded area placed in an Haplic Planosol inside the Caatinga biome (24M 527153m E 9475928.18 m S, 105 m asl – UTM projection). The treatments consisted of application of three organic inputs (carnauba straw - 10 t ha^{-1}, goats and sheep manure - 10 t ha^{-1} and cattle manure - 10 t ha^{-1}), and a control treatment (no application of organic input) in a randomized complete block design with four treatments and five replication. We evaluated the establishment of the plant Cashew and "Sabiá" through the percentage of survival of each species. The variables: height, stem diameter (10 cm from the ground level) and canopy spread were measured nine months after planting only in "Sabiá", due to the high mortality of cashew plants in all treatments. Like all variables presented normal distribution and homocedasticity was applied to analysis of variance (ANOVA) F, followed by the Tukey test at 5% probability, using the statistical program SISVAR.

Table 1. Chemical analyze of the experimental area.

Deph	pH	O.M.	P	K	Na	Ca	Mg	Al	H+Al	SB	CTC	V
		g kg^{-1}	mg dm^{-3}	----------------- cmol$_c$ dm^{-3} -----------------								%
0-0.2 m	5.0	4.7	1.83	0.09	0.05	0.7	0.16	0.25	1.6	1.0	2.6	37.5

Results and Conclusions: There was no effect between organic inputs on the percentage of survival of cashew seedlings, with an average of 23.32%. The low percentage of survival of cashew seedlings might be due to the low rain precipitation. In relation to the "Sabiá", there was 100% survival of seedlings in all the treatments, showing that culture is quite tolerant to drought. Regarding to height and canopy spread crown diameter to the "Sabiá" plants, no differences were observed among goat and sheep manure, carnauba straw or cattle manure. However using goat and sheep manure increased both variables compared to control treatment, probably due to the greater amount of nutrients when compared to other soil covers (Kielh, 1985), supporting the development of the seedlings.

Figure 1. Cashew and "Sabiá" seedlings survival percentage under different organic farm inputs

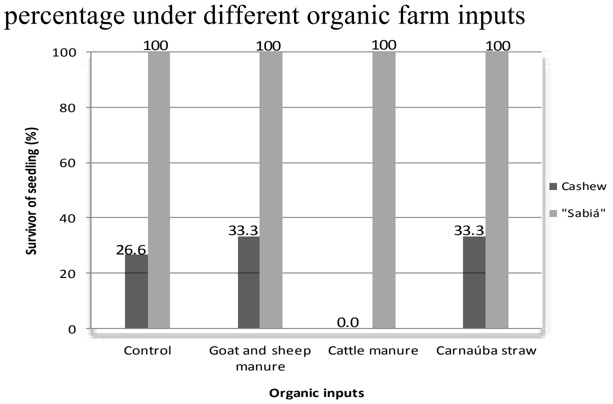

Table 2. Biometric variables in "Sabiá" seedlings under different organic farm inputs

Treatment	Variable		
	Stem diameter (mm)	Height (m)	Canopy spread (cm)
Control	8.92	0.96 b	13.11 b
Carnauba straw	11.47	1.31 ab	18.67 ab
Goats and sheep manure	11.69	1.40 a	25.67 a
Cattle manure	10.79	1.13 ab	17.67 ab
Coefficient of variation (%)	12.11	12.05	16.73

We concluded that Sabiá seedlings showed higher tolerance to drought compared to cashew ones. Furthermore, the farm inputs and soil cover increases the height and diameter of "Sabiá" seedlings.

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To the Embrapa and Confederation of Agriculture and Livestock of Brazil (CNA) by the financial support.

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Piatã grass intercropped with maize hybrids in integrated crop-livestock-forest system

Andréia da Cruz QUINTINO[1]*, Roberto Giolo de ALMEIDA[2], Joadil G. de ABREU[1], Manuel C. M. MACEDO[2], Davi J. BUNGENSTAB[2]
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Introduction

The use of agrosilvopastoral systems can be an affordable alternative to reclaim and intensify the use of pastures leading to more sustainable cattle husbandry (Paciullo et al., 2007). In this context, in the Brazilian Cerrados, adoption of such systems is increasing, combining crops, trees and cattle husbandry through rotation, mixing or succession of sown pastures with crop farming.

Material and Methods

A trial was carried out in Campo Grande, MS, Brazil (20°27' S, 54°37' W, 530 m asl) in an integrated crop-livestock-forest system based on 22x2 m single rows of eucalyptus trees (227 trees ha^{-1}) planted in 2009. Experimental design was random blocks with split plots having the three maize hybrids in the plots (Riber Sementes 9005 PRO; Dekalb 390 PRO and Dow Agrociences 2B707 HX). Split plots were sampling points (A, B, C, D, and E) with four repetitions. Points A and E were respectively the closest to tree rows and C was the central point between tree rows with B and D as intermediate points. In December 2012 maize was seeded using no-till system in 0.9 m spaced lines until 1.0 m from each side of tree rows intercropped with Piatã grass (*Brachiaria brizantha*). In April 2013 maize was harvested and Piatã grass was sampled and separated into leaf blade, stem and dead material. Photosynthetically active radiation (PAR) was measured twice a month in the morning and afternoon using a ceptometer (Accupar, model PAR-80). Crude protein of Piatã grass leaf blade content was determined using near infrared spectroscopy system (NIRS). Analysis of variance was performed and means were grouped by Scott-Knott test ($p<.05$).

Results and Conclusions

Table. 1. Forage dry matter, leaf blade proportion and crude protein of Piatã grass at five sampling points with the respective photosynthetically active radiation (PAR).

Variable	Sampling point				
	A	B	C	D	E
Forage dry matter (kg ha^{-1})	431 b	1072 a	831 a	971 a	649b
Leaf blade (%)	60,65 a	43,21 b	46,40 b	45,68 b	46,21 b
Crude protein (%)	6,60 a	4,35 b	4,89 b	4,64 b	4,95 b
PAR (%)	55,26 c	94,42 a	93,49 a	78,63 b	54,14 c

Different letters in the line are significantly diferent through the Scott-Knott test ($p<.05$).

There was no effect of maize hybrid over Piatã grass yield. There were variations on values of parameters evaluated according to sampling points, i.e. distance from trees (Table 1). At point A, under lower PAR, grass yield was lower, associated to higher leaf blade proportions and crude protein content. Therefore, for Piatã grass mixed with maize on integrated crop-livestock-system, shading has negatively influenced grass yields without reducing crude protein contents.

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Acknowledgements

Embrapa, UFMT, Capes.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Roberto Giolo Almeida

Piatã grass intercropped with maize hybrids in integrated crop-livestock-forest system

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Brachiaria genotypes yield under integrated crop-livestock-forest system in the Brazilian Cerrado

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Introduction
To better explore the production potential of integrated systems, information is needed about forage behavior under such systems. In this context, this work addressed dry matter yield of six *Brachiaria* genotypes under different levels of shading in an integrated crop-livestock-forest system in the Brazilian Cerrado.

Material and Methods
The experiment is located at Embrapa Beef Cattle, Campo Grande-MS, Brazil (20º27'S and 54º37'W; mean altitude of 530 m). Experimental design was randomized blocks in split split plots with two replicates. Plots corresponded to the forages: *Brachiaria brizantha* cultivars Marandu, Paiaguás, Piatã, Xaraés, *B. brizantha* access B4 and *Brachiaria* hybrid BRS RB 331 Ipyporã. Split plots corresponded to sample points (A, B, C, D, E and F, with different levels of shading) and the split split plots corresponded to harvesting period in 2014 (February, April and June). The system is based on 22 m distant single rows of eucalyptus trees (227 trees ha^{-1}) planted in 2009. Pastures are kept for three years, followed by one season of soybeans crop. As reference, a similar system with no trees was also established. Forages evaluated were seeded in October 2013, in 20 x 1.5 m plots with 0.25 m space between grass rows, receiving 50 kg ha^{-1} NPK 0-20-20 at seeding and 90 kg ha^{-1} after the second forage harvest. Seeding rates were adjusted for 60 pure viable seeds ha^{-1}. Forage samples were taken at five equidistant points (A, B, C, D and E) between eucalyptus rows. Point F was located in the reference system. Photosynthetically active radiation (PAR) was measured in the morning and in the afternoon using a ceptometer (Accupar, model PAR-80). Plants were cut close to the ground, weighted and dried in forced-air oven at 65ºC until constant weight was reached. Analysis of variance was performed and means were compared through Tukey test ($p<.05$).

Results and Conclusions
PAR in grass canopy at sampling points A, B, C, D, E and F averaged 302; 599; 538; 591; 365 and 1,027 $\mu m\ m^{-2}\ s^{-1}$, respectively. Grasses performed similarly for all harvests, with higher yields at point F and direct relationship between the yield and light incidence (Table 1). There was no statistical difference in dry matter yield of the different grasses, averaging 2,541 kg ha^{-1}.

Table1. Dry matter yield (kg ha^{-1}) of *Brachiaria* genotypes for three harvest periods in 2014 on sampling points with different levels of shading.

Harvest / Point	A	B	C	D	E	F
February	838 bB	1,418 abB	1,846 abB	1,263 abB	1,109 abB	2,378 aC
April	2,330 cdA	4,087 bA	3,513 bcA	2,734 cdA	1,998 dAB	5,594 aA
June	2,582 bA	3,039 abA	2,459 bAB	2,005 bAB	2,221 bA	4,331 aB

Means followed by the same letter, lowercase in lines and uppercase in columns, do not differ by Tukey test ($p>.05$).

Acknowledgements
Embrapa, Unipasto.

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Panicum maximum genotypes yield under integrated crop-livestock-forest system in the Brazilian Cerrado

Mariana PEREIRA[1*], Roberto Giolo de ALMEIDA[2], Davi J. BUNGENSTAB[2], Maria G. MORAIS[3], Beatriz LEMPP[4], Manuel C. M. MACEDO[2]
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Introduction

The trial was carried out to evaluate yield of four cultivars and one access of *Panicum maximum* grass under integrated crop-livestock-forest system (ICLF), with Eucalyptus, in the Brazilian Cerrado.

Material and Methods

The area is located at Embrapa Beef Cattle research station in Campo Grande-MS (20º27'S and 54º37'W; mean altitude of 530 m). Experimental design was randomized blocks in split split plots with two replicates. Plots corresponded to the forages: *Panicum maximum* cultivars Massai, Mombaça, Tanzânia and BRS Tamani (hybrid), and *P. maximum* access PM44 (hybrid). Split plots corresponded to sample points (A, B, C, D, E and F) and the split split plots to harvesting period in 2014 (February, 34 days of regrowth, April, 50 days of regrowth, and June, 60 days of regrowth). The ICLF system is based on single row (22 m distance) Eucalyptus trees with 227 trees ha^{-1} planted in 2009. Pastures are kept for three years, followed by one season soybeans. A similar system with no trees was seeded as reference. Forages evaluated were seeded in October 2013, in 20 x 1.5 m plots with 0.25 m spaced rows, receiving 50 kg ha^{-1} NPK 0-20-20 at seeding and 90 kg ha^{-1} in April 2014, after the second harvest. Seeding rates were adjusted for 200 pure viable seeds ha^{-1}. Forage samples were taken at five equidistant points (A, B, C, D and E) between Eucalyptus rows. Point F was located in the reference system. Plants were cut close to the ground, weighted and dried in forced-air oven at 65ºC until constant weight was reached. Photosynthetically active radiation (PAR) was also measured in these points using a portable ceptometer in the morning and afternoon, being used the daily average figures for comparisons. Analysis of variance was performed and means were compared through Tukey test ($p<.05$).

Results and Conclusions

PAR in grass canopy at sampling points A, B, C, D, E and F averaged 302; 599; 538; 591; 365 and 1,027 µm m^{-2} s^{-1}, respectively. The percentage of shade in relation to full sun was 69%; 47%; 52%; 48%; 63% and 0% on sampling points, respectively, what reflected in forage yield, showing higher average dry matter yield in point F (7,308 kg ha^{-1}) than in point E (4,774 kg ha^{-1}). But these points did not statistically differ between the points A (5,962 kg ha^{-1}), B (6,400 kg ha^{-1}), C (6,574 kg ha^{-1}) and D (5,191 kg ha^{-1}). Average dry matter yield of the forages was higher in June (7,089 kg ha^{-1}) and February (6,139 kg ha^{-1}), followed by April (4,876 kg ha^{-1}). Grasses BRS Tamani and Mombaça showed higher average dry matter yield than the access PM44 (Table 1), showing to be more adapted to shading.

Table1. Dry matter yield (DMY, kg ha^{-1}) of *Panicum maximum* genotypes (average of three cuts).

Variable	Massai	Mombaça	Tanzânia	PM44	BRS Tamani
DMY	6,156 ab	7,176 a	5,474 ab	4,008 b	7,360 a

Means followed by the same letter do not differ by Tukey test ($p>.05$).

Acknowledgements

Embrapa, Unipasto.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Roberto Giolo Almeida

Panicum maximum genotypes yield under integrated crop-livestock-forest system in the Brazilian Cerrado

APHM

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Stock and carbon levels in the soil in the tree lines or pasture lane in integrated production system (iCLF) in the western Brazilian Amazon

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Introduction:

Animal production systems in Brazil are constantly singled out as largely responsible for the emission of greenhouse gases (GHGs), mainly due to changes in land use, generated by the farming expansion, felling native vegetation and implementation of new pastures.

Integrated systems are shown as an alternative to increase the soil organic carbon accumulation, mitigating part of the carbon emitted once the presence of greater root diversity and greater biomass production from the annual crop, pasture, and forest species has led to increases in carbon stock in iCLF systems.

Despite there being the increase in the C stock, the place where this increase occurs is still controversial. Therefore, the objective of this study was to evaluate the stock (STC) and the C content (Ccont) in the soil in the tree lines or pasture lane of an integrated system iCLF with Mahogany (*Swietenia macrophylla*) and *Brachiaria brizantha* cv. Xaraés sown after corn cultivation in western Brazilian Amazon.

Materials and methods:

The work was conducted at the Experimental Station of Embrapa Western Amazon, located at km 54 of BR 174 highway. The object of the study was an agrosylvopastoral system implemented in 1991, made up of six paddocks 3000 m^2 each, with pasture associated with Mahogany, arranged in two central lines. This system pasture was reformed through the cultivation of corn associated with Xaraés and then grazed by sheeps for two years in a rotational arrangement of 7 days of grazing and resting period of 35 days. The soil is a Xanthic Ferralsol (FAO, 1990) [dystrophic Yellow Latosol –Brazilian classification (EMBRAPA, 1999)] with clayey texture and kaoliniticmineralogy.

Two years after the pasture reform, six soil samples were collected at a depth of 0 to 20cm in pasture range and at the tree lines of each of the six paddock to analyze the organic carbon content. Next to each of these samples, soil were collected with cylinders at the depth of 7cm to determine soil bulk density (BS). The STC was estimated by the formula of Veldkamp (1994). Analysis of variance was performed using the design of randomized blocks, with six replications and the means compared by F test.

Results:

The Ccont were highest on the tree lines with 19.3 g/kg of the pasture lane with 17.9 g/kg ($P < 0.0994$), however, due to the smaller bulk density (BS) in the line of trees than in the observed in the pasture lane, 0.92 g/cm^3 and 1.02 g/cm^3 respectively ($P < 0.0210$), the STC was the same in both conditions, with 36.2 Mg/ha. Although higher the BS values are in the range of normal pasture to Yellow Latosol of clay or clayey that present in the original vegetation soil density of about 1 g/cm^3.

Conclusions:

The smaller BS soil in the tree lines offsets the higher Ccont of the tree line, making the STC indistinguishable between the range of grassland and the tree line when considering the horizon of 0 - 20cm.

Rogério Perin

Stock and carbon levels in the soil in the tree lines or pasture lane in integrated production system (ICLF) in the Western Brazilian Amazon

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Macronutrient levels in tropical forage in consortium with sorghum and/or pigeon pea dwarf in Integrated Crop-Livestock Farming System

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Introduction The limitation in the nutrients absorption and changes in mineral nutrition can reduce the nutritional quality of tropical forages. The major nutrients (nitrogen, phosphorus and potassium) play an important role in the forage fertilization because of the participation in the cost of production and due to the tolerance of forage grasses to acids soil.

Material and Methods

The study was conducted in the agricultural year of 2013/14 in Selvíria, MS. The experimental design was a randomized block design with 6 treatments and 4 replications. The treatments were the sorghum (cv Volumax.) in monocrop (SS) and sorghum in consortium with: *U. brizantha* cv. Marandu (SB); *P. maximum* cv. Mombaça (SP); pigeon pea dwarf (*C. cajan*) (SG); Marandu grass and dwarf pigeon pea (SBG); and Mombaça grass and pigeon pea dwarf (SPG), cut down in the height of 0.30 m for silage (February 2014). The sorghum and forage were mechanically sown on the same line and the pigeon pea dawrf was sown between rows, spaced 0.50 m. In sowing fertilization it was used 300 kg ha^{-1} of the formulated 08-28-16 and in the cover it was used 120 kg ha^{-1} N (ammonium sulfate). To evaluate the content of macronutrients (N, P, K, Ca, Mg and S) in the resulting forage consortia, the material present in 1 m² (3 replicates/share) was cropped, oven dried (65 °C), ground and analyzed second methodology of Malavolta et al.(1997).

Results and Conclusions

It was observed in Table 1, that the consortia of forage with sorghum and/or pigeon pea dwarf was no significant difference in relation to levels of P, K and Ca, especially the Marandu grass consortia that presented the double K compared to Mombaça grass with sorghum and pigeon pea dwarf. While for P the effect was the opposite, especially for the Mombaça grass .

Table 1. Levels of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sulfur (S) in the tropical forage consortium with sorghum and/or pigeon pea dwarf in Integrated Crop-Livestock Farming System in Cerrado.

Treatments	N	P	K	Ca	Mg	S
	g kg^{-1}					
SBG	15,0 a	2,6 b	12,0 ab	2,0 b	2,2 a	1,6 a
SB	13,3 a	2,5 b	13,5 a	3,1 a	2,8 a	1,8 a
SPG	14,8 a	5,3 a	6,0 bc	2,0 b	2,4 a	1,4 a
SP	14,3 a	5,1 a	5,5 c	4,0 b	2,4 a	1,3 a
CV (%)	9,93	11,54	32,73	34,02	14,33	17,12

CV (%) = coefficient of variation; different letters in the column differ in 5% by Tukey test.

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Sanderley Simões Cruz

Macronutrient levels in tropical forage in consortium with sorghum and/or pigeon pea dwarf in integrated crop-livestock farming system

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Available potassium soil contents in pasture season of a long-term no-till integrated crop-livestock system under different grazing intensities

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Introduction

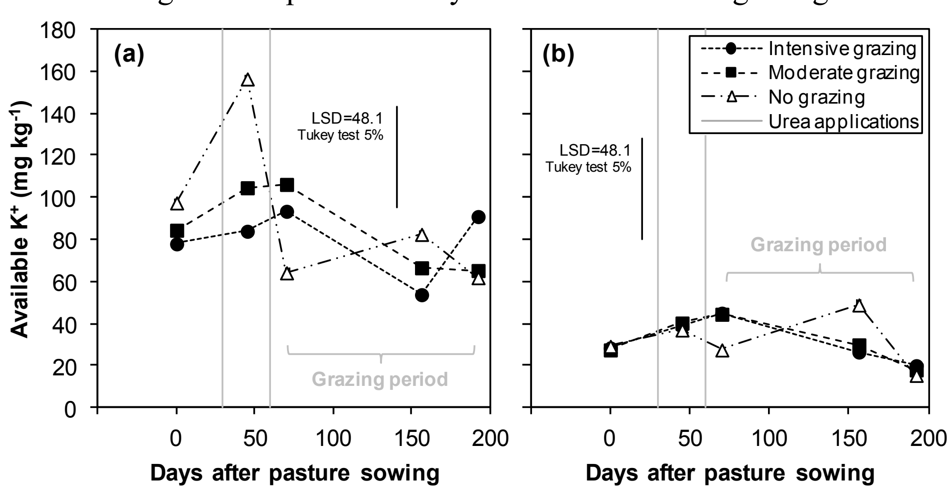
The soil chemical resilience in an integrated crop-livestock system (ICLS) (soybean-beef cattle) was verified by Martins et al. (2014), with more acidic conditions after soybean cropping. According to these authors, one of the reasons is the higher uptake of basic cations (as potassium – K^+) by soybean plants. Because K^+ availability on soil can be affected during the pasture season of the ICLS, according to pasture plants K^+ uptake, cycling and recycling, that was affected by grazing intensity (Ferreira et al., 2011), as well as the dynamics of nitrogen (N) applied as fertilizer, we aimed to verify available K^+ soil contents during the pasture season of a long-term no-till integrated crop-livestock system under different grazing intensities.

Material and Methods

An experiment was established in 2001 for an ICLS on a Rhodic Hapludox soil. Crop succession consisted of soybean cultivation during summer and a mix of black-oat + Italian ryegrass during winter. Treatments consisted of varying grazing intensities during winter: intensive grazing (IG – 10 cm pasture height), moderate grazing (MG – 20 cm pasture height), and no grazing (NG). Soil was sampled during the 2012 pasture season, when 60 + 80 kg N ha^{-1} were broadcast applied as urea. Available K^+ was determined by Mehlich 1 extractor. A three-way ANOVA and a Tukey test (5% of significance) was performed to determine the least significant difference (LSD).

Results and Conclusions

Fig. 1. Available K^+ contents in the 0-20 (a) and 20-40 (b) cm soil layer during the pasture season of a long-term no-till integrated crop-livestock system under different grazing intensities.



Available K^+ soil contents were affected by soil layer (highest values in soil surface), sampling time and grazing intensity (Fig. 1). Grazed treatments presented higher stability of K^+ contents during the pasture season evaluated.

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Martins et al. (2014) Soil Till. Res. 144: 141-149

Acknowledgements To Agrisus and CNPq for the financial and scholarship support.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Sarah Hanauer Lochmann

Available potassium soil contents in pasture season of a long-term no-till integrated crop-livestock system under different grazing intensities

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Forage production on integrated crop livestock system on southern Brazil

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Introduction

Grasslands play a key role in the dynamics of the atmosphere and hydrosphere, which turn lead to global impacts and contributes to the preservation of biodiversity and achievement future food security (Lemaire et al., 2011). Sward height management is a key factor to a good animal performance and other ecosystemic benefits. Therefore, this study aimed to ascertain whether there is a pattern in forage production over ten years of research on integrated agricultural production systems.

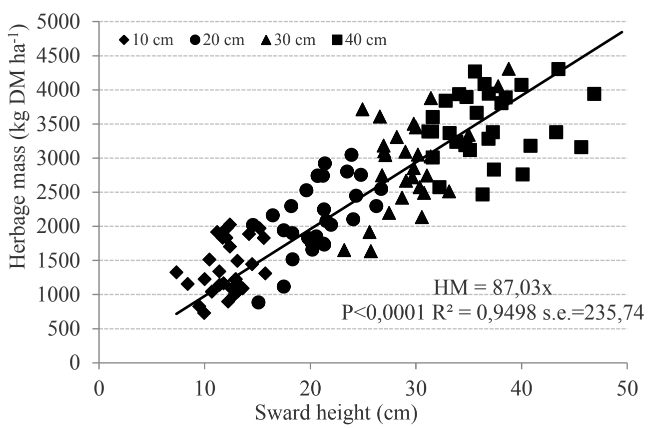
Material e Methods

The experimental area had 22 ha, divided in 12 paddocks ranging from 0.8 to 3.6 ha. It was located in the Espinilho Farm at southern Brazil. This long term protocol on ICLS is composed by an mixed pasture-oat (*Avena strigosa*) × annual ryegrass (*Lolium multiflorum*) continuously stocked over winter and soybean during summer.

Treatments corresponded to four sward surface heights: 10, 20, 30 and 40 cm, corresponding to grazing intensities. The experimental design is a randomized complete block design with three replications. Regression analysis was performed until a quadratic order, with a 10-year database (2001-2011).

Results and Conclusions

Fig 1. Herbage mass (HM) in relation to average actual sward height in mixed pastures of oats and ryegrass in a crop-livestock system under no-till.



Mean stocking rate for sward management was 1272, 915, 614 and 340 kg of LW, corresponding respectively to 10, 20, 30 and 40 cm. There are plus of 87 Kg of DM/ ha, to each centimeter summed at sward height. Total herbage accumulation and residues are different between sward surface heights evaluated increasing in 71 and 116 Kg of DM/ ha, respectively.

References

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Acknowledgements To CNPq, CAPES and FAPERGS for the financial and scholarship support.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Sylvio Solom Santana Mendina

Forage production on integrated crop livestock system on Southern Brazil.

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Multivariate analysis in integrated crop livestock systems

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Introduction

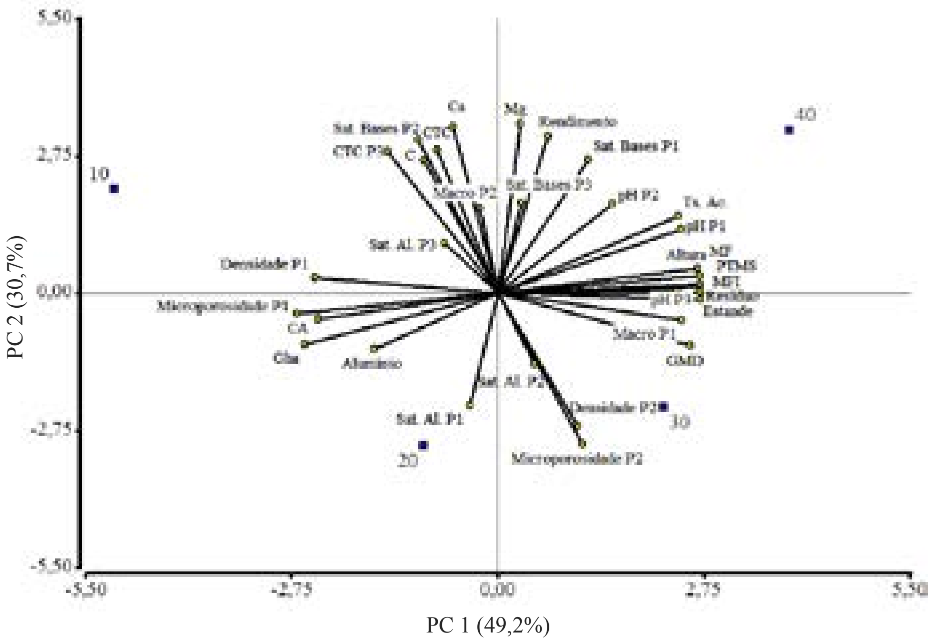
Integrated crop livestock systems (ICLS) promote ecological interactions between the different components of productive ecosystem making them more efficient in nutrient cycling through the preservation of natural resources and the environment, improving soil quality and increasing biodiversity (Lemaire et al., 2014). The importance of knowledge and study of the relationships between variables in ICLS under different spatial and temporal scales are of fundamental importance to the proper understanding of integrated systems.

Material e Methods

The work was carried out on a basis of 10 years of data (2001-2011) on ICLS under no-tillage with four treatments based on sward heights of the pasture (10, 20, 30 and 40 cm). The ICLS is composed of mixed oat x ryegrass during the winter period, with continuous grazing and variable stocking, and soybeans during the summer period. Plant variables were used (soy and pasture), soil and animal multivariate statistical analysis main components.

Results and Conclusions

Fig 1. Principal components analysis of systems variables after 10 years of the adoption of differents managenments in integrated crop-livestock systems in no-tillage in Southern Brazil.



All variables of pasture are associated with the heights 30 and 40 cm, while the variable of physic is the ground surface are associated with higher intensity grazing (10 cm).

References

Lemaire et al. (2014). **Agric. Ecosyst. Environ.** 190: 4–8.

Acknowledgements To CNPq, CAPES and FAPERGS for the financial and scholarship support.

How does integrating cropping-livestock-forest systems influence sustainability issues?

Taise Robinson Kunrath

Multivariate analysis in integrated crop livestock systems

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Crude protein content of *Brachiaria brizantha* cv. BRS Piatã in integrated crop-livestock-forest system and its relationship with the SPAD index

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Introduction

Crude protein (CP) content in tropical grasses is one of the main nutritional limiting factors for livestock on pasture. Under arboreal systems there is an increase of CP in forages. The design of a fast, efficient and cost-effective method for CP determination is strategically very important. Therefore, so the relationship of SPAD index with the CP content was tested in a trial.

Material and Methods

An experiment was carried out at Embrapa Beef Cattle (20°24'90" S, 54°42'72" W, 530 m altitude), in Campo Grande, MS, Brazil. Treatments were formed by sampling locations comprised by 5 equidistant points (A, B, C, D and E) in a pasture (*Brachiaria brizantha* cv. BRS Piatã) between the rows of eucalyptus trees, distant 22x2 m, and one location under full sun (F), in a similar pasture with no trees. Evaluations were carried out in January, April and August 2014. SPAD readings were taken on any newly shot forth grass leaf. A Chlorophyll Meter SPAD-502 was used. CP content was determined via near infrared spectroscopy system (NIRS). The data were processed using regression statistics.

Results and Conclusions

Levels of CP and SPAD index values showed the same behavior along the transects through the trees (fig. 1). They were significantly higher in shaded sampling points (A, B, C, D and E), than under full sun (F). It was possible to establish a linear model with $R^2 = 0.94$ for the relationship between contents of CP, and SPAD index readings (fig. 2), the SPAD index, as well as the CP content was positively influenced by shading. The results indicate that chlorophyll content index (SPAD) may be used as an indicator for protein content on this forage.

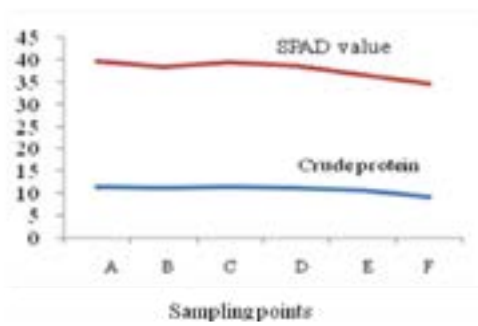

Fig.1. Crude protein (%) and SPAD values along the transect between trees (points A, B, C, D and E) compared to full sun (F).

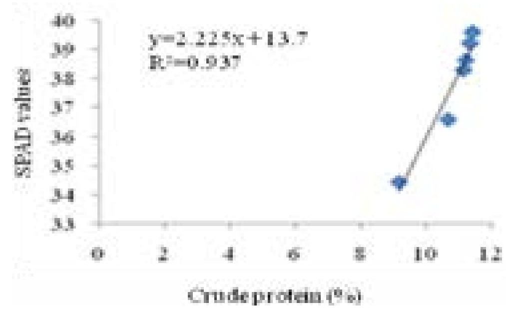

Fig. 2. Relationship between the crude protein (CP,%) and SPAD values.

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Acknowledgements

To Embrapa, Department of animal science Esalq/USP and UFMS, and all research scientists, technicians and field workers at the Embrapa Beef Cattle.

Valéria Ana Corvalã Santos

Crude protein content of brachiaria brizantha cv. Brs piatã in integrated crop-livestock-forest system and its relationship with the spad index

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Forage dry mass and crude protein of *Brachiaria brizantha* cv. BRS Piatã under an integrated crop-livestock-forest system

Valéria A. C. dos SANTOS[1*], Roberto Giolo de ALMEIDA[2], Érick L. GAMARRA[3]
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Introduction

Reduction of light incidence in arboreal systems can affect mass accumulation of fodder under the canopy. However, under moderate shading, grasses might be able to increase nitrogen content in the leaves, improving forage quality (Souza et al., 2010). Goal of this study was to investigate the influence of photosynthetically active radiation (PAR) on forage dry mass and crude protein content of *Brachiaria brizantha* cv. BRS Piatã under integrated crop-livestock-forest system (ICLF) compared to the same pasture in full sun.

Material and Methods

The trial was carried out at Embrapa Beef Cattle (20°24'90"S, 54°42'72"W, 530m altitude), in Campo Grande, MS, Brazil. There were five equidistant sampling points (A, B, C, D, and E) between the Eucalyptus trees single rows (22 m between rows) with 227 trees ha^{-1} planted in 2009. Point F was set in neighboring reference pasture (*Brachiaria brizantha* cv. BRS Piatã) in full sun and under the same forage allowance. Evaluations were carried out in January, April and August 2014. Forage was harvested and weighted. PAR was measured with a portable ceptometer (Accupar, PAR-80 model). Crude protein content was determined by near infrared reflectance spectroscopy (NIRS). Data were processed by analysis of variance and Scott- Knott test of means at 5% level of significance. Regression analysis was made using forage dry mass as the dependent variable and PAR as the independent variable.

Results and Conclusions

Forage dry mass was lower in points under trees than in the point under full sun (Table 1). Forage dry mass of Piatã grass shows linear behavior with respect to PAR, showed regression equation $y = 1.407x + 1{,}160$ ($R^2 = 0.87$). Points A, B, C, D, and E showed higher crude protein content than point F. Therefore, under integrated crop- livestock-forest system there is a reduction in the forage dry mass of Piatã grass but there is an increase in crude protein content.

Table 1. Forage dry mass (kg ha^{-1}) and crude protein (%) of Piatã grass, among sampling points in ICLF (average of three cuts).

Sampling point	Forage dry mass (kg ha^{-1})	Crude protein (%)	PAR reduction (%)
F	2,797 a	9.7 b	0
A	1,442 c	11.4 a	72
B	1,930 b	11.1 a	55
C	1,903 b	11.3 a	72
D	1,661 c	11.2 a	59
E	1,624 c	10.7 a	71

Means followed by the same letter do not differ by Scott-Knott test (p>.05).

References cited

SOUZA, W. et al. (2010) Revista Brasileira de Zootecnia, 39 (3): 685-694.

Acknowledgements

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Valéria Ana Corvalã Santos

Forage dry mass and crude protein of brachiaria brizantha cv. Brs piatã under an integrated crop-livestock-forest system

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Grain yield of corn and marandu-grass after intercropping according to the inoculation with *Azospirillum brasilense* in Cerrado

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Introduction The use of maize intercropped with forage species in Brazilian Cerrado (Savanna type vegetation) provides a favorable environment for recovery or maintenance of soil properties by trash accumulation of cover crops or pastures, apart from the increase and availability of forage in the dry season with quality. The objective of this work was to evaluate the corn crop cultivated exclusively or intercropped with marandu-grass and the use of *Azospirillum brasilense*.

Material and Methods

The experiments were conducted in Cerrado area in the sector of Plant Production (FEIS / UNESP) in Selvíria, MS, the total precipitation during the experiment was 505 mm and the average of temperature was 26º C. The treatments were consisted of corn cultivated exclusively or intercropped with marandu-grass (*Urochloa brizantha* cv. Marandu) under SPD and irrigated conditions and rainfed, inoculated or not with *Azospirillum brasilense* in corn seed and/or marandu-grass. At the end of agricultural year (2014/2015), were evaluated the mass of 100 grains, dry matter production of marandu-grass and grain yield.

Results and Conclusions

It was observed in Table 1 that in irrigated area, the mass of 100 grains and the dry matter of marandu-grass cultivated exclusively or intercropped, inoculated or not was significant. In dry conditions, there was a higher dry matter yield in intercropping systems because the low water availability committed the productivity of grains, however, intercropping systems, inoculated or not provided the highest grain yield and dry matter of grass.

Table 1. Mass of 100-grain in corn (C100), Dry matter of *Urochloa brizantha* cv. Marandu (DMU) e Grain Yield (GY), Selvíria – MS, 2014/2015.

Areas	Irrigated			Rainfed		
Treatments[1]	C100	DMU	GY	C100	DMU	GY
	g	-------- t ha^{-1} --------		g	------- t ha^{-1} --------	
	*	*	ns	*	*	*
SC	40.3a	6.6a	11.0	38.5a	2.7b	1.6c
IC	36.1c	5.8ab	10.5	39.6a	8.7a	2.6b
ICIU	39.1ab	4.2b	10.2	33.0b	4.0b	2.9b
ICIC	36.3c	6.7a	10.2	35.4ab	7.6a	3.8a
SCI	36.0c	4.9ab	9.5	36.4ab	2.9b	3.7a
ICII	37.1bc	6.3ab	9.7	37.8a	3.0b	4.1a
CV%	3.6	27.3	8.4	7.8	25.8	16.3

[1] SC=Single corn tillage without inoculation; IC=intercropped corn without inoculation; ICIU=intercropped corn inoculated in *Urochloa brizantha*; ICIC=intercropped corn inoculated in corn; SCI=single corn tillage inoculated; ICII=intercropped corn inoculated in both seeds. CV=coefficient of variation *Means followed by the same letter do not differ significantly at P 0.05 (“t” test).

Acknowledgements

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Viviane Cristina Modesto

Grain yield of corn and marandu-grass after intercropping according to the inoculation with azospirillum brasilense in Cerrado

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Light Organic Matter under Integration of Agriculture, Livestock and Forestry Systems (SP-Brazil)

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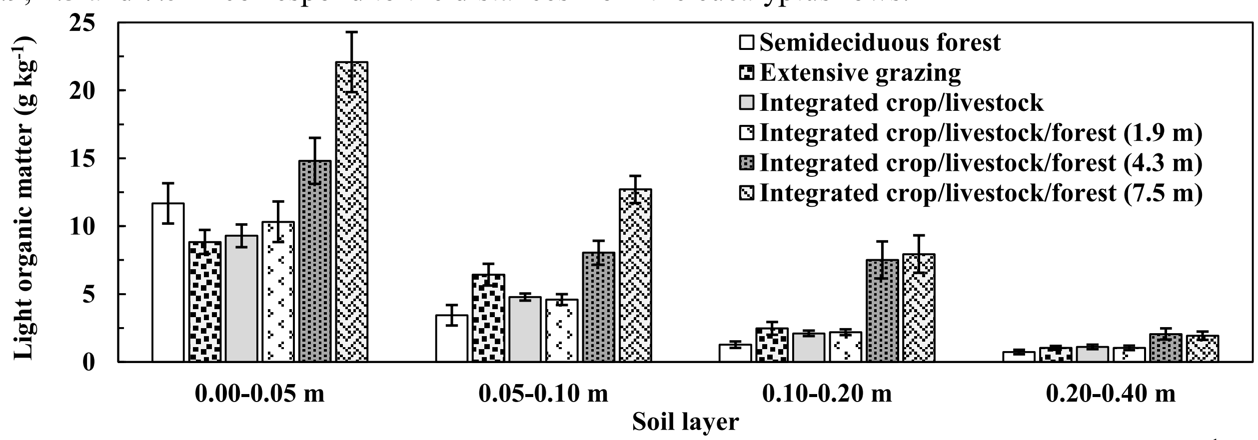
Introduction The study of the different fractions of soil organic matter (SOM) can set, or even predict, the function of soil in carbon (C) storage or loss in agroecosystems. The light organic matter in water (LOM) can be easily measured and it is among the most sensitive compartments to management effects. In this study, we evaluated the effects of extensive grazing (EG), integrated crop/livestock (ICL) and integrated crop/livestock/forest (ICLF) on LOM content in the soil.

Material and Methods

The systems were installed in an area previously used with EG, located at Embrapa Pecuária Sudeste (22°01'S, 47°54'W, 856 m asl), São Carlos, SP. The treatments were: (i) EG with *Urochloa decumbens* since 1980; (ii) ICL, rotating two years of *Urochloa brizantha* and one year of *Zea mays* since 2005; (iii) ICLF including, besides the *Urochloa brizantha* and *Zea mays, Eucalyptus urograndis* with interrows of 15 meters. In this treatment, installed in 2011, the distances of 1.9, 4.3, and 7.5 m were also assessed. (iv) semideciduous forest (SF). Soil samples (n=6), each one composed of five simple samples, were collected in the 0.00-0.05, 0.05-0.10, 0.10-0.20 and 0.20-0.40 m soil layers. The LOM was determined according Anderson & Ingram (1989).

Results and Conclusions

Fig. 1. Light organic matter in water (LOM) under crop, pasture and forest systems (n=6). Note: 1.9, 4.3 and 7.5 m correspond to the distances from the eucalyptus rows.



The average values for the LOM in ICLF system (n=18) were 15.74, 8.44, 5.88 and 1.68 g kg^{-1} for the 0-5, 5-10, 10-20 and 20-40 cm soil layers, respectively. The LOM contents were higher mainly at distances of 7.5 and 4.3 m from eucalyptus lines (Fig. 1). The ICLF showed the highest values of LOM, being a promising system in SOM input. The LOM in EG and ICL was lower when compared to SF at a depth of 0-5 cm, but was equivalent or even higher in the other layers.

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Acknowledgements

We thank the CNPq and the São Paulo Research Foundation (FAPESP) for supporting the project 2014/17927-2, and Embrapa Pecuária Sudeste for allowing and helping us to conduct this research.

Chlorophyll content on maize plants in a crop-livestock-forest system in the southwest of Brazilian Amazon

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Introduction

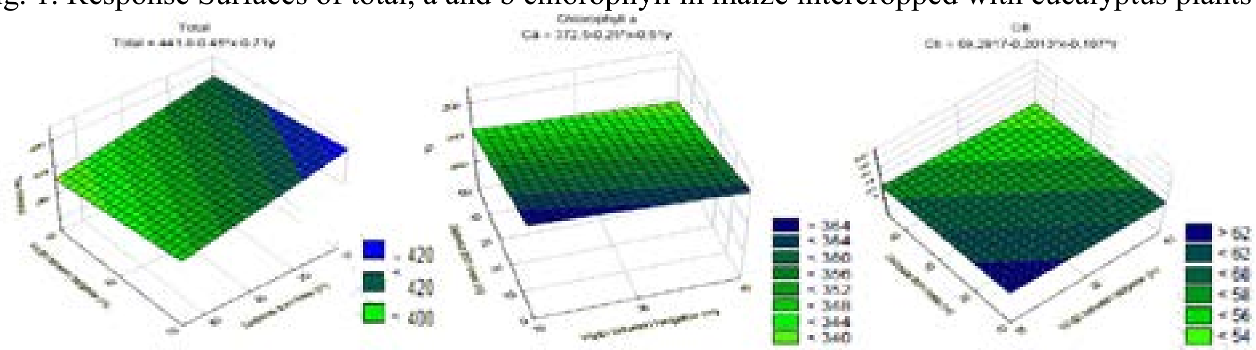
To design sustainable cropping systems, adapted and appropriated to the specifics soils and climate conditions is mandatory to understand the environmental and plant production physiology. The appropriate photosynthetic radiation supply is essential for the corn properly grow, to develop and produce. Especially in the rainy Amazon biome and agrosystems with the presence of shade trees.

Material and Methods

The chlorophyll contents in maize plants were evaluated under the influence of the eucalyptus trees (hedgerow), planted in 2013, in a long term experiment in the southwest of the Amazon, in Porto Velho, Rondonia (Passos et al., 2013). The spatial arrangement of the trees comprehends hedgerow of four rows of eucalyptus plants spacing in 18, 32 and 42 meters among them. Among the hedgerows the maize intercropped with *Brachiaria brizantha* cv Xaraés was valued for total, a and b chlorophyll contents using a portable device (Clorofilog®). The treatments were three distances of the hedgerow versus four proportions of distances from the trees (10, 20, 30 and 45%). The treatments were laid out in a randomized complete block design (RCBD) with forty-eight replicates.

Results and Conclusions

Fig. 1. Response Surfaces of total, a and b chlorophyll in maize intercropped with eucalyptus plants



Distances corn plants from the tree hedgerows and the width between hedgerows influenced linearly the leaf contents of total, a and b chlorophyll in plants. The higher chlorophyll levels were observed in areas closest to trees, possibly due to lower supply of photosynthetic radiation in these regions. Similarly, the lowest levels were observed at larger spacing between trees (42 meters). The levels of chlorophyll a presented the same levels in all hedgerows, in the areas closest to eucalyptus. The chlorophyll correlated with radiation levels, hours of light due to the distance of plants inside the rows. The largest variations, of 13.5% of total chlorophyll were observed in the 42 meters wide. The smallest, were measured in the 30 m wide. The environmental conditions due the tree interferes significantly on the physiological response of maize for the production of chlorophyll a and type b.

References cited PASSOS, et al. (2013). In: XII CONGRESSO INTERNACIONAL DO LEITE.

Acknowledgements Embrapa and CNPq

Alexandre Martins Abdão dos Passos

Chlorophyll content on maize plants in a crop-livestock-forest system in the Southwest of Brazilian Amazon

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Soil nitrogen dynamics in mechanized and non-mechanized agroforestry systems in the region of the Cerrado, Central Brazil

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Introduction In the last decades, the agriculture production models have altered the ecosystem structure as well its composition and functioning. Such modifications in the land use and cover directly affect the dynamics of soil organic matter, which in turn, is a major drive to maintain the carbon and nitrogen cycle at ecosystem level. Properly designed agroforestry systems can provide ecosystem services that contribute to mitigate some effects of the conversion of large areas of Cerrado protecting soil and water resources, increasing landscape diversity associated with high production. We compared some metrics that directly or indirectly affect the dynamics of soil nitrogen in mechanized and non-mechanized agroforestry systems and compared them with an adjacent pasture of 30 years to assess a major ecosystem service, which is the primary production.

Material and Methods

The field experiment was conducted at the rural property "Sitio Dagrofloresta" (15°34'51"S; 47°22'42''W), in the northeastern region of the Federal District, Central Brazil. Before the implementation of the agroforestry systems the area was used as pasture. The non-mechanized agroforestry was established about 14 years ago while the mechanized agroforestry was established in 2010. The former is an example of successional and biodiverse agroforestry for timber production while the mechanized had the intentional growing of trees and shrubs in combination with forage. Soil was sampled from 0 to 10 cm depth. Soil texture, pH in water, exchangeable bases, CEC, available P, and organic matter was performed according with the EMBRAPA methodologies (EMBRAPA, 1997). Soil N-NH4+ was measured using the Nessler reagent and soil N-NO3- was measured using the difference between 218 and 228 nm and 245 and 280 nm in an UV spectrophotometer. All results were expresses in dry weight basis (at 105°C for 72 hours).

Results and Conclusions

Soil texture was quite similar among the studied areas, averaging 40% of clay, 10% of silt and 50% of sand. Soil pH was 6.0, 5.4 and 6.6 for pasture, non-mechanized and mechanized agroforestry, respectively. Soil available P was higher in the agroforestry systems compared with the pasture. The highest soil organic matter content was found in the non-mechanized agroforestry, but total N was about 0.20% in every site. Soil gravimetric water content varied considerable during the year, but the agroforestry systems had quite higher water content compared with the pasture. The soil concentration of N-NH4+ predominated in relation to N-NO3 throughout the year. N-NH4+ varied more than N-NO3- along the year with higher values during the dry season. On the other hand higher N-NO3- occurred during the rainy season (reaching 3 mg kg-1 in the agroforestry systems). Soil nitrogen dynamics followed the same pattern among systems, but the higher availability of mineral N in the agroforestry systems indicate that the more N could be available for plant uptake in these systems.

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Amanda Rodrigues Vieira

Soil nitrogen dynamics in mechanized and non-mechanized agroforestry systems in the region of the Cerrado, central Brazil

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The third year of an integrated crop-livestock-forest system at the Amazon Biome: soybean

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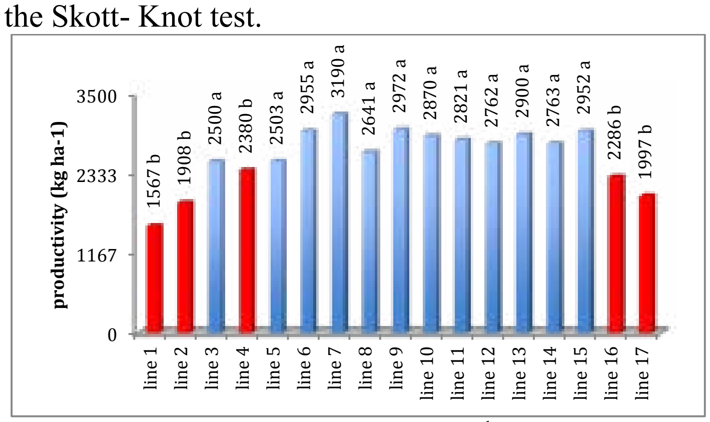
Introduction
The soybean has been widely used within integrated systems, especially in the first stages of development of forestry species when competition for resources such as light, water and nutrients are lesser. Being able to timely cultivate legumes within an integrated system is of ultimate importance since soil characteristics, both physical and chemical, are concurrently improved with income generation.

Material and Methods
The study was conducted at the Crop-Livestock-Forestry Reference Technology Unit (URT), Gamada Ranch, Nova Canaã do Norte, Mato Grosso, Brazil. The treatments constituted of, three-line spaced forestry species of eucalyptus and "*cuiabano*" pine tree (3 x 2 x 20 m), and *pau-balsa* and teca (3 x 2 x 20 m). In the previous years, rice (first year) and soybean (second and third years) were cultivated. The yield within each line is shown below (Fig. 1).

Results and Conclusions
Fig. 1. Average of soybean grain yield harvested on 17 rows in all treatments. Overall average: 2,586 kg ha^{-1}; CV (%): 30.93. Means followed by the same letter are not statistically different from each other at 5% probability by the Skott- Knot test.



In the third year, the average of soybean yield was 2,586 kg ha^{-1}; however the yield was reduced in the edges of the rows (lines). Shading impaired soybean crop yield, which affected more plants were cover by shade on morning than afternoon. The water availability is not a problem in the Amazon region. Second year, in the same area, the average of soybean yield was 3,342 kg ha^{-1}, with no reduction by shading.

Acknowledgements
The authors appreciate the assistance received from UFMT (Sinop campus), Embrapa Arroz e Feijão, Fazenda Gamada, Agrisus, Fapemat, CNPq, Bunge and all academics who participated in this work.

Anderson Lange

The third year of an integrated crop-livestock-forest system at the Amazon biome: soybean

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Maize and brachiaria intercropping system efficiency in the use of soil phosphorus reserves

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Introduction: The objective of this study is to contribute to a more systematic assessment of the residual effect of soil phosphorus. If the recovery of added P is of interest not only in the year of application but in subsequent years as well, this raises the following questions: (a) over what time scale should recovery be measured?, (b) can the residual P produce yields that are economically viable for the farmer?, and (c) what is the effect of the crop system, braquiaria intercropping with corn, in to optimize the use of residual phosphorus?

Material and Methods: The experiment was conducted in summer season of 2012-13, at the Embrapa-Maize and Sorghum Research Center in Sete Lagoas, MG, Brazil (19° 28' S, 44° 15' W and 732 m above sea level). The soil is clayey red oxisol under savanna vegetation. In 2003, three levels of soil P were established by broadcasting 0, 218 and 436 kg P ha^{-1}, corresponding to 500 and 1,000 kg.ha^{-1} of P_2O_5 (triple superphosphate 45 % P_2O_5), and incorporating it into the top 0.10-0.15 m of soil. After that, the experiments started its residual phase with no further applications of P fertilizers and under zero tillage soil management, as described by Coelho (2014).

Results and Conclusions: The residual value of P can be determined by measuring the increase in corn yields in the years following the initial application of P, compared with the yield obtained on soil that had not received this nutrient (Table 1).With the residual effect of P applied was possible to get gains in the grain yield in more than 20 % as compared to control. In this research there is no evidence that the use of brachiaria intercropping with corn can to optimize the use of residual phosphorus.

Table 1.Content of phosphorus in leaves, grain and grain yields of corn cultivated after soybean

P – level[1] ($kg\ ha^{-1}$)	P-Soil[2] ($mg\ dm^{-3}$)	Crop system	P-Leave ($g\ kg^{-1}$)	P- Grain ($g\ kg^{-1}$)	Grain yield ($t\ ha^{-1}$)
0	6.97	Corn	1.84	1.68	7.58
(Low)	6.05	Corn+brachiaria	1.81	1.78	7.43
Means	6.51c		1.83c[3]	1.73b	7.50b
218	10.10	Corn	2.17	1.78	8.42
(Medium)	10.53	Corn+brachiaria	2.18	1.85	8.05
Means	10.32b		2.17b	1.81b	8.24b
436	23.86	Corn	2.56	2.26	9.27
(High)	23.43	Corn+brachiaria	2.58	2.35	9.28
Means	23.65a		2.57a	2.30a	9.27a
Crop system	13.34A	Corn	2.19A	1.90B	8.43A
Means	13.65A	Corn+brachiaria	2.19A	1.99A	8.25A
Overall means	13.50		2.19	1.95	8.34
CV %	42		9	8	11

[1]P-level applied in 2003; [2]P – soil in 2010, extractor Mehlich1; [3]Means in the column with the same letters do not present differences by test tukey 5%. Small letters compare P levels and capital ones crop system.

Reference: Coelho, A.M. (2014) 16th World Fertilizer Congress of CIEC, Rio de Janeiro, Brazil.

Antonio Marcos Coelho

Maize and braquiaria intercropping system efficiency in the use of soil phosphorus reserves

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Efficiency in the use of soil phosphorus reserves by soybean cultivated after maize intercropped with brachiaria

Antônio M. COELHO

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Introduction: The objective of this study is to contribute to a more systematic assessment of the residual effect of soil phosphorus. If the recovery of added P is of interest not only in the year of application but in subsequent years as well, this raises the following questions: (a) over what time scale should recovery be measured?, (b) can the residual P produce yields that are economically viable for the farmer?, and (c) what is the effect of the crop system, braquiaria intercropping with corn, in to optimize the use of residual phosphorus?

Material and Methods: The experiments were conducted at the Embrapa-Maize and Sorghum Research Center in Sete Lagoas, MG, Brazil (19° 28' S, 44° 15' W and 732 m above sea level). The soil is clayey red oxisol under savanna vegetation. In 2003, three levels of soil P were established by broadcasting 0, 218 and 436 kg P ha^{-1}, corresponding to 500 and 1,000 kg.ha^{-1} of P_2O_5 (triple superphosphate 45 % P_2O_5), and incorporating it into the top 0.10-0.15 m of soil. After that, the experiments started its residual phase with no further applications of P fertilizers and under zero tillage soil management, as described by Coelho (2014).

Results and Conclusions: The residual value of P can be determined by measuring the increase in soybean yields in the years following the initial application of P, compared with the yield obtained on soil that had not received this nutrient (Table 1). In this research there is no evidence that the use of brachiaria intercropping with corn can to optimize the use of residual phosphorus.

Table 1.Soybean grain yields cultivated after single corn and corn intercropping with brachiaria

P – level[1] (kg ha^{-1})	P-Soil[2] (mg dm^{-3})	Crop system (soybean after)	Grain yield (t ha^{-1})[3]		
			2009-10	2010-11	2013-14
0	6.97	Corn	2.62	1.30	1.97
(Low)	6.05	Corn+brachiaria	2.52	1.23	2.14
Means	6.51c		2.57a[4]	1.27b	2.05b
218	10.10	Corn	2.75	1.87	2.27
(Medium)	10.53	Corn+brachiaria	2.34	2.02	2.17
Means	10.32b		2.55a	1.95a	2.27ab
436	23.86	Corn	2.88	2.21	2.33
(High)	23.43	Corn+brachiaria	1.95	2.13	2.47
Means	23.65a		2.42a	2.17a	2.40a
Crop system	13.34A	Corn	2.75A	1.77A	2.24A
Means	13.65A	Corn+brachiaria	2.27B	1.82A	2.21A
Overall means	13.50		2.51	1.79	2.23
CV %	42		15	15	13

[1]P-level applied in 2003; [2]P – soil in 2010, extractor Mehlich1; [3]Cultivars: Valiosa (2009-10), Monsoy (2010-11), BRSMG 580 (2013-14). [4]Means in the column with the same letters do not present differences by test tukey 5%. Small letters compare P levels and capital ones crop system.

Reference: Coelho, A.M. (2014) 16th World Fertilizer Congress of CIEC, Rio de Janeiro, Brazil.

Soybean tolerance to shade in crop-livestock-forest integration system

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Introduction

For the soybean crop, besides the fact that solar radiation is related to photosynthesis, it is also responsible for other aspects related to plant physiology. The objective of this study was to evaluate the performance of soybean cultivars at different levels of shading in the system of integrated crop-livestock-forest (ICLF).

Material and Methods

The Split block experimental arrangement with four replications was used. The treatments consisted of 18 cultivars of three different maturity groups and growth habits and three shading levels (level 1: full shade in the morning; Level 2: intermediate shade in the morning; level 3: full sun). shadow projection; electrical conductivity (EC) of soil, soil temperature, photosynthesis, stomatal conductance, transpiration and agronomic characteristics of plants were evaluated

Results and Conclusions

The shadow environment of eucalyptus trees caused productivity differences among cultivars and the early maturity cultivars had highest yields in all shading levels. However, the differences in productivity varied among cultivars tested in the levels of assessed shading. The cultivar NS 7255 was considered more efficient for use in systems IAFP, it showed high productivity in both shaded areas and in areas with full sun, very important feature in the context of integrated crop- livestock-forest systems.

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Acknowledgements
To Embrapa and CNPq.

Austeclinio Lopes Farias Neto

Soybean tolerance to shade in crop-livestock-forest integration system

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Corn grain yield in function of residual nitrogen in Integrated Crop-livestock System

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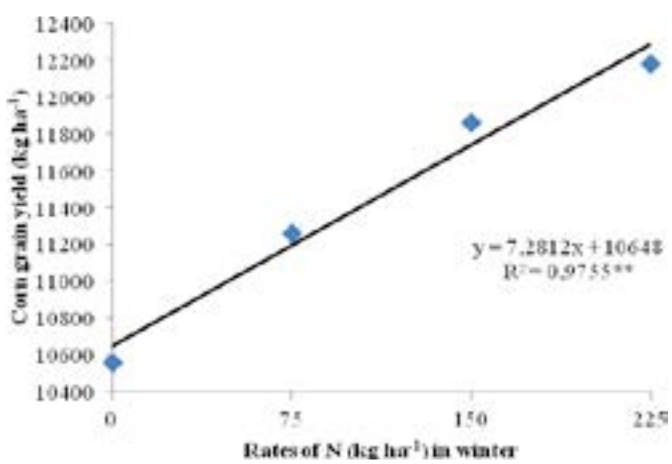
Introduction The nitrogen fertilization on pasture in integrated crop-livestock systems can provide high grain production. The aim of this study was to evaluate the corn grain yield in function of residual effect of previous nitrogen (N) fertilization on pasture under grazing condition.

Material and Methods

The study was conducted at Universidade Estadual do Centro-Oeste, in Guarapuava-PR, in 2011/2012. The area is in the sixth year of an experiment with crop-livestock system, in winter the area was under grazing by sheep. The experimental design was randomized block in split plots, with three replications. The treatments consisted of N in winter (0, 75, 150 and 225 kg N ha^{-1}) applied at tillering of oat (*Avena sativa* L.) and italian ryegrass (*Lolium multiflorum* Lam). After the corn harvest, grain yield was assessed in kg ha^{-1}. The data were submitted to analysis of variance and comparison of treatment means by Tukey test at $P < 0.005$ significance level. Regressions were made for the grain yield. It was chosen the model that best fitted the data using software Microsoft Excel. Linear and quadratic models were tested and the regression significance coefficients were verified by Student's t test. Analysis was also performed in software Sisvar.

Results and Conclusions

Fig. 1. Corn grain yeld (kg ha^{-1}) in rates 0, 75, 150 and 225 kg N ha^{-1} in winter ($P < 0.005$).



Maize grain yield was positively affected, with a quadratic response (Fig.1). It was found a residual effect of N applied on pasture due to the behavior of maize plants. Similar results were obtained by Sandini et al. (2011). Corn grain yield responded to N rates fertilized in winter, indicating residual effect of N for the summer crop.

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Delma Fabíola Ferreira Silva

Corn grain yield in function of residual nitrogen in integrated crop-livestock system

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Modeling carbon stocks in integrated crop-livestock systems in Cerrado, a Brazilian savanna

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Introduction Changes in land use practices, such as decreasing fire frequency as well as adoption of integrated crop-livestock systems have been associated with shifts in soil organic carbon (C_{soil}). In this work modeling was applied to evaluate the effects of land management on soil C stock dynamics.

Material and Methods Changes in soil carbon stocks were estimated over 40 years (1991-2030) after the replacement of native savanna vegetation of cerrado sensu stricto (cerrado) by crop, followed by low and high fertility pastures and integrated cycles 2yr/ harvests soybean crop and 4-yr livestock systems (ICL) (Figure 1). Data from Clayey Oxisol (Typic Haplustox) field-based assessments were taken at three long-term experiments located at EMBRAPA Cerrados (Planaltina, DF, Brazil) and applied to parameterize/validate Century Ecosystem model - sub model savana (PARTON et al., 1987).

Results and Conclusions Regarding soil C stocks in cerrado, the ecosystem equilibrium simulations compared to field-based values consisted of errors below 4%. The model reflected truthfully the effects of different fire frequency [every two and a half and five years intervals: Fire-2.5yrs and Fire-5yrs, respectively] on C storage and was efficient in simulating both a fast decrease in the C loss rate due to soil disturbance as well as rates of C accumulation after setting-up ICL (r = 0.99; RMSE: FIRE-2.5 = 0.80%; FIRE-5 = 3.99%).

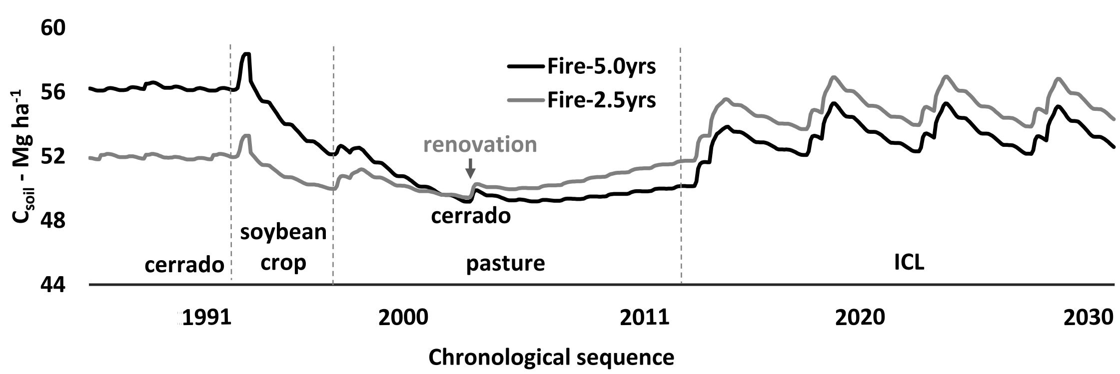

Figure 1. Simulations (1991-2030) by the Century model, of C stock in the 0-20 cm layer. Fire-2.5yrs and Fire-5yrs means a chronological sequence having as baseline a native vegetation of cerrado sensu stricto uppon two and a half, and five years intervals fire frequency, respectively.

The starting point (C stock baseline as a result of fire frequency in cerrado) defined how much C will be accumulated in the soil due to management changes (Figure 1). The direction and rates of changes in the C stocks caused by management were identified with greater accuracy. Nevertheless, in terms of magnitude of values, the improvement of the model still needs investment, particularly considering the estimates of C accounting due to reference systems (baseline) choices.

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Impact of integration on nutrient and water-use efficiency

Eloisa Aparecida Belleza Ferreira

Modeling carbon stocks in integrated crop-livestock systems in Cerrado, a Brazilian Savanna

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Initial growth of eucalypt clones in different spacings within strips

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Introduction

There are many possible arrangements of integrated crop-livestock-forest systems (iCLF). The distribution of trees deserves special attention since it is the component with the longest rotation. Besides the distance between tree strips, the spacing within strips might influence wood yield. Therefore, this work aimed at assessing the growth of eucalypt clones in different spacings within strips.

Material and Methods

The experiment was carried out in the experimental field of Porto Velho (Embrapa Rondônia). The climate is of Am type and the soil is a Latossolo Amarelo distrófico plintossólico, according to the Brazilian System of Soil Classification (Embrapa, 2013). Six 250 m strips (three of GG100 and three of VM01 clones) with four rows of eucalypts were planted in March, 2013, to compose an iCLF experiment. The distance between strips varied from 18 to 42 m. The spacings used were 3.5x2.0 and 3.5x3.0 m, distributed evenly within each strip (125 m per spacing). Therefore, each strip contained one clone (plot) and two spacings (subplot). Each of the 12 subplots had an utile area of 945 m² (10.5x90.0 m). Two years after planting the trees were assessed for total height (Ht), diameter at 1.3 m above soil level (DBH), volume per tree (Vol_{tree}) and volume per subplot ($Vol_{subplot}$), considering a form factor of 0.5. The data were subjected to ANOVA considering a 2x2 split-plot factorial design and the 5% significance level.

Results and Conclusions

Table 1. Summary of the ANOVA. Plot: Clone. Subplot: Spacing. Means followed by the same capital letter (row) or small letter (column) do not differ significantly by the F test at the 5% level.

Spacing	Clone							
	DBH (cm)		Ht (m)		Vol_{tree} (m³)		$Vol_{subplot}$ (m³)	
	GG100	VM01	GG100	VM01	GG100	VM01	GG100	VM01
3.5x2.0 m	9.3Ba	11.6Aa	12.0Aa	12.5Aa	0.0424Ba	0.0659Aa	7.0749Ba	10.7758Aa
3.5x3.0 m	11.3Ba	12.8Aa	13.3Aa	12.8Aa	0.0684Ba	0.0834Aa	7.7423Ba	9.2903Aa
CV_{plot}(%)	2.42		3.51		5.74		5.22	
$CV_{subplot}$(%)	13.14		11.95		35.88		41.94	

No significant difference was found between spacings for any of the variables measured. However, the VM01 clone showed higher diameter and volume (per tree and per subplot) than GG100. Usually, the lower the number of trees per row, the lower the production costs. Therefore, since no difference was found between spacings, and the VM01 performed better than GG100, the VM01 clone with 3.5x3.0 m spacing is recommend for the establishment of tree strips in conditions similar to those found in this study.

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Henrique Nery Cipriani

Initial growth of eucalypt clones in different spacings within strips

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Analysis of the economic viability from an integrated system of rice and beef cattle in the Pampa Biome of Rio Grande do Sul, Brazil

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Introduction

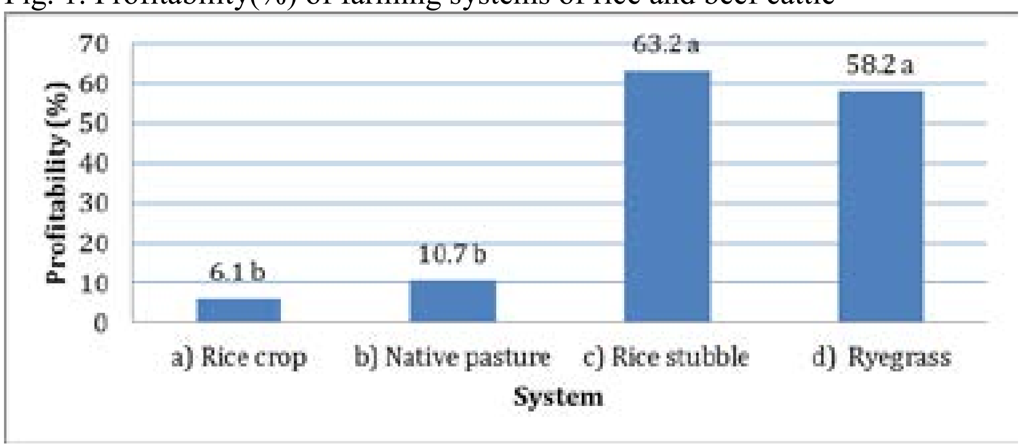
The environmental conditions of the Pampa Biome are favorable to the degradation of soil, especially when grain crops are introduced in this region, traditionally exploited with beef cattle systems. The preservation of this biome becomes easier when integrated systems are developed, increasing productivity and profitability. In this context, the present work reports the profitability results of four different agricultural systems.

Material and Methods

The field experiment was carried out in a native pasture area, located at the Embrapa Pecuária Sul Research Centre, Bagé (31°22'S, 53°59'W, 176 m asl) in 2009/2010 growing season. The treatments were: a) rice crop- in conventional plough tillage; b) native pasture- with beef cattle with a forage allowance of 12 kg of dry matter (DM) per 100 kg of live weight (LW) (DM at 12% of LW); c) rice stubble- integrated crop/livestock system with steers grazing rice stubble (DM at 12% of LW); d) ryegrass- integrated crop/livestock system with steers grazing ryegrass pasture planted after rice crop (DM at 12% of LW). For each system, it was evaluated the cost of disbursement, opportunity cost of land and opportunity cost of capital. The gross revenue was also evaluated for each system. Finally, we calculate the profitability, deducting all the costs from the gross income and dividing it by total cost.

Results and Conclusions

Fig. 1. Profitability(%) of farming systems of rice and beef cattle



During the 2009/2010 growing season, irrigated rice cropping under conventional plough tillage and steers grazing on native pasture, explored without rotation systems, presented lower profitability than steers grazing systems in rice stubble and steers grazing ryegrass planted after rice crop (Fig. 1). Therefore, integrated crop-livestock systems which include rice and steer fattening are more efficient under the economic point of view than individual systems involving only one of these farming productions.

Joao Batista Beltrao Marques

Analysis of the economic viability from an integrated system of rice and beef cattle in the Pampa biome of Rio Grande do Sul, Brazil

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Sylvopastoral system as a replacement of nitrogen fertilization of *Brachiaria brizantha* on Brazilian Northeast coastal tablelands

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Introduction
In coastal tablelands (CT) of the Brazilian Northeast fertilization of pastures is a major factor for expression of their productive potential. Nitrogen is the highest responsive nutrient of such pastures. However, the use of fertilizer in the Northeast is still weak. An economical way to provide nitrogen to pasture and improving animal diet quality is the consortium of grass with tree forage legumes (RANGEL et al, 2014).

Material and methods
The study evaluated the productivity of Nellore steers in a silvopastoral system of *B. brizantha* with *Gliricidia sepium*, compared to monoculture systems of *B. brizantha* with increasing levels of N (0, 80, 160 and 240 kg N / ha year) in the period July / 2013 to December / 2014 in an Oxisol of TC. The pastures were managed in a "put and take" system with seven days of use and 35 rest in the rainy season and 49 in the dry season. Data were analyzed by ANOVA procedure of the statistical package SISVAR.

Results and Conclusions
The silvipastoral system resulted in an individual weight gain (IWG) higher than the highest level of nitrogen (Table 1). There was a significant linear response to nitrogen in the weight gain per area (WGPA) (TAB 1. Similar as IWG, WGPA in silvopastoral system was also higher than in the highest levels of N. It was concluded that the silvopastoral system was more efficient in improving live weight gain than the application of mineral nitrogen in conditions of the TC.

Table 1 – Individual Weight Gain (IWG) and Per Area Weight Gain (PAWG) of steers in isolated pasture of B. *brizantha* fertilized with different levels of N or in a silvopastoral system of *B. brizantha* and *G. sepium.*

Parameter	N levels (kg/ha)					Pr>Fc	$R^{2/}$ Linear Regression (N levels)	
	0	80	160	240	SP			
IWG (g/anim/day)	300.2b	302.0b	344.3b	373.2b	59.,1a	0.67	ns	-
PAWG (g/ha/day)	1287c	1513c	2115bc	2499b	3129a	0,002	0,9743	y=5,2982x+1217,8

Pr>Fc Probability of significance.

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José Henrique de Albuquerque Rangel

Sylvopastoral system as a replacement of nitrogen fertilization of brachiaria brizantha on Brazilian Northeast coastal tablelands

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Gliricidia sepium in dairy cattle integrated systems in Brazil´s Northeast

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Introduction

In the Semiarid and Coastal Tablelands of Brazil´s Northeast, the incorporation of gliricídia (*Gliricidia sepium*) in silvopastoral systems works with a dual purpose: 1. Improving soil fertility and 2. Serving as a food supplement to lower livestock production costs during the dry season of the year (Rangel et al., 2010). The objective of this study was to measure the effect of substituting corn silage by gliricídia silage on milk yield and fat content.

Material and Methods

It was used a single Latin Square design with five cows, five treatments (silage substitution levels of 0%, 25%, 50% 75% and 100%) and five periods. The experiment was conducted at Embrapa Semi-Arid experimental station - CPATSA in Gloria county, Sergipe, from January, 30 to March, 29, 2012, with the diets being offered to animals during 12 days per period, being the first of 05 days used to adapt animals to the diets and the remaining 07 days to collect data. The evaluated variables were milk yield (MY) and fat content (FC). The statistical analysis was carried out using the PROC MIXED procedure of the Statistical Analysis System (SAS).

Results and Conclusions

There was a quadratic effect ($P < 0.05$) (Table 1) of the diets on milk production, such that the maximum level of gliricídia silage inclusion was of 34.65%, which corresponds to the yield of 9.7 kg Milk / day. However, there was no effect of diets on fat content.

Table 1 – Milk yield (MY) and fat corrected milk (FCM) in crossbred cows HxZ fed diets containing different inclusion rates of gliricídia silage

Item	Gliricídia Silage % (dry matter)					SEM	Value P[1]		
	0	25	50	75	100		L	Q	C
MP (kg/dia)	9,39	12,02	11,00	8,74	5,04	1,69	0,0003	0,0003	0,3710
FCM (%)	3,79	3,89	3,27	4,04	3,82	0,25	0,7381	0,3466	0,6802

[1]L, Q e C: linear, quadratic and cubic effects on the inclusion amount of gliricídia silage.
SEM – Standard Error of the Mean

Although gliricídia is considered as an important protein source to lower production costs of dairy cattle systems in the Semiarid and Coastal Tablelands of Brazil´s Northeast, its inclusion in diets at levels above 34%, approximately, can reduce milk production.

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Corn and soybean yield in the Integrated Crop-Livestock System in the Cerrado, Maranhão Eastern Region

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Introduction

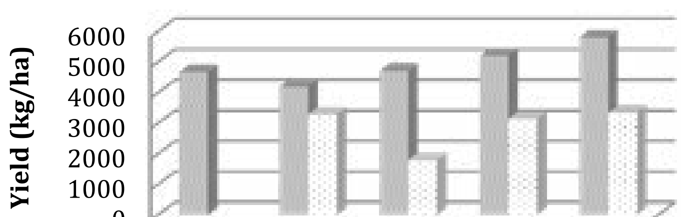
The Cerrado of the East region in Maranhão state is located in the agricultural expansion area called MATOPIBA where soybeans production has grown on a large scale. This region requires special care in the management and conservation of soils, including crop rotation and no-tillage system, due to characteristics of soil and climate. The Integrated Crop-Livestock System (ICLS) has been introduced to facilitate the management of soil in rotation with corn and grazing and to improve soil coverage during the period between harvests. This system also allowed the introduction of the animal component, diversifying farm production.

Material and Methods

The study was conducted from 2009 to 2014 in the Barbosa Farm, located in Brejo country, Maranhão State (3º42'33"S; 42º56'44"W). Corn and grass (*Brachiaria ruziziensis*) were cultivated in 2010. In the following years soybean was planted on the grass straw (no-tilled system). So, the corn and soybean yields in these areas with ICLS were evaluated. In the areas planted with corn and grass, after corn harvest, cattle were allocated to graze the grass according to the forage available.

Results and Conclusions

The Fig. 1 shows the corn and soybean yield in ICLS, in the Barbosa Farm. The average yield of corn and soybean in Brejo county for the last ten years was 858 kg ha^{-1} and 2,591 kg ha^{-1}, respectively (IBGE, 2014). The corn yield average in ICLS presented 473% higher than the average of the municipality. The yield obtained during the five years of evaluation for corn and four years for soybeans show that ICLS is one of the technological alternatives that can be adopted to improve the grain yield in the eastern region of Maranhão. It is noteworthy that the ICLS improves the soil physical properties and allow animal inclusion on the farm system.



	2010	2011	2012*	2013	2014
Corn	4680	4200	4710	5200	5800
Soybean		3300	1800	3150	3360

Fig. 1. Corn and soybean yields in ICLS, Barbosa Farm, Brejo Country – Maranhão State
*In 2012 there was drought, influencing negatively the yield

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Acknowledgements

To Embrapa, Fundação Eliseu Alves and Barbosa Farm.

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3rd International Symposium on Integrated Crop-Livestock Systems

Performance of integrated systems (CLS and CLFS) in Ponta Porã, Brazil

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Introduction

Aiming at to monitor the agronomic performance of integrated production systems having soybean and corn with pasture and eucalyptus was implemented in a transition area between the Atlantic Forest and Cerrado biomes a technological reference unit (URT).

Material and Methods

The URT is located in an Oxisol, 350 g kg^{-1} clay, altitude of 680 m, Cfb climate (Koppen) in Ponta Porã, MS, Brazil (22°32'56"S 55°38'56"W). The systems were established in 2009 in crops cultivated area last 30 years. The following systems are implanted: L-PC: monoculture with soybean in the summer and corn in the fall/winter with soil preparation; b) L-PD: No-till, with soybean in the summer and corn intercropped with forage (*Brachiaria ruziziensis*) in the fall/winter; ILP: integrated crop-livestock system with the alternation between crops (soybean/corn+*B. ruziziensis*) and pasture (*B. brizantha* cv. Xaraés) conducted in No-till, with two-year cycles; ILPF: integrated crop-livestock-forest system with alternating crops with pasture, grown in single lines of trees (eucalyptus) spaced 25 m (200 trees/ha) and 12.5 m (400 trees/ha), the rotation of crops and pasture is a two-year cycle; F: Eucalyptus forest, 2x3 m (1666 trees/ha); PP: continuous pasture *B. brizantha* cv. Xaraés under pasture of beef cattle.

Results and Conclusions

Soybean and corn yield were consistently higher than the ILP system compared to other systems, being influenced in an expressive way by the presence of trees in the smaller spacing between rows and to the extent of the growth of trees. Integrated systems (ILPF) resulted in smaller trees in height but with greater diameter of the trunks and wood volume compared to the forest system (F). Systems with pastures had increases in carbon content in the soil (Table 1). The pasture has benefited from the presence of trees in years with occurrence of frosts.

Table 1. Relative soybean and maize grain yield, mean values for diameter at breast height (DBH), height and volume of eucalyptus trees to 57 months after planting and variation (Δ) of the total organic carbon (TOC) of soil layers between the years 2010 and 2013, in management systems.

systems	relative grain yield (L-PC=100)							variables trees			Δ TOC (g kg^{-1})		
	soybean				maize			DBH	high	volume	0 - 5	5 - 10	10 - 20
	2011	2012	2013	2014	2011	2012	2013	---- m ----		m^3	------- cm --------		
L-PC	100	100	100	100	100	100	100				-0,94	-1,69	-2,24
L-PD	104	114	115	100	99	85	109				-0,04	0,07	-0,51
ILP	82	174	130	103		104	128				6,20	-0,14	-0,97
ILPF12	89	117	84	48	89	86	43	0,24	17,20	0,41			
ILPF25	92	134	114	96	133	100	87	0,24	18,52	0,41			
PP											3,68	2,87	3,97
F								0,21	20,33	0,37			

Acknowledgements

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INTEGRATION OF CROP-LIVESTOCK-DEGRADED PASTURE IN THE AMAZON: SOIL CHEMICAL ASPECTS.

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Introduction The necessity of creating sustainable livestock production in the Amazon has stimulated the adoption of management practices that preserve or recuperate soil fertility. Currently, 50% of pasture areas in the Amazon can be considered as degraded or in the process of being degraded (DIAS-FILHO, 2011). In this study we evaluate the chemical changes in two soil types used in livestock management.

Material and Methods

This experiment was conducted on the Jaraguá farm (02°46'3.7014" S and 54°34'.2123" W) and the Walfredo farm (02°43.625" S and 54°36.209" W) in the municipality of Mojuí dos Campos, on highway PA 435, State of Pará, Brazil. Average annual temperature and precipitation vary between 25° and 28°C, and 1900 to 2100 mm respectively, and average humidity ranges from 84 to 86%. Soil samples were collected at 20 sample points that were combined to take one composite sample, and samples were taken at depths 0-5 cm, 5-10 cm, 10-20 cm, and 20-30 cm. Soil laboratory analyses were done at the Escola Superior de Agronomia Luiz de Queiroz at São Paulo University (ESALQ- USP) in Piracicaba, State of São Paulo.

Results and Conclusions

Fig. 1.

		pH CaCl2		p		k		Ca		Al		H + Al		SB		CEC	
Depths	Year	KKN	JW	KKN	JW	KKN	JW	KKN	JW	KKN	JW	KKN	JW	KKN	JW	KKN	JW
0-5 cm	2013	4,8	4,8	10	13	1,7	2,7	15	38	1	0	38	42	24,5	51,8	62,5	94
	2014	4,8	4,9	6	11	3,6	3	38	33	2	4	31	34	50,6	46	81,6	80
5-10 cm	2013	4,5	4,6	10	10	1,3	1,7	24	38	1	1	42	44	29,3	48,4	71,5	92
	2014	4,9	5	6	8	4,1	2,2	26	30	2	3	28	31	36,1	41,2	64,1	72,2
10-20 cm	2013	4,1	4,3	8	8	1	1,3	25	32	5	3	42	48	29,3	39,5	71,5	87,4
	2014	4,7	4,9	4	6	2,6	1,6	12	19	3	3	25	34	17,6	25,6	42,6	59,6
20-30 cm	2013	3,9	4,1	6	7	0,6	1	15	29	11	5	46	46	17,2	33,8	63,6	80,2
	2014	4,8	4,7	4	4	2,6	1,1	5	12	3	3	28	31	9,6	15,1	37,6	46,1

There was no variation in pH between the study sites, and the values for P, K, Ca, SB and CEC were larger in the crop-cattle integration system. The degraded soil had very high values for exchangeable Al in the first year of the study. These results suggest that the crop-cattle integration system is an efficient method of increasing sustainability and productivity of cattle ranching in the Amazon.

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Kedson Alessandri Lobo Neves

Integration of crop-livestock-degraded pasture in the Amazon: soil chemical aspects

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ICLF in cooperative systems: a strategy to achieve net positive environmental and socioeconomic budgets

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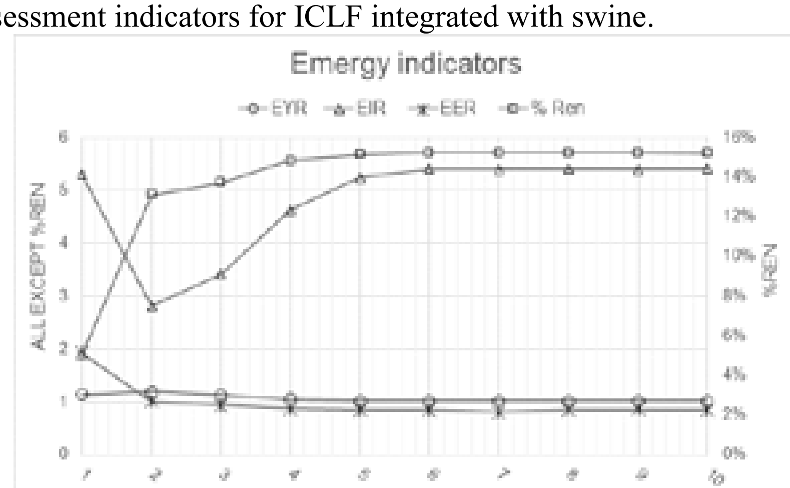
Introduction
ICLF systems are suitable for cooperative designs that gather small and large farmers. We use an agricultural cooperative in Mato Grosso do Sul state (COOASGO) as an example of ICLF including swine to produce a model of nutrients recycling, stormwater recovery and renewable energy production (electric power). Based on pilot farms studies, in this presentation we show that the upscaling of these technologies to the entire cooperative level can improve environmental and socioeconomic indicators.

Material and Methods
The field experiment was installed in São Gabriel do Oeste, MS, Brazil. Emergy accounting is the sustainability assessment tool that provides environmental and socioeconomic indicators. Based on field and literature data, a similar ICLF (Buller et al., 2014) was redesigned to include solid fertilizer production by means of liquid-solid phase separation of the digester effluent. A mass balance for the overall process considering inputs, storages, outputs and internal nutrient recycling was performed; parameters and variables used in the temporal assessment include changes in soil C stock, GHG emissions, water savings, electric power self-sufficiency (swine manure biodigester) and substitution of part of chemical fertilizer (NPK) imports.

Results and Conclusions
Fig. 1. Emergy assessment indicators for ICLF integrated with swine.



After a 6-year period, the system stabilizes and emergy indicators show a system less dependent on non-renewable resources (%Ren), despite the demand of economic resources (EIR and EYR), and also the trade with the market (EER) is beneficial to the farmers. The mid/long term planning of investments in those technologies can be inclusive for small and large farmers in more distributive cooperative that ultimately favor both the environment and the socioeconomic performances.

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Luz Selene Buller

ICLF in cooperative systems: a strategy to achieve net positive environmental and socioeconomic budgets

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Forage and wood production in the sixth year of an integrated crop-livestock-forest system in a cerrado region of Minas Gerais

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Introduction

The integrated crop-livestock-forest (ICLF) system has been used to recover degraded areas of crop and pastures in Brazil. These practices contribute with significant increases in carbon sequestration and reduction of emissions of greenhouse gases, promoting biodiversity conservation and low-carbon economy.

Material and Methods

The experiment was carried out at Santa Rita Experimental Farm/EPAMIG, Prudente de Morais, MG, Brazil, (19º27'15" S, 44º09'11 W, 732 m asl) in a degraded pasture of signal grass (*Urochloa decumbens*) recovered in 2008 using an ICLF with eucalyptus and corn. The experimental design was a randomized complete block in a split plot, with three replications. The eucalyptus arrangements double rows (3 x 2) + 20 m; (2 x 2) + 9 m and single rows (9 x 2m) were distributed in the main plots, with 20 and 9 m between rows and 2 m between tree spacing. Eucalyptus clones GG100, I144 and VM 58, were tested in the subplots. Accumulated forage dry matter yield (DMY) from November/14 to April/15 (three grazing period) and eucalyptus height, diameter at breast height (DBH) and Smalian volume in the sixth year of the ICFL was used for statistical analyses.

Results and Conclusions

The forage DMY accumulated from December to April in the (3 × 2) + 20 m eucalyptus arrangement was three times higher than in the (2 × 2) + 9 m and 9 x 2 m structural arrangements (Table 1). The proximity between eucalyptus rows may have resulted in more shading of the forage, contributing for the reduction of pasture productivity in these locations. Also the climate changes at this year with a lower rainy season contributed with a reduction on forage production. There was no difference for forage production in the understory of clones. The double lines provided greater heights. The arrangement (3 x 2) + 20 m and 9 x 2 m had higher diameter and volume per plant.

Table 1 Accumulated dry matter yield (DMY)) of *Urochloa decumbens*, eucalyptus height (HT), diameter at breast height (DBH) and plant volume, and plant number in the sixth year of a ICLF

Arrangement	DMY (kgha^{-1})	HT (m)	DBH (cm)	Volume/plant (m^{-3})	Plant ha^{-1}
(3 x 2)+20 m	1764.00 a	26.95 a	19.30 a	0.033 ab	434
(2 x 2)+9 m	552.69 b	27.69 a	16.85 b	0.027 b	909
9 x 2 m	6679.38 b	24.33 b	19.41 a	0.036 a	556

[1] Means followed by the same lower case on the column do not differ by Tukey's test at 5%

Acknowledgements

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Maria Celuta Machado Viana

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Precision agriculture in crop-livestock system in southern Brazil: use of yield maps as a guide for a site-specific management

Naylor B. PEREZ [1*], Marcos C. NEVES[2], Vinícius do N. LAMPERT[1], Camila G. SOUZA[3], Luiza da S. RIBEIRO[3], Rodison N. SISTI[1], Marcelo PILON[1].
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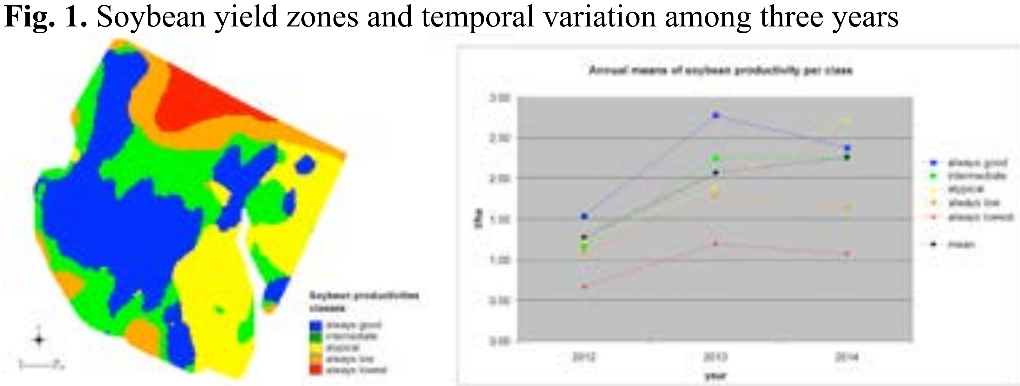
Introduction
Yield maps have been used in precision agriculture to site specific management in order to rationalize inputs, improved productivity and reduced environmental impact due to the better management of variability. As the crop-livestock system imposes greater complexity, due to the mobility of animals, selective grazing, trampling and dung, it is necessary to understand the spatio-temporal variability of productivity and verify its relations with economical variables.

Material and Methods
The trial is being conducted since 2008 in a crop-livestock system, using soybean during the summer (cultivated at a fixed rate of seeds and fertilizer) and ryegrass pasture in the winter. Soybean yield (dry weight) for the year 2012, 2013 and 2014 was obtained from infrared sensors productivity corrected by capacitive humidity and temperature sensors and the weighing performed at the receiving unit. Productivity surfaces, generated by interpolation (kriging), were subjected to classification by iterative minimum distance method with normalization of variables. The economic evaluation used the gross margin per productive class, average price per ton at harvest (US $ 356.74) and average cost of cultivation in the region (US $ 535.12), without considering opportunity cost of land.

Results and Conclusions
Classification using the productivity data of three years resulted in five classes (Figure 1) with different annual means and distinct temporal variability. Blue class (36 % of total area) always had good productivity. Red and orange classes (18 % of total area) always had the lowest productivities and show negative and zero gross margin respectively, while other classes were positive. Green class labeled as intermediate productivity, was affected by the effect of water restriction in 2012, resembling the most productive class in the following years, under better precipitation. The yellow class with poor performance in the first two years, similar to orange class, exceeded all yield classes in 2013, coinciding with the largest rainfall occurred in the grain filling in three years. Average productivity and gross margin were 1.93 tons and US$ 153.15 per hectare. The average return on disbursed capital was 22%, ranging from -53% to 33%. Improve productivity of classes below average for amounts equal to average imply in profitability rise to 27% representing an additional income of US$ 40.00 per hectare. Relationships between yield zones and climatic variations among years and economical impacts must be considered to build site-specific robust models.

Fig. 1. Soybean yield zones and temporal variation among three years



Naylor Bastiani Perez

Precision agriculture in crop-livestock system in Southern Brazil: use of yield maps as a guide for a site-specific management

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Precision agriculture in crop-livestock system in southern Brazil: are soybean and winter pasture yield zones identical?

Naylor B. PEREZ [1*], Marcos C. NEVES[2], Luiza da S. RIBEIRO[3], Camila G. SOUZA[3], Rodison N. SISTI[1]

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Introduction

Yield maps are increasingly accessible to farmers generating large amount of information with high precision. However, the same does not occur with the yield pasture especially under grazing. Since animals throughout the growth cycle consume pasture's production selectively, other methods must be considered. This work aims to identify if the soybean and winter pasture yield zones coincide in crop-livestock system in Southern Brazil.

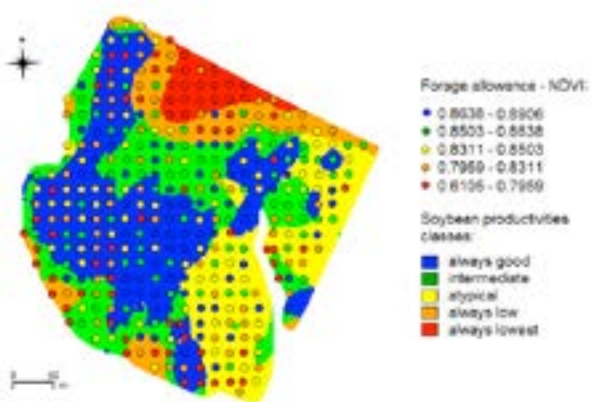
Material and Methods

To check the coincidence zones, 400 geo-referenced points were evaluated in a plot of 12.9 ha conducted since 2008 in a crop-livestock integration system, using soybean during the summer (cultivated at a fixed rate of seeds and fertilizer) and ryegrass pasture in the winter. In order to evaluation of biomass, at each point it was obtained the Normalized Difference Vegetation Index (NDVI) with Crop Circle, just before grazing by steers, in 03.07.2014. The results were overlaid on a map of the soybean yield classes obtained by the classification from three soybean yield maps, for the years 2012, 2013 and 2014. Classification and visualization procedures were performed by QGIS 2.2 software.

Results and Conclusions

Four zones of soybeans showed consistency with the ranking of class productivity over the years. Two of them with the lowest productivity, and two with the best. The most of the sampled points with low forage mass (vegetation index) lying over the low yield soybeans areas, specially in the zone classified as always lowest. This shows that this zone have productivity restrictions at the pasture and crop stages. The other two zones with higher productivity of soybean occurred a large proportion of points with high values of vegetation index. However, in the latter case, the points of high mass grassland were interspersed with other classes of grass production. Based on these results, we can infer that the lowest productivity zone is the same, for soybeans and winter pasture. Accordingly, the identification of the soil-plant relationships can be better evaluated in this zone, in order to identify specific site management practices that improve the system performance.

Fig.1. Soybean yield zones and forage vegetation index



Acknowledgements

To Embrapa, Stara and CNPq.

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3rd International Symposium on Integrated Crop-Livestock Systems

Evaluation of biological nitrogen fixation contribution in soybean and cowpea cultivated under integrated crop/livestock systems in Roraima state.

Claudia P. JANTALIA[1], Segundo URQUIAGA[1], Robert. M. BODDEY[1], Amaury B. BENDAHAN[2], Edmilson E. DA SILVA[2], Gustavo R. XAVIER[1]and Jerri Édson ZILLI[1].
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Introduction The warm conditions of the tropics leads to a rapid degradation of soil organic matter (SOM). To reduce this depletion a positive nitrogen balance in agricultural systems is necessary. The area under integrated crop/livestock systems in Roraima state is increasing. In this context, especially in the transition from pasture to crop, it is important to measure the N derived from biological nitrogen fixation in grain legumes for evaluation its nitrogen nutrition status. The objective of this study was to assess biological nitrogen fixation contribution in soybean and cowpea cultivated in two pasture areas recently converted to cropping of these legumes in Roraima.

Material and Methods

The experiments sites were located near the Embrapa Roraima. Both areas were recently change from pasture to crop under Argissol soil. The sites were located in São Paulo experimental field of Embrapa Roraima and Serra da Prata private farm and the crops were sampled in 2012. To determine the BNF contribution to the crops, three blocks were established at sowing of soybean and cowpea crops. The soybean cultivars were BRS Tracajá and the cowpea cultivars was BRS Guariba. Recommended bacteria strains were used for inoculation of both crops. The contribution of N derived from BNF was determined using the isotopic ^{15}N natural abundance technique.

Results and Conclusions

The results in Table 1 showed that contribution of N in soybean derived from BNF was 65% independently of the sampled area.

Table 1. Proportion of N derived from biological nitrogen fixation (N-BNF%) in soybean and cowpea, estimated through the ^{15}N natural abundance technique.

Site	Soybean N-BNF (%)	Cowpea N-BNF (%)
São Paulo Farm	65	47
Serra da Prata Farm	64.5	66.5
Average	**65**	**56.8**

It was observed that N derived from BNF in cowpea was 47% in São Paulo Farm and 66.5% in Serra da Prata Farm. It is concluded that under recently converted areas from pasture to crop, a considerable proportion of legume N plant can be derived from soil organic matter. However, soil N content can decrease after two or three years. For this reason, more research to improve the efficiency of the *Bradyrhizobium* strains in legume crops is important to maintain satisfactory inputs of N derived from BNF.

Acknowledgements

To Embrapa (project 02.09.01.011.00.00), CNPq, FAPERJ and all research scientists, technicians and field workers at the Embrapa Roraima Centre who diligently maintained these experiments. We gratefully acknowledge also the work of Altiberto M. Baêta and Renato Moutinho da Rocha from Embrapa Agrobiologia for assistance in laboratory analyses.

Robert Michael Boddey

Evaluation of biological nitrogen fixation contribution in soybean and cowpea cultivated under integrated crop/ livestock systems in Roraima state

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Consortium corn-teak in crop-livestock-forest integration system in the state of Roraima

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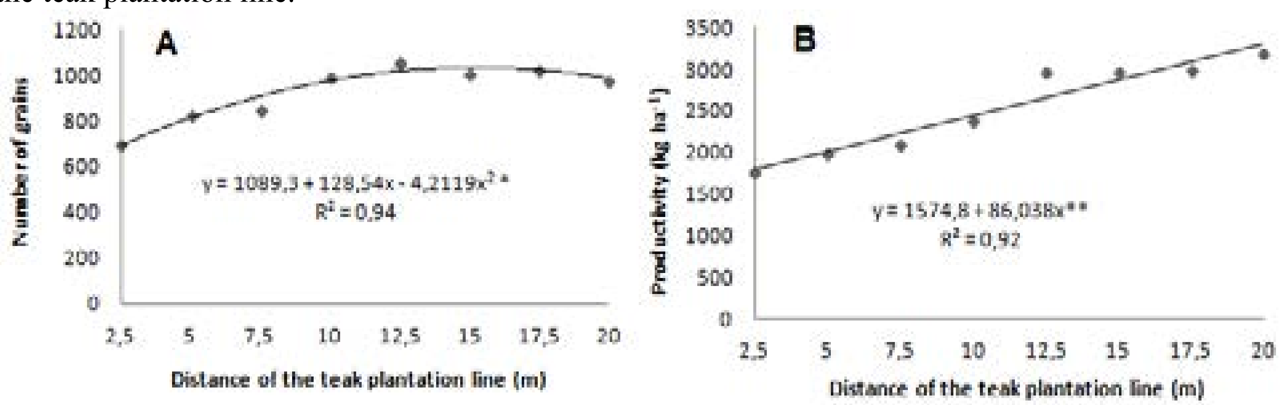
Introduction The crop-livestock-forest (iLPF) appears as a sustainable production strategy that integrates agricultural, livestock and forestry, held in the same area, in consortium, succession or rotation. Different cultures can compose iLPF systems among which stands out the corn. As one of the most important grasses for commercial cultivation and provide a significant amount of straw and organic matter (Silva et al., 2009). In this presentation we report the corn production results in consortium with teak in crop-livestock-forest integration system in the state of Roraima.

Material and methods

The experiment was conducted in the agricultural year 2014, in savannah-forest transition area, in the field Serra da Prata belonging to Embrapa Roraima located in the municipality of Mucajaí-RR in the geographical coordinates 60°58'40" W and 02°23'49,5" N. The experimental design was a randomized block with four replications, the treatments consisted of eight corn sowing tracks (2.5 m, 5.0 m, 7.5 m, 10.0 m, 12.5 m, 15.0 m, 17.5 m and 20.0 m) distanced from the teak plantation line (*Tectona grandis*). Forest animals aged six years planted in seven rows of 3m x 2m. The corn seeding was carried out in the form of tillage on the *Brachiaria ruziziensis* straw previously desiccated. Data were subjected to analysis of variance, determining the significance through the F test at 5% probability, when observed effect of treatments, proceeded to polynomial regression analysis.

Results and conclusions

Fig. 1. Number of grains per cobs (A) and productivity (B) of corn as a function of distance from the teak plantation line.



It shows a quadratic response to the number of grains per spike, where the best average were observed with 12.5 m (1057.6 grains), from that point there is a reduction concurrently with the distance the planting line (Fig. 1A). For productivity observed a linear increase with the distance of the teak plantation line with a maximum average of 3178.7 kg ha^{-1} in 20 m (Fig. 1B). These results seem to indicate a strong competition for water, nutrients, and mainly for light, exerted by the teak on the corn crop. In this context corn yield cultivated in consortium with teak is influenced by the distance from the plant line.

Reference cited

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Roberto Dantas Medeiros

Consortium corn-teak in crop-livestock-forest integration system in the state of Roraima

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Impact of integration on nutrient and water-use efficiency

Roberto Dantas Medeiros

Corn response in consortium with cedar and chestnut integration system crop-livestock-forest

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Corn response in consortium with cedar and chestnut integration system Crop-Livestock-Forest

Roberto D. MEDEIROS*[1], Edgley S. SILVA[2], Ignácio L.G.S. CARMO[2], João L.L. MONTEIRO NETO[2], Luciana B. TRASSATO[2], Alexandre P. SILVA[3], Fernanda R. NASCIMENTO[2].
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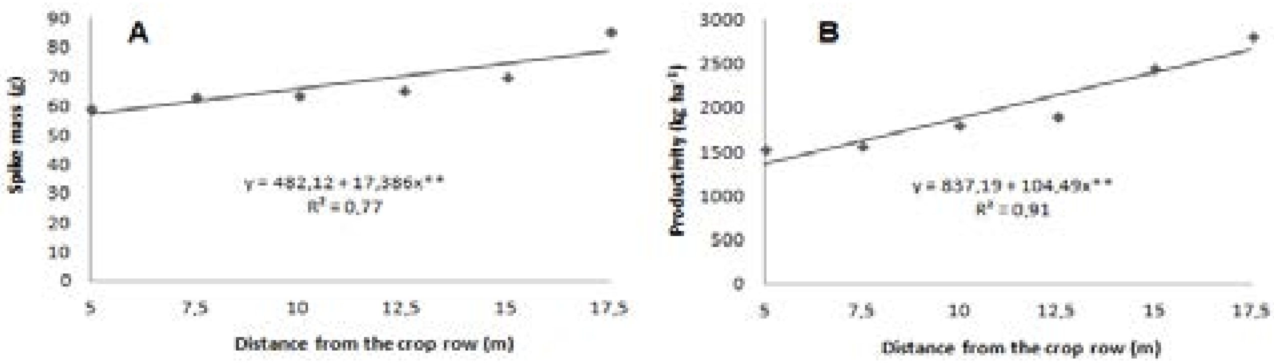
Introduction The combination of agricultural activities, livestock and forestry gives great versatility to the productive system by allowing social, economic and environmental components to be considered for the adequacy of the ideal model of integration to the Cerrado region (BALBINO et al., 2011). Corn stands out in the context of iLPF due to the numerous applications that have cereal on the agricultural property, whether in animal feed, human consumption or to generate revenue through marketing and also for providing significant amount of straw and organic matter to the system. In this presentation we report the results of maize yield in consortium with cedar and chestnut system in crop-livestock-forest in the state of Roraima.

Material and methods

The experiment was conducted in the agricultural year 2014, in savannah-forest transition area, in the field Serra da Prata belonging to Embrapa Roraima located in the municipality of Mucajaí-RR in the geographical coordinates 60°58’40’’ W and 02°23'49,5" N. The experimental design was a randomized block with four replications, the effect of six corn sowing tracks (5.0 m, 7.5 m, 10.0 m, 12.5 m, 15.0 m and 17.5 m), distanced from row planting cedar (*Pachira quinata*) with the nut (*Bertholletia excelsa*). These forest species were aged six years and were planted in consortium with the tier consisting of a cedar plant and other walnut, spaced 6 m. The corn seeding was carried out in the form of tillage on the *Brachiaria ruziziensis* straw previously desiccated. Data were subjected to analysis of variance, determining the significance through the F test at 5% probability, when observed effect of treatments, proceeded to polynomial regression analysis.

Results and conclusions

Fig. 1. Spike mass (A) and productivity (B) of corn depending on the distance from the Cedar plant line with the chestnut tree.



It shows a linear correlation for both characteristic with the distance from the plant line of forest species, where the best average were observed in 17.5 m, with 85.2 g per spike (Fig. 1A) and productivity 2804.1 kg ha^{-1} (Fig. 1B) respectively. The competition for water, light and nutrients were probably the most important factors influencing the productive characteristics of corn plants. In this context to give mass satisfactory yields spike and productivity is recommended corn seeding in larger distances cedar plantation line with the chestnut tree.

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Litter deposition in integrated agricultural systems in the Brazilian Cerrado

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Introduction

In agro-ecosystems, litter is a major component, comprising material that is deposited in the soil by fauna and flora. Integrated crop-livestock systems (ICL) and crop-livestock-forest systems (ICLF) are expected to enhance the use of plant biological cycle. Therefore, this study aimed to characterize litter deposition in integrated systems at the Brazilian Savannah, the Cerrado in Mato Grosso do Sul State, Brazil.

Material and Methods

The trial was carried out in Campo Grande, MS, Brazil (20°27' S, 54°37' W, 530 m altitude). Weather pattern in the region, according to Koppen, lies in the transition zone between Cfa and humid tropical Aw. The ICL system consisted of pasture grass (*Brachiaria brizantha* cv. BRS Piatã) for three years after one season soybeans crop in the Summer 2012. The ICLF system was like the ICL but with eucalyptus trees arranged in 22m x 2m (227 tress ha^{-1}). Pastures were managed under the same forage allowance and a plot in the Cerrado (native Savannah) was used as control. In late Spring 2014 15 representative samples per system (ICL, ICLF and Cerrado) were collected. At each sampling point, litter was collected from a 0,25m x 0,25m square. Subsequently the material was dried to calculate litter dry matter per hectare.

Results and Conclusions

In late Spring samples had only grass residues (Litter 1) resulting in greater litter accumulation for the Cerrado compared to the ICL and ICLF systems which showed no significant difference between them. However, when samples included forestry component (Litter 2), as expected, litter accumulation was lower in the ICL system when compared to ICLF and Cerrado, which did not show statistical difference between them (Table 1). These results indicate that the contribution of litter volume from the forestry component of ICLF is similar to the Cerrado. Therefore, it can be a contribution to agro-ecosystems's biodiversity.

Table 1. Dry mass of litter during spring 2014 in two agro-ecosystems, only fodder (1) and plus forestry component (2) relative to the native vegetation (Cerrado).

System	Litter 1 (kg ha^{-1})	Litter 2 (kg ha^{-1})
ICL	4,607 b	4,607 b
ICLF	4,932 b	7,106 a
Cerrado	9,402 a	9,402 a

a>b, in the column, by Tukey test (p<.05).

Acknowledgements

Embrapa Gado de Corte, Fundect, UEMS.

Roberto Giolo Almeida

Litter deposition in integrated agricultural systems in the Brazilian Cerrado

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Gliricidia sepium seedlings development due to biochar and manure application

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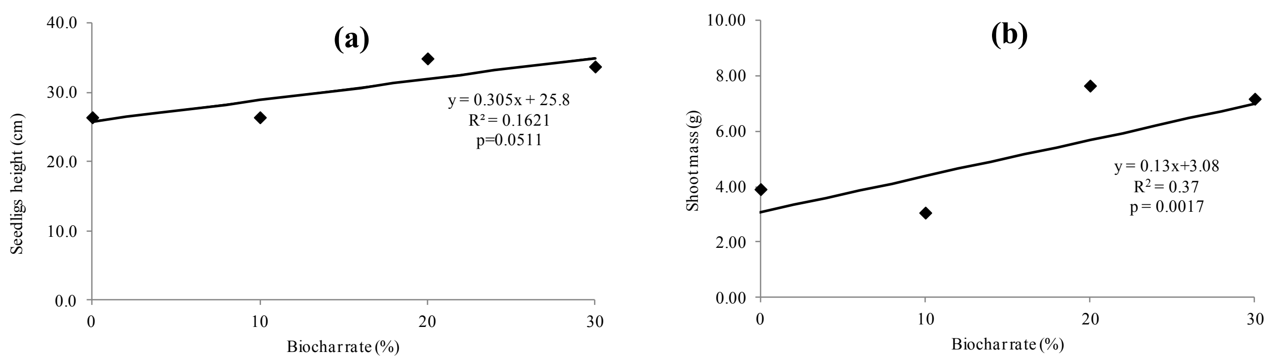
Introduction *Gliricidia* sepium has been used for animal feed in Brazilian Semiarid and is an important component of crop-livestock-forest systems in this region (Voltolini et al., 2011; Sá e Sá, 2006). Biochar can be used as a soil conditioner to improve chemical, physical and biological attributes of soil and can also be used as a substrate to seedlings. Our objectives were to evaluate effects of biochar on *Gliricidia sepium* seedlings development.

Material and Methods

The experiment was installed at Embrapa Semiarid, in Petrolina, Pernambuco state, Brazil. Treatments were distributed in a factorial scheme (4 x 2), with four rates of biochar (0%, 10%, 20%, 30% volume/volume), with and without goat manure, that were mixed to an Oxisol and used as a substrate for *Gliricidia sepium*. Treatments were distributed in a randomized design, with three replicates. Soil, biochar and manure were mixed and used to fill plastic bags (11.5 x 29.5 cm). Three seeds of *Gliricidia sepium* were sown in each bag and eight days after sowing two of them were eliminated. Sixty days after sowing we evaluated seedlings height and root and shoot dry biomass. Results were evaluated by analysis of variance. Means were compared by Tukey and when biochar effects were significant we used regression analysis.

Results and Conclusions

Fig. 1. *Gliricidia sepium* seedlings height (a) and shoot biomass (b) due to different rates of biochar. Data are means of 3 replicate plots.



Interaction between biochar and manure for height and shoot biomass were not significant. Manure had effect just on seedlings height, despite seedlings without manure were higher (35.2 cm) than those with manure (25.5 cm). Increasing biochar increased both height and shoot mass of seedlings. Biochar can be used as an additive to increase the development of *Gliricidia sepium* seedlings and its effects are better than those of goat manure. This information could be used for the production of seedlings for the implementation of livestock-forest systems in Semiarid region.

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Acknowledgements

To Embrapa and CNPq.

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Forage productivity after consortium with sorghum and/or pigeon pea dwarf in Integrated Crop-Livestock Farming System

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Introduction The pasture formed in Integrated Crop-Livestock Farming System can be used as high-quality forage for livestock in the dry season and/or for production of mulch in no-tillage.

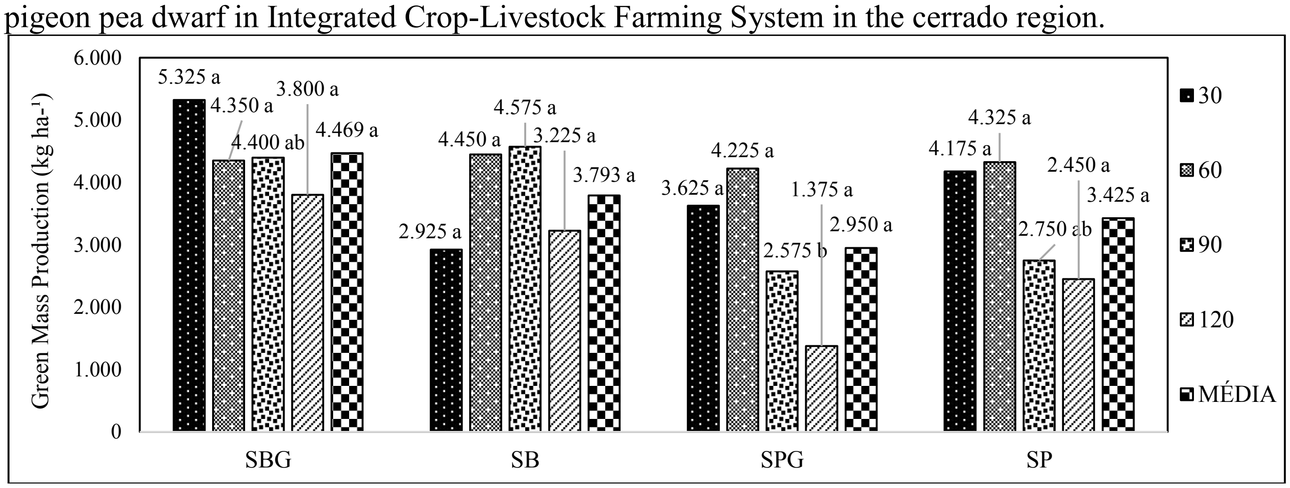
Material and Methods

The study was conducted in the agricultural year 2013/14 in Selvíria, MS. The experimental design was a randomized block design with 4 treatments and 6 repetitions. The treatments were the *U. brizantha* cv. Marandu in consortium with sorghum (cv Volumax.) and pigeon pea dwarf (SBG); Marandu grass with sorghum (SB); *Panicum maximum* cv. Mombaça with sorghum and pigeon pea dwarf (SPG); and Mombaça grass with sorghum (SP). Forage and sorghum were mechanically sown on the same line and pigeon pea dwarf was sown between the lines, spaced 0.50 m and 20 m in length for a total of 7 lines of each crop/plot. The forages were harvested at a height of 0.30 m above the ground at 30, 60, 90 and 120 days after the consortium with sorghum and/or pigeon pea dwarf, with the first cut held on 27/06/14. To determine the forage yield, samples were collected from 1 m² with 3 repetitions/plot, it was immediately weighed on a digital scale and then transformed into green matter per hectare.

Results and Conclusions

It can be observed in Picture 1 that the green mass productivity in the consortia was only influenced among treatments at 90 days after the consortium with sorghum and/or pigeon pea. The highest yield was at 30 days (5325 $kgha^{-1}$) and the lower production was at 90 days (1375 $kgha^{-1}$), respectively, for the grass Marandu intercropped with sorghum and pigeon pea dwarf and Mombaça grass with sorghum and pigeon pea dwarf.

Picture 1. *U. brizantha* and *P. maximum* forage productivity after consortia with sorghum and/or pigeon pea dwarf in Integrated Crop-Livestock Farming System in the cerrado region.



**different letters in the same column differ in 5% by Tukey test.

Acknowledgements

Thanks to FAPESP and CNPq for granting research fellowships to the authors.

Impact of integration on nutrient and water-use efficiency

Sanderley Simões Cruz

Forage productivity after consortium with sorghum and/or pigeon pea dwarf in integrated crop-livestock farming system

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Fertilizing cover of corn and Xaraés grass under no-tillage and conventional tillage with nitrogen levels in an agrosilvopastoral system in Acre State, western amazon

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Introduction In crop-livestock-forest systems in the Amazon region, nitrogen fertilization is highly variable. It varies according to soil type, cropping system and the use of nitrogen demanding species such as corn and *Urochloa brizantha* (xaraés grass). This study was carried out to evaluate the agronomic efficiency of corn and 'Xaraés' intercropping, established in no-tillage and conventional tillage, in an agrosilvopastoral system, with different levels of nitrogen fertilization.

Material and Methods

The field experiment was installed in a farmer's área (9°51'26"S, 67°25'42"W, 181 m asl), in Acre state-Brazil. The soil is an Ultisol. The experiment was conducted in a corn crop area with the forest species "mulateiro" (*Calycophyllum spruceanum* Benth). The experimental design was completely randomized blocks, in a split-plot arrangement with two soil management systems (no-tillage and conventional tillage). Five levels of nitrogen coverage fertilization were tested (0, 50, 100, 150, and 200 kg ha^{-1} N). The corn and forage dried matter productivity were evaluated 50, 90 and 145 days after the corn harvesting.

Results and Conclusions

Fig. 1. Corn yields in no-tillage (NT) and conventional tillage (CT) with different levels of nitrogen fertilization.

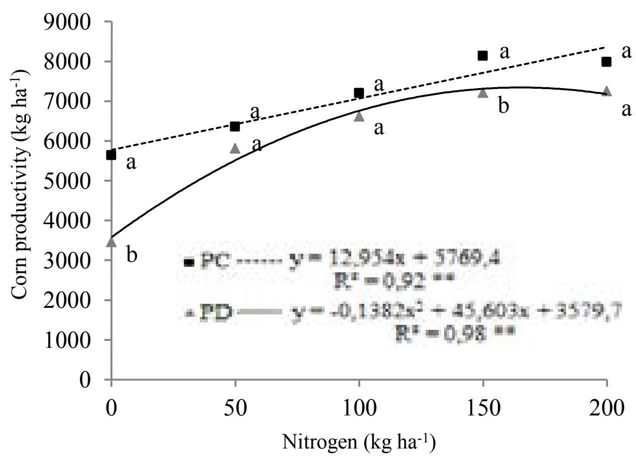
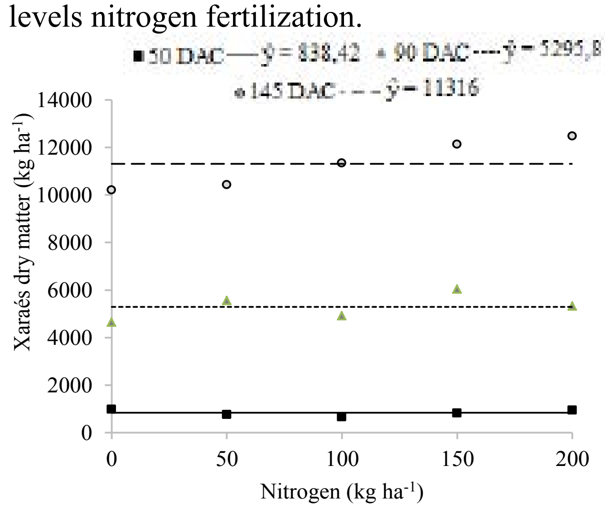


Fig. 2. Dry matter Xaraés 50, 90 and 145 days after corn harvesting (DAH) in different levels nitrogen fertilization.



Corn productivity linearly increased from 0 to 200 kg ha^{-1} N fertilization, in the conventional tillage area. In the no-tillage area N coverage fertilization must have be done to obtain satisfactory yields. Nitrogen fertilization does not influence Xaraés grass dry matter production when intercropped with corn in agrosilvopastoral system.

Acknowledgements
To Embrapa, CNPq, Banco da Amazônia SA., João Evangelista Ferreira by concession of the studied area and all students, technicians and field workers of Embrapa Acre whom since 2009 kept and accompanying this experiment.

Tadário Kamel de Oliveira

Fertilizing cover of corn and brachiaria under no-tillage and conventional tillage with nitrogen levels in an agrosilvopastoral system in Acre state, Western Amazon

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Effect of pasture N-fertilization and sward canopy height on accumulated shoot dry matter soybean yield cultivated in Crop-Livestock System

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Introduction:
With greater complexity of the soil-plant-animal system integrated crop-livestock systems, stocking rates and nitrogen fertilization in pasture can be the most important issues to understand to improve overall system efficiency. The aim of this study was to verify the effect of pasture N-fertilization and grazing intensity on shoot dry matter soybean yield cultivated in Crop-Livestock Systems.

Material and Methods:
The work was carried out from September, 2012 until now, in the county of Abelardo Luz, Santa Catarina, Brazil. The region's climate is subtropical humid with 1,800 mm mean annual rainfall. The soil at the experimental site was a Clayey Oxisol. The treatments were applied in the grazing phase before soybean growing, in randomized block design with three replications. The treatments were arranged in a 2 x 2 factorial arrangement. The first factor was the sward canopy height of black oat + annual ryegrass (15 cm - low canopy height and 30 cm - high canopy height). The second factor was presence or absence of N-fertilization applied as urea (either 0 kg ha^{-1} N or 200 kg ha^{-1} N). Soybean cultivar 'Nidera 5909' was sowed in November, 28, 18 days after removal animals. Shoot dry matter accumulation was evaluated by cutting the 3 m linear of soybean each plot at 51, 64 and 71 days after soybean sowing.

Results and Conclusions:
There was no effect of treatments in accumulated soybean shoot dry matter evaluated at 51 and 64 days after sowing and the average accumulated yield were 1801 kg ha^{-1} and 3794 kg ha^{-1}, respectively. At 71 days after sowing the highest soybean accumulated shoot dry matter (4,904 kg ha^{-1}) were observed in the plots where the sward canopy height was higher and N-fertilizer was applied (200 200 kg ha^{-1} N) (Table 1). However the lowest yield (3,566 kg ha^{-1}) was observed in the higher sward height plots and no N-fertilizers applied (0 N-pasture). This yield did not differ statistically to the plots where the sward canopy height were lower. In conclusion, in high sward canopy height N-fertilization must be applied to assure highest soybean shoot dry matter and low grazing height were harmful to dry matter soybean production.

Table 1: Soybean shoot accumulated dry matter at 71 days after sowing.

	0 N-pasture	200 N-pasture
High Height	3,566 ^{b}	4,904 ^{a}
Low Height	3,879 ^{b}	3,955 ^{b}

$^{a, b}$ Values followed by the same letters did not differs statistically by Tukey Test

Impact of integration on nutrient and water-use efficiency

Wilson Henrique Tatto

Effect of pasture N-fertilization and sward canopy height on accumulated shoot dry matter soybean yield cultivated in crop-livestock system

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Effect of N-fertilizer broadcast on corn over alfalfa shoot residue N release rate

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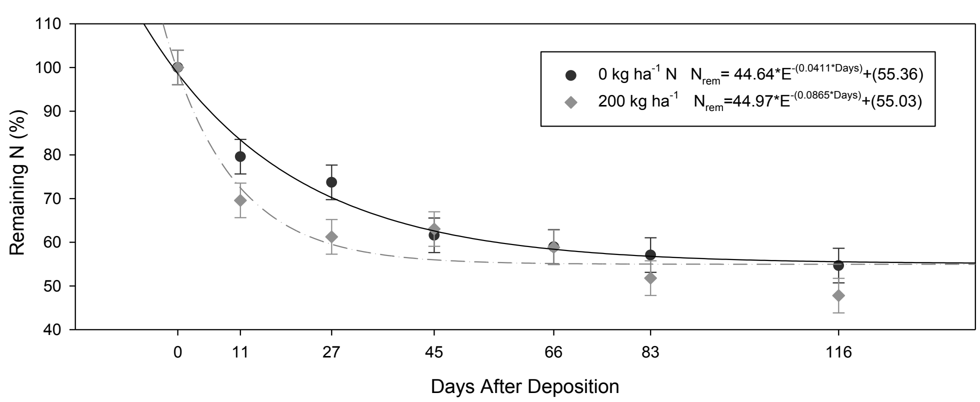
Introduction
In diversified systems, leguminous residues are important nitrogen source to the successive crop. The aim of this work was to verify the effect of N-fertilizer broadcast on corn over alfalfa shoot residue N release rate

Material and Methods
The study was carried out at the experimental unit of the Agronomic Institute of Paraná (IAPAR) in Pato Branco (PR). Alfalfa cultivar Crioula was grown and used as hay for four years. Its final residues (1600 kg DM ha^{-1} with 38.4 g N per kg^{-1} of DM) were desiccated and samples of this material were placed into litter bags (0.1 mm mesh). The experiment was arranged in a complete randomized block design with four replications. Treatments consisted of two nitrogen levels (0 and 200 kg N ha^{-1}) applied as Urea at corn V6 stage. Litter bags were placed on soil surface on September 19 (corn seedling) and collected after several field incubation periods (11, 27, 45, 66 and 116 days). After each incubation period, four litter bags were collected, oven-dried (55 ºC) and weighed. After DM was sulfur-digested to determine the total N concentration by the Kjeldahl method. To describe the N release rate, the percentage of the remaining N concentration was adjusted to nonlinear models, used to fit the decay curves by the statistical program Statgraphics Plus 4.1.

Results and Conclusions
Nitrogen release from alfalfa residue showed higher rates at its initial phase for the corn treatment with nitrogen (Fig. 1). Half-life of the easily decomposable compartment (44.64%) (time needed to release 50% of that compartment) at the treatment without N was of 17 days. On the other hand, when 200 kg ha^{-1} of N were applied on corn, half-life of the easily decomposable compartment (44.9%) came down to 8 days. In conclusion, N release rate from shoot alfalfa residue was affected by N-fertilizer applied on corn.

Fig. 1. Remaining N shoot alfalfa residue after 116 days of field incubation.



* To the bars that are not coincident, the averages differ by DMS test (minimum significant difference) at 5% probability

Impact of integration on nutrient and water-use efficiency

Wilson Henrique Tatto

Effect of N-fertilizer broadcast on corn over alfalfa shoot residue N release rate

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Economic analysis of crop-livestock-forest system: the case of Embrapa Cattle Southeast

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Introduction The more effective use of land and other resources through livestock production systems integrated with forestry and/or crop production has been a sustainable alternative to recover degraded pastures and increase system productivity. The economic analysis of these systems plays an important role in order to ensure its sustainability and to foster its adoption. This study aims to estimate the economic viability of a crop-livestock-forest system carried out in the experimental area of Embrapa Southeast Livestock in São Carlos, SP.

Material and Methods

The crop-livestock-forest system comprises an area of 6 ha. The schedule of activities was: April 2011 - planting of eucalyptus *Urograndis* (2000 trees); season 2011/2012 - planting of corn crop for silage concomitant with sowing of the *Urochloa brizantha* (capim-piatã); season 2012/2013 - fattening of calves; season 2013/2014 - planting of corn crop for silage concomitant with sowing of the *Urochloa brizantha* in 1/3 of area and fattening of steers in 2/3 of area; November 2014 - estimation of eucalyptus harvesting for firewood and selling of animals. The cash flow was structured with income and expenses of the production system over the 2011 to 2014 financial years. The indicators for economic viability, net present value and Internal Rate of Return, were estimated.

Results and Conclusions

Table 1. Cash flow of the crop-livestock-forest system, São Carlos, SP (R$/ha).

Description	2011	2012	2013	2014
Input**	1.864,15	40,09	1.009,86	445,77
Hired labour	425,63	169,65	252,54	290,32
Mechanized operations	151,34	201,45	100,92	88,85
Other expenses	122,06	20,56	68,17	41,25
Purchase of animals		1.881,33	2.570,00	
Infrastructure***		2.675,97	480,00	
Total expenses	2.563,18	4.989,05	4.481,48	866,18
Silage income		1.757,80		466,86
Livestock income			2.715,67	4.605,00*
Forest income				2.618,00*
Total income	0,00	1.757,80	2.715,67	7.689,86
Infrastructure (residual value)				2.524,77
Cash flow	-2.563,18	-3.271,68	-1.846,75	9.147,82
Internal Rate of Return	9%			
Net present value	365,50			
Attractiveness rate	6%			

* Estimated data; **Animal health and feed, seeds/seedlings, fertilizers/pesticides; *** Fence, trough and access to water.

The net present value is positive and the internal rate of return is higher than the attractiveness rate (Table 1), suggesting the project acceptance and that the invested amount will be recovered and there will be earnings in the period of analysis.

Acknowledgements

The research was supported by the Brazilian Agricultural Research Corporation (Embrapa). The analysis and comments are however the authors´ responsibility.

Socio-economic benefits and impacts of change to diversified systems

Alberto Carlos de Campos Bernardi

Economic analysis of crop-livestock-forest system: the case of Embrapa Cattle Southeast

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Economic evaluation of integrated livestock-forest systemat the establishment phase in the southern region of Rio Grande do Sul – Brazil.

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Introduction The integrated livestock-forest system (ILF) is cost effective and sustainable systems to the Pampa region at Rio Grande do Sul State. The ILF allows integrating traditional beef cattle system to forestry systems in this region. This work aims to evaluate the economic performance at the early stages a ILF with eucalypt and beef cattle in the south region of Rio Grande do Sul State.

Material and Methods The Technological Reference Unit (TRU) of 34 hectares was established in April 2013 within the experimental area of Embrapa South Livestock (31°21'09"S and 54°00'57"W). The experimental design was a randomized blocks distributed in a factorial 3x2 with two replications, where the treatments were: three pasture systems: ILF1 with *Eucalyptus grandis* trees in triple rows and density of 750 treesha^{-1} (3x2x14m); ILF2 with *E. grandis* with 375 trees ha^{-1} (3mx2mx34m) and open pasture systems (OP). Each pasture system was splinted into two levels of pasture intensification: native grassland (NG) invaded by AnnoniGrass weed (Ness *Eragrostis plana*) and improved natural grassland (ING) with annual ryegrass (*Lolium multiflorum*), red clover cv. LE116 (*Trifolium pratense*) and Birdsfoot Trefoil cv. Sao Gabriel (*Lotus corniculatus*). Sown in June 2013. In December 2013, the ING paddocks were harvested as hay. From August 2014 to April 2015, all pasture treatments were continuously grazed by Brangus Ibage calves, starting with 90 weaned calves averaging 120kg of live weight. The stocking rate was adjusted every 30 days, maintaining a forage allowance of about 14 kg of pasture dry matter per 100 kg live weight. The daily live weight gain (LWG) per head was evaluated monthly. All deployment and maintenance costs as well as the incomes obtained were evaluated during the experimental period from April2013 to April2015 and an economic evaluation was performed, looking at the applied systems. The exchange rate used for these calculations was 1 Brazilian Real ($R) equaled to 3,25 American Dollar ($US).

Results and Conclusions Investment costs and maintenance of the trees establishment totaled US$18,830.77 and consisted of: herbicide desiccation (glyphosate, 5 l ha^{-1}); soil preparation; Limestone application (4 ton ha^{-1}); 17,000 eucalyptus seedlings; planting labor; NPK fertilization (6:30:6 formula at 50g per seedling); Gel forest application for drought period; control of ants; post planting herbicide application. The total costs of pasture establishment and maintenance was US$7,793.85 and included: herbicide desiccation of native AnnoniGrass weed(glyphosate 5 l ha^{-1}); First year NPK fertilizer (2:30:15 formulaat500 kg ha^{-1}), Winter forage seeds (30 kg ryegrass+10 kg red clover+10 kg Birdsfoot Trefoil per ha); seeds inoculation, labor sowing procedures; Second year NPK fertilization (5:20:20 formula at 300kg ha^{-1}); urea covering fertilization (50 kg ha^{-1}); Herbicide local control for AnnoniGrass(glyphosate at 5 l ha^{-1}, "Campo Limpo" Technology). The out puts at the first year of ILF was based on hay rolls production (88 bales of 250kg and 23 bales of 75 kg, totaling US$ 3,649.85. At the second year, the ILF output was calculated from calves total LWG, resulting in US$ 16,941.54. The mean LWG was: 1.5 kg per head per day from 90 calves between August and October 2014; 0.67 kg from 44 calves between November and December 2014; 0.541 kg from 16 calves between January and April 2015. Therefore, the total gross margin of this ILF was US$6,033.23 up to the second year of establishment, allowing the conclusion that all investment and maintenance costs may be payable at the third year of this ILF, keeping similar beef cattle performance within the system.#

Alexandre Costa Varella

Economic evaluation of integrated livestock-forest systemat the establishment phase in the southern region of Rio Grande do Sul – Brazil

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3rd International Symposium on Integrated Crop-Livestock Systems

Wood production in silvopastoral system: diversification and growth of income in livestock breeding

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Introduction Integrated crop-livestock-forest systems enable a revenue increase compared to the individual production systems. The afforestation of pastures is a form of productive integration that provides benefits to the agriculture, including the generation and diversification of income per hectare and increased regional supply of forest products for energy generation (firewood) (PORFÍRIO-DA-SILVA et al., 2009).

Material and Methods

In 2010 a silvopastoral system Demonstrative Unit was deployed in the city of Olympia, in the state of São Paulo. On 9.5 ha of Yellow-Red Argisol, 4,360 seedlings of *Eucalyptus* spp. GG100 (*urograndis*), VM58 and VM01 (*urocam*) were planted in *Brachiaria decumbens* pasture. The seedlings were planted on existing terraces, arranged in six rows with three lines of trees and spacing of 2 m between plants and 3 m between lines of trees (density of 459 plants / ha). Fertilization, irrigation in the initial period and control of insects (ants) and weeds was carried out. The protection of trees was accomplished with an electric fence, dividing the area into six paddocks. In the period from March to July 2014 the trees were clear cut and sold for firewood. According to IEA (2015), the average price of eucalyptus paid to farmers in São Paulo in the period from March to July 2014 was R $ 46.55 / m³.

Results and Conclusions

The activities were undertaken as part of the daily flow of work on the property, using existing physical and human resources. In addition to the increase in revenues in the wooded pasture area (Fig.1), other benefits related to better utilization of grass production and the welfare of animals were observed during this period.

Fig 1. Revenue earned with timber production in the Silvopastoral System Demonstrative Unit in Olympia - SP, in the period 2010-2014.

Total production of wood in area (m^3)	Average price of wood in March-July 2014 (R$/$m^3$)	Total Revenue from area (R$)	Revenue per ha (R$/ha)	Annual revenue per ha (R$/ha/yr)
950.00	46.55	44,220.60	4,654.80	1,163.70

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Carlos Eduardo Silva Santos

Wood production in silvopastoral system: diversification and growth of income in livestock breeding

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Public policies and recovery of degraded pastures in Brazil

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Introduction The pasture degradation stages can be classified in four levels according to the GeoMS Project: I- not degraded; II- moderate degradation; III- strong degradation; IV- stronger degradation, in which the pasture has low vigor and quality and bare soil. In this presentation it was analyzed public investment and resources needed for pastures recovery, especially at IV degradation level, in three Brazilian regions.

Material and Methods

Analyzes were conducted considering: a) national average percentage of degraded pastures - IV level: estimated at 6% (IBGE, 2006; *Rally* da Pecuária, 2012); b) total value (R$) provided by the ABC Plan (2013); 1,140.00 (R$/ha) estimated for pasture reform with *Brachiaria brizantha* (Anualpec, 2014). The total amount necessary (R$) for reform pastures in the North, Southeast and Midwest of Brazil was compared with to the value provide (2012/2013) by the ABC Plan.

Results and Conclusions

There are discrepancies between the value provided by the ABC Plan and the necessary resources, especially for North and Midwest regions, with deficit percentage to coverage by 97.2 and 90.0, respectively. The Southeast region was the one with greater coverage for degraded areas. The State of São Paulo was the only one who had enough financial support for the ABC plan, with surplus of 32.7 for pastures recovery. The Distrito Federal has 47.9% higher resource provided by ABC plan than the necessary, which does not occur in other states of the region.

Table 1. Investment reform *versus* disbursement of the ABC Plan

Region/State	Degraded area level IV (ha)	Investment reform of pasture level IV (1,000.00 R$)	Resource provided ABC Plan (1,000.00 R$)	Difference (%)
NORTH	**2,195,352**	**2,502,701.3**	**69.023.100**	**-97,2**
Rondônia	243,472	277,558.1	12,307.0	-95,6
Acre	96,639	110,168.5	6,181.2	-94,4
Amazonas	51,201	58,369.1	200.3	-99,7
Roraima	50,169	57,192.7	1,417.2	-97,5
Pará	1,088,059	1,240,387.3	8,113.5	-99,3
Amapá	14,094	16,067.2	599.5	-96,3
Tocantins	651,718	742,958,5	40,204.4	-94,6
SOUTHEAST	**1,662,820**	**1,895,614.8**	**784,288.3**	**-58,6**
Minas Gerais	1,231,246	1,403,620.4	281,564.5	-79,9
Espírito Santo	74,605	85,049.7	17,798.0	-79,1
Rio de Janeiro	41,421	47,219.9	7,639.3	-83,8
São Paulo	315,548	359,724.7	477,286.5	32,7
MIDWEST	**3,357,069**	**3,827,058.7**	**383,134.8**	**-90,0**
Mato Grosso do Sul	782,577	92,137.8	120,278.6	-86,5
Mato Grosso	1,617,260	1,843,676.4	107,468.3	-94,2
Goiás	952,642	1,086,011.9	147,646.8	-86,4
Distrito Federal	4,590	5,232.6	7,741.1	47,9

Public policies that promote regionalized studies and estimate the resources necessary for recovery of degraded pasture areas are more efficient by providing better distribution of resources.

Socio-economic benefits and impacts of change to diversified systems

Cleidson Nogueira Dias

Public policies and recovery of degraded pastures in Brazil

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Embrapa genetic forage in the recovery of degraded pastures

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Introduction The recovery of degraded pastures is strategic for Brazil. Considering that the Embrapa genetics of forage has stake of more than 90% of commercial seed, in the domestic market, this study predicts financial return afforded by Embrapa cultivars in the recovery of degraded pastures in the Central-West and Southeast regions of Brazil. The aim of this study was to obtain investment estimates and financial return in the first year of cultivation when retrieving pasture areas with strong degradation, in order to provide subsidies for strategic decisions of farmers and public policy development.

Material and Methods

It was used national statistics from beef cattle scenario and calculated the gain an arroba with the recovery of pastures by Federative Units. The stocking rate values and average daily gain in kilograms (kg/animal/day) in dry (ADGd) and rain (ADGr) season estimate the annual meat gain (GA) kg with grazing reform, according to equation:

GA= (ADGd * day drought + ADGr * rainy days* stocking rate * ha degraded)/15 * 140

The rainfall INMET was used to calculate the animal's performance in dry and rain season by state assuming by region, the period of low water storage in the soil as effective drought period. Finally, calculating the quantities in arroba and multiplying by the average market value of the arroba in Federative Units (R$ 140.00), the financial return (R$) was estimated to the situation in the whole area recovered it is intended to beef cattle (Table 1). To calculate the stocking rate per animal unit (AU)/ha used the AU = 450 kg of live weight, beyond the effective cattle per animal category in each Federative Unit (Anualpec, 2012), and standard body weight values per age (Gerenpec, 2015).

Results and Conclusions

Table 1. Financial return (R$) using Embrapa forage cultivars.

Region/ Federative Units	Area of pastures in degradation (ha)	Investment Reform Pasture (1,000.00 R$)	Financial Return			
			BRS Paiaguás (*B. brizantha*)	BRS Piatã (*B. brizantha*)	BRS Zuri (*P. maximum*)	BRS Tamani (*P. maximum*)
CENTRALWEST	**3.357.069**	**3.827.059**	**2.839.591**	**2.438.555**	**2.441.365**	**3.386.802**
MS	782.577	892.138	579.246	497.439	498.012	690.871
MT	1.617.260	1.843.676	1.372.407	1.178.581	1.179.940	1.636.880
GO	952.642	1.086.019	883.760	758.946	759.821	1.054.068
DF	4.590	5.233	4.178	3.588	3.592	4.983
SOUTHEAST	**1.662.820**	**1.895.619**	**1.742.412**	**1.496.330**	**1.498.055**	**2.078.188**
MG	1.231.246	1.403.620	1.254.226	1.077.090	1.078.332	1.495.924
ES	74.605	85.050	105.317	90.443	90.547	125.612
RJ	41.421	47.220	63.188	54.259	54.322	75.358
SP	315.548	359.725	319.687	274.538	274.854	381.294

It concludes that the recovery of degraded pastures using Embrapa forage cultivars, besides the recovery of pastures, enables to farmers and cattle breeders the financial return in the first year of investment, a greater or lesser degree, depending on the region and cultivars analyzed.

Cleidson Nogueira Dias

Embrapa genetic forage in the recovery of degraded pastures

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Implementation costs of integrated systems

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Introduction With the current importance of sustainability in agriculture the integration systems have became known for providing the reform of degraded pastures, the improvement in the physical and biological conditions of the soil, the pasture production with conserved forage and grains for animal feed in dry season and also the dependency decrease by external inputs and cost reduction, such in agriculture as in livestock. However, once it is considered a complex system and is important studied about the implementation costs of the same, so this work was conducted aiming to compare the partial variable cost and the total operational cost of agrosylvopastoral system with different tree densities.

Material and Methods

The experiment was conducted at the Paulista Agency of Agribusiness (APTA) located in the municipality of Andradina, in partnership with UNESP/*Campus* of Dracena, with total area of 27ha for experiment. In the second half of 2012, the soil preparation and the planting of soy was conducted, being harvested in May, 2013. Corn with *Urochloa brizantha* cv. Marandu was cultivated in December, 2013, and the corn was harvested for silage in March, 2014. The experimental area was divided into four treatments: Treatment 1: Agrosylvopastoral system with eucalyptus trees planted in single lines, (density of 200 trees/ha); Treatment 2: Agrosylvopastoral system with eucalyptus trees planted in triple lines (density of 500 trees/ha); Treatment 3: Exclusive planting of eucalyptus (density of 1667 trees/ha) and Treatment 4: Crop-livestock integration. In the treatments with eucalyptus a distance between lines of 17 to 21m was used, and the distance between plants of 2m. The cost calculation was determined according to the methodology proposed by Canziani and Dossa (2000), which allows the subdivision of calculation in: partial cost (mechanized and manual operations, inputs) and total operating cost (initial soil preparation, corn, soy, eucalyptus).

Results and Conclusions

According to the data, the operations costs and inputs for the initial soil preparation was similar for all treatments (R$640.26). The cost for planting and maintaining the eucalyptus trees until harvest corn and implementation of pasture per hectare was R$580.00; R$1,320.63 and R$4,201.29 for Treatments 1, 2 and 3, respectively. The cost increased according to the tree density increased, being the Treatment 3 with the higher cost, due to this higher density. The cost for the soy plantation was R$1,295.33; R$1,033.18 and R$1,542.06 and for corn and forage plantation was R$1,505.71; R$1,200.99 and R$1,792.52; respectively for treatments 1, 2 and 4. In relation to total operating cost per hectare, the Treatments 1, 2, 3 and 4 were R$4,021.30; R$4,195.05; R$4,841.55 and R$3,974.83. The difference in costs occurred in consequence of the difference in density of trees, cultivated areas with soy and subsequently corn, which obtained different costs between treatments, with decreased the tree density, increased to useful area for farming and increased operating costs, and the Treatment 4 obtained the highest cost such for soybeans as for corn. The Treatment 1, when compared to Treatment 4 had an increase in the cost of R$46.47, the Treatment 2 increased R$220.22 and Treatment 3 R$866.72 per hectare. According to the results, conclude that the costs in integrated systems differ between treatments due to the difference in tree density. The participation of each operation can devise the best strategies to reduce costs and better plan the activities.

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Potential of FAO's Sustainability Assessment of Food and Agricultural Systems (SAFA) indicators for assessment of integrated crop-livestock-forest systems

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Introduction

Commercial integrated crop-livestock-forest systems (ICLF) using beef cattle, eucalyptus and cash crops like soybeans and maize are increasing in Brazil, especially in the Central part of the country. Broad ranging sustainability assessments of such systems is crucial for local development policies. FAO´s framework for sustainability assessment (SAFA) can be proposed as a tool for addressing local ICLF systems. For such, a previous evaluation of the given framework is important for checking its suitability for the local context. This work shows the results of a preliminary evaluation of the indicators proposed by SAFA in regards to their relevance and feasibility of assessment for typical commercial ICLF systems in Central Brazil.

Material and Methods

SAFA has been developed by the Natural Resources Management and Environment Department of FAO. The SAFA Guidelines, assessment tools, details regarding their use and liabilities as well as other resources are provided by FAO and can be downloaded from: *http://www.fao.org/nr/sustainability/sustainability-assessments-safa/pt/*. SAFA considers four sustainability dimensions: Good Governance (G), Environmental Integrity (E), Economic Resilience (C) and Social Well-Being (S). These dimensions currently cover 21 themes which are considered core sustainability issues associated with its goals as well as they can be implemented at any level. These themes have 58 sub-themes and 116 indicators (FAO, 2015).

Indicators were analyzed and scored from 0 to 5 for the parameters ***relevance*** and ***feasibility of assessment*** in potential sustainability assessments of local ICLF systems. Score 0 meant no relevance or unfeasible while 5 meant of utmost relevance or easily measurable, respectively.

Results and Conclusions

Results showed that 75 from the 116 indicators (65%) had scores above the intermediate score (3) for relevance, but only 43% were considered easy to assess (scores above 3). On the other hand, 21% of the indicators were considered relevant AND easy to assess (scores above 3) while only 3% were of little relevance AND difficult to assess (scores under 3). Also only 3% had score 3 for both parameters. Only 5 indicators were considered not relevant. Environmental and social indicators showed the highest proportions scores 4 and 5 regarding indicator's relevance (67% and 79% respectively) while economic, environmental and governance indicators (56%; 46%; 42% respectively) were considered easy to access on local ICLF systems. As expected for agricultural systems, even though relevant, social indicators were mostly considered not easy to access, having only 22% reaching scores 4 or 5 while scores under 3 reached 47% of these indicators.

These results show that even though they might be considered relevant in a sustainability assessment, many proposed indicators should be difficult to acquire in a given situation. Therefore, users of SAFA for ICLF systems should carefully evaluate the inclusion of each indicator when designing the scope of their studies in order to have good quality results.

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Davi José Bungenstab

Potential of FAO's sustainability assessment of food and agricultural systems (SAFA) indicators for assessment of integrated crop-livestock-forest systems

AP2A

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Initial agro-economic performance of the Crop-Forest Integration System in the Xingu Valley – MT

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Introduction

With a planted area of 45,000 ha, the state of Mato Grosso is the 3rd largest natural rubber producer in Brazil (about 9% of national production). The cultivation of rubber (rubber cultivation) has proven to be a good alternative for small and medium farmers, both in monoculture and in Crop-Forest Integration (CFI). To validate the agro-economically integrated rubber with annual crops (soybeans and corn) on the Xingu Valley (MT), Embrapa in partnership with Certeza Farm, implemented and is leading the five years an area of nine hectares, called Unit Technological Reference (UTR), to validate agro-economically this integration model Crop-Forest.

Material and Methods

The rubber, RRIM 600 clonal material was planted in the UTR in June 2009 in the spacing 8.0 mx 2.5 m, ie, in rows of single lines spaced 8 m with distant trees each other of 2.5 m in line, resulting in an initial stand of trees 500 / ha (expected a final stand operating at around 450 trees / ha). Because of this gap, it was possible to grow annual crops between rows of rubber trees in the early years after his farm deployment. In the agricultural year 2009-10 was used to soybeans / millet; in the agricultural year 2010-11, the succession soybean / corn and in the years 2011-12 and 2012-13 agricultural, the succession soybean / millet, ending the first four years of the agricultural system. Using a seeder of 13 lines (0.45 m between rows), a smaller spray with an adapted 6 m and a smaller harvester bar with a deck of 20 feet was possible to execute all farming cultures treatment mechanically. He became careful not to sow the end of lines (only composting), so as to leave about 1 m between the external lines of the crop and the lines of the adjacent rubber.

Results and Conclusions

With proper irrigation (using kite tank) during the dry season (June-September 2009), the rubber tree seedlings presented high rate of "fixation" and proper development during the sowing (no tillage) of soybeans at the beginning of the rainy season the agricultural year 2009-10. With the adjustments to the machinery, mechanized cultivation of annual crops with reduced costs was possible, enabling agro-economically this CFI model for larger areas (areas have been integrated observed up to 100 ha in Mato Grosso). It has not been observed during the four years of cultivation, reduction in soybean yield or winter maize. Rather, the average productivity of soybean produced in the crop area (less the forest area) within the CFI was 3,780 kg ha^{-1} while the rest of certain farm (about 1100 ha) was 3480 kg ha ^{1}. This agronomic performance of crop component enabled an economic the same result that was enough to cover about 70% of the cost of deployment and maintenance of the forest component in the first four years of the CFI system, accounted for about R $ 7,000.00 ha -1 . Although preliminary, the agro-economic results of the CFI system with rubber trees and annual crops appears to be an excellent choice of sustainable land use for small and medium producers of the Xingu Valley (MT).

Acknowledgements

For Certeza Farm, Embrapa and ICLF Development Network.

Flávio Jesus Wruck

Initial agro-economic performance of the crop-forest integration system in the Xingu Valley, MT

AP2Q

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Perspectives of Crop-livestock-forest systems (ILPF) in System of Payments for Environmental Services (SISA) of state of Acre

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Introduction

The deforestation area in the Acre state correspond to 14% of the territory. The pasture are responsible for 84% of the land use or 1.9 millions of hectares used to create a cattle of 2.7 millions in a extensive system. This activity is responsible for the main income of the rural productive sector. The Crop-livestock-forest systems can contribute decisively to increase the sustainability of the local livestock, increasing significantly the carbon and water on soil and vegetation, recovering of areas in different stages of environmental degradation, increasing the biodiversity, restoring landscapes and enabling of farmers to receive of payments for environmental services from SISA. The aim of this work is analyze the potential the ILPF like income generator and provider the environmental services.

Material and Methods

We will be analyzed the ILPF System, the SISA and program of Incentives for Environmental Services (ISA) in 22% of pastures areas during 20 years. The analysis economic ex-ante was realized presuming values of cost and incomes to three production systems livestock: Traditional livestock System, with ILPF and ILPF with payments for environmental services on the costs and incomes and without. The gross cost average of the traditional system and ILPF are respectively US$ 654 ha.year-1 and US$ 1.435 ha.year-1. The gross income average are US$ 752 ha.year-1 and US$ 2.053 ha.year-1 for traditional system and ILPF respectively. We estimated an additional income the 3% over the incomes from the payments of ES, distributed in 20 years. to make the economics analysis were used like indicators: benefit-cost relation (BCR) and Net Present Value (NPV), according Hoffmann et al. (1987). Likewise was evaluated the SISA operation and the ISA politics.

Results and Conclusions

The outcomes of the ILPF analysis showed that under interest taxes the 6%, 8% and 10% BCR would be 1.21, 1.17 e 1.13 and NPV would be US$ 3.595,4 ha.year-1, US$ 2.417,7 and US$ 1.585,3 ha.year-1, respectively. To ILPF + payment of ES, BCR would be 1.25, 1.20 and 1.16, and NPV could be US$ 4.205,4, US$ 2.920,2 and S$ 2.007,6 ha.year-1, respectively. BCR is less than 1 in the traditional system and the NPV is negative at the interest taxes used. There is potential to implement 420 000 ha of ILPF in 20 years at the 7000 farmers in Acre with a significant increase of income and provision of SA. It was found that the government of Acre has a legal-institutional framework of innovative governance that can leverage the fee for provision of ES. Was created Institute for Climate Change and Regulation of Environmental Services of Acre (BMI), SISA, the Development Company of Environmental Services (CDSA), ISA, follow advice and analysis, promoting the mechanisms and investment instruments SA and sharing of benefits to providers, recognized and legitimized, with participation and social control by the State Commission for Validation and Monitoring of SISA, the Scientific Committee and the Ombudsman System.

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Idesio Luis Franke

Perspectives of crop-livestock-forest systems (ILPF) in system of payments for environmental services (SISA) of state of Acre

AP6Z

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Corn yield in the Integrated Crop-Livestock System in Fortuna, Maranhão State

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Introduction

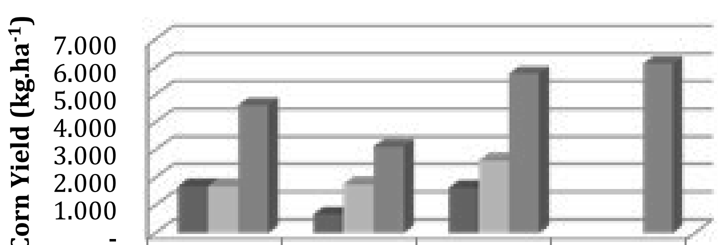
The use of integrated crop-livestock systems (ICLS) promotes moisture retention in the soil, by increase the amount of organic matter. The adoption of this technique improves the conditions for no-tillage system in crop rotation systems, especially in low rainfall areas. Currently, efforts are being made to recover pasture degraded areas in order to achieve a sustainable production and enable the use of the same land over the years. This study aims to evaluate the corn yield of an ICLS, in Fortuna County, Maranhão State, Brazil.

Material and Methods

Corn yield data were obtained from a farm named "Baixa das Coivaras", which adopts the ICLS in Fortuna county, Maranhão State. The corn seeds were sowed in no-tillage system, on the grass straw. Data of corn average yield in the farm were taken from 2011 to 2014. Data of corn yield of the municipality and of the Maranhão State were taken for the same years (2011-2014) using the IBGE System (Brazilian Institute of Geography and Statistics), except 2014, which data have not yet been disclosed. These data sets were compared in order to verify the differences of corn yield between the traditional system and the ICLS.

Results and Conclusions

The corn yield of the farm that adopts ICLS was higher than the municipality and state yield average (Fig 1). In 2012, due to a long drought period, a decrease of 32.47% of corn yield was observed on the farm. Likewise, the Fortuna municipality average presents a 60.29% decrease. These data indicates that losses of the crop production systems resulting from environmental factors can be minimized by adopting integrated systems. Thus, the ICLS can be a technological practice which can improve the crop yield in Fortuna county and Maranhão State.



	2011	2012	2013	2014
Fortuna County	1.700	675	1.630	
Maranhão State	1.695	1.757	2.614	
Farm with ICLS	4.620	3.120	5.760	6.120

Figure 1. Annual yield of Corn (*Zea mays*).

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Joaquim Bezerra Costa

Corn yield in the integrated crop-livestock system in Fortuna, Maranhão state

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Production cost and profitability of an integrated system and an exclusive system of soy and maize in Mato Grosso - Brazilian Midwest region

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Introduction In the literature, there are many assumptions and hypotheses about the economic benefits fostered by integrated economic systems. However, there aren't consistent results about it. The lack of routines and methodologies to accomplish a comprehensive economic analysis of this systems has been an incentive for the creation of URTE project " *Establishment of Technological and Economic Reference Units in the State of Mato Grosso: Proposal Economic Assessment"* by an economist group formed by specialist of Embrapa Agrosilvopastoral and IMEA. Using data and the framework developed in this project, this work analyzes an integrated crop-livestock-forest system in Brazilian Midwest region.

Material and Methods The experimental field was installed at Embrapa Agrossilvipastoral, Sinop, north of Mato Grosso in 2011. The treatment of choice has 2.9 hectares and included a combination of eucalyptus, planted in double lines, with 58m between rows, 2m between trees and 3m between lines, maize silage, cowpea and dairy cattle. The cost system was based on ABC system allowing the association between cost production with each activity performed. Furthermore, and for comparison, was used the economic results presented by IMEA for the modal farm at Mid-North region of Mato Grosso, characterized as a region of maize and soybeans producers.

Fig.1 - Consolidated Financial Statement - Crop year 2013/2014

	Modal Farm	Experimental field
(+) **Gross Revenue**	R$ 3.956,23	R$ 5.033,82
(=) Net Revenue	R$ 3.824,06	R$ 4.918,10
(=) **Gross Profit**	R$ 1.271,96	R$ 1.677,80
(-) **Administrative Expenses**	R$ 225,84	R$ 235,60
(-) **Sold Expenses**	R$ 421,93	R$ 0,00
(=) EBITIDA	R$ 624,20	R$ 1.442,20
(=) EBIT	R$ 461,05	R$ 787,40

(-) Tax Gross

(-)Cost of Goods Sold

(-)Depreciation/ Amortization

Results and Conclusions The total production system cost, for de crop year 2013/2014, was R$3.672,2/ha, a similar value presented by IMEA which was R$ 3.677,74 for the soybean and maize modal farm in the midwest region. Although cowpea was not actually sold in the experimental field, was considered the sale of maize silage and cowpea to calculated the Gross Revenue. The high prices (R$55/bag de 60 kg) of cowpea, at that time, and the good productivity of maize silage, provided a operating profit of R$787,4/ha in Sinop. One of the things that make the economic results of soybean + maize farms decrease (operating profit of R$461,05), in 2013/2014, was the decrease in maize international prices caused by maize oversupply. Even taking account the experimental character, these results allow observe two important aspects: i) a comprehensive approach to evaluate economic characteristics of integrated systems, considering the production systems as an aggregate and not as an set formed by exclusive production systems; ii) this result evidences and confirm the hypothesis that integrated systems can be a good strategy of production to protect farmers revenue of the market prices fluctuation.

Acknowledgement: Brazilian National Research Council (CNPq), Embrapa Agrosilvopastoral and National Service of Rural Learning (SENAR – MT) for financial support of this research.

Júlio César dos Reis

Production cost and profitability of an integrated system and an exclusive system of soy and maize in Mato Grosso - Brazilian Midwest region

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São Mateus System - soybean and beef production in sandy soil of the Brazilian Cerrado

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Introduction

In part of the Brazilian savanna, as in eastern Mato Grosso do Sul state, there is a an unfavorable condition for cultivation of crops, in conventional production system due to the occurrence of sandy, acid and low fertility soils (Quartzpsamments), associated to the occurrence of drought periods with variable duration. In this region, large areas are occupied by pastures whose significant portion presents degradation, with low zootechnical indexes and economic outcomes.

Material and Methods

On São Mateus farm (9% clay) was implemented in 2008 an technological reference unit (URT) containing distinct management systems: a- soybean monoculture under conventional soil tillage (CS), b- soybean monoculture under no-till (NTS) over sorghum or maize straw, c- integrated crop-livestock system (SSM) in NTS where soybean is rotated with *Brachiaria brizantha* cv. Marandu in cycles of one/two years, and d) pasture *B. brizantha* cv. Marandu in degradation reference system.

Results and Conclusions

For such environmental conditions was proposed procedure for chemical and physical adequacy of the soil enabling the production of soybeans and high productivity of beef. At ICLS, the best soil physical conditions, with higher water storage capacity, coupled with deep root growth of soybeans, allowed good grain and beef yields even with occurrence of dry periods (Table 1). Besides the higher water storage capacity, lower losses by evaporation were also observed compared to other systems. At ICLS, grazing showed higher cattle support capacity, whit more than double live weight gains, and greater forage production than the reference system.

Table 1 - Soybean yield in 6 seasons and beef in two years in the São Mateus system (SSM), no-till system (NTS), conventional system (CS) and permanent pasture (PP).

year	soybean yield			daily weight gain and beef yield‡			
	SSM	NTS	CS	SSM	PP	SSM	PP
	(kg ha^{-1})			g animal^{-1} day^{-1}		kg ha^{-1}	
2008/09	1080^{ns}	900	900				
2009/10	3060	nd	nd				
2010/11	3973a	3027b	3286b	460.0	553.0	262.5	75.0
2011/12	2075	nd	nd	735.5	642.0	287.2	118.5
2012/13	3960	2650	nd				
2013/14	1902	1352	nd				
2014/15	1744a	1643a	1279b				

ns: not significant nd: not determined. harvesting was not conducted due to low productivity

‡for the periods nov/10 - may/11 and nov/11 - jun/12 *same letters indicate similarity between the means by Tukey 5%

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Julio Cesar Salton
São Mateus system - soybean and beef production in sandy soil of the Brazilian Cerrado
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Income from agricultural and livestock activities in integrated crop-livestock systems on Cerrados of Maranhão

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Introduction - The cerrados of Maranhão have stood out in grain production during the rainy season. However, the agricultural areas remain idle after grain harvest until the end of the dry season. An alternative for diversifying and intensifying the use of these areas is the crop-livestock integration system (CLI). The strategy used in this work consisted of evaluating a representative farm in the region in which the land use history was partly based on monoculture using soil tillage with disc harrows, and partly based on no-tillage seeding on a millet mulch. The prevailing activities in the farm were soybean - with an average crop yield of 47 bags (60 kg)/ha, corn - with an average crop yield of 132 bags (60 kg)/ha, and a small area dedicated to cattle production. This work aimed at assessing and validating an integrated production system under real conditions over time. It aimed also to introduce and disseminate the crop-livestock integration system in the cerrados of Maranhão.

Material and Methods - The study was carried out at Santa Luzia Farm, in São Raimundo das Mangabeiras, MA. The farm is located at 6º49'48" S and 45°23'52" W, with 475 m of altitude. Activities were initiated in the 2003/04 cropping season in an area of 2 ha of maize intercropped with *Brachiaria brizantha*. Initial results led the farmer to expand the area to 43 ha in the 2004/05 cropping season and to substitute the forage grass to *Brachiaria ruziziensis*. The size of the area under this system was increased every year. In 2013 the area of corn intercropped with *B. ruziziensis* followed by soybean under no-till system reached 1,000 ha. The feasibility of the direct seeding of soybean on the *B. ruziziensis* and millet mulch was evaluated over eight successive cropping seasons. We also evaluated the cattle production during the off-season (dry season) in pastures formed in the intercrop. The stocking rate used was 2 AU/ha, which is equivalent to 2.26 animals/ha

Results and Conclusions

The corn yield ranged from 137 to 168 bags (60 kg)/ha, with an average of 153 bags (60 kg)/ha. This is higher than that obtained up to 2004, before the establishment of the CLI system (132 bags [60 kg]/ha). Yield of soybean sowed on *B. ruziziensis* mulch ranged from 57.1 to 63.0 bags (60 kg)/ha, with an average of 59.7 bags (60 kg)/ha. This was also higher than the crop yield of soybean cultivated on the millet mulch (52.0 bags [60 kg]/ha) and the average of the soybean crop yield obtained in 2004 (47 bags [60 kg]/ha). The soybean grain yield increase in the CLI system was, therefore, 7.7 bags (60 kg)/ha higher than that of soybean sowed on millet mulch and 12.7 bags (60 kg)/ha higher than that obtained in 2004, before the establishment of the CLI system. The average weight gain of steers at the end of 120 days was 4.08 @/animal, resulting in an average weight gain of 9.8 @/ha. The results obtained led the farmer to adopt the system as a farm exploration strategy, which indicates the feasibility of the CLI system in Maranhão State.

Marcos Lopes Teixeira Neto

Income from agricultural and livestock activities in integrated crop-livestock systems on Cerrados of Maranhão

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At what Scale should Livestock-Forest Systems be considered?

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Introduction

The focus of many papers in this congress is on the integration of crop-livestock-forest systems at a farm or perhaps regional level. The premise of this paper is to review the evidence as to whether the production and environmental benefits from, for example, beef and wood production are maximised by considering systems at a global scale. It does this by comparing beef and wood production in Brazil and the UK.

Material and Methods

A life cycle assessment (LCA) was undertaken to contrast the potential environmental impacts of beef and wood production in Brazil and in the UK, assuming that both were consumed in the UK. The study focused on the global warming potential over 100 years (GWP_{100}) of a tonne of product from each system. The LCA for beef production used the research described by Williams et al. (2006; 2009); the LCA for wood production is described by Sanchez Martinez (2011). A key parameter in the comparison of the beef systems was the proportion of beef derived from dairy (which had a smaller environmental footprint) than suckler-beef systems and relative growth rates of beef cattle.

Results and Conclusions

The analysis showed that Brazilian forest plantations have shorter rotation periods and larger yields (per unit time) than forest plantations in the UK. Hence, assuming a certain level of beef and wood consumption, UK consumers purchasing British rather Brazilian beef and using wood from Brazilian rather than British forest plantations, was predicted to result in lower global warming than the other options studied. For example, pine plantations in Brazil can produce similar amounts of wood (with similar levels of input per hectare) in about half the time period of UK plantation. Hence it can be argued that supporting afforestation in Brazil is a more efficient way to offset greenhouse gas emissions than doing that in the UK. By contrast UK beef production is relatively efficient with better forage quality. It should be noticed that this analysis did not consider other environmental effects such as acidification and ozone depletion, or the social or economic implications. However the study does highlight that the development of the most environmentally beneficial livestock-forest systems may require a global perspective.

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Paul John Burgess

At what scale should livestock-forest systems be considered?

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world congress on integrated crop-livestock-forest systems

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Economic viability of integrated crop-livestock systems using dual-purpose wheat: farm case study in the Northern region of Rio Grande do Sul state, Brazil

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Introduction Dual purpose (DP) wheat is an alternative to minimize forage shortage composing integrated crop-livestock systems (ICLS) to increasing income and crop diversification. The aim of this study was to estimate costs and profitability of an ICLS using DP wheat adopted in a farm in the Northern of Rio Grande do Sul state, Brazil.

Material and Methods

The case study was conducted in a crop-beef cattle farm in Boa Vista das Missões, RS (Lat. 27° 39' 26" S, Long. 53° 19' 8" W and 600 m asl), in a dystrophic Red Latosol (Oxisol) and total area of 111.8 ha). The cropping system adopted by the farm at 2011/12 and 2012/13 was soybean-oat-corn-dual purpose wheat. The production costs (variable, operational and total costs) using linear depreciation and economic results (gross revenue, gross margin, operational profit margin, profit and income-cost ratio) (HOFFMANN et al., 1987) were determined.

Results and Conclusions

The table shows economic analysis obtained by crop rotation system.

INDICATOR	2011/2012	2012/2013	TOTAL
Yield	3,480 kg ha^{-1} soybean 250 kg ha^{-1} a meat	8,100 kg ha^{-1} corn 2,700 kg ha^{-1} DP wheat 300 kg ha^{-1} meat	
Variable cost (US\$ ha^{-1})	970	1,760	2,730
Operational cost (US\$ ha^{-1})	1,098	1,821	2,919
Total cost (US\$ ha^{-1})	1,539	2,221	3,760
Gross revenue (US\$ ha^{-1})	2,440	2,844	5,284
Gross margin (US\$ ha^{-1})	1,470	1,084	2,554
Operational margin (US\$ ha^{-1})	1,342	1,023	2,364
Profit (US\$ ha^{-1})	901	623	1,524
Income-total cost ratio	1.59	1.28	1.40

The economic results from the ICLS adopted by the farmer in two years were positive, generating average profit of US$ 1,524 per ha and income/total cost ratio of 1.40. Comparing this ICLS with a system simulation of summer crop without rotation in winter and livestock (soybean-fallow-corn-fallow; total revenue US$ 3,522 per ha; total cost US$ 2,703 per ha, profit US$ 819 per ha) was observed a profit increase of 86.2% per hectare in two years.

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Renato Serena Fontaneli

Economic viability of integrated crop-livestock systems using dual-purpose wheat: farm case study in Northern region of Rio Grande do Sul state, Brazil

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Economic viability of integrated crop-livestock-forest systems: a comparative analysis

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Introduction

Several studies have shown the agronomic benefits of integrated crop-livestock systems (ICL) and integrated crop-livestock-forest systems (ICLF). However, from an economic point of view, there is lack of information. This work aims to analyze the economic viability of three integrated production systems, with different densities of eucalyptus trees.

Material and Methods

Three integrated systems [ICL (soybean + hay + cattle); ICLF1 (ICL + 227 eucalyptus trees/ha); and ICLF2 (ICL + 357 eucalyptus trees/ha)] were studied in Campo Grande region, MS, Brazil. The systems were established in 2008 as strategies to recover degraded pasture and consisted of four-year cycles: one year with crop (soybean) followed by three years with *Brachiaria brizantha* cv. BRS Piatã, with or without *Eucalyptus grandis* × *E. urophylla*. Investment analysis was used to assess the systems economic viability and a12-year cash flow was built for each project. From 2008 to 2014, experimental data were used. For the following years, the parameters were estimated. Prices refer to 2014, with beef quoted at R$ 3.46/kg live weight, soybeans at R$ 59/bag of 60 kg, Piatã hay at R$ 166.70/ton, coal at R$ 46/m^3 and wood at R$ 123/m^3. The net present value (NPV) and the benefit-cost ratio were calculated for a discount rate of 10%. For further descriptions of the production systems, including their implementation costs, see Costa et al. (2012).

Results and Conclusions

All three integrated production systems were economically viable. The ICLF2 presented the highest economic return, followed by ICLF1 and ICL, as indicated by the NPV's of the projects (Table 1).

Table 1. Investment parameters of three integrated production systems

Parameters	ICL	ICLF1	ICLF2
NPV (R$/ha)	3,425	6,391	8,618
Benefit/Cost	10.7	6.3	6.2
Initial Investment (R$/ha)	2,182	2,641	2,974
Payback period (year)	1	3.5	7.2

The payback period, the initial investment and the negative cash flow may limit the adoption of integrated systems that include forestry. It is worth noting that these parameters are not the only ones used in investment decision-making.

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Roberto Giolo Almeida

Economic viability of integrated crop-livestock-forest systems: a comparative analysis

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Bioeconomic evaluation of sorghum consortium with different forage species in integrated crop-livestock system in Nova Porteirinha, Minas Gerais, Brazil

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Introduction

Semi-arid region has great potential for agricultural exploration. Several researches are being developed aiming the recovery and exploration of degraded areas by integrated crop-livestock systems (iCL). Given the importance of the subject, the diversity of combinations of different forage species and the lack of information by economic outlook, this research was conducted to evaluate the bioeconomic viability of sorghum consortium with different forage species in iCL system.

Material and Methods

This research was conducted in the experimental field of EPAMIG in Nova Porteirinha, MG, Brazil. In the first year, seven species of forages were sowed intercropped with sorghum, beside the single sorghum (control), in two spacings (40 and 80 cm). It was performed conventional planting of sorghum grain (140,000 plants/ha) and the seeds of forages (420 CV/ha) were mixed with the fertilizer. The experiment was conducted in a randomized block design with four repetition and parcels of six rows of five meters each. It was simulated deferred grazing of the animals seven months after the intercropped sowing. In the second growing season, forages were desiccated for direct seeding of sorghum. The cost of production was composed by cost of mechanized operations, cost of labor, and input costs. Revenues were calculated by the sale value of sorghum grain (R$ 0.30/kg) and rent of the pastures (R$ 20.00/AU/month). To calculate the carrying capacity of the pastures was considered animals of 450 kg (1 AU) consuming 1.5% of their body weight of dry matter forage. Economic viability was determined by subtracting the total revenue and total cost. Economic efficiency indicators used were Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit/Cost relation (B/C) in a horizon of 10 years.

Results and Conclusions

Table 1. Summary of the bioeconomic analysis of the experiment conducted in Nova Porteirinha, MG, Brazil

	Treatments	Economic viability (R$)	NPV[1] (R$)	IRR[2] (%)	B/C[3]
40 cm spacing	*Andropogon gayanus* + sorghum	-784,70	-2.668,31	*	-1,89
	Cenchrus ciliaris cv. Aridus + sorghum	167,40	832,91	19,01	2,42
	Cenchrus ciliaris cv. 131 + sorghum	-474,28	-1.528,75	*	-0,49
	Braquiária decumbens + sorghum	-571,20	-1.896,67	*	-0,91
	Braquiária brizantha + sorghum	341,40	1.467,83	27,66	3,19
	Braquiária ruziziensis + sorghum	113,00	627,51	15,97	2,16
	Panicum maximum + sorghum	-267,16	-767,77	*	0,45
	Single sorghum	-119,00	-216,26	2,04	1,13
80 cm spacing	*Andropogon gayanus* + sorghum	128,90	693,77	17,01	2,25
	Cenchrus ciliaris cv. Aridus + sorghum	-876,20	-3.007,59	*	-2,30
	Cenchrus ciliaris cv. 131 + sorghum	-855,08	-2.930,11	*	-2,21
	Braquiária decumbens + sorghum	-322,00	-979,61	*	0,20
	Braquiária brizantha + sorghum	-106,20	-179,35	2,77	1,17
	Braquiária ruziziensis + sorghum	372,20	1.581,38	29,16	3,33
	Panicum maximum + sorghum	-1.153,56	-4.029,77	*	-3,55
	Single sorghum	-647,00	-2.159,32	*	-1,27

[1]NPV = Net Present Value, [2]IRR = Internal Rate of Return, B/C = Benefit/Cost. *It was not possible to be estimated because the total revenue was less than the total operating costs, resulting in negative cash flows.

The forages species tested affected the productivity of sorghum grain. Due to high productivity and low value of pasture implantation the most recommended was sorghum intercropped with *B. ruziziensis* and *B. brizantha* in 80 and 40 cm spacings, respectively. The results suggest the need of iCL systems studies in the semiarid region, emphasizing the importance of economic results as guiding of the management activities and making decisions of the farmer.

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Economic analysis of Pantanal locally adapted lambs finished under three production systems

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Introduction. The economic evaluation of the sheep industry is important to help decision making by the producer in order to choose the most accurate lambs termination system in the Midwest region of Brazil. This study compares the Pantanal locally adapted lambs termination systems as the economic results and the cost per produced unit of weight.

Material and Methods.

The trial was conducted at Embrapa´s Midwest Regional Center of Goats and Sheep, Terenos – Mato Grosso do Sul. 25 and 16 male and female lambs were finished per system in 2013 and 2014 years, respectively. All lambs were weaned at 70 days and were completely dewormed. Treatments were: Piatã-grass and Paiaguás-grass pastures stablished in succession to sorghum and soybean crops (LCS-Livestock-Crop System) , respectively in 2013 and 2014; Piata-grass as five months stockpiled pasture (STOCKED); feedlot (CONF) with sorghum silage as roughage. Lambs were fed a 2% of body weight energy-protein concentrate (15% CP and 70% TDN) in all treatments. Economic analysis was carried out considering total production costs (cost of inputs and animal purchase, effective operational cost of pasture maintenance, of crop production, and of feedlot, and depreciation on buildings for each system), prorated by lamb (TCL-Total Cost by Lamb), and total revenue in grains and meat sales, beyond the economic leveling point. The lamb per kg live weight price was considered R$ 5.96 (1 USD = 3 R$-Brazilian Reais). The soybean yield was 110.23 bushel ha^{-1}, priced R$ 29.50 per bushel.

Results and Conclusions

Table 1. Economic analysis of “pantaneiro” lamb finishing systems in Mato Grosso do Sul, Brazil. Prices in Brazilian Reais (R$).

INDICADORES	*2013 (63 days)- 25 lambs*			*2014 (70 days)- 16 lambs*		
	CONF	STOCKED	LCS	CONF	STOCKED	LCS
	R$					
TCL (kg)	8,55	5,82	5,49	11,93	9,98	8,30
TCL (kg of carcass)	18,99	12,94	12,19	26,51	22,18	18,45
Total Sales Income	3.770,53	4.030,45	4.362,72	2.558,51	2.443,12	3.059,15
Total Costs	5.406,50	3.937,38	4.016,18	5.121,33	4.091,09	4.262,45
Profit	(-1.635,96)	93,07	364,54	(-2.562,82)	(-1.647,96)	(-1.203,30)
	Lambs					
Leveling point	34	24	23	32	27	22

Economic results were favorable to livestock-crop systems considering all evaluated variables (Table 1). Prices at sale, climate conditions, and genetic animal variation have to be taken into account for a profitable decision making by the sheep meat farmers.

Acknowledgements

To Embrapa, postgraduate students and all research scientists, technicians and field workers at the Embrapa Beef Cattle Centre who contributed to successful of trials.

Sergio Giovanni Espinosa Villafuerte

Economic analysis of Pantanal locally adapted lambs finished under three production systems

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Economic Analysis of systems "Santa Fé" (corn intercropped with brachiaria) in the southwestern region in the Brazilian Amazon

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Introduction Crop livestock systems (CLS) require appropriate level of technical, economic and administrative knowledge in order to ensure positive results and competitiveness. This research aimed to evaluate the economic performance of corn genotype intercropped with the grass *Brachiaria ruziziensis* in the Amazonic biome of Rondônia.

Material and Methods
The experiment was carry out in agricultural year of 2012/2013 at Embrapa's field in Porto Velho-Rondonia. The treatments correspond to four genotypes of corn intercropped with Urochloa ruziziensis in two systems of rotation and succession of culture began in 2008. [system 1: soybean (2008/9), corn silage (2009/10), soybean-sorghum grain (2010/11) and soybean (2011/12) & system 2: soybean (2008/9), fallow (2009/10), soybean-corn silage with *B. ruziziensis* (2010/11) and grazing (2012). The cost of production was constituted by expenditure with inputs, implantation and cultural practices, extern transport, Funrural and capital interests of working capital (06 months), calculated to an hectare of land (R$ 2,267.00/ha), based on the Agrianual (2012).

Results and Conclusions
Table 1. Economic analysis of CLSs systems through Variable Total cost (VT), Unit Total cost (Ut), Gross revenues (GR), Net revenues (NR), Benefit:Cost (BC), Contribution Margin (CM), Unit of Contribution Margin (UCM) and Opportunity Cost (OC)

System	Corn cultivar	Grain Yield		VT	Ut	GR	NR	BC	CM	UCM	OC
		kg/ha	Bags/ha	R$/ha					R$/ha		%/ha
1	BRAS3010	5991	99,9	2026,08	20,28	1998,56	-28,08	0,99	-28,08	-0,28	-0,20
1	BR 106	6600	110,0	2044,87	18,59	2200,23	155,13	1,08	155,13	1,41	1,10
1	LG6304YG	8974	149,6	2118,52	14,16	2992,53	873,48	1,41	873,48	5,84	5,58
1	SG6030YG	9894	164,9	2146,98	13,02	3298,75	1151,02	1,54	1151,02	6,98	7,08
2	BRAS3010	4316	71,9	1974,00	27,45	1438,65	-536,00	0,73	-536,00	-7,45	-4,39
2	BR 106	5636	93,9	2014,92	21,46	1878,13	-136,92	0,93	-136,92	-1,46	-1,03
2	LG6304YG	5899	98,3	2023,10	20,58	1966,31	-57,10	0,97	-57,10	-0,58	-0,42
2	SG6030YG	7053	117,6	2059,00	17,51	2352,13	293,00	1,14	293,00	2,49	2,04

The genotype BRS 3010 (system 1) presented the lowest cost of total production, however it presented, due to grain yield (revenue), the lowest cost x benefits ratio. The cultivar SG6030YG presented viability in both systems, better margin of contribution (CM) with the average opportunity cost in the systems of the 4,6 % in the period, showing economically viable in the 2012-2013 year. The highest performance and profitability were shown in the rotation systems of module 1. The consortium is dependent of the correct use of genotype and depends on the succession and system rotation used. The iLP is presented as a viable economic alternative, in order to recovery of degraded pasture in the region in North of Rondonia.

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Socio-economic benefits and impacts of change to diversified systems

Simone Marçal Quintino

Economic analysis of systems "Santa Fé" (corn intercropped with brachiaria) in the Southwestern region in the Brazilian Amazon

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Cost analysis of silage of corn intercropped with brachiaria in the southwestern region in the Brazilian Amazon

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Introduction Crop livestock systems (CLS) using corn intercropped with forage can represent an important technique to improve the land use efficiency in the tropics. In the Brazilian Amazonia, the use of corn intercropped with brachiaria represents a way to recovery degraded pastures avoind the deflorestation of native areas.

Material and Methods

The experiment was carry out in agricultural year of 2012/2013 at Embrapa's field in Porto Velho-Rondonia. The treatments correspond to two genotypes of corn intercropped with Urochloa braizantha cv Xaraés in two systems of rotation and succession of culture began in 2008. [system 1: rice (2008/9), corn silage (2009/10), soybean-sorghum grain (2010/11) and corn silage (2011/12) & system 2: rice (2008/9), fallow (2009/10), soybean-corn silage with *B. ruziziensis* (2010/11) and rice (2012). The cost of production was constituted by expenditure with inputs, implantation and cultural practices, extern transport, Funrural and capital interests of working capital (06 months), calculated to an hectare of land (R$ 2,267.00/ha), based on the Agrianual (2012).

Results and Conclusions

Table 1. Economic analysis of CLSs systems through Variable Total cost (VT), Unit Total cost (Ut), Gross revenues (GR), Net revenues (NR), Benefit:Cost (BC), Contribution Margin (CM), Unit of Contribution Margin (UCM) and Opportunity Cost (OC)

System	Corn cultivar	Silage Yield	VT	Ut	GR	NR	BC	CM	UCM	OC
		Mg/ha	R$/ha					R$/ha		%/ha
1	BRS3010	14,1	2026,08	20,28	1998,56	-28,08	0,99	-28,08	-0,28	-0,20
1	PL1335	11,3	2044,87	18,59	2200,23	155,13	1,08	155,13	1,41	1,10
2	BRS3010	14,5	2118,52	14,16	2992,53	873,48	1,41	873,48	5,84	5,58
2	PL1335	10,3	2146,98	13,02	3298,75	1151,02	1,54	1151,02	6,98	7,08
			R$/Mg							
1	BRS3010	14,1	158,60	20,28	1998,56	-28,08	0,99	-28,08	-0,28	-0,20
1	PL1335	11,3	199,30	18,59	2200,23	155,13	1,08	155,13	1,41	1,10
2	BRS3010	14,5	155,32	14,16	2992,53	873,48	1,41	873,48	5,84	5,58
2	PL1335	10,3	218,65	13,02	3298,75	1151,02	1,54	1151,02	6,98	7,08

The genotype BRS 3010 (system 1) presented the lowest cost of total production, however it presented, due to grain yield (revenue), the lowest cost x benefits ratio. The cultivar SG6030YG presented viability in both systems, better margin of contribution (CM) with the average opportunity cost in the systems of the 4,6 % in the period, showing economically viable in the 2012-2013 year. The highest performance and profitability were shown in the rotation systems of module 1. The consortium is dependent of the correct use of genotype and depends on the succession and system rotation used. The iLP is presented as a viable economic alternative, in order to recovery of degraded pasture in the region in North of Rondonia.

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Simone Marçal Quintino

Cost analysis of silage of corn intercropped with brachiaria in the Southwestern region in the Brazilian Amazon

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Corn Yield in the Integrated Crop-Livestock System in Peritoró, Cocais Region of Maranhão State

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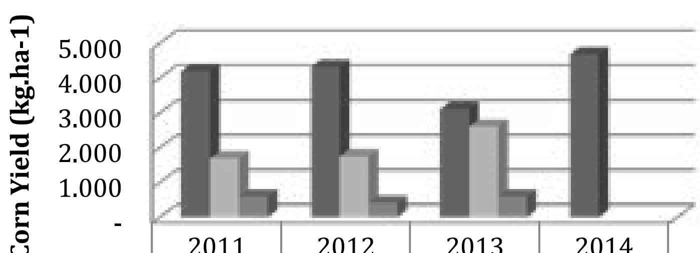
Introduction
Integrating crop and livestock systems have been currently disseminated as a viable alternative to obtain both grain production and forage in the same cultivated area. In the Maranhão state sustainable agricultural practices has been adopted by some Farms. Examples are the Integration Crop-Livestock Systems (ICLS) and No-Tillage System, which provide numerous benefits for the soil conservation, allow an increase of grain yield and sustainability of the system. This study aims to evaluate the corn yield in a farm which adopted the ICLS, in Peritoró County, Maranhão State, Brazil.

Material and Methods
The data of annual corn yield from Gaspar Farm, located in Peritoró County, Maranhão State, which adopted the ICLS, were measured from 2011 to 2014. Corn yield average of the municipality and of the Maranhão State were taken for the same years using the IBGE System (Brazilian Institute of Geography and Statistics), except 2014, which data have not yet been disclosed. These data sets were compared in order to verify the differences of corn yield between the traditional system and the ICLS.

Results and Conclusions
The annual average corn yield in Gaspar Farm was 4,080 kg.ha^{-1} (Fig. 01). This value was 619% and 92% higher when compared to the municipality and state annual corn yield average, respectively. A decrease was observed in the corn yield in 2012 due to a long drought period, but the effect of this climate factor was minimized in the Gaspar Farm, probably by the high level of organic matter on the soil, an intrinsic improvement of ICLS. This suggests that cumulative benefits for the soil contribute to improve grain yield of the ICLS.



	2011	2012	2013	2014
Gaspar Farm	4.200	4.320	3.120	4.680
Maranhão State	1.695	1.757	2.614	
Peritoró County	600	420	600	

Figure 1. Annual yield of Corn (*Zea mays*).

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Socio-economic benefits and impacts of change to diversified systems

Talmir Quinzeiro Neto

Corn yield in the integrated crop-livestock system in Peritoró, Cocais region of Maranhão state

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Hematological responses of Nellore in the rearing phase in agrosilvopastoral system

Aline SAMPAIO ARANHA[1], Cristiana ANDRIGHETTO[1], Erikelly RIBEIRO SANTANA[1], Helena SAMPAIO ARANHA[1], Gelci Carlos LUPATINI[1], Gustavo PAVAN MATEUS[2], João Henrique SILVA VERA[3].

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Introduction

The interaction between animals and the environment is critical for decided about management strategies to be used to maximize the productive responses. Thus, understanding the the changes in physiological responses allows the adoption of adjustments that promote comfort to animals. The shadows of trees in agrosilvopastoral system protect the animal from heat stress. Therefore this study aimed to characterize hematological responses of cattle subject to production systems with and without shade.

Material and Methods

The experiment was conducted at APTA, Andradina/SP, in a randomized block design with four replications. It was evaluated: Treatment 1 - Agrosilvopastoral system with eucalyptus trees planted in single rows, with a density of 200 trees ha^{-1}; Treatment 2 - Agrosilvopastoral system with eucalyptus trees planted in triple rows, with a density of 500 trees ha^{-1}; Treatment 3 - integration crop livestock integration system without planting eucalyptus trees. Sixty Nelore cattle were used in rearing phase, 20 in each treatment. Blood samples was harvested in summer station, by jugular for determine serum concentrations of total protein, hemoglobin, red blood cells and platelets. The results were submitted to analysis of variance and the comparison test of means.

Results and Conclusions

The results are in Table 1. The concentration of red blood cells and hemoglobin was lowest in treatment 1 and 3, and the values obtained in the treatment 1 were numerically lower than treatment 3. There wasn´t statistical differences between the treatments for platelets. Similar results was observed by Brazil et al. (2000) in buffaloes, the authors found reduction in red blood cells submitted to heat stress and assigned the results from increased consumption of water.

Table 1. Hematological responses of Nellore rearing phase in agrosilvopastoral system and crop livestock integration

Parameters	Treatment 1	Treatment 2	Treatment 3
Red blood cells ($10^6.\mu L^{-1}$)	11.58 ab	12.14 a	10.77 b
Hemoglobin ($g.dL^{-1}$)	15.19 ab	15.02 a	12.84 b
Platelets ($10^3.\mu L^{-1}$)	300.63 a	326.70 a	398.91 a

Means followed by the same letter do not differ by Tukey test at 5% probability.

Beef cattle Nelore in the rearing phase when in system without eucalyptus trees showed reduction of the thermal comfort decrease the red blood cells and hemoglobin.

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Aline Sampaio Aranha

Hematological responses of nellore in the rearing phase in agrosilvopastoral system

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3rd International Symposium on Integrated Crop-Livestock Systems

Thermal comfort of composite beef heifers (*Bos taurus* vs *Bos indicus*) raised in livestock-forest systems in Southeastern Brazil

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Introduction

Animal productivity may be higher in livestock-forest systems. The shading provided by the trees seems to determine higher performance in cattle breeds that show less resistance to the tropical climate (Castro et al, 2008), what can be associated with regulation of physiological parameters and thermal comfort (Garcia et al, 2011). Thus, our objective was to study the influence of shading on physiological parameters related to thermal comfort of composite beef heifers (respiratory frequency - RF; heart beat frequency - HBF; rectal temperature - RT) and their correlation with bioclimatic indexes.

Material and Methods

The study was conducted at EMBRAPA's (Brazilian Agricultural Research Corporation) experimental station, located in the Southeast region of Brazil (climate Cwa, according Koppen). Thirty-two Canchim (3/8 Nelore + 5/8 Charolais) heifers (16 months old; 211 kg live weight) were randomly allocated to two rotational grazing areas: shaded area (SA; eucalyptus trees in a 15 x 2 m spacing) and non-shaded area (NSA); and evaluated every 14 days, in the morning, from January to April 2015. The RF (breath/min), HBF (beats/min), RT (˚C), temperature-humidity index (THI) and black globe humidity indexes (BGHI) were recorded at the moment of each animal evaluation. The physiological parameters (least square means±SE) were analyzed as repeated measures by PROC GLIMMIX of SAS®. Bioclimatic indexes and physiologic parameters were correlated using PROC CORR of SAS®. Results were significant when P<0.05.

Results and Conclusions

Heifers grazing SA had lower RF and RT than those grazing the NSA area (Table 1). There was a positive correlation between THI and RT (r^2 = 0.32543, P<0.0001), as well as between BGHI and RT (r^2=0.36285, P<0.0001). The HBF index had negative correlations with THI (-0.19, P<0.001) and BGHI (-0,28P<0.0001). It was not observed correlation between THI or BGHI and RF.

Table 1. Least square means ± SE of physiologic parameters.

Area	RF (breath/min)	HBF (beat/min)	RT (˚C)
	P<0.001	*P=0.2558*	*P<0.001*
SA	44.61±0.77	99.17±1.66	39.19±0.05
NSA	49.09±0.76	101.83±1.64	39.58±0.05

The results indicate the necessity of shading in pastures, in order to increase animal comfort and, possibly, zootechnical indexes.

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Amanda Prudêncio Lemes

Thermal comfort of composite beef heifers (bos taurus vs bos indicus) raised in livestock-forest systems in Southeastern Brazil

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Microclimatic evaluation of shade from native tree species of the Brazilian Cerrado

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Introduction The provision of shade is one of the most efficient practices to improve the thermal comfort in open-field pastures, and their presence is essential for the good animal welfare on tropical regions. The objective of this study was to evaluate two native tree species and its potential to mitigate the animal thermal stress.

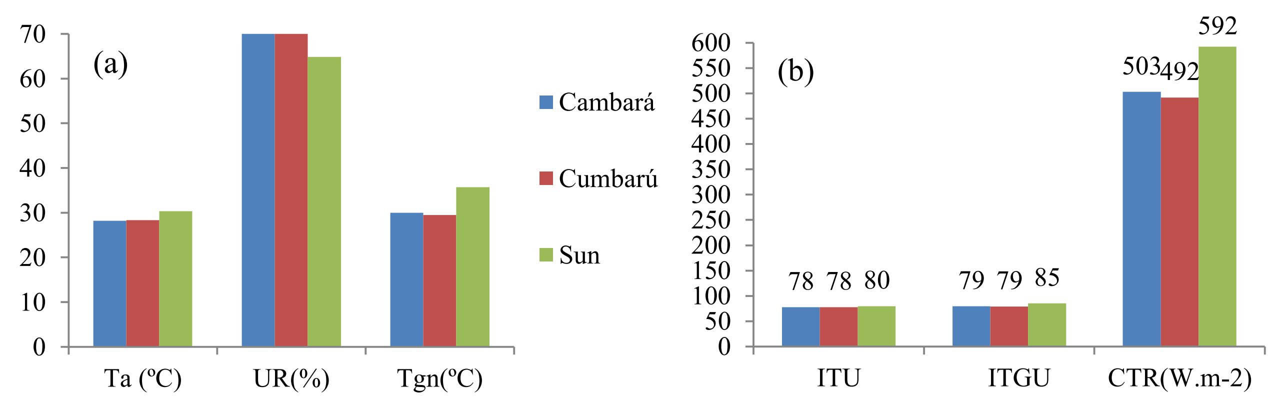
Material and Methods

The experiment was conducted in Campo Grande-MS (20º27' S, 54º37' W, 530 m asl), at Embrapa Beef Cattle, in February 2015. The experimental area consists of 6 ha with Piatã grass (*Brachiaria brizantha* cv. BRS Piatã), and scattered Cambará (*Gochnatia polymorpha*) and Cumbaru (*Dipteryx alata*) trees, with five trees/ha. It was determinate some microclimatic parameters (air temperature - Ta, relative humidity - RU and black globe temperature - Tbg), under the sun and under the shade of each tree. It was also determinate the Temperature and Humidity Index (THI), Black Globe Temperature and Humidity Index (BGHI) and Radiant Thermal Load (RTL), as described by Karvatte Junior (2014). For the interpretation of the data it was performed descriptive analysis.

Results and Conclusions

The data refers to 4-day evaluation, 3 individuals per specie. Both species ameliorate the ambient under their canopy. Cumbaru intercepts more quantity of solar radiation (Fig.1).

Fig.1. Microclimatic parameters (a) and thermal comfort indexes (b), under the shade and under the sun.



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Camilla Diniz Barreto

Microclimatic evaluation of shade from native tree species of the Brazilian Cerrado

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Herbage accumulation and animal performance in piata and paiguas palisadegrass on integrated crop/pasture system

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Introduction The animal production is an important goal in integrated crop/pasture systems. It is important to know the limitations of this system and to generate recommendation about grazing management on integrated systems. The grazing height is an important framework to reach maximum animal and grains production in the system has being used in many sustainable grazing systems. The aim of this work is to evaluate herbage and animal production in piata and paiaguas palisadegrass at two swards height on integrated crop/pasture system.

Material and Methods

The experiment was realized in an area of Embrapa Beef Cattle (20º27' S, 54º37'W, 530 m asl) from September 2014 to April, 2015. *Brachiaria brizantha* cvs. BRS Piata and Paiaguas were established after soybean culture and managed at two grazing heights, 25 and 40 cm. The experimental design was randomized blocks with factorial arrangement. Were evaluated the herbage mass and animal performance in grass forages submitted at integrated systems. The data were analyzed using the Mixed procedure (PROC MIXED; SAS Institute).

Results and Conclusions

Tab. 1. Averages for herbage offer, stocking rate and gain per area of piata and paiguas pastures managed at two grazing heights.

Variables	Sward height (cm)		
	25	40	p
Herbage offer (kg DM/100 kg LW)	8.0 B	11.0 A	0.0076
Stocking rate (AU ha^{-1})	4.7 A	3,6 B	0.0022
Gain per area (kg ha^{-1})	1,004 A	882 B	0.0102

Means followed by different letter in the same line are different by Tukey test (p<.005)

Herbage offer was affected by sward height and when grasses were maintained at 25 cm height it was possible to maintain more 1.1 AU/ha and to produce 122 kg/ha of live weight (Tab. 1) compared with 40 cm sward height, during a period of 194 days of pasture utilization. The herbage accumulation rate was similar between grasses, 67 kg ha^{-1} day^{-1}, on average. The daily gain was 657 g animal^{-1} day^{-1} on average for piata and paiaguas palisadegrass. The preliminary results show that is possible to enhance animal production at least 10% on integrated livestock systems, in comparison with traditional systems (Euclides, et al., 2008; Nantes et al., 2013). These results can be a consequence of soil quality improvement promoted by soybean crop. It is expected that the sward height will promote effects in grains production in the second crop that will be yet evaluated.

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Denise Baptaglin Montagner

Herbage accumulation and animal performance in piata and paiguas palisadegrass on integrated crop/pasture system

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Morphological composition and herbage intake rate of *Brachiaria brizantha* cv. Piatã subjected to shade regimes in a crop-livestock-forest integration area

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Introduction

Trees change the light environment (quantity and quality) in crop-livestock-forest areas, altering growth patterns of forage plants and interfering with its morphological composition and intake potential. The objective of this experiment was to evaluate the morphological composition and the short-term herbage intake of *Brachiaria brizantha* cv. Piatã cultivated in a crop-livestock-forest area.

Material and Methods

The experiment was carried out at Embrapa Agrossilvipastoril, Sinop, MT (11º51'S, 55º35'W and 384 m a.s.l.), from December 2013 to February 2014. The area was divided into three light regimes: (1) Piatã brachiariagrass cultivated in the absence of trees (*Eucaliptus* H13 clone) (full natural light; FL); (2) shade produced by a double row of trees on the edges of the paddocks (181 trees ha^{-1} - S1); and (3) shade produced by four triple rows of trees with pasture in between them (718 trees ha^{-1} - S2). Monitoring of light interception was performed taking reference readings of the incident light on pasture in two ways: (1) under the tree canopy for all light regimes, and (2) in open field condition (natural light), only for the light regime S2. The grazing method used was rotational stocking and management executed using as pre- and post-grazing targets 95% canopy light interception during regrowth and 50% of the pre-grazing height, respectively. The morphological composition of the consumed herbage was determined according to Trindade et al. (2007) and the short-term rate of intake according to Hodgson (1982). Statistical analysis was performed using PROC Mixed of the statistical package SAS at a 5% probability level.

Results and Conclusions

Table 1 shows only significant results detected in the statistical analysis. In general, there was no effect of light interception method on any of the response variables studied. The higher level of shading associated with treatment S2 resulted in higher percentage of stem and dead material and lower percentage of leaf in the consumed herbage at both pre- and post-grazing relative to treatments FL and S1. It also resulted in smaller bites and reduced intake rate.

Table 1. Morphological composition, bite mass, bite rate and intake rate of *Brachiaria brizantha* cv. Piatã subjected to shade regimes in a crop-livestock-forest integration area

	Pre-Grazing					Post-Grazing				
	Bite mass (g bite $^{-1}$)	Intake rate (g min^{-1})	Leaf (%)	Stem (%)	Dead Material (%)	Bite rate (bites min $^{-1}$)	Bite mass (g bite $^{-1}$)	Intake rate (g min^{-1})	leaf (%)	Stem (%)
FL	1,1 a	53,9 a	96,3 a	3,5 b	0,1 b	38,7 b	1,02 a	39,8 a	62,0 a	32,8 b
S1	1,1 a	46,0 a	94,3 a	5,5 b	0,1 b	38,9 b	0,98 a	38,2 a	59,0 a	36,1 ab
S2	0,9 b	42,7 b	89,0 b	9,9 a	1,0 a	42,6 a	0,81 b	34,7 b	50,4 b	42,7 a

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Eliana Vera Geremia

Morphological composition and herbage intake rate of brachiaria brizantha cv. Piatã subjected to shade regimes in a crop-livestock-forest integration area

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Etiane Tanise Sonego

Nitrogen management on cynodon sp. Tifton 85 nitrogen content

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world congress on integrated crop-livestock-forest systems

Nitrogen management on *Cynodon sp*. Tifton 85 nitrogen content

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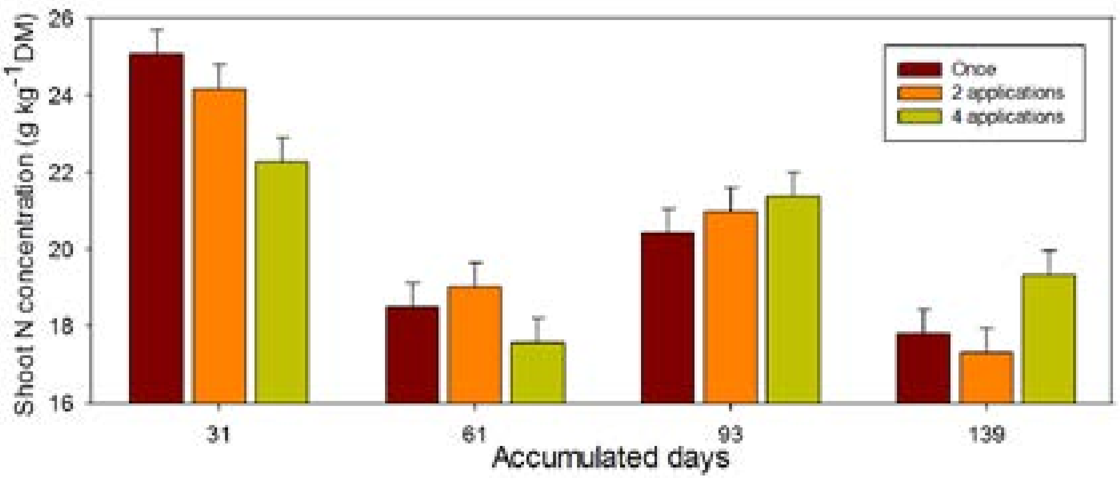
Introduction Many studies reports positive answer of N-Fertilization over grasses dry matter yield and its crude protein content. Although, N management still deserves more studies. Split or not N fertilizer applications can play an important role in a nutrient management strategy that is productive, profitable and environmentally responsible. This study assessed the effect of nitrogen fertilization strategies (split or not) on cultivated Cynodon sp. Tifton 85 Shoot N concentration.

Material and Methods

The study was carried out from Sep/2012 until Feb/2013 at the experimental unit of the Agronomic Institute of Paraná (IAPAR) in Pato Branco (PR). Experimental treatments were set up in a split-split plot randomized block design with four replications. Nitrogen management (applied all at once or split into two and four applications) was allocated at the main plots. Nitrogen rates as urea (0, 100, 200 and 300 Kg ha^{-1} of N) were allocated at the split plot. Forage dry matter yield and N shoot concentration were evaluated by cutting the pasture at 31, 61, 93 and 139 days after the standardization cut.

Results and Conclusions

Fig. 1. Tifton 85 shoot N concentration in relation to N management (2012/2013)



* To the bars that are not coincident, the averages differ by DMS test (minimum significant difference) at 5% probability

Tifton 85 shoot N content increased linearly as N rates increased (Shoot N=18.6 +0.016X R2=0.99 P=0.0067). Nitrogen management affected Tifton 85 shoot N content, as it is noticed on Figure 1. At the 1st evaluation (31 days), independently of N rates, that split N-fertilizer rates reduces shoot N content. The best forage quality is obtained in the initial stages of growing. Nitrogen content in the shoot biomass decreased along the growing season. In consequence split N doses reduce the protein potential of C4 forages. In conclusion, N-fertilizer rates must be applied all at once in the initial stages of regrowth to assure a suitable Tifton 85 protein quality.

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Shade quantity and quality of native and exotic tree species in the Brazilian Midwest

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Introduction The use of trees in pastures is recommended to mitigate the effects of heat stress on animals, caused mainly by high ambient temperatures and intense solar radiation. The aim of this study was to evaluate the shadow area and the radiant heat load of three tree species in pastures of the Brazilian Midwest.

Material and Methods

The experiment was conducted in the summer (january and february, 2015), at Embrapa Beef Cattle, Campo Grande-MS, Brazil (20º27'S, 54º37'W, 530 m asl). The trees were in an experimental area of integrated crop-livestock-forest system, with 18 ha, that contains Piatã grass (*Brachiaria brizantha* cv. BRS Piatã), and (1) eucalyptus (*Eucalyptus grandis* x *urophylla*, clone H 13), 22x2 m (227 trees/ha), 26 m (height), pruned 6 m, and; (2) scattered native Cambará (*Gochnatia polymorpha*) and Cumbaru (*Dipteryx alata*) trees (five trees/ha). The Radiant Heat Load (RHL) was determined in accordance as Karvatte Junior (2014). The prediction of the tree species projected shade area was calculated according to the methodology of Silva (2006), according to the different types of crowns (ellipsoid and spherical). For the data interpretation it was performed descriptive analysis.

Results and Conclusions

At 12h00, the surface area of shades projected by trees was 50.7 m² (eucalyptus) and 153.2 m² (native trees). The Radiant Thermal Load (RTL) under the shade of eucalyptus was 2.27% lower than under the shadows of native species (515 $W.m^{-2}$ vs. 527 $W.m^{-2}$), representing interception of 18.6% (eucalyptus) and 16.7% (native) compared to the sun (633 $W.m^{-2}$). The differences in the shaded surface area and interception of solar radiation by native and exotic tree species influence the quantity and quality of the available shade for the animals. Therefore, the choice of the arboreal component to insert onto an integrated crop-livestock-forest system is determinant for the animal welfare.

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Fabiana Villa Alves

Shade quantity and quality of native and exotic tree species in the Brazilian midwest

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Black globe temperature and humidity index in integrated crop-livestock-forest systems in the Brazilian Midwest

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Introduction The meat and milk production in tropical countries, as Brazil, is mainly on pastures (free-range systems). In these regions, the offering of enough shade to animals is an alternative for protection against solar radiation and mitigation of excessive heat, even in winter (Karvatte Junior, 2014). This study aimed to evaluate the thermal comfort index of an integrated system (crop-livestock-forest system) in Brazil Midwest.

Material and Methods

The experiment was conducted in winter (july-september, 2013), at Embrapa Beef Cattle, Campo Grande-MS, Brazil (20°27'S, 54°37'W, 530 m asl). The experimental area, with 6 ha, consists of a integrated crop-livestock-forest system with Piatã grass (*Brachiaria brizantha* cv. BRS Piatã), and eucalyptus (*Eucalyptus grandis* x *urophylla*, clone H 13), 22x2 m (227 trees/ha), 26 m (height), pruned 6 m. It was determined hourly some microclimatic variables (dry and wet bulb air temperatures - Ta and Tbw, black globe temperature - Tbg, dew point temperature - Tdp, wind speed - ws and relative humidity - RU). It was also calculated the Black Globe Temperature and Humidity Index (BGHI) as Karvatte Junior (2014). It was calculated the analysis of variance and regression at 5% probability (SAS 9.0).

Results and Conclusions

Significant quadratic effects were found ($P < 0.05$) for local conditions and time. At 12.00 pm, in the sun, it was obtained the highest levels of Tbw (25,1ºC), Tbg (38.5°C) and BGHI (89.0). The presence of trees resulted in a decrease of 8.2% on Tbw and 12.0% on Tbg, resulting in a lower value of BGHI (5.3%). Thus, the tree component (eucalyptus) is able to promote changes in the understory environment and to improve the welfare animal, by blocking of solar radiation. The integrated crop-livestock-forest systems are a good alternative for the thermal stress mitigation in tropical regions, like Brazil.

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Fabiana Villa Alves

Black globe temperature and humidity index in integrated crop-livestock-forest systems in the Brazilian midwest

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Management of grazing circuits in order to promote extensive livestock welfare

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Introduction

In Northeast Portugal, small ruminant production is an extensive activity based on daily movements of livestock around their villages. Driven by shepherds, goat and sheep flocks use several daily itineraries. Some decisions about the circuit's organization are greatly influenced by the environmental conditions because animals are very sensitive to extremes of temperature and availability of resources.

Material and Methods

Fieldwork was conducted over the territory of Morais village located near Bragança, (N41° 29' 23" W6° 46' 44"; 600 m above sea level), northeast Portugal. Three goat and three sheep flocks were monitored along their grazing circuits with a hand rover GPS (Global Position system), every three months for a year, in order to determine morning departure and evening return, and grazing itineraries length and duration.

Results and Conclusions

Tab 1: Duration of the grazing day and distances walked per day by season in goats and sheep.

	Duration of grazing day (min d^{-1})		Length of grazing itinerary (km d^{-1})	
	Goats	Sheep	Goats	Sheep
Autumn	528a±153	562a±105	7.019±0.828	10.441a±0.584
Winter	346b±75	402b±75	6.136±1.589	5.065b±2.684
Spring	388b±43	490ab±114	5.156±0.845	3.997c±1.842
Summer	376b±119	564a±111	6.128±0.893	6.272b±3.478

The results showed that morning departure varied significantly according to animal species and seasons. Sheep flocks set out for pasture earlier in the morning than goats, and their departure for pasture was even earlier in autumn and summer. Evening return was significantly later for sheep flocks than goats; the higher difference was found in summer. Sheep spent more daytime on grazing itineraries than goats independently of the season. The greatest differences were found in summer and spring. The length of the grazing itineraries was significantly longer in autumn compared to the other seasons.

José Ferreira Castro

Management of grazing circuits in order to promote extensive livestock welfare

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Integrated crop livestock systems: Ten years of animal performance at southern Brazil

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Introduction

According to Anghinoni et al. (2011), the dilemma between conservation *versus* productivity on integrated crop-livestock systems (ICLS) has a compatible solution whilst taking into account the current demands of society and the consumer market. In southern Brazil, the most widely used form of ICLS under no till is the soybean crop in the summer and the production of beef cattle during the winter. A key factor to be an successful system is adjusting the stocking rate, reflecting directly on animal production. Therefore, the aim of this work was to determine the relationships between the sward surface height, measured during ten years, aiming to couple the best animal performance with individual daily gain.

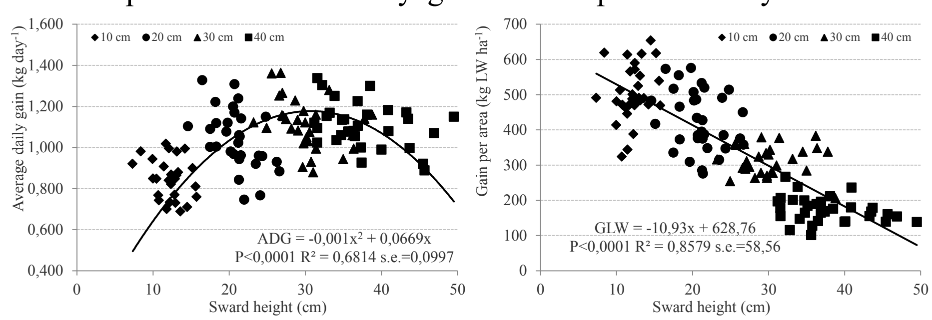
Material and Methods

The experimental area had 22 ha, divided in 12 paddocks ranging from 0.8 to 3.6 ha. It was located in the Espinilho Farm at southern Brazil. This long term protocol on ICLS is composed by an mixed pasture-oat (*Avena strigosa*) × annual ryegrass (*Lolium multiflorum*) continuously stocked during winter and soybean during summer.

Treatments corresponded to four sward surface heights: 10, 20, 30 and 40 cm, corresponding to four grazing intensities. The experimental design is a randomized complete block design with three replications. Regression analysis was performed until second order, with a 10-year database (2001-2011).

Results and Conclusions

Fig 1. Individual daily average gain (ADG) and gain per area (GLW) in relation to average actual sward height in mixed pastures of oats and ryegrass in a crop-livestock system under no-till.



Stocking rates were 1272, 915, 614 e 340 kg LW, respectively 10, 20, 30 and 40 cm. Maximum live weight gain occurred at 33 cm of sward surface height. The gain per area was reduced in 11 kg of LW ha^{-1} for each centimeter augmented in the height of the management of the pasture. The sward management height which allows average daily gains and per area is between 20 and 30 cm.

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Luís Fernando Picasso Quadros

Integrated crop livestock systems: ten years of animal performance at Southern Brazil

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Fourteen years of Nelore bulls performance on tropical pastures of an integrated crop-livestock system

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Introduction

Perennial tropical pastures implanted in conventional way have shown loss in productivity over time due to no fertilization maintenance and proper management. Thus, the average stocking rate and production in tropical pastures are about 0,8 AU/ha and 90 Kg of live weight/year. The resulting fertilization due to the sequence of cultures of an integrated crop-livestock system and the renewal of the pasture in different cultures cycles allow the increasing of animal production and stocking rate per area. This paper reports the results of 14 years of animal production on pastures of an integrated crop-livestock system in the Brazilian savannah (Cerrado biome).

Material and Methods

The system was installed at the Rice and Beans Research Center of Embrapa – Brazilian Agricultural and Livestock Research Corporation, located at Santo Antonio de Goiás, in the state of Goiás - Brazil. The pastures consisted of *Brachiaria brizantha* BRS Marandu and BRS Xaraes, a *Brachiaria ruziziensis* monoculture. Every three years crops of rice, soy or corn replaced the pastures. The pastures returned to crop system in the fourth year. It was also carried out in this area a Nellore bulls' performance test since 1999, in which the animals were tested at 8 months of age until completing 16 months of age. The pasture was management in a rotational system, a rich-urea-mineral supplement was used in the dry season (0.1-0.3% of LW), and a mineral supplement was used in the rainy season. Forage mass pasture, quality and live weight gain were measured at regular intervals. The data consists of basic statistics of the 14 years of the performance test.

Results and Conclusions

In the 14 years of the performance test (Table 1) was observed an average Stocking rate of 1.4 and 2.5 AU/ha, an average Daily Weight Gain of 0.29 and 0.65 kg/d and an average Total Weight Gain of 79.4 and 355.2 kg in the dry season and rainy season, respectively. These data are far superior to the mean of meat production in the Brazilian savannah biome.

Table 1. Means of 14 years of Nellore bulls performance test: Stocking rate, average daily gain, gain per area and final and initial weights

Year	Stocking rate (AU/ha)		Daily Weight Gain (kg/d)		Total Weigh Gain (kg/ha)			Initial weight	Final weight
	Dry	Rain	Dry	Rain	Dry	Rain	total	kg	kg
98/99	1,1	2,5	0,268	0,697	69	381	450	233	394
99/00	1,1	2,4	0,318	0,711	97	350	447	242	401
00/01	1,0	2,1	0,440	0,541	118	337	455	217	390
01/02	1,3	2,5	0,189	0,608	59	504	563	211	365
02/03	1,1	3,5	0,593	0,647	56	415	471	229	383
03/04	1,9	3,2	0,228	0,813	58	420	478	222	361
04/05	1,8	3,3	0,302	0,743	108	502	610	226	381
05/06	2,5	3,7	0,300	0,654	177	564	741	233	407
06/07	2,7	1,2	0,109	0,494	80	182	262	246	438
07/08	2,0	3,6	0,460	0,558	164	314	478	231	422
08/09	1,1	2,7	0,177	0,563	40	401	441	237	434
09/10	0,7	1,4	0,357	0,684	51	237	288	249	433
10/11	0,6	1,2	0,151	0,609	17	161	178	250	430
11/12	0,5	1,3	0,171	0,782	17	205	222	246	462
mean	1,4	2,5	0,290	0,650	79,4	355,2	434,6	233,7	407,2

Animal management and welfare in integrated systems
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Integrated livestock-forest systemin southern region of Rio Grande do Sul: a suitable alternative for degraded pasture recovering with AnnoniGrass weed (*Eragrostisplana*Ness.)

Melissa BATISTA MAIA[1*], Alexandre COSTA VARELLA[2], Jamir Luís SILVA DA SILVA[3],Ricardo Willians MACIEL TADEO[4], Ana Cecília da LUZ FRANTZ[4], Ivone Maria BARP PAIM VIEIRA[5],

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IntroductionThe low shade tolerance of the main invasive weed of Brazilian southern grasslands, the Annoni Grass(*Eragrostisplana* Ness) is well recognized. The Integrated Livestock-Forestry system(ILF) can play an importantrole on the recoveryof degradedgrasslands severely occupied by this weed in southern Brazil.This study aims toevaluate ILF alternative store the yield capacity of grasslands severely invaded by Annoni Grass weed.

Material and Methods

The Technological Reference Unit (TRU) of 34 hectares was established in April 2013 within the experimental area of Embrapa South Livestock (31°21’09”S and 54°00’57”W). The experimental design was a randomized blocks distributed in a factorial 3x2 with two replications, where the treatments were: three pasture systems: ILF1 with *Eucalyptus grandis* trees in triple rows and density of 750 treesha^{-1} (3x2x14m); ILF2 with *E. grandis* with 375 trees ha^{-1} (3mx2mx34m) and open pasture systems (OP). Each pasture system was splitted into two levels of pasture intensification: native grassland (NG) invaded by Annoni Grass weed (Ness *Eragrostisplana*) and improved natural grassland (ING) with annual ryegrass (*Loliummultiflorum*), red clover cv. LE116 (*Trifoliumpratense*) and Birdsfoot Trefoil cv. Sao Gabriel (*Lotus corniculatus*) sown in June 2013. From August 2014 to April 2015, all pasture treatments were continuously grazed by BrangusIbageweaned calves. The stocking rate was adjusted every 30 days, maintaining a forage allowance of about 14 kg of pasture dry matter per 100 kg liveweight. The daily liveweight gain (LWG) per head was evaluated monthly. All deployment and maintenance costs as well as the incomes obtained were evaluated during the experimental period Dry matter (DM) yield was measured every 30 days within 3 transects per experimental unit. Each transect was established between the external tree rows and had 5 sampling points, totaling 15 points per treatment. Botanical composition (%) was measured in all treatments, separating native and cultivated grasses, native and cultivated legumes, AnnoniGrass weed and other species. Tree height was measured in May 2014 and April 2015 in each ILF, totaling a sample of 10% of the trees planted.

Results and Conclusions

Total DM yieldfrom October 2013 - March 2015 was 4,090kgha^{-1} at ILF1/ING treatment, 3,857 kg ha^{-1} at ILF1/NG, 4,094 kg ha^{-1} at ILF2/ING, 4,000 kg ha^{-1} at ILF2/NG, 4,335 kg ha^{-1} at OP/ING and 4,316 kg ha^{-1} at OP/NG. The botanical compositionshowed 20% of AnnoniGrass weed at ILF1/ING, 82% at ILF1/NG; 27% at ILF2/ING, 91% at ILF2/NG, 30% at OP/ING and 80% at OP/NG($P<0,05$). Treeswere similar withan average 2.35m height in May 2014 and 5.47 m in March 2015. The mean LWG per day was 1.5 kg from 90 calves between August and October 2014; 0.67 kg from 44 calves between November and December 2014; 0.541 kg from 16 calves between January and April 2015.By this stage, Annoni Grass weed was unaffected by trees shading. On the other hand, intensive pastures were more effective to control Annoni Grass than the type of pasture system. As tree shade increases, recovery of degraded ´grasslands by Annoni Grass weed may be more effective in the future.#

Melissa Batista Maia

Integrated livestock-forest systemin southern region of Rio Grande do Sul: a suitable alternative for degraded pasture recovering with annonigrass weed (eragrostisplananess.)

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Thermal comfort indexes, in the summer, in integrated crop-livestock-forest systems in the Brazilian Cerrado

Nivaldo KARVATTE JUNIOR[1]*, Fabiana V. ALVES[2], Roberto Giolo de ALMEIDA[2], Eliane S. MIYAGI[1], Camilla D. BARRETO[3], Caroline C. de OLIVEIRA[4]

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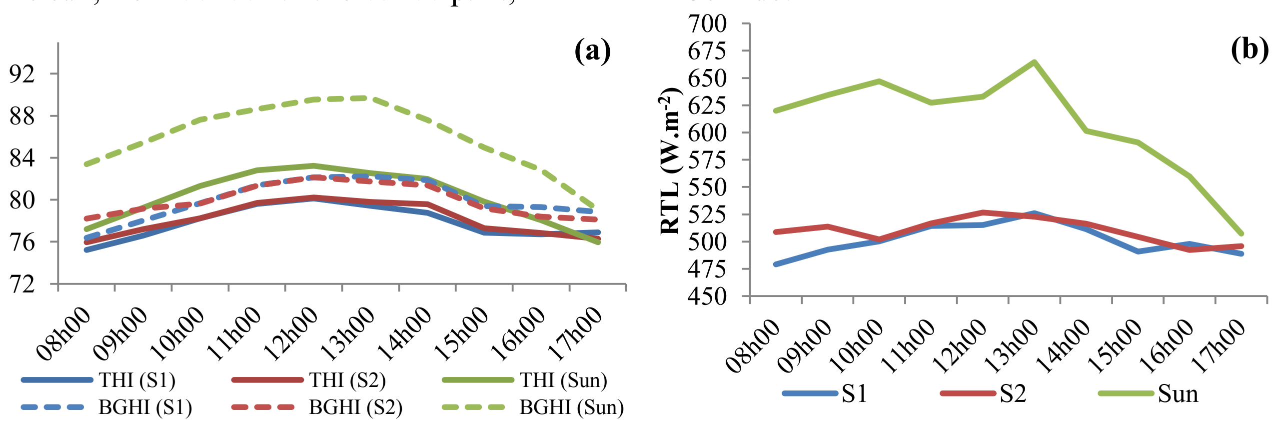
Introduction Shade in enough quantity helps pasture-raised animals from tropical regions to reduce the thermal load associated with the direct solar radiation, enhancing its thermal comfort. Thus, in these regions, systems that are able to mitigate heat stress are essential for the sustainability. Our objective was to evaluate some thermal comfort indexes, in the summer, in integrated systems in the Brazilian Cerrado.

Material and Methods
The experiment was conducted in the summer (january and february, 2015), at Embrapa Beef Cattle, Campo Grande-MS, Brazil (20º27'S, 54º37'W, 530 m asl). The experimental area, with 12 ha, consists of integrated crop-livestock-forest systems with Piatã grass (*Brachiaria brizantha* cv. BRS Piatã), and (1) eucalyptus (*Eucalyptus grandis* x *urophylla*, clone H 13), spacing 22x2 m (227 trees/ha), 26 m high, pruned up to 6 m; (2) scattered Cambará (*Gochnatia polymorpha*) and Cumbaru (*Dipteryx alata*) trees, with five trees/ha. The equations of thermal comfort systems were constructed as Karvatte Junior (2014). For the interpretation of the data it was performed descriptive analysis.

Results and Conclusions
In the shade, there was a reduction of 3.6% in temperature and humidity index (THI), 8.3% in the Black Globe Temperature and Humidity Index (BGHI) and 21.3% in Radiant Thermal Load (RTL), compared to the sun. Presence of trees, despite of the type and arrangement onto the systems, is effective for the mitigation of thermal stress and improves the sustainability of livestock production on tropical pastures.

Fig.1. THI (a) and RTL (b) in integrated systems with eucalyptus (S1), native trees (S2), or under the sun, from 08h00 a.m. to 05h00 p.m., in Brazilian Cerrado.



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To Embrapa, CNPq, Fapeg and Fundect.

Nivaldo Karvatte Júnior

Thermal comfort indexes, in the summer, in integrated crop-livestock-forest systems in the Brazilian Cerrado

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Microclimate on integrated crop-livestock-forest systems, in summer, in the Brazilian Cerrado

Nivaldo KARVATTE JUNIOR[1]*, Fabiana V. ALVES[2], Eliane S. MIYAGI[1], Camilla D. BARRETO[3], Caroline C. de OLIVEIRA[4], Ariadne P. MASTELARO[1]

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Introduction In tropical countries, such as Brazil, the production of beef cattle is predominantly on pastures. Thus, during the summer, the animals are constantly exposed to high temperatures, influencing their welfare and productivity. The objective was to evaluate the microclimate of two types of integrated crop-livestock-forest systems, in summer, in the Brazilian Cerrado.

Material and Methods

The experiment was conducted in the summer (january and february, 2015), at Embrapa Beef Cattle, Campo Grande-MS, Brazil (20º27'S, 54º37'W, 530 m asl). The experimental area, with 12 ha, consists of integrated crop-livestock-forest systems, with Piatã grass (*Brachiaria brizantha* cv. BRS Piatã), and (1) eucalyptus (*Eucalyptus grandis* x *urophylla*, clone H 13), 22x2 m (227 trees/ha), 26 m (high), pruned up to 6 m, and; (2) Cambará (*Gochnatia polymorpha*) and Cumbaru (*Dipteryx alata*), scattered, with a density of five trees/ha. The mainly microclimate parameters were collected, in accordance to Karvatte Junior (2014). For the data interpretation it was utilized descriptive analysis.

Results and Conclusions

The highest microclimatic values were obtained in the sun, in all systems, between 11h00 a.m. and 01h00 p.m. In the shadow, the area with eucalyptus presents air temperatures (Ta) and black globe (Tbg) values 9.1 and 18.0% lower than the sun (Ta, 32.9°C and Tbg, 39.7°C); for the system with scattered native species, there was a reduction of 7.9% on Ta and 17.0% on Tbg. In both systems, there was a reduction of 4.0% in the dew point temperature (Tdp) and a 6.3% increase in relative humidity (RH) for the same time interval listed above. The wind speed (ws) showed to be very variable along the day, but always greater in the sun, reaching a maximum of 1.5 $m.s^{-1}$. Moore et al. (2012) affirm that high values of air temperature, solar radiation and humidity provide an uncomfortable thermal environment by imposing compensation systems by animals to maintain homeotermy, even if they are well adapted. So, the presence of trees, regardless of species, provides more favorable microclimate in pastures.

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Acknowledgements

To Embrapa, CNPq, Fapeg and Fundect.

Animal management and welfare in integrated systems

Nivaldo Karvatte Júnior

Microclimate on integrated crop-livestock-forest systems, in summer, in the Brazilian Cerrado

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Chemical quality of sorghum silage regrowth intercropped with forage and/or dwarf pigeon pea in the Cerrado region

Sanderley S. CRUZ[1]*, Isabô M. PASCOALOTO[2], Marcelo ANDREOTTI[3], Gilmar C. LIMA[2], Caroline A. SOARES[4], Gabriela N. MORAIS[2], Catharine B. D. AZAMBUJA[2]
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Introduction

The sorghum culture has the capacity to withstand water stress. Thus, it is an alternative to increase the food supply in the form of grain and/or forage, especially if grown in consortium with forage plants in integrated crop-livestock farming system, including possible use of its regrowth.

Material and Methods

The experiment was conducted in the agricultural year 2013/14 in Selvíria city, Brazil. The experimental design was a randomized blocks with 6 treatments and 4 replications. The treatments were: sorghum (cv. Volumax) in monocrop (SS); and sorghum in consortia with: *U. brizantha* (Marandu grass) (SB); *P. maximum* (Mombaça grass) (SP); pigeon pea dwarf (*C. cajan*) (SG); Marandu grass and dwarf pigeon pea (SBG); and Mombaça grass and pigeon pea dwarf (SPG). The sorghum and forage were mechanically sown on the same line and pigeon pea was sown between the lines, spaced 0,50 m. All treatments were mechanically cutted down in 0,30 m for silage in May 2014, ensiled with average particle 0,025 m, and stored in plastic buckets for a period of 30 days. The chemical analyzes followed the recommendations in Silva & Queiroz (2002).

Results and Conclusions

The levels of NDF, ADF, HEM, CEL and LIG were influenced significantly ($p<0.05$) by the treatments. The higher content of CP obtained was 8,11% for sorghum silage in consortium with Marandu grass (SB).

Table 1. Levels of Crude Protein (CP), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Hemicellulose (HEM), Cellulose (CEL) and Lignin (LIG) of sorghum silage regrowth in consortium with forage and/or pigeon pea dwarf in integrated crop-livestock farming system in the Cerrado.

Treatments	CP (%)	NDF (%)	ADF (%)	HEM (%)	CEL (%)	LIG (%)
SBG	6,65 a	72,92 ab	50,25 ab	22,66 c	41,06 abc	7,57 a
SB	8,11 a	70,67 b	45,79 c	24,88 b	38,94 cd	5,43 d
SPG	6,73 a	73,15 ab	51,50 ab	21,65 c	42,95 ab	7,13 ab
SP	6,78 a	74,71 a	53,06 a	21,65 c	43,74 a	7,01 abc
SG	4,62 a	73,50 ab	48,50 bc	25,00 b	40,57 bcd	6,08 bcd
SS	4,17 a	72,65 ab	45,42 c	27,23 a	37,95 d	5,89 cd
CV(%)	30,30	2,31	3,34	4,01	3,04	7,58

CV (%) = coefficient of variation; different letters in the column differ in 5% by Tukey test.

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Sanderley Simões Cruz

Chemical quality of sorghum silage regrowth intercropped with forage and/or dwarf pigeon pea in the Cerrado region

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Dry mass production of tropical forage after harvest sorghum and/or pigeon pea dwarf in integrated crop-livestock farming system

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Dry mass production of tropical forage after harvest sorghum and/or pigeon pea dwarf in Integrated Crop-Livestock Farming System

Sanderley S. CRUZ[1]*, Isabô M. PASCOALOTO[2], Marcelo ANDREOTTI[3], Gilmar C. LIMA[2], Caroline A. SOARES[4], Gabriela N. MORAIS[2], Guilherme F. ROSSI[2]
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Introduction

The intercropping and the integrated crop-livestock farming system are important allies to sustainable and economically viable crop production. The use of pasture is the most economical and practical way used in ruminant feed. The main purpose of this study was to evaluate the dry matter production of tropical forage after the consortium installation with sorghum and/or pigeon pea dwarf in non-irrigated conditions in Cerrado.

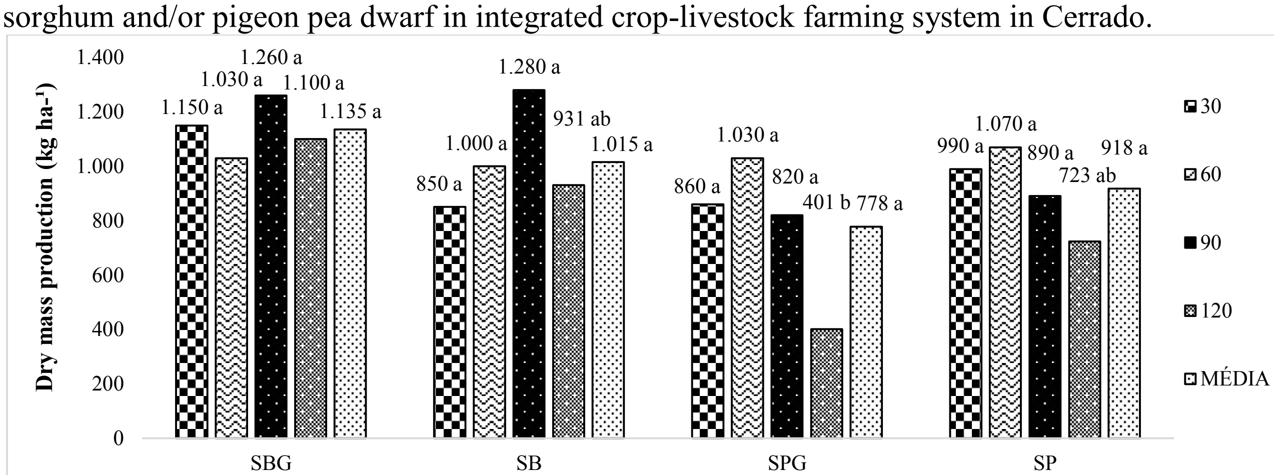
Material and Methods

The study was conducted in the agricultural year of 2013/14 in Selvíria city, Brazil. The experimental design was a randomized blocks with 4 treatments and 6 repetitions. The treatments evaluated were: *U. brizantha* (Marandu grass) in consortium with sorghum (SB); *P. maximum* (Mombaça grass) with sorghum (SP); Marandu grass with sorghum and pigeon pea dwarf (SBG) and Mombaça grass with sorghum and pigeon pea dwarf (SPG). The forage and the sorghum were mechanically sown on the same line (7 lines) and the pigeon pea (7 lines) was sown between the lines, spaced 0,50 m, 20 m long. The forages were harvested at 30, 60, 90 and 120 days after the consortium with sorghum and/or pigeon pea dwarf, and the first cut was made in June 2014. To determine the dry mass were collected 1 m² (3 replications/plot) of forage in height of 0,30 m and then immediately weighed to after be put into circulation forced air oven (65°C) for a period of 72 hours.

Results and Conclusions

It can be seen from Picture 1 that the dry matter forage production was affected at 120 days after the consortium with sorghum and/or pigeon pea. The highest production of dry forage mass (1135 kg ha^{-1}) was obtained after the consortium Marandu grass with sorghum and/or pigeon pea dwarf.

Picture 1. Dry mass production of *U. brizantha* forage and *P. maximum* forage in consortium with sorghum and/or pigeon pea dwarf in integrated crop-livestock farming system in Cerrado.



**different letters in the same column differ in 5% by Tukey test.

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Forage availability and nutritional value of paiaguás-grass and piatã-grass for lamb finishing systems

Andrei PEREIRA NEVES[1], Jose A. AGIOVA da COSTA[2]*, Sergio G. ESPINOSA VILLAFUERTE[3], Gelson L. DIAS FEIJÓ[4], Fernando ALVARENGA REIS[2], João B. CATTO[4]
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Introduction

The *Brachiaria* spp has great adaptability to the most varied environmental conditions, with elevated forage productivity, although limited in nutritional value. When used in integrated crop-livestock (ICL) systems or managed to provide leaf blades production, provide suitable conditions for lambs finishing, a high nutritional demand animal category.

Material and Methods

The experiment was conducted at Embrapa´s Midwest Regional Center of Goats and Sheep, Terenos – Mato Grosso do Sul. Grazing system under evaluation were: Piatã-grass and Paiaguás-grass pastures stablished in succession to sorghum and soybean crops (LCS-Livestock-Crop System) in 2013 and 2014, respectively; Piatã-grass as five months stockpiled pasture (STOCK). The forages were evaluated every 14 days between July and October, separated into leaf blades/stem/dead material components, dried at 65° C and analyzed by NIRS. Weaned Pantanal locally adapted lambs were used under continuous grazing.

Results and Conclusions

The average leaf blades component in forage available during the grazing period was greater for LCS, 1.0 t DM.ha^{-1} and 1.8 t DM.ha^{-1} compared to STOCK, 0.9 DM.ha^{-1} t and 1.1 t DM.ha^{-1}, in 2013 and 2014 years, respectively. There were system effect and year effect, for Piatã-grass in STOCK system for nutritional value, higher in year 1 and lower in year 2. Nutritional values were found superior in ICL system to Paiaguás-grass (Table 1).

Table 1. Chemical composition (%) of forage available to lamb grazing during the dry season.

Systems		CP	NDF	ADF	IVDOM	Lig S	Lig P	Pulp	Sílica
LCS	Piatã (2013)	6.81 c	75.69 d	38.68 c	54.98 c	3.82 b	8.53 c	28.25 d	3.58 c
	Paiaguás (2014)	10.47 a	73.16 a	35.42 a	59.42 a	3.88 c	7.19 a	25.91 a	2.42 a
STOCK	Piatã (2013)	7.43 b	75.53 c	36.75 b	56.14 b	3.66 a	7.87 b	27.21 b	2.72 b
	Piatã (2014)	5.78 d	75.23 b	39.53 d	46.93 d	3.88 c	8.98 d	27.48 c	3.83 d

Distinct letters in the column differ by Tukey-Kramer test (P <0.01).

Silva et al. (2014) argue that the nutritional value depends on the chemical composition and digestibility of forage. Forage leaf blade availability should be plentiful during the grazing period for satisfactory animals weight gain. Lamb total body weight gain was greater (P <0.05), in LCS (13.22 kg) compared to STOCK system (11.25 kg) in average for the two years study. In the LCS system leaf blade supply was higher, providing a better performance. The nutritional value changed from year to year to Piatã-grass due to the initial conditions of grazing, but the nutritional value of Paiaguás-grass was superior.

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Herbage production from deferred grazing of Piatã brachiariagrass cultivated in a silvipastoral system

Steben CRESTANI[1*], Eliana V. GEREMIA[1], Jorge D. CABALLERO [1], Miquéias MICHETTI [2], Roberta A. CARNEVALLI[2], Sila C. DA SILVA [1]
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Introduction

Deferred grazing is one of the possibilities for dealing with surpluses of herbage during the pasture growing season and ensuring feed for periods of deficit during periods of low pasture growth. Silvipastoral systems aim at maintaining animal production all year round, but also augment and diversify farm income. The objective of this experiment was to evaluate the suitability of Piatã brachiariagrass (*Brachiaria brizantha* cv. Piatã) cultivated under trees for deferred grazing and the possible advantages in relation to cultivation under full natural light condition.

Material and Methods

The experiment was carried out at Embrapa Agrossilvipastoril, Sinop, MT (11°51'S, 55°35'W and 384 m a.s.l.), from February to June 2014, in a crop-livestock-forest integration area. The area was divided into three light regimes: (1) Piatã brachiariagrass cultivated in the absence of trees (*Eucaliptus* H13 clone) (full natural light; FL); (2) shade produced by a double row of trees on the edges of the paddocks (181 trees ha^{-1} - S1); and (3) shade produced by four triple rows of trees with pasture in between them (718 trees ha^{-1} - S2). Treatments were applied only in light regimes FL and S2, and corresponded to combinations between two shutting off dates (C1 – February 26, C2 – March 28) and two grazing dates (G1 – May 16, G2 – June 16). These were applied to experimental units (15 x 4 m plots) according to a 2x2 factorial arrangement, with four replications. Total rainfall and duration of deferment corresponded to 223 mm and 79 days, 257 mm and 110 days, 150 mm and 80 days, and 126 mm and 49 days, respectively. At the shutting off dates (C1 and C2), plots were mowed at 10 cm and samples harvested at the end of the deferment period (G1 and G2). From each plot, 20 readings were taken with a ruler for determining the extended sward height and herbage samples harvested within four 0.25 m^2 metallic frames for determining herbage mass and the percentage of leaf, stem and dead material. Statistical analysis was performed using PROC Mixed of the statistical package SAS at a 5% probability level.

Results and Conclusions

Light regime S2 showed 40% of the light transmittance of light regime FL (100%). Average temperature for the experimental period was 32 °C. Sward herbage mass was greater for FL than S2 (7790 and 4640 kg DM/ha) and for C1 than for C2 (7030 and 5400 kg DM/ha, respectively). Leaf percentage was higher for S2, C2 and G1 (43.4, 46.5 and 47.2%) relative to FL, C1 and G2 (40.3, 37.3 and 36.6%, respectively). There was no treatment effect for stem percentage in sward herbage mass (average of 39.5%), and dead material percentage was higher for C1 and G2 (22.5 and 24.1%) relative to C2 and G1 (14.3 and 24.1%, respectively). Given the similar herbage mass and the higher percentage of dead material relative to leaf, extension of the deferment duration during periods of low rainfall resulted in negative impact for both light regimes. The main effect of shading (lower availability of light) on the pasture was the reduced herbage production.

Acknowledgements

Embrapa Agrossilvipastoril, CNPq, CAPES, ESALQ/USP.

Suitability of Piatã brachiariagrass to deferred grazing in silvipastoral systems

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Introduction

The use of integrated systems of production has been encouraged based on the assumption that they ensure a higher degree of sustainability to farming systems. However, several management techniques and technologies well known and used in monoculture conditions need to be studied in integrated systems condition to verify their effectiveness under the wide range of conditions associated with crop-livestock-forest integrated systems. The objective of this experiment was to evaluate the suitability of Piatã brachiariagrass cultivated in a crop-livestock-forest integration area for deferred grazing and determine the potential benefits in relation to full natural light condition.

Material and Methods

The experiment was carried out at Embrapa Agrossilvipastoril, Sinop, MT (11°51'S, 55°35'W and 384 m a.s.l.), from February to June 2014, in a crop-livestock-forest integration area. The area was divided into three light regimes: (1) Piatã brachiariagrass cultivated in the absence of trees (*Eucaliptus* H13 clone) (full natural light; FL); (2) shade produced by a double row of trees on the edges of the paddocks (181 trees ha^{-1} - S1); and (3) shade produced by four triple rows of trees with pasture in between them (718 trees ha^{-1} - S2). Treatments were applied only in light regimes FL and S2, and corresponded to combinations between two shutting off dates (C1 – February 26, C2 – March 28) and two grazing dates (G1 – May 16, G2 – June 16). These were applied to experimental units (15 x 4 m plots) according to a 2x2 factorial arrangement, with four replications. Total rainfall and duration of deferment corresponded to 223 mm and 79 days, 257 mm and 110 days, 150 mm and 80 days, and 126 mm and 49 days, respectively. At the shutting off dates (C1 and C2), plots were mowed at 10 cm and samples harvested at the end of the deferment period (G1 and G2). From each plot, herbage samples were harvested within four 0.25 m^2 metallic frames for determining herbage accumulation, specific leaf area, sward leaf area index (LAI) and tiller population density. Statistical analysis was performed using PROC Mixed of the statistical package SAS at a 5% probability level.

Results and Conclusions

Light regime S2 showed 40% of the light transmittance of light regime FL (100%). Average temperature for the experimental period was 32 °C. Herbage accumulation was greater for light regime FL and grazing date G1 (104.9 and 98.4 kg DM/ha.day) relative to S2 and G2 (60.1 and 66.6 kg DM/ha.day, respectively). The specific leaf area was greater for FL relative to S2 (191.4 and 137.6 cm^2/g, respectively). Greater LAI values were recorded for FL and G1 (4.2 and 4.3) relative to S2 and G2 (3.7 and 3.6, respectively). There was an interaction between light regime and shutting off date and another between shutting off and grazing date, with greater values recorded for FL relative to S2 and for treatment C2G1 relative to the remaining treatments (687, 471 and 729 tillers/m^2, respectively). Piatã brachiariagrass cultivated under trees in crop-livestock-forest areas has tiller lower population and produces thinner leaves as a means of optimising light capture and decreasing intraspecific competition. However, these adaptive responses were associated with reduced LAI and herbage accumulation relative to plants cultivated under full natural light conditions.

Acknowledgements

Embrapa Agrossilvipastoril, CNPq, CAPES, ESALQ/USP.

Steben Crestani

Suitability of piatã brachiariagrass to deferred grazing in silvipastoral systems

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NITROUS OXIDE LOSSES FROM BEEF CATTLE EXCRETA IN AN INTEGRATED CROP- LIVESTOCK SYSTEM

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Introduction The nitrogen originated from bovine excreta and deposited in pasture, can be lost from the production system in various forms, including gaseous emissions. Nitrous oxide is one of the most potent greenhouse gases due to its high global warming potential. The objective of this study was to evaluate the effect of bovine excreta and of their deposition on the soil in the wet or dry season, on gaseous losses of nitrogen in an integrated Crop-Livestock system (iCL).

Material and Methods

Fourty eight plots were established in a randomized complete block of split-plots: 3 treatments (urine, dung and control), 2 pastures, 2 periods of excreta application (dry and wet seasons) repeated in time (two years of applications) in four blocks. The gas samples were taken by the method of manual static chambers. Immediately after the application of the excreta samples were taken during seven consecutive days. Then the frequency of sampling was reduced to twice a week and, finally, fortnightly, totaling 502 days in the dry seasons and 388 in the rainy seasons. Concurrently, soil sampling was carried out to verify the water filled pore space (WFPS), pH, nitrate and ammonium levels. Descriptive statistics was used to demonstrate the daily N_2O flux. Data were subjected to analysis of variance (ANOVA) and means were compared by Tukey's test ($p<0.05$).

Results and Conclusions

The deposition of excreta in the pastures under iCL increased soil N_2O fluxes, compared to those from the control site. In the dry season positive fluxes of N_2O occurred after rainfall event, responding increased WFPS. In the rainy season emissions increased soon after application of excreta. In the dry season the N_2O fluxes were associated with greater availability of ammonium, however, in the rainy season the fluxes were correlated with the availability of nitrate. It was not possible to conclude whether nitrification or denitrification was the dominant process in N_2O production, however it seemed that both played relevant roles, like described by Sordi et al. (2014). Urine deposition resulted in greater losses of nitrogen than dung. The largest FE were observed for urine in the rainy season of the year (0,44%). It was below the default 2% EF recommended by the IPCC. The EF of urine in the dry season was 0,20%. For dung it was 0,13% in the rainy and 0,08% in the dry season. Our results suggest that the EF proposed in the IPCC Guidelines (2006) for cattle excreta are overestimated for the tropical savannah ecosystem of Brazil. Similarly to the findings by Lessa et al. (2014), the disaggregation of EF for excreta type is recommended.

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Adriana Rodolfo da Costa

Nitrous oxide losses from beef cattle excreta in an integrated crop-livestock system

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Greenhouse gas mitigation and offset options for beef cattle production under contrasting pasture management systems in Brazil

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Introduction This study estimates the GHG balance (emissions and sinks) related to the beef cattle production in three contrasting production scenarios on *Brachiaria* pasture in Brazil: 1) Degraded pasture (DP), 2) Managed pasture (MP), and 3) Crop–livestock–forest integration system (CLFIS).

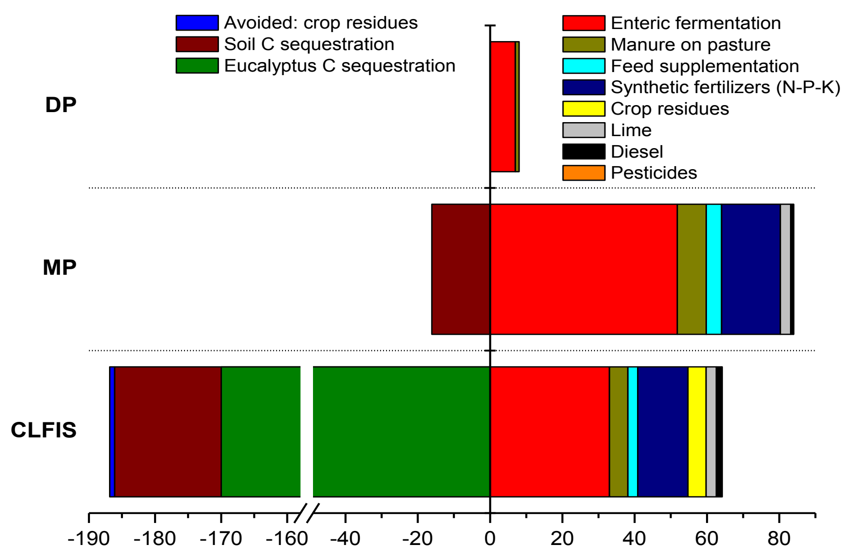
Material and Methods

The calculation of GHG balance was performed using the IPCC (2006) methodology combined with Brazil specific database of several scenarios of Brazilian pasture management systems, considering inputs and outputs from 1 hectare of land within the farm for each scenario over a 10-yr time span, taking into account only fattening phase of cattle.

Results and Conclusions

Figure 1 presents emissions (positive) and sinks (negative) distinguishing sources for each of the production scenarios. Carbon footprint of beef cattle estimated was 19.2 kg CO_2eq per kg LW (Live weight) in DP, followed by 14.7 kg CO_2eq per kg LW in CLFIS and 9.3 kg CO_2eq per kg LW in MP. Taking into account the technical potential for C sequestration to offset related emissions in MP (soil C) and CLFIS (soil and *Eucalyptus* C), C footprint from beef cattle could be reduced to 7.5 and -28.1 kg CO_2eq per kg LW respectively.

Fig. 1. GHG emission per source (right bars) and potential for C sink (left bars) (Mg CO_2eq ha^{-1}) accumulated over the 10-year period for each pasture management system: Degraded Pasture (DP), Managed Pasture (MP) and Crop-Livestock-Forest-Integration system (CLFIS) in Brazil.



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Carlos Cesar Ronquim

Greenhouse gas mitigation and offset options for beef cattle production under contrasting pasture management systems in Brazil

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Carbon dynamics in a Cerrado Oxisol under specialized and mixed systems as assessed by natural abundance ^{13}C

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Introduction The warm conditions of the tropics are conducive to the rapid degradation of soil organic matter (SOM). Preservation of SOM in these soils is of crucial importance for their long-term integrity and sustainable productivity. In this presentation, we report the results of 12 yr of cropping or pastures, or integrated crop/livestock systems on soil carbon stocks dynamics in the Brazilian Cerrado.

Material and Methods

The field experiment was installed in an area of native vegetation at the Embrapa Cerrados Research Centre, Planaltina, near Brasilia in 1990. Treatments included grazed pastures *Brachiaria brizantha* in monoculture or in mixed grass/legume sward, continuous cropping under no-till (NT) or plough-till (CT) and integrated 4-yr crop/ 4-yr livestock systems. Soil samples were taken to 100 cm depth for soil density and analysis for total N, C and ^{13}C abundance and soil C and N stocks were calculated on a the basis of a mass of soil equal to that under the native vegetation (NVeg) as described by Sisti et al. (2004).

Results and Conclusions

Fig. 1. Soil total C and C derived from C_4 stocks to 100 cm depth under different crop and pasture systems 12 years after establishment. Data are means of 4 replicate plots/paddocks.

Over a 12-year period, 21% of total SOC in the continuous grass pasture changed to C_4. The cropping under conventional tillage showed no reduction in soil carbon stocks (Fig. 1). The fertilized mixed legume grass pasture, and integrated crop/pasture systems under no-till, showed accumulation of carbon beyond that present originally in the soil of the native savanna.

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Claudia Pozzi Jantalia

Carbon dynamics in a Cerrado oxisol under specialized and mixed systems as assessed by natural abundance 13C

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N_2O fluxes and soil nitrogen mineralization in integrated production systems in the region of the Cerrado biome.

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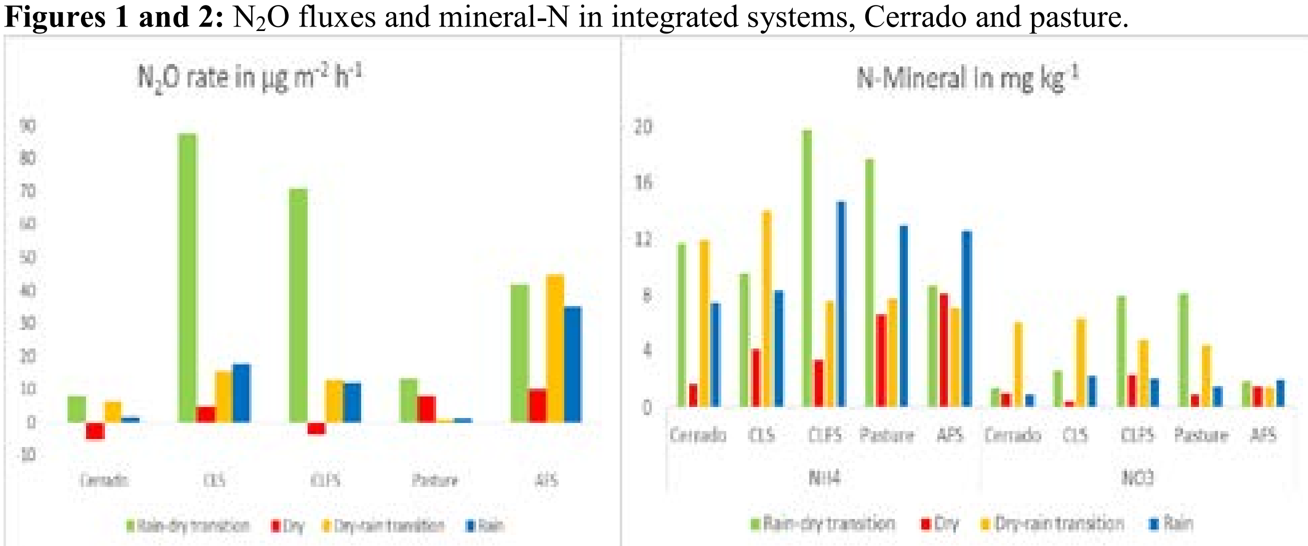
Introduction Among the greenhouse gases (GHGs), nitrous oxide (N_2O) has the greatest importance for the agricultural sector since its emissions are related to the dynamics and availability of nitrogen (N) in the soil, but also to high rainfall, to biomass production and to soil temperatures. Integrated production systems like Agroforestry System (AFS) generate a very diverse environment, creating better conditions for soil microbes and, possibly, to mitigate greenhouse gases, such as N_2O.

Material and Methods The experiments on Crop-Livestock-Forest System (CLFS) and Crop-Livestock System (CLS), native Cerrado area and pasture were conducted at Embrapa Cerrados in Planaltina (DF, Brazil) under a randomized block design with three replications. The treatments were: Sorghum and *B. brizantha* cultivated with rows of *Eucalyptus urograndis*, spaced 2 x 2 m between plants and 22 m between rows - CLFS; sorghum and *B. brizantha* grown without the presence of *E. urograndis*– CLS; native vegetation of Cerrado; pasture of low productivity. The Agroforestry System (AFS) is located in a private property, in Planaltina (DF, Brazil). Sampling for N_2O and soil (0-5 and 5-10 cm) for NO_3^- e NH_4^+ quantification in CLS, CLFS, Cerrado and pasture were carried out considering the Cerrado seasonal periods: rainy-dry transition (March-April / 2013); dry season (July / 2013); dry-rainy transition (November / 2013); rainy season (January-February / 2014). CLFS and CLS received N fertilization in March 2013 (200 kg N ha^{-1}) and in February 2014 (130 kg N ha^{-1}). Samples for N_2O and for soil analysis were also taken from the AFS in the same months and periods of 2014/2015.
N_2O emissions were evaluated using static closed chambers and analyzed by gas chromatography.

Results and Conclusions Among the integrated systems, AFS resulted in lower emissions and CLS in higher, during rainy-dry transition when N fertilizer was applied to CLS and CLFS. The CLFS and pasture showed higher rates of NH_4^+ during the rainy-dry transition. At the AFS the variability of NH_4^+ and NO_3^- concentration between seasons is lower compared to all the other treatments.

Figures 1 and 2: N_2O fluxes and mineral-N in integrated systems, Cerrado and pasture.



Practical quantification of greenhouse gas emissions and removals across ICLF systems

Eloisa Aparecida Belleza Ferreira

N2O fluxes and soil nitrogen mineralization in integrated production systems in the region of the Cerrado biome

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Nitrous oxide emissions and microbial biomass carbon in integrated crop- livestock-forest system in the Brazilian savanna (Cerrado)

Arminda M. CARVALHO[1]*, Willian R. D. OLIVEIRA[2], Maria Lucrécia G. RAMOS[2], Thais R. COSER[1], Kleberson W. SOUZA[1], Luciano G. TIMÓTEO[1], Luciano A. PINHEIRO[1], Juaci Vitoria MALAQUIAS[1], Antônio Marcos Miranda SILVA[2], Manuel Messias LACERDA[2], Robélio Leandro MARCHÃO[1]
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Introduction: Nitrous oxide (N_2O) is a major greenhouse gas and its concentration has increased in the atmosphere due to the increased use of nitrogen fertilizers in agriculture. In integrated systems such as crop-livestock-forest system (ICLF) and crop-livestock system (ICL) with a larger amount of high quality litter, the availability of nitrogen (N) and carbon (C) in the soil for microbes may increase, influencing N_2O emissions. In ICLF system, the contribution of the plant material from *Eucalyptus urograndis* with high cellulose content, which is resistant to decay, should still be considered.

Material and Methods: The experiment was carried out at Embrapa Cerrados, Brasília, DF - Brazil from February 2012 to April 2014, following the transition from crop to livestock phase, which began in March 2012, with the planting of *B. brizantha* (cv. Piatã) intercropped with sorghum and then continued with *B. brizantha* until April 2014. The experimental design was a randomized block with three replicates. The treatments were: Sorghum intercropped with *B. brizantha* cultivated between rows of *Eucalyptus urograndis*, spaced 2 x 2 m between tree lines and 22 m between rows – ICLF; sorghum intercropped with *B. brizantha* grown without the presence of *E. urograndis*– ICL; native vegetation of Cerrado; pasture of low productivity. Soil samples for quantifying microbial biomass carbon (MBC) were collected in February 2012 and 2014 (rainy season) and July 2012 and September 2013 (dry season), at depths 0-10, 10-20 and 20-30 cm. N_2O emissions were evaluated using closed static chambers and gas chromatography .

Results and Conclusions: N_2O emissions were below 20 μg N m^{-2} h^{-1}, with approximately 20% of the data being negative. ICL system had the highest cumulative emission (2.84) kg ha^{-1}, while ICLF system resulted in 2.05 kg N ha^{-1} (Table 1). The native Cerrado showed the lowest balance, approximately zero, (- 0.05 kg N ha^{-1}). In February 2012 and in September 2013 the MBC, in the depth 0-10 cm, for ICLF were significantly lower ($p<0.05$) (234.34 and 238.36 mg C kg^{-1} solo) than ICL (359.5 and 282.1 mg C kg^{-1} solo), respectively. Therefore, higher cumulative N_2O emissions in ICL can be explained through the CBM concentrations. The largest production of plant biomass with more litter, in part due the absence shading caused by Eucalyptus urograndis trees, reflected the higher values of CBM.

Table1: Cumulative N_2O emission from soil in integrated systems (CLS and CLFS), pasture and native vegetation of Cerrado**.**

System	Periods						
	02 a 05/12	05 a 09/12	10/12 a 02/13	02 a 05/13	05 a 09/13	10/13 a 02/14	02 a 04/14
	kg N ha^{-1}						
Cerrado	-0.12 aB	0.02 aA	0.00 aB	0.07 aB	-0.07 aA	0.04 aA	0.01 aA
Pasture				0.02 aB	0.18aA	0.19 aA	0.03 aA
CLS	0.38 bcA	0.03 cA	0.47 bA	0.99 aA	0.35 bcA	0.25 bcA	0.37 bcA
CLFS	0.32 bA	0.02 bA	0.26 bAB	0.84 aA	0.19 bA	0.15 bA	0.27 bA

[1]Means followed by the same small case letters in the row and same capital letters in the column, did not differ from each other by Kruskal-Wallis, test ($p<0.05$).

Practical quantification of greenhouse gas emissions and removals across ICLF systems

Kleberson Worsley Souza

Nitrous oxide emissions and microbial biomass carbon in integrated crop-livestock-forest system in the Brazilian Savanna (Cerrado)

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The effect of stocking density on the carbon stock with silvopastoril systems in the northern region of Colombia

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Introduction

There is evidence that proves how livestock production systems can contribute to carbon sequestration by implementation of silvopastoril systems, through its immobilization in the different compartments of the system such as the soil, pastures and the biomass of trees that integrate them, showing its potential to mitigate global warming acting as carbon sinks (Fisher et al. 2004). One of the most important variables that define the management of silvopastoril systems is the stocking density. The goal of the present study was to evaluate the effect of two stocking densities (high and low) in the capture of carbon in the different compartments of silvopastoril systems.

Material and Methods

The experiment was conducted in the municipality of San Sebastián de Buena Vista (Province of Magdalena), northern region of Colombia, (9° 22' N y 74°15 O, 150 masl) in the dry tropical forest ecosystem (DTFs), with a rainy precipitation of 1511 mm/year. Treatments included a silvopastoril system of *Eucaliptus tereticornis* + *Megathyrsis maximus* in 6 hectares (Ha), that was divided in two pens and handled with two stocking densities, high (3.5) and low (2.5 animal units (AU)/Ha). 1 AU= 450 Kg live weight; in a rotational grazing system with an occupation period of 6 d and a rest period of 30 d. Soil samples were taken for density and carbon content measurements with depths of 0-20, 20-40 y 40-60 cm. Pastures were sampled in their aerial and radical parts, as well as Eucalyptus trees.

Results and Conclusions

Table 1 shows data of the carbon stored in soil, pasture, and in the trees compartments (in the aerial and radical parts). There was an effect of the stocking density in the immobilization of carbon in the aerial part of the *Megathyrsus maximus* pasture, and in the total carbon stored in the silvopastoril system managed with a low stocking density (2,5 AU/Ha. On the other hand, the total carbon stored in the different compartments of the silvopastoril system with a high stocking density is lower.

Table 1. Effect of the stocking densities (high and low) on the carbon stock in the total and different compartments of silvipastoril systems with of *Eucaliptus tereticornis* + *Megathyrsis maximus.*

Treatment (Stocking ensity)	Soil (Ton/Ha)	Aerial (Pasture) (Ton/Ha)	Roots (Pasture) (Ton/Ha)	Trees (Ton/Ha)	Total CO_2 (Ton/Ha)
Low(2.5 AU/Ha)	68,08 a	2,3 a	0,50 a	81,07 a	151,95 a
High (3.5 AU/Ha)	65,98 a	1,6 b	0,46 a	78,71 a	146,75 b

Different letters within columns indicate difference according to Tukey test (P<0.5).

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Acknowledgements

The authors would like to thank Colciencias for funding this project (Contract number 662-2011).

Practical quantification of greenhouse gas emissions and removals across ICLF systems

Luis Alfonso Giraldo Valderrama

The effect of stocking density on the carbon stock with silvopastoril systems in the northern region of Colombia

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Mitigation of greenhouse gases with integrated crop-livestock system in Cerrado biome

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Introduction

The crop-livestock systems (CLS) have been used successfully in several regions of Brazil, standing out for higher productivity and lower environmental impact. It is expected that these systems also contribute to mitigation of greenhouse gas emissions (GHG).

Material and Methods

The soil management experiment was implemented in 1995 in Dourados, MS, Brazil (22º16'56.08"S and 54°48'17.17"W) with the following systems: NTS – no-tillage with sucession soybean (*Glycine max* (L.) Merr.)/oats (*Avena strigosa* Schreb. or *Avena sativa* L.); ICLS – integrated crop-livestock with soybean/oat and pasture under no-till, rotating every two years, and PP – permanent pasture constituted by *B. decumbens*. Soil carbon was sampled every two or three years, and soil GHG monitored for two years (mar/2012 to mar/2014) with static chambers, being estimated the global warming potential (GWP).

Results and Conclusions

The rate of soil carbon accumulation increased with permanence of grass forages, and decreased with soil disturbance (NTS<ICLS<PP). Nitrous oxide (N_2O) and methane (CH_4) accounted for the smallest portion for GWP, while enteric CH_4 represent the greatest portion of it (Table 1). Grain and meat production in integrated systems reduced in 20% the GWP compared to equivalent production in simple systems. In addition, the ICLS has a higher meat production per area (Salton et al., 2014), which leads to a lower emission rate per product.

Table 1. Soil C accumulation rate in 0-30 cm, soil N_2O and CH_4 emission, enteric CH_4, production costs in C equivalent, and GWP, estimated per hectare with crop or meat.

	Soil C accumulation rate	N_2O	CH_4	Enteric CH_4	C equivalent costs	GWP[1]
	kg $C_{equivalente}$ ha^{-1} $year^{-1}$					
ICLS (1 ha crop + 1 ha livestock)	511.2	20.1	2.3	626.1	68.4	205.8
NTS + PP	426.2	13.8	19.3	575.0	68.2	250.1
NTS (1 ha crop)	36.4	10.9	-13.1		65.2	26.6
PP (1 ha livestock)	389.9	2.9	32.4	575.0	3.0	223.4

[1] GWP= Soil C accumulation rate – N_2O – CH_4 – CH_4 enteric – C equivalent costs.

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Acknowledgements

To Rede de Fomento iLPF, Embrapa, CNPq and Fundect for financial support. To all research scientists, technicians and field workers at the Embrapa Western Agriculture who conducted the experiment over time.

Fluxes of N_2O in pasture of *Urochloa* spp. under integrated crop-livestock management

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Introduction Nitrous oxide (N_2O) is an important greenhouse gas. Despite its low concentration in the atmosphere, this gas stands out due to its long time of permanence in the atmosphere and to its high global warming potential. Fourty three percent of the direct emissions of N_2O from agricultural soils originate due to animals in grassland (MCTI, 2013). The objective of this study was to evaluate soil N_2O fluxes in a bracharia (*Urochloa* spp.) pasture in an integrated crop-livestock system (iCL) and identify the physical and chemical soil attributes that influence the fluxes.

Material and Methods The study was conducted at Fazenda Capivara of Embrapa Rice and Beans, located within the municipal limits of Santo Antônio de Goiás, GO, Brazil. The investigated integrated crop-livestock (iCL) system was consolidated in 2000. The study was carried out between Feb and Sep 2013 when *Urochloa* spp. was in the field. The studied area occupied 10,000.00 m^{-2} within a 7.5 ha field. The area was used to create beef cattle (Nelore "BRGN"). Synthetic nitrogen was applied twice, 45 kg N ha^{-1} during the rainy season (Feb – Apr) and another 100 kg N ha^{-1} during the dry season (May - Sep). Nitrous oxide was sampled using 25 closed static chambers in the pasture and 5 in the reference area (native forest fragment). Sampling was done between 9:00-11:00 in the morning, being the sampling times 0, 15 and 30 minutes. The N_2O concentration was determined by gas chromatography.

Results and Conclusions The N_2O the fluxes in the pasture varied from -21.10 µg N-N_2O m^{-2} h^{-1} (EP ± 3.01) to 1045.22 µg N-N_2O m^{-2} h^{-1} (EP ± 155.61) and were higher when compared to the soil under native vegetation, what varied from -30.08 µg N-N_2O m^{-2} h^{-1} (EP ± 8.42) to 55.01 µg N-N_2O m^{-2} h^{-1} (EP ± 27,39). Under pasture and native vegetation the daily average fluxes were of 50.83 µg N-N_2O m^{-2} h^{-1} (EP ± 31.06) and -8.82 µg N-N_2O m^{-2} h^{-1} (EP ± 2.17), respectively. The N_2O fluxes under pasture showed significant positive correlation with the water filled pore space (WFPS) of the soil in the rainy season, and with the soil ammonium (NH_4^+) and nitrate (NO_3^-) levels in the dry season. It is reported in the literature that higher N_2O fluxes occur when the WFPS is above 60%, that was also observed in this study in the rainy season. In the dry season, larger magnitudes of N_2O fluxes were favored by the occurrences of rains after dry periods, as also reported by Lessa et al. (2014). The positive correlations observed between N_2O fluxes and both soil NH_4^+ and NO_3^- suggest that both processes, nitrification and denitrification contribute to the formation of N_2O and occur parallel in the soil.

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Soil N_2O emissions under maize-forage intercropping systems in the Cerrado

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Introduction Brazilian agricultural and livestock sector was responsible, in 2012 for 94% of N_2O emissions, mainly from agricultural soils (MCTI, 2014). This is caused mainly because of nitrogen (N) added as N fertilizer, low N recovery efficiency by cash crops and N recycling from crop residues (Robertson and Vitousek, 2009). Therefore, the objective of this study was to evaluate the effect of intercropping maize with tropical forages on the cumulative N_2O emissions from a typical dystrophic Red Yellow Latosol in the Central West region of Brazil.

Material and Methods The study was conducted at the Experimental Farm, University of Brasilia, Brazil (latitude 15° 55' S, longitude 47° 51' W; 1080 m). The experimental plots were established in October 2007 as a randomized complete block design with three replications. The no-tillage treatments consisted of: maize monoculture; maize intercropped with *Panicum maximum* cv. Aruana; and maize intercropped with *Brachiaria humidicola*. N-fertilizer was applied on 01/11/2012 (50 kg N ha^{-1}), 02/02/2012 (50 kg N ha^{-1}) and 12/14/2012 (30 kg N ha^{-1}). N_2O emissions were evaluated during a period of 360 days (22nd of Dec, 2011 to 23rd of Dec, 2012) using closed static chambers. Cumulative N_2O emissions were calculated by linear interpolation between adjacent sampling dates using Sigma Plot software.

Results and Conclusions Maize/*P. maximum* had higher cumulative N_2O emissions (1,4 kg N ha^{-1}) compared to maize monoculture (0,9 kg N ha^{-1}), even though all treatments received the same amount of N-fertilizer. Therefore, results show that the effectiveness in mitigating N_2O emissions will depend on input and quality of residues (such as C:N and decomposition rate) and on magnitude of increases in CO_2 uptake by the cover crop and of carbon stored in the soil (Abdalla et al., 2013).

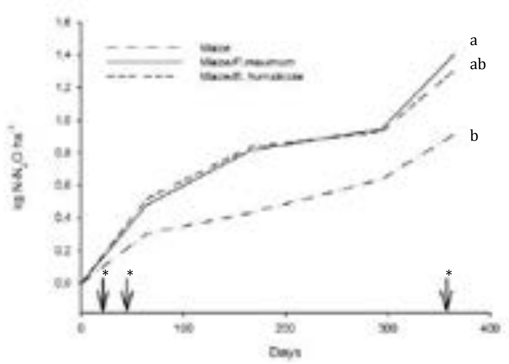

Fig. 1. Cumulative soil N_2O emissions under maize monoculture, intercropped with *P maximum* cv. Aruana and with *B. humidicola.* *Days of N-fertilizer application.

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To FAP-DF and Embrapa Cerrados

Soil NO_x, N_2O and CO_2 emissions in maize-cover crops with potential use for crop-livestock integrated systems in the Cerrado region

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Introduction The Management and quality of crop residues in tillage and no-tillage systems, the use of N-fixing species and the application of nitrogen (N) fertilizers are practices that might influence greenhouse gases (GHGs) fluxes from soil. Nitric oxide (NO) is a component of photochemical smog and it participates in tropospheric photochemical reactions that produce ozone in the troposphere. Nitrous oxide (N_2O) and carbon dioxide (CO_2) are greenhouse gases (GHGs) in the troposphere. NO_x and N_2O are formed through the microbial process of nitrification and denitrification. The emission of CO_2 from soil occurs as a consequence of the respiration of microorganisms and roots. The production and emission of NO_x, N_2O and CO_2 from soil are result of the mineralization of organic matter and depend on environmental factors, such as inorganic N availability, temperature, soil moisture and land use. The interactions between cover plants for crop livestock integrated systems and GHGs fluxes in the Cerrado region are still unclear.

Material and Methods The NO_x, N_2O, and CO_2 fluxes were evaluated in plots cultivated with *Crotalaria juncea* L., *Mucuna pruriens* (L.) DC, and natural fallow under conventional and no-tillage systems in an experiment conducted at Embrapa Cerrados, Planaltina, Federal District (S 15º36'37,5 "and W 47º44'36,8"), Brazil. NO-N and CO_2–C were measured using dynamic chamber technique and N_2O-N fluxes were measured with static chambers. NO was analyzed using a NOx Box (Scintrex LMA-3), after first converting NO to NO_2 by passing the gas sample through CrO_3. CO_2 was analyzed using a photosynthesis system with integrated infrared gas analyzer and data system (LiCor 6200). Four gas samples (N_2O) were collected from the headspace of chamber using 60mL polypropylene syringes with siliconized polypropylene plungers at intervals of 10 min. The samples were analyzed with a gas chromatograph fitted with a ^{63}Ni electron capture detector.

Results and Conclusions Plots with legumes showed higher annual emissions of N gases than the natural fallow under no-tillage system ($p < 0.05$). Plots with legumes under no-tillage system showed higher annual emissions of CO_2 from soil to the atmosphere ($p < 0.05$). However, even though the use of legumes in no-tillage system showed positive annual emissions of GHGs in the conditions of this study, it also promoted the accumulation of carbon in the soil and increased the productivity of maize (Carvalho et al., 20108; 2014). Therefore, its use as crop livestock integrated systems may be favorable for the mitigation of GHGs.

Table 3. Annual emissions of GHGs from soil under cover plants in conventional and no-tillage systems (Planaltina, Brazil).

Cover plants	C-CO_2 ($Mg.ha^{-1}$)		N-(NO + N_2O) ($kg.ha^{-1}$)	
	Conventional	No-tillage	Conventional	No-tillage
Crotalaria juncea	18.8 (a)	20.1 (a)	0.9 (a)	0.7 (a)
Mucuna pruriens	18.5 (a)	24.2 (a)	0.9 (a)	1.0 (a)
Natural fallow	14.7 (b)	16.3 (b)	0.5 (b)	0.9 (a)

Means in the same column followed by the same letter are not significantly different at $P < 0.05$ according to Wilcoxon `s test.

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Methane emission by grazing steers under integrated crop–livestock system

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Introduction

Major global issues are occurring due to negative impacts caused by human actions that violate the carrying capacity of grasslands environments. Several studies show that the integrated systems such as crop-livestock besides intensifying land use and diversify production have the potential to contribute to reducing emissions of greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), per unit of agricultural product. The objective in this study was to evaluate how strategies for grazing management targets can influence animal production and methane emission in areas on Integrated Crop-Livestock Systems (ICLS).

Material and Methods

The experiment was conducted in a long term protocol in an area belonging to Espinilho Farm, at southern Brazil. The ICLS model was based on soybean (*Glycine max*) as summer crop in rotation with cool season pasture-common oats (*Avena strigosa*) plus annual ryegrass (*Lolium multiflorum*). The grazing phase was continuosly stocked with Angus x Hereford steers with 4 treatments based on sward height (10, 20, 30 and 40 cm). Daily CH_4 emission was measured using the SF_6 tracer technique reported by Johnson et al. (1994). The air sampling system used stainless steel cylinders (0.5 L volume) as sample collection device with sample flow regulated by a brass ball-bearing (Gere and Gratton, 2010). CH_4 emissions were assessed twice in 2013 and three times in 2014 on 36 animals.

Results and Conclusions

In ICLS, steers continuously stocked on moderate/low grazing intensity (treatments 20,30 and 40 cm of target) shown better live weight (LW) gain per individual as well as high CH_4 emission per individuals. The values of daily methane emission was 183,02 ± 49,52. CH_4 emission efficiency was better on treatment 20 cm of sward height when CH_4 emissions per kg of LW gain was minimized (0.159 kg CH_4 / kg LW gain). The results shown a strong relationship between the data of evaluation and the mean emission of CH_4 pointing out other explaining factor as forage digestibility and inter-individual variations. Integrated crop-livestock systems (ICLS) with steers continuously stocked on black oat/Italian ryegrass pastures with moderate grazing intensity maximized LW gain and optimized CH_4 emission efficiency.

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Acknowledgements

"The research leading to these results has been conducted as part of the AnimalChange project which received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under the grant agreement nº 266018". This work is also a part of the 'Pecus Network' http://www.agropediabrasilis.cnptia.embrapa.br/web/pecus.

William de Souza Filho
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Spatial variability of soil fertility in an integrated crop livestock forest system

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Introduction The knowledge of spatial variability soil properties is useful in the rational use of inputs, as in the site specific application of lime and fertilizer. The objective of this research was to evaluate the changes and the spatial variability of soil fertility parameters in an integrated crop-livestock-forest system (ICLFS).

Material and Methods The 6-ha field experiment was carried out at Embrapa Cattle Southeast in São Carlos, SP, Brazil (21°57'S, 47°50'W, 860 m alt) during the growing season of 2013/2014. The ICLFS is planted with *Eucalyptus urograndis* (GG100) planted in single rows with 15m-distance and 2m between plants. Pasture is *Urochloa brizantha* cv. Piatã. Annually 1/3 of area is renewed with the corn sown together with the Piatã grass. Soil fertility parameters (P, K^+, cation exchange capacity – CEC, basis saturation-V% and soil organic matter - SOM) were evaluated at 1.5; 3.0; and 7.5m distance from the trees and 0-20 cm depth, before and after annual crop corn growth.

Results and Conclusions

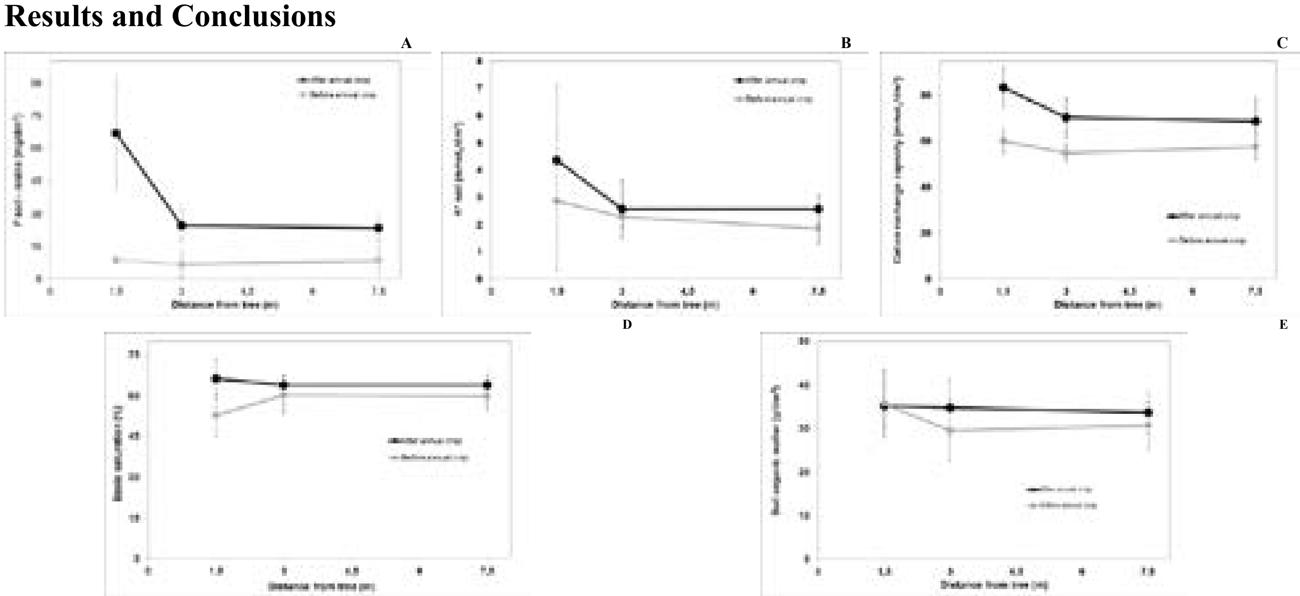

Figure1. P (A), K^+ (B), CEC (C), V% (D) and SOM (E) in an ICLFS, as a function of distance form trees and after and before the growth of annual crop (corn). São Carlos, SP, Brazil- 2013/2014 growing season.

Soil P; K^+ and CEC values increased with liming and fertilization applied to the annual crop at the renewing of the pasture. There are no differences V% and SOM values. As close as the trees (1.5m) there were higher values of P, K and CEC comparing to the further point (7,5m). These differences probably were due the lower biomass production of corn and pasture plants close to trees, which received nutrients, however they did not absorbed it. Results showed the accumulation of nutrients close to the trees, leading a spatial variability in the system. Liming and fertilization practices of the next season should consider these differences, instead of uniform application of lime and fertilizers.

Acknowledgements
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Alberto Carlos de Campos Bernardi

Spatial variability of soil fertility in an integrated crop livestock forest system

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Soil P, K, and Al contents in a Crop-Livestock-Forest integration system in Mato Grosso State

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Introduction

The implementation and development of the crop-livestock-forest integration system (CLFi) may change the distribution of the levels of nutrients in the physical and biological parameters of the soil. The objective of this study was to evaluate the soil P, K, and Al contents in a CLFi system established in Nova Canaã do Norte-MT, Brazil.

Material and Methods

The experimental area of CLFi was established in 2009, consisting of nine 5-ha paddocks. For the evaluations in this study, the species Teca (*Tectona grandis* L. f.) and Pau-de-balsa (*Ochroma pyramidale* (Cav. ex Lam.) Urb.) were used in a triple spacing (3 × 3 × 20 m) arrangement with four replicates, and the P, K, and Al contents were determined in May 2013. The samples for the chemical analyses were collected from the top 0-20 cm layer of the soil at points located 10, 6, and 3 m from the forest from both sides, plus one point in the understory in between the forests, totaling seven samples, whose analyses were conducted at the Soil Laboratory of Universidade Federal de Mato Grosso, Sinop, according to the methodology of Silva (2009).

Results and Conclusions

Table 1. Mean values of soil P, K, and Al contents in a CLFi system.

Species	P	K	Al
	mg dm^{-3}		cmol$_c$ dm^{-3}
Teca	3.06	41.1	0.1
Pau-de-balsa	3.17	30.9	0.2
CV %	108.25	81.50	167.19
Distance			
10 L	2.31	38.2	0.1
6 L	3.53	36.2	0.1
3 L	4.50	46.3	0.1
0	0.96	41.5	0.2
3 R	4.36	17.5	0.1
6 R	3.64	37.3	0.1
10 R	2.49	34.9	0.1
CV %	120.30	54.82	90.16
Mean	3.11	36	0.13

In conclusion, for P, K, and Al, no difference was found between Teca and Pau-de-balsa species with the distance treatments.

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Angélica da Silva

Soil P, K and Al contents in a crop-forest integration system in Mato Grosso state

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Organic matter in forest arrangements within the Crop-Livestock-Forest Integration System in Mato Grosso State.

Angélica da SILVA[1]*, Anderson LANGE[2], Flávio J. WRUCK[3], Kamile ZOMPERO[4], Cassiano CAVALLI[4], Edilson CAVALLI[5], Antônio C. BUCHELT[6].
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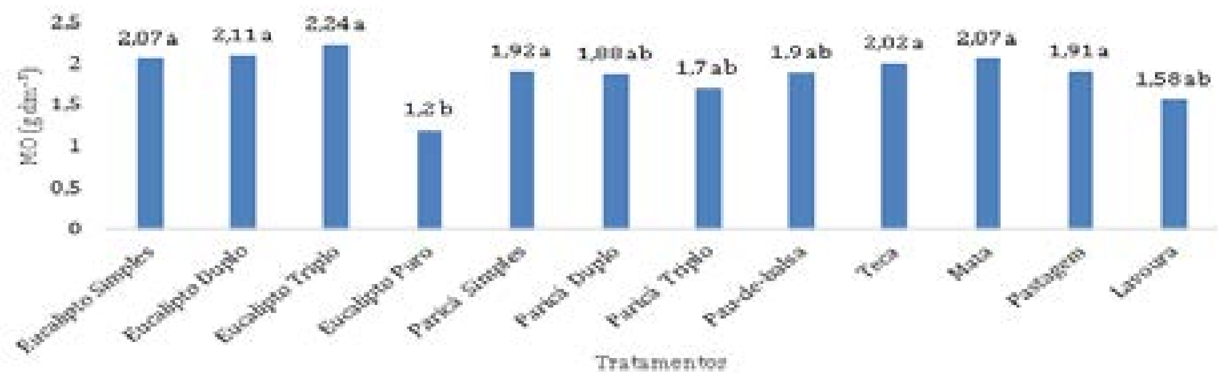
Introduction The crop-livestock-forest integration (CLFi) system is a sustainable production strategy that integrates agricultural, livestock, and forestry activities, conducted in the same area, in an intercropped cultivation in succession or rotation (Balbino et al., 2011). In Mato Grosso State, the main objectives of this integration are the shading provided to the animals, the improvement in the pastures' fertility, and the availability of wood for use at the property.

Material and Methods

The study is being developed on Gamada Farm, located in Nova Canaã do Norte - MT, Brazil, in an experimental crop-livestock-forest integration (CLFi) area. Soil samples were collected from the treatments transversally to the rows of the forest species. The samples for the chemical analyses were collected from the top 0-20 cm layer. Analyses took place at the Soils Laboratory of the Federal University of Mato Grosso, Sinop Campus - MT, according to the methodology of Embrapa (2009).

Results and Conclusions

Fig 1. Soil organic matter values for different forest arrangements in a CLFi system. Means followed by the same letter do not differ statistically at 5% probability, according to the Scott-Knott test.



The highest organic matter contents were found in the single, double, and triple eucalyptus and forest, which did not have a close relationship with the accumulation of plant litter, which was greater in the balsa tree. The plant litter material has different origins; thus, the decomposition time is different. The lowest organic matter contents were observed in the pure eucalyptus, resulting from the absence of animals in the area, and also from the lower level of fertilization compared with the areas in which the crop activity was practiced.

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Acknowledgments

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Angélica da Silva

Organic matter in forest arrangements within the crop-livestock-forest integration system in Mato Grosso state.

APG4

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Sward structural characteristics of Marandu palisadegrass in silvopastoral and full sun systems

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Introduction

Tropical grasses are generally more efficient and adapted to grow under full sun. So, the evaluation of systems that provides some shade as silvopastoral became a necessity. The objective was to evaluate structural characteristics of Marandu palisadegrass *(Brachiaria brizantha* cv. Marandu) in silvopastoral and full sun systems, through seasons, under intermittent harvest.

Material and Methods

The experiment was carried out at Embrapa Agrosilvopastoral, from November 2013 to November 2014. The design was completely randomized with two treatments, silvopastoral (SSP; 30 meters between trees rows) and full sun system (PS), using Marandu palisadegrass (*Brachiaria brizantha* cv. Marandu) and eucalyptus (*E. urograndis* H13). The experimental units has 64 m^2 and four replications (in each face: north and south) in the SSP and plots of 25 m^2 with four replications in PS. Harvest was done to simulated intermittent defoliation, where every 28 or 42 days during rainy or dry season, respectively, with a 12 cm stubble height. Five seasons were considered: late spring, summer, autumn, winter and early spring. To characterize changes in the sward structure we measured: height (with ruler and transparency); and light interception (LI), leaf area index (LAI) and foliage angle (ANG), with the canopy analyzer LI-COR LAI model – 2200. These measurements were done immediately after harvest, every week and immediately before harvest.

Results and Conclusions

There was no system effect (P = 0.23, 0.96, 0.71 and 0.86, respectively), or the interaction season x system x (P = 0.26, 0.06, 0.16, 0.95, respectively) on pre-harvest height, IAF, LI and ANG. The height, LAI and LI did differs over the seasons (P<0.001). Higher height was registered in summer (23 cm) and lowest in winter (15.5 cm). Similar answer were measured for LAI and LI, where highest values were measured in summer and lower in winter. Pre-harvest IL was 94.8% in summer and 64.5% in winter. For that reason, LAI was 3.98 and 1.35 in summer and winter, respectively. In the post-harvested, LAI did not differ for system (P=0.79) or interaction (P = 0.82). Although, the average values of LAI modify in function of the season (P<0.0001), from 2.1 in summer to 0.98 in winter. LI differ between season (P<0.0001), with higher value in the summer (75.3%) and lowest in winter (51.2%). ANG differ only between season (P=0.005), where higher values were registered in winter (59) and lower values recorded in autumn and summer (47 and 49, respectively). The stubble height of 11.3 cm on average, for both systems. Changes in the structural canopy characteristics of Marandu palisadegrass indicates that shading provided by Eucalyptus trees begins to interfere and cause morphological and physiological changes. It can reduce forage production in consecutive years in silvopastoral system.

Acknowledgements

Thanks are due to FAPEMAT, CAPES/FAPEMAT, CNPq and Embrapa Agrosilvopastoral to the financial support of this research.

Availability of phosphorus in soil after six years of fertilization with poultry litter and swine manure under crop-livestock integration system

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Introduction

Organic fertilizers derived from poultry litter and swine manure are alternatives which can increase of availability of phosphorus in soil in crop-livestock integration (CLI) systems. This study aimed to determine the availability of phosphorus in soil after six years of fertilization with different doses of poultry litter, swine manure and mineral fertilizers based in crops present on CLI system.

Material and Methods

Experimental design was a randomized complete block, in the 4x3+1 factorial, with four replications. The treatments consisted of four increasing doses (0, 100, 200 and 300 kg ha^{-1} N) in interaction with four types of fertilizers, two of them were organic (poultry litter and swine slurry) and two balanced minerals with the same amounts of N, P and K as the organic ones, M1 related to swine manure and M2 with poultry litter.

Results and Conclusions

Table 1. Avalability of phophorus in soil (g dm^{-3}) by reason increase doses organic and mineral fertilizers under crop-livestock integration (CLI) systems.

Doses (kg ha^{-1})	0	100	200	300	Regression
Fertilizer			P 0-5 cm		
Poultry Litter	64,3	101,0 a	124,0 a	140,0 a	70,33 + 0,25** x R^2 = 0,97
Swine Manure	64,3	59,4 b	72,5 b	85,1 b	$\bar{m}$ = 70,3
M1	64,3	52,3 b	60,8 b	63,4 b	$\bar{m}$ = 60,2
M2	64,3	69,8 b	85,6 b	133,0 a	54,99 + 0,22** x R^2 = 0,84
			P 5-10 cm		
Poultry Litter	61,3	76,9 a	108,0	111,0 a	62,33 + 0,18** x R^2 = 0,92
Swine Manure	61,3	58,6 ab	89,4	79,4 b	59,39 + 0,08* x R^2 = 0,56
M1	61,3	44,6 b	99,4	49,4 c	$\bar{m}$ = 63,7
M2	61,3	45,0 b	85,0	112,0 a	57,78 - 0,13* + 0,001* x^2 R^2 = 0,91
			P 10-20 cm		
Poultry Litter	48,1	55,0	54,4 b	49,1 b	$\bar{m}$ = 51,6
Swine Manure	48,1	61,9	72,5 a	50,9 b	46,67 + 0,28** - 0,0009** x^2 R^2 = 0,89
M1	48,1	41,3	51,1 b	56,0 b	$\bar{m}$ = 49,1
M2	48,1	52,0	32,9 c	108,0 a	54,01 - 0,38* + 0,002** x^2 R^2 = 0,79
			P 20-40 cm		
Poultry Litter	31,6	42,7 b	53,0 a	44,6	30,65 + 0,19** - 0,0005** x^2 R^2 = 0,93
Swine Manure	31,6	41,0 b	53,6 a	43,8	30,27 + 0,19** - 0,0005** x^2 R^2 = 0,87
M1	31,6	38,7 b	39,1 b	43,1	32,83 + 0,03** x R^2 = 0,89
M2	31,6	60,6 a	35,0 b	39,4	35,78 + 0,18* - 0,00062* x^2 R^2 = 0,30

Means followed by different letters in the same column are different ($P<0.05$) by Student's t-test.

After five years with organic and mineral fertilizer under CLI system observed increase in availability of P in the soil, where the poultry litter and M2 were better on top layers of 0-5 and 5-10 cm, while swine manure had contribution on the 5-10 cm layer, and all fertilizers allow the P leaching until 20-40 cm layer (Table 1).

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Claudio Eduard Neves Semmelmann

Availability of phosphorus in soil after six years of fertilization with poultry litter and swine manure under crop-livestock integration system

ANH2

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Silvopastoral systems: forage accumulation of Marandu palisadegrass (*Brachiaria brizantha* cv. Marandu) in function of face and distance

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Introduction

The space between rows, height and the direction of arrangement of trees are crucial to obtaining suitable microclimate conditions for the development of tropical forage in silvopastoral systems (SSP). The aim of this study was to evaluate the forage accumulation and morphological composition of Marandu palisadegrass (*Brachiaria brizantha* cv. Marandu) in SSP.

Material and Methods

The experiment was carried out at Embrapa Agrosilvopastoral, from November 2013 to November 2014. The design was completely randomized in a split plot arrangement (plots of 64 m²), with four replications. The two factors were: the face of sun exposure (North and South) and distance from the row of Eucalyptus (3, 6, 10 and 15 m). The experimental units has 64 m^2 and four replications (in each face: north and south) of Marandu palisadegrass (*Brachiaria brizantha* cv. Marandu) pastures with 30 meters space rows of eucalyptus (*E. urograndis* H13). Harvest was done to simulated intermittent defoliation, where every 28 or 42 days, during rainy or dry season, respectively, with a 12 cm stubble height. Five seasons were considered: late spring, summer, autumn, winter and early spring. In each cycle, immediately before harvest, two samples were taken from a rectangular frames (0.5 x 1.0 m) for measuring the forage mass (MF) at each distance of the trees (3, 6, 10 and 15 m).

Results and Conclusions

Face of sun exposure, distance of the row and the interaction face x distance did not affect yearly forage accumulation ($P>0.05$) during the experimental period. On average, forage accumulation was 7350 kg ha^{-1}. Although, forage accumulation was different for season ($P<0.05$) and interaction season x distance ($P<0.05$). In general, forage accumulation was higher in summer and lowest in early spring (3390 kg DM ha^{-1} and 315 kg DM ha^{-1}, respectively). Analyzing the interaction, the lowest forage accumulation were recorded in winter and early spring, in the distance of 3 meters from the eucalyptus row, with 300 and 87 kg DM ha^{-1}, respectively. There is no differences in the others distances trough seasons, on average, 480 and 150 kg DM ha^{-1} were registered in winter and early spring, respectively. On autumn, summer and late spring, forage accumulation were similar in all distances: 2160, 3390 and 1233 kg DM ha^{-1}, respectively. The system was in its third year after planting and Eucalyptus trees were on average 9 meters high, it can be the reason why there is no remarkable effects in forage accumulation in the distances evaluated, despite some shadow were provided. On the other hand, forage accumulation were highly affected by seasons, as in others systems.

Acknowledgements

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Dalton Henrique Pereira
Silvopastoral systems: forage accumulation of marandu palisadegrass (brachiaria brizantha cv. marandu) in function of face and distance
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Herbage accumulation of Marandu palisadegrass (*Brachiaria brizantha* cv. Marandu) in silvopastoral and full sun system

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Introduction

The knowledge of systems that provide shade as silvopastoral systems has been a necessity. As well as forage evaluation to understanding mechanisms that drives the answers in production systems. The objective was to evaluate the accumulation of Marandu palisadegrass (*Brachiaria brizantha* cv. Marandu) in a silvopastoral and full sun system.

Material and Methods

The experiment was carried out at Embrapa Agrosilvopastoral, from November 2013 to November 2014. The design was completely randomized with two treatments, silvopastoral (SSP; 30 meters between trees rows) and full sun system (PS), using Marandu palisadegrass (*Brachiaria brizantha* cv. Marandu) and eucalyptus (*E. urograndis* H13). The experimental units has 64 m^2 and four replications (in each face: north and south) in the SSP and plots of 25 m^2 with four replications in PS. Harvest was done to simulated intermittent defoliation, where every 28 or 42 days during rainy or dry season, respectively, with a 12 cm stubble height. Five seasons were considered: late spring, summer, autumn, winter and early spring. In each cycle, immediately before harvest, samples were taken from a rectangular frames (0.5 x 1.0 m) for measuring the forage mass (MF). Two samples at each distance of the trees (3, 6, 10 and 15 m) in the SSP and two samples per experimental unit in the PS.

Results and Conclusions

For a year evaluations, the total forage accumulation was similar in both systems ($p = 0.1495$), with 7350 kg DM ha^{-1} in the silvopastoral and 9010 kg DM ha^{-1} for full sun system. Although, forage accumulation (FA) was different when analyzed by season, where $P = 0.0050$ to the interaction season x system. In the PS system, the means of FA were higher in summer and autumn (3420 and 3820 kg DM ha^{-1}, respectively), intermediate productions for all seasons, and lowest in early spring (235 kg DM ha^{-1}). The silvopastoral production system presented a similar pattern of answer, with higher values of FA in summer (3240 kg ha^{-1} MS) and lower in the early spring (115 kg DM ha^{-1}). During the summer, the FA was similar in SSP (3240 kg DM ha^{-1}) and PS (3420 kg DM ha^{-1}). At the beginning of the rainy season (late spring), the FA was higher in the SSP than PS.

Marandu palisadegrass pastures in silvopastoral systems, with rows spaced 30 meters and eucalyptus trees, with 9 meters high, presented total herbage accumulation similar to full sun.

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Fabricio Marquez Resende

Herbage accumulation of marandu palisadegrass (brachiaria brizantha cv. marandu) in silvopastoral and full sun system

AKGX

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Sheep termination evaluation in Massai grass (*P. maximum*) irrigated pastures supplemented with different sunflower cake levels replacing soybeans meal

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Introduction

Brazil's Northeast region accounts 9.7 million heads of sheep, which represents 54% of the national herd (IBGE, 2014). The State of Piauí the fifth place among Brazilian states with 1.3 million head. Although the herd is expanding, it is not enough to meet current demand so Brazil imports lamb meat to supply the needs of the internal market (Rodrigues, 2011). In tropical regions of Brazil nutritional supplementation of animals during off season is very important so that the animals do not lose weight. The sunflower cake is a by-product industry and is inexpensive compared to soybeans and corn. So the aim of this study was to evaluate the growth of sheep kept on pasture supplemented with various levels of this byproduct replacing soybean meal.

Material and Methods

The study was conducted during 90 days in the 2014 off-season in the experimental field of EMBRAPA Mid North in Campo Maior city, Piauí State. We used twenty-four sheep of Santa Inês breed, with five months of age and initial weight of 19.51 kg, kept in irrigated pastures of *Panicum maximum* cv. Massai under rotational stocking. The evaluations included weight gain and the average daily gain (kg/day). The experimental design was completely randomized with four treatments: T1= 100% soybean meal; T2= 8.3% of sunflower cake; T3= 16.5% of sunflower cake and T4 = 21.9% of sunflower cake with six replications, represented by animals.

Results and Conclusions

The initial body weight of the animals was 19.51 kg and after 90 days the final weight ranged from 24.12 to 31.00 kg with an average daily gain per animal ranged from 51.22 to 127.77g. Although weight gain occurred in all treatments the weight gain of sheep kept in *Panicum maximum* cv Massai irrigated pasture was inversely proportional to the levels of sunflower cake added in diets with soybean meal evaluated.

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Geraldo Magela Cortes Carvalho

Sheep termination evaluation in massai grass (p. Maximum) irrigated pastures supplemented with different sunflower cake levels replacing soybeans meal

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Bulk Density of *Urochloa brizantha* cv. Piatã in Integrated Crop-Livestock-Forest systems in the Brazilian Cerrado

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Introduction The selection of forage by the animal depends on the distribution of green leaves in the pasture structure. One of the main factors affecting the consumption of forage by grazing animals is the size of the bit, which is the result of the forage volume and density, which is being taken up. This study aimed to evaluate the forage density in different arrangements of Crop-Livestock-Forest Integration systems in the Brazilian Cerrado.

Material and Methods
The experiment was conducted at Embrapa Cerrados-DF (15°36'41.51"S 47°42'08,92"O and 988m) from April/2013 to April/2014. The evaluated grass was *Urochloa brizantha* cv. Piata and the tree species was the *Eucalyptus urograndis* planted on the north-south orientation. The treatments were integrated crop-livestock system with: (a) one year old pasture - ICL1, (b) one year old pasture established under *Eucalyptus urograndis* trees with spacing between alleys of 12m (715 trees.ha^{-1})– ICLF12 and (c) one year old pasture established under *Eucalyptus urograndis* trees with spacing between alleys of 22m (417 trees.ha^{-1})– ICLF22. Three pastures replicates (1.3 ha each), were set in a randomized complete block design. Tukey test ($P<0.05$) was used to compare treatment means. Monthly, ten forage samples were taken in each plot to determine height and dry mass (DM) availability per hectare. The density of the forage (kg DM/ha/cm) was determined by dividing the dry weight of grass (kg DM/ha) by the height of pasture (cm).

Results and Conclusions
The forage density was higher (93kg/ha/cm) in ICL1 without trees, followed by ICLF22 (57kg/ha/cm) and ICLF12 (37kg/ha/cm). The average height of the canopy were 41, 45 and 49cm for ICL1, ICLF22 and ICLF12, respectively. As the proportion of trees, and thus the shading, increased in silvopastoral system, there was a reduction in forage density, 60% and 38% for ICLF12 and ICLF22 systems, respectively, which can harm the animal consumption due to the bit rate. The bits rate estimates the facilities that the animal seize fodder, which together with the time spent by the animal to the grazing process, integrate plant-animal relationships responsible for amount consumed (Trevisan et al., 2004). The animals may have different grazing behavior according to the species of grass and handling adopted, which depends of available forage and its structural features. This is of great importance for the indication of grazing management by height, which the greater heights canopy, in silvopastoral systems, do not indicated greater amount of dry matter forage, but represented the stem elongation.

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Giovana Alcantara Maciel

Bulk density of urochloa brizantha cv. Piatã in integrated crop-livestock-forest systems in the Brazilian Cerrado

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José Ricardo Macedo Pezzopane

Production of corn for silage in integrated crop livestock forest systems

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Production of corn for silage in integrated crop livestock forest systems

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Introduction Integrated crop-livestock-forest systems are strategies to integrate agriculture, livestock and forest in the same area and to achieve a more sustainable livestock production. Corn is one of the most used crops in integrated systems due to its multiple uses on farm, like grain or silage production. This study aimed at evaluating the productivity of corn for silage in two integrated livestock production systems.

Material and Methods The field experiment was carried out in an 12 ha area of integrated crop livestock forest systems at Embrapa Cattle Southeast in São Carlos, SP (21°57'S, 47°50'W, 860 m alt) during the 2013/2014 and 2014/2015 growing seasons. At the integrated crop livestock (ICL) treatment the summer crop corn was snow with the forage *Urochloa brizantha* cv. Piatã. The integrated crop livestock forest (ICLF) system there also the *Eucalyptus urograndis* (Clone GG100) trees planted in single rows (East-West orientation) with 15 m between rows and 2m between plants. Corn was harvested for silage purpose and the productivity was evaluated at both ICL and ICLF systems. At the ICLF, four distance from North eucalyptus rows evaluated: 1.5m (A); 3.75m (B); 7.5m(C) e 11.25m(D) from North row. Light transmission by the trees was also evaluated.

Results and Conclusions

Table1. Productivity of corn for silage in integrated crop livestock (ICL) system and integrated crop livestock forest system (ICLF), evaluated at four distances between the eucalyptus rows (ICLF A to ICLF D), during the 2013/2014 and 2014/2015 growing seasons in São Carlos, SP, Brazil.

Treatment	Growing season 2013/2014			Growing season 2014/2015		
	Dry Matter (10^3Kg ha^{-1})	% of grains	Light Transmission (%)	Dry Matter (10^3Kg ha^{-1})	% of grains	Light Transmission (%)
ICL	8.1 ab	16.2 a	100	12.1 a	28.5 b	100
ICLF A	3.5 d	7.1 b	39.7	6.6 b	28.3 b	44.7
ICLF B	5.3 c	11.5 ab	89.6	10.0 a	34.3 ab	67.9
ICLF C	7.0 ab	17.0 a	86.8	11.6 a	41.4 a	75.5
ICLF D	5.7 bc	14.5 a	72.9	11.1 a	37.4 ab	60.8
CV (%)	12.06	25.26	-	10.27	13.55	-

Different letters mean significant differences, at P<0.05

In the two growing seasons dry matter productivity showed differences (P <0.05) according to the positions of the corn rows in relation to eucalyptus rows, with higher yields in the corn rows more distant from eucalyptus rows and in the ICL system. In 2013/2014, under severe drought, these differences were higher, despite the higher light transmission, indicating strong competition for water. The average dry matter productivity in the floor area between eucalyptus rows was 5,380 kg ha^{-1}, corresponding to 66% of production in ICL. In 2014/2015, with satisfactory water supply , despite the low light transmission, differences between production systems were lower (ICLF productivity corresponded to 81% of the ICL system). In this season, % of grains in the samples was higher in the ICLF system.

Acknowledgements
To Embrapa and CNPq for financial support.

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Forage production intercropped with corn for silage in integrated crop livestock forest systems

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Introduction Integrated crop livestock forest systems are strategies to integrate agriculture, livestock and forest in a same area, to achieve a more sustainable livestock production. In these systems, pasture sowing can be made simultaneously with annual crops sowing, such as corn. This study aimed evaluating the forage productivity of *Urochloa brizantha* cv. Piatã, implemented with corn for silage in two integrated livestock production systems.

Material and Methods We evaluated the forage productivity of *U. brizantha* cv. Piatã intercropped with corn for silage, simultaneously sowed in integrated production systems. The field experiment was carried out in an area of integrated crop livestock forest system at Embrapa Cattle Southeast in São Carlos, SP (21°57'S, 47°50'W, 860 m alt) during the growing season of 2013/2014. Sixty days after corn harvest were evaluated forage productivity and forage quality. The treatments included integrated crop livestock (ICL) system and integrated crop livestock forest (ICLF) system with *Eucalyptus urograndis* (Clone GG100) planted in single rows (East-West orientation) with a distance of 15 m between rows and 2m between plants. In the ICLF were evaluated four points between the eucalyptus rows (0m-A; 3.75m-B; 7.5m-C e 11.25m-D from North row). Light transmission by the trees was evaluated.

Results and Conclusions

Table1. Forage productivity and quality of *U. brizantha* cv. Piatã in integrated crop livestock (ICL) system and integrated crop livestock forest system, evaluated at four points between the eucalyptus rows (ICLF A to ICLF D), during the 2013/2014 growing season in São Carlos, SP, Brazil.

Treatment	Plant Heigth (cm)	Forage Dry matter (Kg ha^{-1})	Foliage dry matter (Kg ha^{-1})	Crude Protein (%)	In vitro Dry Matter Digestibility (%)	Light Transmission (%)
ICL	62.9 b	3058.7 ab	1894.0 a	9.1 b	66.1 ab	100
ICLF A	64.8 b	2226.2 b	1131.9 b	11.1 ab	60.7 b	35.1
ICLF B	73.2 ab	2522.1 ab	1377.6 ab	12.6 ab	65.1 ab	35.3
ICLF C	90.7 a	3707.1 a	1897.2 a	14.0 a	66.7 a	65.1
ICLF D	85.9 a	3353.2 ab	1690.0 ab	13.1 a	65.7 ab	79.4
CV(%)	13.8	24.3	21.7	14.9	4.6	-

Different letters mean significant differences, at P<0.10

There are no significant differences in ICL forage production in comparison with the different points of ICLF system (P<0.10), despite the effect of trees on light transmission in ICLF system. The average forage productivity in ICLF was 2,952 kg DM ha^{-1}, corresponding to 97% of productivity at ICL. Significant differences was found among the points of ICLF for forage productivity and foliage dry matter with higher yields in the farthest point from eucalyptus row (ICLF C), such as the higher plant height and higher values of crude protein and in vitro dry matter digestibility. The average protein content of the ICLF system was 12.7% versus 9.1% in the ICL system.

Acknowledgements
To Embrapa and CNPq for financial support.

Superior banana varieties in a Cacao-Cabruca agroforestry system in South of Bahia

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Introduction

Since the cacao tree is a shade tolerant plant, it is cultivated in association with species which provide it with temporary and permanent shade, being considered one of the most classic agroforestry systems (AFS). The species mostly used for providing temporary shade is banana, which stays in the system for up to three to four years and can also serve as food and provide income in the period preceding the cacao production. The bananas cultivated in the cacao region of Bahia are the traditional ones from the AAB genomic group and are susceptible to main diseases such as Fusarium wilt and Sigatoka leaf spot. The objective of the present work was to evaluate productive performance of three traditional banana varieties and their respective tetraploid hybrids (AAAB) under a Cacao-Cabruca agroforestry system.

Material and Methods

The field experiment was established at the experimental farm at the Mars Center for Cocoa Science, Barro Preto - BA. The experiment was established in an area of cacao crop renovation in a more than 20 year old Cacao-Cabruca System. The experimental design was in random blocks with six treatments and four replicates. The treatments were the banana varieties: Silk, BRS Princesa, Prata Anã, BRS Platina, Pacovan and BRS Pacovan Ken and spacing of 3 m x 3 m. Bunch weight per plant and survival of plants at the end of the first production cycle, were the characteristics evaluated.

Results and Discussion

The bunch weight of the BRS Pacovan Ken and BRS Platina tetraploids was higher in comparison to the traditional varieties of the same subgroup (Fig. 1). BRS Princesa did not differ from Silk for the bunch weight characteristic, but due to its tolerance to Fusarium wilt, it reached the end of the first cycle with 100% of live plants, whereas Silk bananas registered 50% survival. The superior banana varieties had good performance in the Cacao-Cabruca agroforestry system in the South Region of Bahia and can be considered for potential use in AFSs.

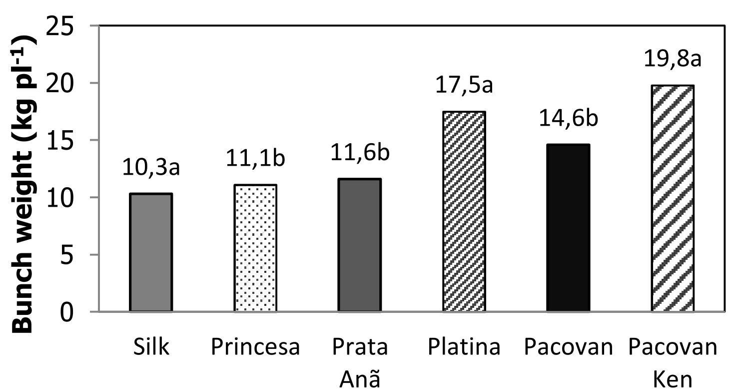

Figure 1. Bunch weight of six banana varieties in the Cacao-Cabruca agroforestry system, Barro Preto, BA. Average of 24 plants per treatment, harvest of first cycle.

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Doses of poultry litter and swine manure for crop-livestock integration system

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Introduction

Organic fertilizers derived from poultry litter and swine manure are alternatives which can increase the efficiency in the soil's nutrient availability in relation to mineral fertilizers in crop-livestock integration (CLI) systems. Thus, this study aimed to determine the response of fertilization with doses of poultry litter, swine manure and mineral fertilizers based on the corn yields through the years of 2011-2013 for .

Material and Methods

Experimental design was a randomized complete block, in the factorial with four replications. The treatments consisted of four increasing doses of N (0, 100, 200 and 300 kg ha^{-1} N) in interaction with four types of fertilizers, two of them were organic (poultry litter and swine slurry) and two balanced minerals with the same amounts of N, P and K as the organic ones, M1 related to swine manure and M2 with poultry litter.

Results and Conclusions

Table 1 - Corn yields (kg ha^{-1}) due to increasing levels of nitrogen with organic and mineral (M) fertilizers in crop livestock integration (CLI) systems in the 2011/2012 and 2012/2013 seasons.

Doses (kg ha^{-1})	0	100	200	300	Regression
			Crop 2011/2012		
Poultry Litter	6.184	8.567 b	8.698 c	11.153 b	$6394 + 15{,}0^{**}x$ $R^2 = 0{,}91$
Swine Manure	6.184	8.410 b	11.753 b	14.629 a	$5942 + 28{,}7^{**}x$ $R^2 = 0{,}99$
M1	6.184	12.666 a	14.925 a	14.118 a	$6242 + 80{,}7^{**}x - 0{,}182^{**}x^2$ $R^2 = 0{,}99$
M2	6.184	11.516 a	14.219 a	15.621 a	$6250 + 60{,}5^{**}x - 0{,}098^{*}x^2$ $R^2 = 0{,}99$
			Crop 2012/2013		
Poultry Litter	3.327	6.485 ab	7.382	7.812	$3416 + 34{,}8^{**} - 0{,}07^{*}\ x^2$ $R^2 = 0{,}99$
Swine Manure	3.327	6.904 a	7.702	8.826	$3482 + 35{,}7^{**} - 0{,}06^{*}\ x^2$ $R^2 = 0{,}97$
M1	3.327	7.940 a	8.859	8.646	$3455 + 53{,}1^{**} - 0{,}120^{**}\ x^2$ $R^2 = 0{,}98$
M2	3.327	5.378 b	8.250	9.065	$3.491 + 20{,}1^{**}\ x$ $R^2 = 0{,}96$
			Corn Yield in the system		
Poultry Litter	9.511	15.051 b	16.079 c	18.964 b	$9830+49^{**}x – 0{,}07^{**}x^2$ $R^2 = 0{,}92$
Swine Manure	9.511	15.313 b	19.455 b	23.454 a	$9587+59^{**}x – 0{,}04^{**}x^2$ $R^2 = 0{,}91$
M1	9.511	20.605 a	23.783 a	22.763 a	$9697+134^{**}x – 0{,}30^{**}x^2$ $R^2 = 0{,}93$
M2	9.511	16.893 b	22.469	24.686 a	$9434+90^{**}x – 0{,}13^{**}x^2$ $R^2 = 0{,}96$

Means followed by different letters in the same column are different ($P<0.05$) by Student's t-test

The positive results of corn yield in both years allowed direct relationship between increasing doses of N with organic and mineral fertilizers and the total production in CLI system (Table 1). Organic fertilizer with poultry litter and swine manure shows the same efficiency as for as mineral fertilizer when N doses fertilizer were adopted.

Acknowledgements

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Implementation of a silvopastoral system with African mahogany in the brazilian semiarid

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Introduction

The silvopastoral systems are intentional combination of trees, pasture and cattle in the same area at the same time and managed in an integrated manner. This research project is a partnership between the Post Graduate Program in Animal Science from the State University of Southwest Bahia (UESB) and the Federal Institute of Education Science and Technology Baiano (IFBAIANO). The main objective is to analyze ecophysiological relationships existing between arboreal and forage components of a silvopastoral system with *Khaya senegalensis*, *Brachiaria brizantha* cv. Marandú and *Stylosanthes spp*. cv. campogrande since its implementation.

Material and Methods

The implementation of silvopastoral system was at the Federal Institute Baiano, campus Itapetinga, region southwest of Bahia, in the basin of river Catolé in February 2015. According to Köppen and Geiger climate classification is Aw. The average temperature is 23,6 °C with a precipitation annually of 857 mm. They were installed 16 permanent plots in a grassland area with *Brachiaria decumbens* invaded by *Sporolobus indicus*. The experimental design was completely randomized (DIC). The treatments were divided into paddocks with 600 m^2 including the (T1): *Brachiaria brizantha* cv. Marandú; (T2): *Brachiaria brizantha* cv. Marandú consortium with *Stylosanthes spp*. cv. campogrande; (T3): *Brachiaria brizantha* cv. Marandú consortium with African Mahogany (*Khaya senegalensis*); (T4): *Brachiaria brizantha* cv. Marandú consortium with *Stylosanthes spp*. cv. campogrande and African Mahogany (*Khaya senegalensis*). The soil preparation consisted of subsoiling up to 40 cm and plowing with leveling harrowing to try to combat *Sporolobus indicus* species. There was a fertilization of plots with superphosphate 600 kg/ha. The forage species were planted in rows spaced 0,50 cm sown manually. The pits were opened with a depth of 40 cm and fertilized with 100 g. of Monoammonium phosphate (MAP). At planting have been used up to 5 liters of hydrogel for seedlings. The spacing used in the planting of the seedlings was 3,0 m x 5,0 m, with a density of 666 plants ha^{-1}.

Results and Conclusions

Preliminary results indicate a survival of 100% to Khaya senegalensis. On the 15th day was the beginning of the emergence of seedlings *Brachiaria brizantha* cv. Marandu and Styloshantes spp. cv. campogrande. Until the present moment was not noticed reinfestation of Sporolobus indicus. The soil had a pH in H_2O, at 0-20 and 20 to 40 cm of 5,8 and 6,1 respectively. Soil texture is sandy clay franc to the layer of 0-20 cm and sandy clay 20-40 cm. Still will be assessed the availability of complete forage, the forage supply and stocking rates, the Leaf Area Index (LAI), green mass (MV), fibrous and non-fibrous carbohydrates, fiber content, photosynthetic rate, stomatal conductance and transpiration rate, CRA, N and P in forage. The forestry component will be evaluated for survival, stem diameter, height and diameter at breast height (DBH). It is expected that the implementation of silvopastoral system recover degraded pasture, triggers an increase in herbage allowance and Wellness animal proving the benefits of the system

Acknowledgements: To Federal Institute of Science Education and Technology Baiano (IFBAIANO) and State University of Southwestern Bahia (UESB).

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Biomass production in different eucalyptus compartments in a crop livestock forest system (CLFS)

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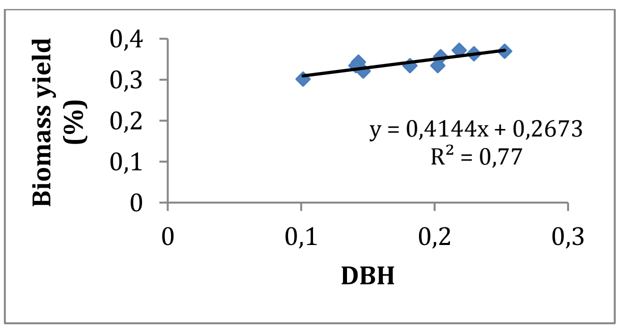
Introduction Forests accumulate biomass through photosynthesis, in preparing photo assimilates. The variation due to environmental factors and factors related to the plant itself, promote a different accumulation in each place where it is measured. When canopies start to compete, stem production increases and leaves and barks gradually decrease. This study had as objective to get the yield in compartmentalized biomass in different diametric classes (diameter at breast height - DBH).

Material and Methods This study was conducted at Boa Vereda farm, Cachoeira Dourada (GO). Experimental field consists on a six year crop livestock forest system, where *Eucalyptus* x *urograndis* is planted in triple rows (3 m x 2 m), spacing 14 m between rows, where *Urochloa decumbens* is cultivated. All trees components (stem, bark, branches and leaves) were weighed and sampled. For branches, bark and leaves, a sample from each tree was taken; for stem three samples were taken, corresponding to 0%, 50% and 100% from commercial height. Fresh weight from wood and bark were separately obtained. All branches were removed from the tree and then were defoliated. All branches and leaves were weighed and sampled. Samples were dried in circulation oven with air exchange at 70ºC. A simple linear regression with a 95% level of significance was performed to evaluate the increase of biomass in each of the eucalyptus according to the DBH.

Results and Conclusion

Fig 1. Biomass yield in Eucalyptus bark (*Eucalyptus x urograndis*) as the increase in DBH.



For bark there was an increase in mass yield with the increase of DBH ($p>0{,}005$) (Fig. 1). It is possible to infer that the increase in bark is due to the fact that by losing water the bark does not detach from the plant, as opposed to leaves and barks that dry and detach from the plant. There was no relationship between the DBH and the increase in mass for leaves, branches and stem ($p<0.005$).

This result can be explained by the fact of being a homogenous stand of *Eucalyptus x urograndis* clones. Therefore, all individuals have the same proportional level of income (dry matter), since the samples were taken within a system of the same age.

Acknowledgements Thanks to Fundação de Amparo à Pesquisa do Estado de Goiás (FAPEG) for sponsoring this study and also thanks to Dr. Abílio Pacheco, the owner of the experimental area, where this study was conducted.

Rosana Alves Gonçalves
Biomass production in different eucalyptus compartments in a crop livestock forest system (CLFS)
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Eucalyptus and digitaria grass Intercropping in the Chapada do Araripe, Pernambuco, Brazil.

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Introduction

The region of Chapada do Araripe, in Brazil, is an important producer of gypsum, having high energy demand for the industrial process. Currently, the main source of energy is the wood from Caatinga vegetation. In order to reduce deforestation and promote the regional gypsum industry, eucalyptus has been indicated as an alternative to generate energy. Eucalyptus integrated systems with adapted forage plant is a strategy to ensure stability and diversify the production systems, increasing the supply of wood for energy and fodder for animal feeding.

Material and Methods

The experimental area was established in 2008 in the Experimental Station of the Instituto Agronômico de Pernambuco-IPA IPA, Araripina-PE. Treatments were three planting spacing of eucalyptus hybrid (*Eucalyptus camaldulensis* x *Eucalyptus grandis*), 6 x 6m; 6 x 12m and 12 x 12m, intercropped with digitaria grass (*Digitaria decumbens* Stent) and two control treatments, sole eucalyptus (3 x 3m) and sole digitaria grass. The evaluation was performed for six years after establishment, measuring plant height (m), diameter breast height (DBH) (cm), survival rate (SR) (%) and wood volume (m^3 ha^{-1}) for eucalyptus and forage mass (kg DM ha^{-1}) for digitaria grass.

Results and Conclusions

Figure 1 presents the overview of eucalyptus x digitaria grass integrated system and Table 1 shows the productive characteristics of eucalyptus and digitaria grass.

Figure 1. Eucalyptus x digitaria grass integrated system in Chapada do Araripe, Pernambuco, six years after establishment.

Table 1. Productive characteristics of eucalyptus cultivated in different spacing and digitaria grass in integrated and isolated systems, six years after establishment in the Chapada do Araripe, Pernambuco.

Treatment	Height (m)	DBH (cm)	Survival (%)	Wood volume (m^3 ha^{-1})	Forage mass (Kg DM ha^{-1})
Sole Eucalyptus (3 x 3m)	12.6	11.3	100	98.1	-
Eucalyptus + Digitaria (6 x 6m)	12.7	17.9	100	62.2	4,241
Eucalyptus + Digitaria (6 x 12m)	13.4	17.8	100	32.5	3,677
Eucalyptus + Digitaria (12 x 12m)	12.9	18.1	100	16.0	3,621
Sole Digitaria	-	-	-	-	3,273

The eucalyptus survival rate was 100% for all studied spacing. Among the integrated systems, 6 x 6 m plant spacing promoted better performance for eucalyptus and digitaria (62.2 m^3 ha^{-1} of wood and 4,241 kg DM ha^{-1} of forage mass). Sole Eucalyptus (isolated) presented more wood volume (98.1 m^3 ha^{-1}) than intercropping systems, while forage mass (of isolated) for sole digitaria was 3,273 kg DM ha^{-1}.

Acknowledgements

To BNB for the financial support and Instituto Agronômico de Pernambuco (IPA) for the partnership in the establishment of this work.

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world congress on integrated crop-livestock-forest systems

Chemical composition of Gliricidia in different regions of the Sergipe State

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Introduction

In Brazil, the use of tropical forage legumes with high protein content have been a viable alternative to reduce costs of diets, however most livestock systems are susceptible to temperature rising and water scarcity, leading to a significant decline in forage production in dry periods (Aroeira *et al*., 2011). Considering that soil and climate are important factors influencing the growth characteristics of forage plants, this study aimed to evaluate the chemical composition of Gliricidia (*Gliricidia sepium*) in three different regions, with different rainfall, of Sergipe State.

Material and Methods

Samples were collected in different areas cultivated with Gliricidia, in three regions of the Sergipe State (Northeastern Brazil), classified according to rainfall, as Coastal zonee (over 1600 mm), Agreste (800-1600 mm) and Semiarid (less than 800 mm). For each of the three sampled locations, 25 branches, of about 50 cm long and 1.0 cm in diameter, with regrowth age of 3 to 4 months werw collected for chemical analysis of dry matter (DM), mineral content (MC), ethereal extract (EE), crude protein (CP), acid detergent fiber (ADF) and neutral detergent fiber (NDF).

Results and Conclusions

Table 1. Chemical composition of gliricídia averaged for dry matter (DM), mineral content (MC), ether extracted fat (EEF), crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF), in Costal zone, Agreste and Semiarid regions of Sergipe State

	DM	MM	EE	CP	NDF	ADF
Coastline	21,92	8,85[a]	5,58	20,92	44,59[ab]	31,51
Agreste	24,05	7,43[b]	6,51	20,7	48,29[a]	30,1
Semiarid	21,51	9,41[a]	5,99	21,43	40,31[b]	28,96
SEM	1,636	0,434	0,72	1,615	1,441	1,985
P*	0,447	0,018	0,613	0,94	0,007	0,674

** Values followed in different lowercase letters in the same column differ significantly at 5% significance. (SEM = standard error of the mean; P = probability)*

There was a significant effect ($P < 0.05$) for MM and NDF, where the value of MM was lower in samples collected in the Agreste region them in samples collected in the regions of the Coastal zone and Semi-arid, with no significant differences between their means, that was attributed to the similarity in soil composition of the areas being both rich in minerals. However, the observed differences in NDF values were assigned to different volumes and water distributions throughout the year, observing intermediate rainfall in a short period in the arid zone, high precipitation in average length of coastline and low rainfall in a short period in the semiarid. These results, supported by Norton & Poppi (1995) allow us to conclude that the chemical composition of gliricídia depends mainly on soil composition and annual water distribution, regardless of where it was located.

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Chemical composition of Gliricidia in different cropping systems

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Introduction

Tropical forage legumes have high crude protein content and dry matter digestibility similar or better than tropical grasses, compared at the same stage of development and cultivation condition, however the operational system can result in changes in its development, affecting its nutritional quality (Leonel *et al*., 2009). Knowing that these legumes with high forage potential can be exploited in different cropping systems, this study aimed to evaluate the chemical composition of gliricídia (*Gliricidia sepium*) under high density cultivation and intercropping system.

Material and Methods

The samples were collected in 30 different areas of gliricídia arrangement, with 15 in intercropping system (consisting of double rows, spaced apart by 1.0 meters, with lanes 5-7 meters between the double rows, intercropped with beans, roots and prickly palm) and 15 in high density system (with plant spacing of 1.0 meters by 1.0 meters for protein bank formation). For each of the 30 locations, 25 branches, about 50 cm long and 1.0 cm in diameter, with regrowth age of 3 to 4 months were sampled for chemical analysis of dry matter (DM), mineral matter (MM), ethereal extract (EE), crude protein (CP), acid detergent fiber (ADF) and neutral detergent fiber (NDF).

Results and Conclusions

Table 1. Chemical composition average gliricídia for dry matter (DM), mineral matter (MM), ether extract (EE), crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF), in dense planting and intercropping systems

	DM	MM	EE	CP	NDF	ADF
Dense planting	22,58	8,48	6,3	21,13	44,62	32,14
Intercropping	22,4	8,64	5,76	20,89	44,18	28,24
SEM	1,259	0,334	0,555	1,243	1,078	1,528
P*	0,922	0,753	0,514	0,896	0,778	0,109

** Values followed in different lowercase letters in the same column differ significantly at 5% significance. (SEM = standard error of the mean; P = probability)*

There was no significant interaction effect between the different types of cultivation (P> 0.05) or for the main effect of each cultivation type (P> 0.05) for any of the variables presented. These results demonstrate that, under the conditions evaluated, there was no change in the composition of the independent gliricídia cultivation system used, concording with the results obtained by Barcellos *et al*. (2008) using legumes intercropped with pasture. Based on these results, we can conclude that Gliricidia can be arranged in dense or mixed systems, with no change in its chemical composition.

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Samuel Figueiredo Souza

Chemical composition of gliricidia in different cropping systems

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Dry matter yields of *Urochloa brizantha* and *Cajanus cajan* intercropping with corn at two cutting heights in irrigated area

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Introduction Species used as green manures, especially legumes, can be used in no-till because they present short term advantages such as nutrient release during decomposition. The corn intercropping system with green manure, specifically pigeonpea (*C. cajan*) or (*C. spectabilis*), was called St. Bridget System (Oliveira, 2010). The objective of this study was evaluated the dry matter yields of *Urochloa* and pigeonpea intercropping with corn at two cutting heights in irrigated area.

Material and Methods
The work is being developed in FEPE belonging to Faculty of Engineering of Unesp - Campus Ilha Solteira, in irrigated area located in Selvíria-MS. The experimental design was in randomized block with six replicates, in a factorial scheme 2 x 2, being two intercropping (MB: *U. brizantha* intercropping with corn and MBG: *U. brizantha and C. cajan* intercropping with corn) and two cutting heights (0.20 and 0.45 m).Were evaluated the dry matter yields of *U. brizantha* and *C. cajan.*

Results and Conclusions

Table 1. Dry matter yields (DMY) of *U. brizantha* and *C. cajan* intercropping with corn in two cutting heights in irrigated area. Selvíria - MS, 2013/2014.

Intercrops**	DMY of *U. brizantha* (kg ha^{-1})	DMY of *C. cajan* (kg ha^{-1})
MB	231.96a	-
MBG	128.81b	-
Cutting heights (m)		
0.20	241.16a	253.33a
0.45	119.61b	177.09b
D.M.S	36.53	67.78
C.V	20.78	17.94

* means followed by the same letters in the columns, do not differ significantly by 5% Tukey test.
** MB (*U. brizantha* intercropping with corn); MBG (*U. brizantha and C. cajan* intercropping with corn).

There were significant differences in the intercrops, with the highest yield in the consortium MB. However, in both intercrops, the dry matter yields of forage was low, this was probably due to the high shading caused by the corn and the *Cajanus cajan*. Regarding the cutting height, the dry matter yields of *U. brizantha* and *Cajanus cajan* was higher when the cut was to 0.20 m from the ground, which is the most interesting option to increase the production of silage.

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Acknowledgements
The FAPESP for granting the scholarship.

Traditional smallholder mixed farming systems
Sanderley Simões Cruz
Dry matter yields of urochloa brizantha and cajanus cajan intercropping with corn at two cutting heights in irrigated area
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Fermentation pattern of sorghum silage intercropped with tropical forages and/or pigeon pea dwarf in Integrated Crop-Livestock Farming System

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Introduction The silage may have amended their nutritional value due to the procedures used in their production and conservation. In this sense, aimed at evaluating the standard fermentative in the sorghum silage intercropped with tropical and/or pigeon pea dwarf process in non-irrigated conditions in Cerrado in the Integrated Crop-Livestock Farming System.

Material and Methods

The study was conduct in the agricultural year 2014/15 in Selvíria, MS. The experimental design was a randomized blocks design with 6 treatments and 4 repetitions: forage sorghum in monocrop; in consortia with *U. brizantha* cv. Marandu; *M. maximum* cv. Mombaça; pigeon pea dwarf; Marandu and pigeon pea dwarf; and Mombaça and pigeon pea dwarf. The forages and the sorghum were sown on the same line (7 lines) and the pigeon pea dwarf between the lines, spaced 0.50 m and 20 m long. The material was harvested mechanically and was chopped into particles averaging 0,025 m at a height of 0.30 m at 124 days after sowing. The material was ensiled in plastic buckets (12 kg) with adapted covers with silicone flanges and bagged sand in the bottom. After opening the silos (30 days), it was collected the material to determinate pH, total dry matter losses (RMS), losses gas (PG) and losses by effluent (PE) using the methodology contained in Jobin et al. (2007).

Results and Conclusions

It can be seen in Table 1 that the pH of the silage are in the fermentation patterns. The sorghum in monocrop had less losses gases and effluents and presented the best DMR.

Table 1. pH Values, losses gases (LG), losses effluent (LE) and dry matter recovery (DMR) of sorghum silage single and consortia on Crop-Livestock Integration system.

Treatment	pH	LG (%)	LE (kg/t MV)	DMR (%)
Sorghum +*U. brizantha*+*C.cajan*	3.69 ab	5.9 a	1.7 a	84.1 a
Sorghum +*U. brizantha*	3.66 b	4.0 b	2.0 a	79.0 a
Sorghum+*M. maximum* +*C.cajan*	3.72 ab	4.4 b	2.1 a	71.8 a
Sorghum +*M. maximum*	3.74 ab	3.8 b	1.9 a	80.4 a
Sorghum+*C. cajan*	3.76 a	4.3 b	2.0 a	85.3 a
Sorghum single	3.68 ab	3.7 b	1.7 a	90.3 a
D.M.S	0.09	1.1	0.5	20.4
C.V %	1.69	17.9	19.6	16.8

References cited

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Acknowledgements
Thanks to FAPESP and CNPq for granting research fellowships to authors.

Eucalypt and native tree species growth in integrated crop-livestock-forest systems (ICLFS) in the Brazilian Cerrado

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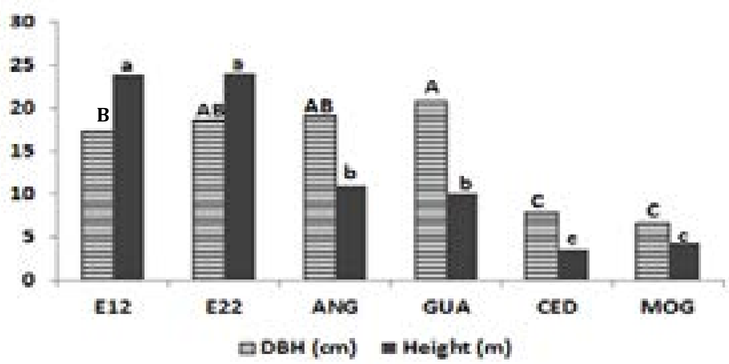
Introduction The ICLFS is part of Federal Government directives in the field of agriculture. For this system to produce satisfactory results are needed phytotechnical and zootechnical knowledge and their interaction. The objective of this study was to verify the growth in height and trunk diameter for eucalyptus and native tree species in integrated crop-livestock-forest systems.

Material and Methods The study was conducted at Embrapa Cerrados Research Center, Brasília, DF, Brazil. The soil was classified as Oxisol. The experiment was established in 2009 in a randomized complete block design with three replicates. The treatments for the eucalypt (*E. urophylla* x *E. grandis* hybrid) were alleys of 2 lines (2 x 2 m between plants) and distance between alleys of 22 m (E22) and 12 m (E12). The native species [*Anadenanthera macrocarpa* (angico), *Swietenia macrophylla* (mogno), *Cedrela fissilis* (cedro), *Schizolobium parahyba* (guapuruvu)] presented alleys of 2 lines (4 x 4 m between plants) and 12 m between alleys. Were determined the diameter of the trunk and height of the plants.

Results and Conclusions

Fig.1. Growth in diameter at breast height (DBH) and height of eucalypt (E12, E22) and natives trees *Anadenanthera macrocarpa* (ANG), *Schizolobium parahyba* (GUA), *Cedrela fissilis* (CED), *Swietenia macrophylla* (MOG) 66 months after planting for eucalypt and native trees, respectively. The same capital letters (DAP) and lowercase letters (height) do not differ at 5% by Tukey test.



It is observed in Fig. 1, considering the eucalypt and native trees, the highest mean values of DBH were obtained by guapuruvu, angico and eucalypt trees. With regard to the height growth of trees, the highest mean values were obtained by eucalyptus (E12 and E22), which were statistically different from all native tree species. The eucalypt trees followed by *Schizolobium parahyba* and *Swietenia macrophylla* trees showed better canopy architecture and trunk compared with the other species studied. The mean wood productivity for eucalypt trees was higher as compared to the native tree species.

Acknowledgements

To Embrapa, and all research scientists, technicians and field workers at the Embrapa Cerrados Center who diligently have maintained this experiment.

Silvopastoral systems: sward structural characteristics of Marandu palisadegrass in function of face and distance

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Introduction
Silvopastoral systems are a promising alternative, which can help reduce the problems of deforestation and ecosystem degradation. In order to address management issues and to generate information for producers who are willing to silvopastoral systems, research was initiated to investigate sward structure pasture responses, when grass and trees are interacting.

Material and Methods
The experiment was carried out at Embrapa Agrosilvopastoral, from November 2013 to November 2014. The design was completely randomized in a split plot arrangement (plots of 64 m²), with four replications. The two factors were: the face of sun exposure (North and South) and distance from the row of Eucalyptus (3, 6, 10 and 15 m). The experimental units has 64 m^2 and four replications (in each face: north and south) of Marandu palisadegrass (*Brachiaria brizantha* cv. Marandu) pastures with 30 meters space rows of eucalyptus (*E. urograndis* H13). Harvest was done to simulated intermittent defoliation, where every 28 or 42 days, during rainy or dry season, respectively, with a 12 cm stubble height. Five seasons were considered: late spring, summer, autumn, winter and early spring. To characterize changes in the sward structure we measured: height (with ruler and transparency); and light interception (LI), leaf area index (LAI) and foliage angle (ANG), with the canopy analyzer LI-COR LAI model – 2200. These measurements were done immediately after harvest, every week and immediately before harvest.

Results and Conclusions
There is no effect on height, LI, LAI and ANG to pre or post-harvest in silvopastoral systems, independent of distance of row and face of exposure ($P>0.05$). In summer, higher values were registered for height, and LI: 23 cm and 96%, on average, as well the winter had the lower values (15 cm and 64%, respectively). Higher ANG was registered in the winter (53.2º), probably because the low accumulation. On average, the others seasons had 41º. Leaf area index was higher during the summer in the north face (4.2) and lower in winter in the south face (1.3). Post-harvest was characterized as 11 cm height. During the summer the stubble had higher values (2.1 of LAI and 85% of LI) than winter (0.85 of LAI and 65% of LI). Higher ANG were registered in winter (60º) and lower in autumn (46.1º). The structural characteristics of Marandu palisadegrass pastures indicate that shading can affect morphological and physiological responses. It can cause more strong changes after early years after implementation of silvopastoral system, and can be influenced by the face of sun exposure and distance from Eucalyptus row.

Acknowledgements
Thanks are due to FAPEMAT, CAPES/FAPEMAT, CNPq and Embrapa Agrosilvopastoral to the financial support of this research.

Solange Garcia Holschuch

Silvopastoral systems: sward structural characteristics of marandu palisadegrass in function of face and distance

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Alexandergrass panicles production dynamic: a step towards the conversion of a weed to a forage plant

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Introduction

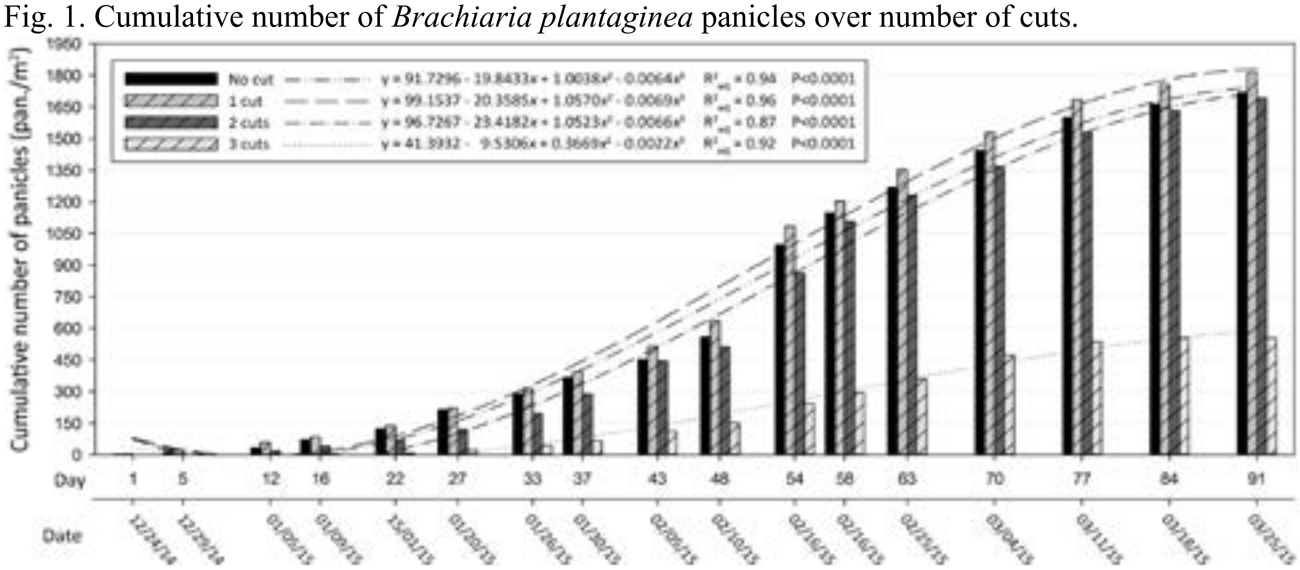
Family farming constitute the most of Crop-Livestock Integration in Southern Brazil. In these systems Alexandergrass (*Brachiaria plantaginea*), a wide spread spontaneous plant, has been often used as forage, presenting high production and good bromatological quality. However, there is no technology available or scientific knowledge on the Alexandergrass seed management, and pastures are settled just from soil seed bank (natural reseeding). Better understanding of Alexandergrass inflorescences production dynamic could help the development of methods to control the seed harvesting and seeding, avoiding establishment failures caused by climatic and edaphic changes.

Material and Methods

The study was carried out in the experimental area of UTFPR - Pato Branco, PR (28°10’39”S, 52°41’17”W, 750m asl), from December 2014 to March 2015. Plants were established from soil seed bank. Treatments were number of cuts in Alexandergrass: 0 (No cut), 1, 2 and 3 cuts executed at 20cm, when the sward reached 40cm. Plots of 1m^2 in a randomized blocks design with 4 replications were used. Panicles were counted weekly and marked with a cotton string.

Results and Conclusions

Fig. 1. Cumulative number of *Brachiaria plantaginea* panicles over number of cuts.



Alexandergrass panicles production presented similar behavior on the treatments No cut, 1 cut and 2 cuts (Figure 1), and substantially decreased on 3 cuts. This could be related to the injury caused by the sward biomass removal and its influences on the plant phenology, what were evidenced in the most intense treatment (3 cuts). Similarities on the first three treatments bring the possibility to graze Alexandergrass until 2 times before seed production, enabling animal feeding and seed harvesting at the same growing station. Besides the forage, at the end of the assessing period 0, 1 and 2 cuts allowed the production of almost 1700 panicles/m^2, each one with around 200 seeds, resulting in a estimated production of 340 thousands seeds/m^2.

Juliano Rossi Oliveira

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Seed dormancy breaking towards the control of Alexandergrass seeding in Crop Livestock Systems of Southern Brazil

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Introduction

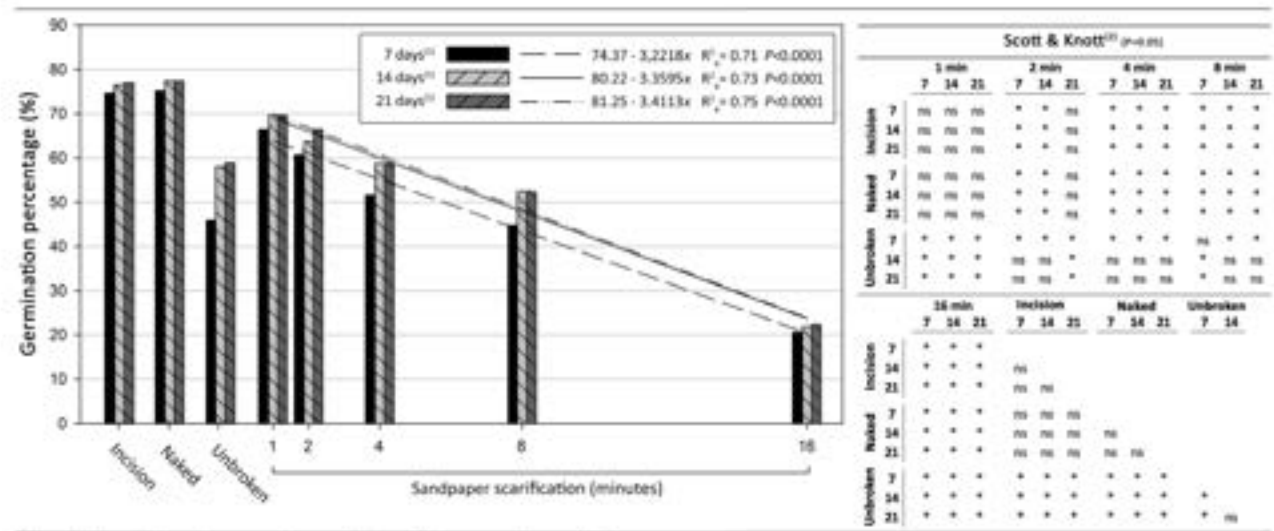
In Southern Brazil, one of the most common spontaneous plants in family farms that develop Crop-Livestock Integration is the Alexandergrass (*Brachiaria plantaginea*), which is at the same time an excellent forage plant, and an important weed of grain crops. Better understanding of Alexandergrass seed dormancy breaking allow the development of methods to establish the pasture properly, and helps to improve the cultural/preventive weed control when the plant is not desired.

Material and Methods

The experiment was carried out at the UTFPR Seed Laboratory (April, 2015). Alexandergrass seeds harvested in April 2014 by manual sweeping (fallen seed method) and stored at ambient temperature were used. Treatments were composed of 5 sandpaper scarification periods (1, 2, 4, 8, 16 minutes) in Seed Scarifier (DeLeo®; sandpaper 320; 3600rpm), and 3 control treatments: Naked (removal of the palea, lemma, and glumes, with tweezers); Incision (perpendicular razor blade cut, on the seed tip opposed to embryo) and Unbroken (no physical action on the seed). Germination was assessed in gerbox (11 x 11 x 3.5 cm) with germination paper, using a BOD germinator (Dark: 11hours, 20°C / Light: 13hours, 30°C), on 7th, 14th and 21th day after experiment start.

Results and Conclusions

Fig. 1. Germination of *Brachiaria plantaginea* seeds over dormancy breaking treatments.



(1) Quantitative treatments compared among themselves by regression analysis.
(2) Scott & Knott test compare all treatments versus qualitative treatments. "*" Treatments differ ($P < 0.05$). "ns" Treatments do not differ ($P > 0.05$).

The linear decrease observed in germination as the sandpaper scarification period increased could be related to embryo injuries. Bigger the time the seed keeps being sanded, bigger the damage it suffers. 1 minute of sandpaper scarification, however, promoted higher germination than observed on unbroken seeds (P<0,05), presenting yet no differences with the results of Naked and Incision treatments (P>0,05). Considering these results and practicality, 1 minute of sandpaper scarification could be used to improve Alexandergrass seed germination and the pasture establishment.

Juliano Rossi Oliveira

Seed dormancy breaking towards the control of alexandergrass seeding in crop livestock systems of southern Brazil

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Productive performance of Pantanal locally adapted lambs finished under three production systems.

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Introduction

The performance evaluation of the sheep industry is important to help decision making by the producer in order to choose an appropriated lamb finishing system to the Midwest Region of Brazil. This study compares the Pantanal locally adapted lambs finished at pasture as an alternative to feedlot system, the latter widely used to avoid worm infestation in tropical conditions.

Material and Methods

The trial was conducted at Embrapa´s Midwest Regional Center of Goats and Sheep, Terenos – Mato Grosso do Sul. 122 weaned 70 days old male and female lambs were completely dewormed at weaning and randomly grouped to the treatments: Piatã-grass and Paiaguás-grass pastures stablished in succession to sorghum and soybean crops (LCS-Livestock-Crop System) in 2013 and 2014, respectively; Piatã-grass as five months stockpiled pasture (STOCK); feedlot (CONF) with sorghum silage as roughage. Lambs were fed a 2% of body weight energy-protein concentrate (15% CP and 70% TDN) in all treatments. The trial period was 63 and 70 days in the dry season (August to October) in each year, respectively.

Results and Conclusions

Tabela 1. Productive performance of Pantaneiro lambs finished in the dry period.

Variables	STOCK	LCS	CONF	CV
	----------------------------	kg	---------------------------	--- % ---
Final liveweight	28.56 b	30.53 a	27.69 b	9.48
Liveweight gain	11.25 b	13.22 a	10.38 b	24.90
Average daily gain	0.151 b	0.177 a	0.139 b	18.64

Averages followed by distinct letters in line are different by the Tukey-Kramer test ($P < 0.05$).

Lambs finished at pasture in LCS system showed better performance (Table 1). Lambs initial average liveweight was 17.43 kg. The grater liveweight gain and average daily gain in LCS treatment might be attributed to highest and better nutritional value of forage available to lambs in this system. Although a more complex system, LCS is an economic alternative to the sheep meat farmers in central region of Brazil.

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To Embrapa postgraduate students and all research scientists, technicians and field workers at the Embrapa Beef Cattle Centre who contributed to success of trials.

Sergio Giovanni Espinosa Villafuerte

Productive performance of pantanal locally adapted lambs finished under three production systems

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Twenty years of cropping systems and their effects on soil aggregation in the Brazilian Cerrado

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Introduction The adoption of practices based on the conservation of soil and water may improve soil structural quality upon conversion of conventional tillage system to no-till. In this presentation, we report the results of 20 yr of cropping after this conversion in the Brazilian Cerrado.

Material and Methods

The field experiment was installed in an area of Unesp (21º15' S e 48º18' W; 595 m asl), Jaboticabal-SP in 1988. Treatments included nine cropping systems with maize, six continuous cropping under no-till and three under conventional tillage system (disc harrow, disc plow, moldboard plough). Soil samples were taken from the 0-5 and 5-10 cm depth in each management treatment in October 2008, for determining the stability in water and organic carbon content.

Results and Conclusions

Table 1. Organic carbon (SOC), Degree of clay flocculation (DCF), Weight diameter aggregates (WDA), Geometric mean diameter (GMD), Water stable aggregates (WSA) and percentage of stable aggregates > 2 mm (PSA) under different crop systems 20 years after establishment. Data are means of 3 replicate plots.

Crop Systems	SOC	DCF	WDA	GMD	WSA	PSA > 2,00mm
	$g\ kg^{-1}$	%	mm		%	
			Soil layer (0,0 - 5 cm)			
No-till 1	24,17 Aabc	54,32 Aabc	4,91 Aa	3,77 Aab	69,50 Aab	82,74 Aa
No-till 2	29,33 Aa	63,60 Aa	4,02 Aab	2,71 Abc	68,17 Aab	67,33 Aab
No-till 3	22,67 Abc	52,17 Abc	5,12 Aa	4,23 Aa	74,50 Aa	86,50 Aa
No-till 4	26,50 Aab	60,48 Aab	4,86 Aa	3,85 Aab	67,00 Aab	82,00 Aa
No-till 5	26,33 Aab	57,34 Aabc	4,58 Aab	3,49 Aab	69,67 Aab	77,47 Aab
No-till 6	26,00 Aab	59,77 Aab	4,98 Aa	4,06 Aab	68,17 Aab	85,06 Aa
Moldboard plough	14,67 Ad	53,00 Abc	2,35 Ac	1,43 Acd	44,50 Ac	38,00 Acd
Disc Plow	14,50 Ad	47,40 Ac	1,63 Ac	0,86 Ad	42,83 Ac	24,27 Ad
Disc harrow	18,50 Acd	48,29 Ac	3,19 Abc	2,00 Acd	54,33 Abc	53,07 Abc
			Soil layer (5 – 10 cm)			
No-till 1	16,00 Ba	45,59 Ba	3,89 Ba	2,17 Bab	60,17 Babc	56,52 Ba
No-till 2	17,00 Ba	45,94 Ba	2,90 Bab	1,78 Bab	60,17 Babc	47,80 Bab
No-till 3	17,17 Ba	43,64 Ba	3,63 Ba	2,40 Ba	61,33 Bab	61,33 Ba
No-till 4	17,50 Ba	42,88 Ba	3,18 Bab	1,94 Bab	58,83 Babc	53,10 Bab
No-till 5	17,67 Ba	49,46 Ba	3,89 Ba	2,68 Ba	70,67 Aa	65,73 Ba
No-till 6	18,00 Ba	50,22 Ba	2,84 Bab	1,74 Bab	63,17 Aa	47,67 Bab
Moldboard plough	15,50 Aa	44,16 Ba	2,93 Aab	1,89 Aab	45,67 Abc	48,33 Aab
Disc Plow	15,33 Aa	45,72 Aa	1,77 Ab	0,96 Ab	46,33 Abc	26,38 Ab
Disc harrow	19,00 Aa	42,69 Aa	3,49 Aa	2,28 Aab	58,67 Aabc	59,55 Aa

Values followed by the same letter are not significantly different by Tukey test (P <0.05) compared. Letter upper layers within the same management system, lowercase letters compare management systems within the same layer.

The adoption of a no-tillage system improves soil aggregation and its stability. The aggregation indexes differentiated the no-tillage systems to conventional systems, with higher values on no-tillage systems in the layer 0-5 cm.

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Alba Leonor Martins

Twenty years of cropping systems and their effects on soil aggregation in the Brazilian Cerrado

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Initial development of eucalyptus clones with potential for use in ICLF systems

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Introduction

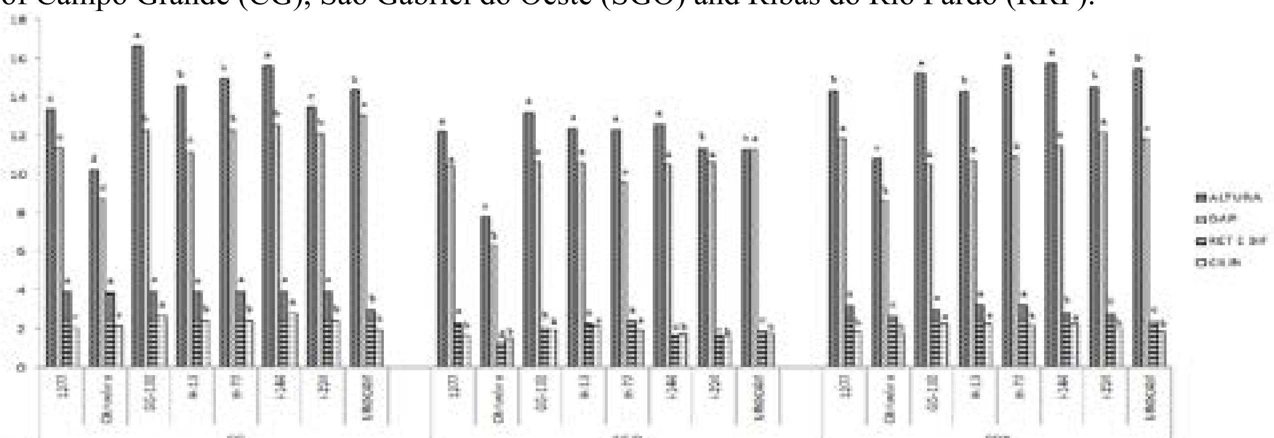
For the success of integrated crop-livestock-forestry systems, it is necessary to select the most suitable tree species and cultivars, looking for the highest potential for synergy among system's components. However, research on the subject for the State of Mato Grosso do Sul has been incipient. The objective was to evaluate the initial development of eucalyptus clones with potential for use in crop-livestock-forestry systems under different soil and climate conditions in Mato Grosso do Sul.

Material and Methods

A trial was started in 2011 combining three locations (Campo Grande (MS), São Gabriel do Oeste (MS) and Ribas do Rio Pardo (MS)), using a randomized block experimental design. Treatments were the different eucalyptus genotypes classified as multipurpose, *i.e*: 1277 (*E. camaldulensis* x *E. grandis*), I-144 (*E. urophyla*), I-224 (*E. urophyla* x *E. grandis*), GG100 (*E. urophyla* x *E. grandis*), H13 (*E. urophyla* x *E. grandis*), H77 (*E. urophyla* x *E. grandis*), Urocam VM2 (*E. urophyla* x *E. camaldulensis*) and *Corymbia citriodora.* Tree growth were evaluated following the methodology proposed by Porfírio-da-Silva et al. (2009) and for stem straightness, bifurcation and roundness the scales proposed by Malinovsky et al. (2006) were used.

Results and Conclusions

Fig. 1. Mean height, diameter at breast height (DAP), straightness and bifurcation (RET and BIF) and roundness of the stem (Cilin), of eucalyptus trees 30 months after planting in the municipalities of Campo Grande (CG), São Gabriel do Oeste (SGO) and Ribas do Rio Pardo (RRP).



In Fig. 1 it can be noticed that the GG100, H13 and I144 clones showed the best potential in Campo Grande. In São Gabriel do Oeste, wood yield was similar for eucalyptus clones, the citriodora had the lowest yield. In Ribas do Rio Pardo, GG100, H13, H77 and I144 clones were considered the most promising.

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Porfírio-da-Silva et al. (2009) – Embrapa Florestas, Colombo, PR. 48p.
Malinovski et al. (2006) –Floresta, v.36, n.2

Acknowledgments

To Embrapa, FINEP, FUNDECT and CNPq.

André Dominghetti Ferreira
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Decomposition of cover plants with potential use for crop-livestock integrated systems in the southwestern of Brazilian Amazon

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Introduction

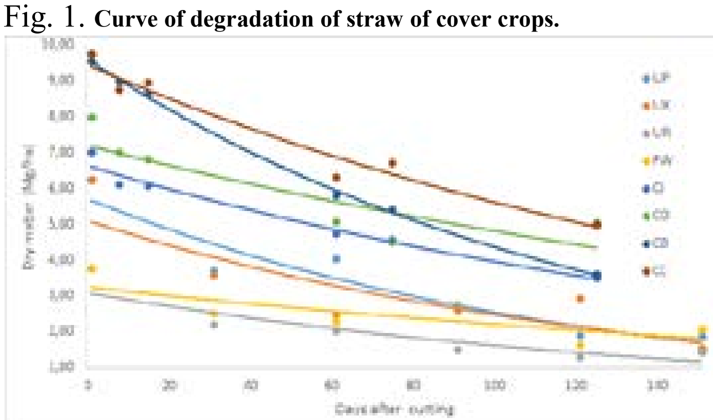
In crop-livestock integrated (CLS) systems, the use of ground cover plants is preponderant as a best agronomic practice. Avoiding erosion of the soil, increasing soil organic matter, improving soil quality, promoting carbon-sequestration and boosting the water efficient use are some benefits of the cover crops use. It is expected that plants of genre Urochloa provide very recalcitrant straws and legumes plants, in opposite, with lower C/N ratio, provide labile straws.

Material and Methods

In order to evaluate the response of several cover crops in a CLS under no tillage was carried out in the southwest of the Amazon, in Porto Velho, Rondonia. The experiment began in March 2014 after soybean crop in the summer. The straw of the *Urochloa ruziziensis* (UR), *U. brizantha* cv Xaraés (UX), *U. brizantha* cv Piatã (UP), *Canavalia brasiliensis* (CB), *Cajanus cajan* (CC), *Crotalaria juncea* (CJ) and *C. ochroleuca* (CO) were evaluated using litter bags. The control treatment consisted of natural fallow. Two cuts in UP, UX and UR were performed to simulate grazing effect. The mathematical model of the exponential type ($X = X_0e^{-kt}$) were used (Torres at al., 2015).

Results and Conclusions

Fig. 1. **Curve of degradation of straw of cover crops.**



The highest dry matter yields were obtained from the CB and CC plants. The UP and CB presented faster decompositions. Except the UR, all the treatments presented higher biomass yield than the control (fallow). The fallow treatment did not presents suitable R^2 value in the model of degradation.

Table 1: Parameters of degradation of straw

Treatments	X_0	k	T½life	R^2
UP	5,7	0.008	87	0,92
UX	5,1	0.007	99	0,77
UR	3,1	0.006	116	0,83
FW	3,2	0.004	173	0,60
CJ	6,6	0.005	139	0,98
CO	7,2	0.004	173	0,73
CB	9,6	0.008	87	0,99
CC	9,5	0.005	139	0,96

$X = X_0e^{-kt}$

X= dry biomass remaining after a period of time (t)

Xo= initial amount of dry biomass

k= constant of the residue's decomposition

The Urochloa species presented lower biomass yield in the initial time due the previous cutting to simulate the grazing effects. Among them, the UR provided 39.2 and 45.6% less dry biomass than UX and UP, respectively. The evaluated cover crops can represents values alternatives to compose crop-livestock integrated (CLS) systems in the Amazon.

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Acknowledgements: Embrapa

Andréia Marcilane Aker

Decomposition of cover plants with potential use for crop-livestock integrated systems in the Southwestern of Brazilian Amazon

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Morphogenetic and structural characteristics of *Brachiaria brizantha* cv. Marandu subjected to levels of shading

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Introduction
The integrated crop-livestock-forest systems (iCLF) through the arrangement of its components generate different medium conditions and thus interfere with the supply of biotic and abiotic factors, among which solar radiation, is essential to the development and growth of plants, this so it is necessary to know the response of forage front of oscillation of this factor.

Material and Methods
To evaluate the response of *B. brizantha* (*Urochloa brizantha*) cv. Marandu to three shading levels (0, 20 and 50%), an experiment was conducted at Embrapa Rondônia in Porto Velho-Brazil; in randomized complete block design with replications, three blocks and five replications. The dynamics of leaf development followed the methodology of marked tillers, if conducting weekly evaluations, for 36 days elapsed from the beginning of September and early October 2011, when the determined condition of the leaves (expanding, expanded in senescence and senesced), and told, we measured the length of leaf blade and heights sheath and tiller. From this information we determine the morphogenetic traits: rates the of leaves expansion (LER-cm of laef.tiller^{-1}.GD^{-1}), senescence (LRS-cm of laef.tiller^{-1}.GD^{-1}) and appearance (LAR-laef.tiller^{-1}.GD^{-1}), phyllochron (PHILO-GD.laef^{-1}.tiller^{-1}), leaf lifespan (LLS-GD.laef^{-1}.tiller^{-1}) and rate of stem elongation (RSE-cm of stem.tiller^{-1}.GD^{-1}); as well as structural characteristics: total amount (TL-n° laves.tiller^{-1}) and green leaves (GL-n° laves.tiller^{-1}), leaf blade length (LBL-cm.laef^{-1}) and height of tillers (HT-cm.tiller^{-1}). The means were submitted to analysis of variance and compared by Tukey test (P 0.05%), and regression analysis.

Results and Conclusions
The LER, RSE and LLS were influenced by shading, with the highest values observed under high shading towards more levels, and responded to that factor as models ($P \leq 0.05$): LER = 0.071 + 0.002 x (R^2 = 79); RSE = 0.047 + 0.0018 x (R^2 = 72) and LLS = 1.271 + 8.969 x (R^2 = 67). The more morphogenetic traits were not affected and neither responded to restriction levels of solar radiation. The behavior of these characteristics acted on the structural attributes determined by the same, being detected effect of shading on TL, GL, LBL and HT, with the highest values observed under high shading and the smallest full sun, with responses given by the models ($P \leq 0.05$): GL = 4.7 + 0.0314 x (R^2 = 75); LBL = 23.5 + 0.272 (R^2 = 87) and HT = 40.5 + 0.875 x (R^2 = 89). Demonstrating that the grass assumed adaptation strategies the condition of the shaded, what gives *B. brizantha* cv. Marandu potential for use in silvopastoral and integrated crop-livestock-forest systems. Demonstrating that the grass assumed adaptation strategies the condition of the shaded, which seek maximize interception and absorption of solar radiation, through the allocation and arrangement of their photosynthetic apparatus (f.e. increasing the height of tillers and leaf length), and increasing the photosynthetic tissue (f.e. maintaining a higher amount of green leaves). What gives the Marandu grass potential for use in iCLF.

Acknowledgments
Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq.

Claudio Ramalho Townsend

Morphogenetic and structural characteristics of brachiaria brizantha cv. Marandu subjected to levels of shading

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Integrated Crop-Livestock-Forestry systems: alternative recovery/renewal of pastures in Rondônia-Brazil

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Introtuction

The cattle in Rondonia has evolved expressively in recent decades, going from an importer to a major exporter of meat, milk and derivatives, currently one of the main economic and social relevance activities. However, there are still many challenges to make it look sustainable, mainly in the environmental area, but in opposition at this reality, there are several opportunities available in order to mitigate or to overcome these challenges. In this sense the integrated Crop-Livestock-Forestry systems (iCLF) have been indicated as an alternative. However, a larger scale the adoption, especially in the Amazon biome, requires certain caution, since it does necessary long-term research to identify different models of implementation and maintenance thereof.

Material and Methods

With this order was implemented a Technology Reference Unit-TRU in iCLF at the Experimental Field of Embrapa Rondônia in Porto Velho, RO, Brazil. Where the climate is tropical humid type Am and the predominant soil type is Latosol dystrophic, clayey, which was limed and fertilized as analysis results to meet the requirements of the crops. The TRU was divided into four modules of 2.5 ha each, totaling 10 ha, established in pasture in the degradation process, which from 2008 began to be cultivated with different crops (Table 1) and pastures (Table 2) rotations and successions.

Results and Conclusions

The results and information collected by 2013 (Tables 1 and 2) corroborate and point to the potential of iCLF as conversion tool and degraded areas, as well as the maximization of production factors of the system components, and point to bottleneck related to infrastructure harvesting, postharvesting and marketing of harvests.

Table 1. Productivity of crops established in the TRU in iCLF/Porto Velho-RO-BR, from 2008 to 2012.

Crops	Average productivity		Harvests
	Kg de grains(1) ha^{-1}	Sacks of grains ha^{-1}	
Rice (in shell)	3.003	50	2008/09 e 2011/12
Soybeans	2.856	47	2008/09, 2010/11 e 2011/12
Corn grain	3.331	56	2009/10
	t de MV ha^{-1}	t de MS ha^{-1}	
Corn silage	31,0	10,0	2009/10 e 2011/12

(1)Corrected so13% moisture.

Table 2. Production of pastures established in the TRU in iCLF/Porto Velho-RO-BR, from 2008 to 2013.

Grass	Grazing	DM	Weight gain		Stocking	
		kg ha^{-1}	g animal^{-1} day^{-1}	kg LW ha^{-1}	AU ha^{-1}	kg LW ha^{-1}
Ruziziensi(1)	I(3)	4.093	393	228	3,0	1.304
	II(4)	5.947	456	141	2,1	947
Xaraés(2)	II(4)	6.999	384	118	2,0	916

(1)*Brachiaria ruziziensis*; (2)*B. brizantha*. Xaraés; (3)Intermittent grazing 02/12-18/10/12; (4)Continuous grazing 10/07-13/11/13.

Modifying the monoculture systems of the developed world

Claudio Ramalho Townsend

Integrated crop-livestock-forestry systems: alternative recovery/renewal of pastures in Rondônia - Brazil

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Analyzing the characteristics that define tree ideotypes for agroforestry systems

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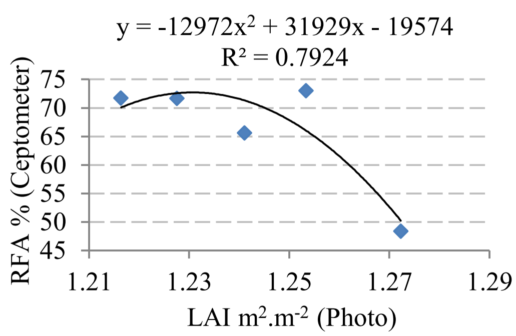
Introduction. In Crop-Livestock-Forest systems, tree species characteristics, such as canopy architecture, growth, shape of stem and leaves, must be assessed in order to optimize production of other components within the system. In agroforestry systems, the set of characteristics that delineate a tree ideotype, or ideal tree type, should consider radiation availability, which must be greater than 50% in full sun (VARELLA et al., 2012) so that the level of photosynthetic activity of temperate forage crops species does not change. This study aims to develop a methodology to evaluate light restriction percentage reaching the forage canopy in such systems.

Material and Methods
We assessed the relationship between photosynthetically active radiation (PAR) transmittance under the tree canopy and the leaf area index (LAI) in a 5 year-old agroforestry system with *Eucalyptus* sp trees planted at a spacing of 20 m x 3 m. We used hemispherical photographs processed in Hemiview® to assess LAI, and PAR was measured using the Accupar LP 80 ceptometer, within and outside the system. Hemispheric photographs and ceptometer measurements were taken every two meters along a transect of 30 m arranged transversely to the rows of planted trees, at a height of one meter above ground level.

Results and Conclusions
The results show 75% correlation between the variables. A 2nd degree polynomial provided an accurate representation of the dispersion of the points, with an R^2 of 0.79. We believe that by integrating more data, including other spacings and ages of various *Eucalyptus* species (including clones and hybrids) will further validate the equation and its use in choosing ideotypes in agroforestry systems. From this equation, the percentage of PAR in a given could be obtained without the use of a ceptometer.



Photosynthetically active radiation transmittance measured with a ceptometer *versus* leaf area index measured with fisheye photos. Points represent the mean of three measurements.

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Forages straw decomposition oversowing on soybean consortium in crop-livestock system

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Introduction There are many peculiar features in the Cerrado Biome, characterized by soils with sandy texture, low latitudes, high temperatures and rainfall in great intensity in the summer, but with dry winter. In these regions, the major limitations for the sustainability of integrated systems involving agriculture and livestock is the low forage production in the fall period until the beginning of spring, combined with difficulty in mulch training on the ground for tillage. To try to solve this problem, the intercropping of grain crops with forage species have shown promising results. Among the consortium arrangements, the oversowing of forage species in soybean for these purposes presents operational and agronomic advantages.

Material and Methods The work was conduced during the 2013/14 crop yield in field conditions at Gurupi, Tocantins State, in Oxisol. The forages species *Urochloa (*Syn. *Brachiaria) brizantha* cv. Marandu, *Urochloa ruziziensis*, *Panicum maximum* cv. Mombaça and *Panicum maximum* cv. Massai was sown in two amounts: 5 kg ha^{-1} e 10 kg ha^{-1} of viable seeds pure (SPV, in Portuguese). The oversowing of forages species were held manually, when the soybean reached the R_5 stage (50% of plant with grains in top filling the pods). After soybean harvest, the forages remained growing during the autumn-spring season (april-november). Before the forages drying with herbicide, the dry matter productivity was determined. The straw decomposition evaluation was carried out through of packaging of litter bags made in naylon containing the dry matter proportional to each forage. In november 2013, the litter bags were alleatory distributed in the treatments and collected at 15, 30, 45, 60, 75 e 90 days after management with herbicide. Each season, after collected the litter bags, the material were dry in greenhouse forced air circulation for weighing and determined the dry matter residual in kg ha^{-1}. The difference between each season was determinate the percentage of dry matter remained.

Results and Conclusions The seeds amount influenced significantly in productivity and straw decomposition rate, even comparing the dry matter residual between the species. The *Urochloa* grasses in 10 kg ha^{-1} of SPV showed increased the dry matter productivity and 90 days after the management with herbicide about 50% of dry matter remained in the soil surface. In the *Panicum* grasses, the decrease of dry mass occurred exponentially, independent of seeds amount. Between the species evaluated, *Panicum maximum* cv. Mombaça showed the higher straw rate decomposition, whereas 15 days after management with herbicide 46% of dry matter had degraded. At 90 days after management with herbicide, only 14% of dry matter remained in the soil surface, corresponding to 1856 kg ha^{-1}. The results found showed the seeds amount influenced directly in forage productivity for the *Urochloa* grasses when oversowing on soybean. In this high-temperature region of the Cerrado Biome, the forages can be the solution for the forage production in the autumn-spring and straw for soybean in the next crop year under no-tillage system.

Acknowledgements To Embrapa, CNPq and Federal University of Tocantins - Campus of Gurupi.

Evaluation of agro forestry system coconut/sheep in Costal Low Lands Northwest of Brazil

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Introduction - The low planting densities observed in coconut favors the spontaneous establishment of herbaceous vegetation, with forage potential. The integrated farming with animal husbandry constitutes an alternative control and exploitation of this natural vegetation while providing an additional income to the producer. In this work, we evaluated the effects of grazing sheep and mechanical slashing on animal performance and production of coconut trees.

Material and Methods - The study was conducted over three years, in an area with coconut trees giant variety aged around 30 years, and sheep Santa Ines, in Coastal Lowlands area of Sergipe. The soil was characterized as Spodosol and climate according to Koeppen classification is the type (hot and humid). The average rainfall in this region is around annual 1.416mm. The chemical analysis of the soil revealed the following levels: pH - 5.9; Al - 0.11 meq / 100 g; Ca + Mg - 0.8 meq / 100 g; P - 2.5 ppm; and K - 10.0 ppm. The experimental design used was a randomized complete block design with four replications, with the following treatments: T0 = slashing vegetation held twice a year (control); T1 = light stocking rate (2.4 sheep / ha); T2 = average stocking rate (3.2 sheep / ha); T3 = heavy stocking rate (4.0 sheep / ha). In sub treatments, it evaluated the effect of manual crowning of coconut palms held twice a year, with and without fertilization of coconut trees.

Results / Conclusions – Animal weight gains obtained in the first year were low, and declined linearly with increasing stocking rate. After control of parasitic diseases, animal performance improved markedly, while in the third year, under heavy grazing, there has been decline in weight gain, by the effect of the gradual replacement of the ginger grass (*Paspalum maritimum, Trind.),* intensely grazed, by the grass *Papophorum sp*., unpalatable to the animals. Mechanical slashing more than doubled the proportion of these grasses at the expense of legumes and other forbs. The coconut production did not change significantly (P <0.05) according to the intensity of grazing, although the crowning of coconut trees has produced significant effects (P <0.05) in slashing areas and in areas under ligh and medium grazing. In a complementary experiment, the growth of ginger grass and its phosphorus content responded significantly (P <0.01) to P fertilization. Its crude protein and in vitro dry matter digestibility declined with age of the plant, irrespective to the fertilization treatment. Vegetation under coconut trees, with dominance of ginger grass, can therefore be used to sheep production under medium intensity grazing, without effect on the coconut production

Humberto Rollemberg Fontes

Evaluation of agro forestry system coconut/sheep in costal lowlands northwest of Brazil

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Development of an organic crop-livestock-forestry system as a Technology Transfer tool

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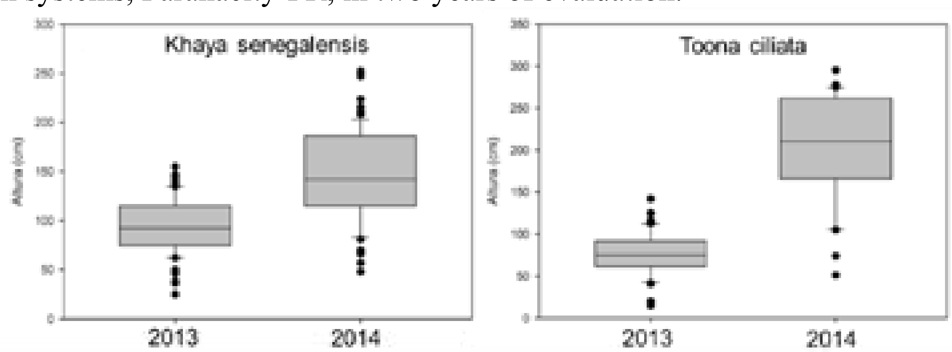
Introduction In order to implement alternative production systems and carry out forestry technology transfer (TT), Embrapa Forestry and the Cooperative Agricultural Production Vitória (Copavi) proposed an organic crop-livestock-forestry integration (CLFI) system using species *Khaya senegalensis* (African mahogany) and *Toona ciliata* (Australian cedar), crops and dairy cattle. This paper presents the preliminary results of the implemented production systems and the technology transfer method.

Material and Methods

In a forest TT action, Embrapa Forestry and Copavi had implemented an organic CLFI system in Paranacity, Paraná State, South Brazil, adapting from Porfírio-da-Silva e Baggio (2003). The strategy consisted of the planting of tree species *Khaya senegalensis* and *Toona ciliata* in areas cultivated with organic sugar cane and cassava respectively. Later, when the trees reach adequate size, crops will be replaced by cultivated pasture for dairy farming in organic production system. We presented here some preliminary results of the installation and conduct activities of areas and TT activities.

Results and Conclusions

Fig. 1. Box plot of *Khaya senegalensis* and *Toona ciliata* height in crop-livestock-forest organic integration systems, Paranacity-PR, in two years of evaluation.



The African mahogany establishment was satisfactory, with losses of 5% in the field. However, the Australian cedar lost 22% of the seedlings, due to heavy rains in the next planting week. Thus, we performed a replanting four months after the initial planting. The box plot indicated that the cedar grew, on average, more than mahogany in a year of evaluation. Furthermore, it indicated there was higher variability African mahogany compared to the Australian cedar, illustrated by the higher amount of outliers.

Together with the implementation of CLFI was started the TT activities. Were performed several technical visits and a training course for 30 technicians. In addition, after one year of implementation of the CLFI, there was adoption of technologies in other areas of the cooperative that indicates assimilation of technology. Those partial results indicate that CLFI installed in Copavi is promising as a TT tool.

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Ives Clayton Gomes dos Reis Goulart

Development of an organic crop-livestock-forestry system as a technology transfer tool

APH4

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Grass biomass accumulations in am agroforestry system eucalyptus: the role of radiation

Jhinmy K. HEMERYTH Bartra[1], Ciro A. RIGHI[1], Marco BERNARDES[2], Maria L.F. NICODEMO[3],
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Introduction

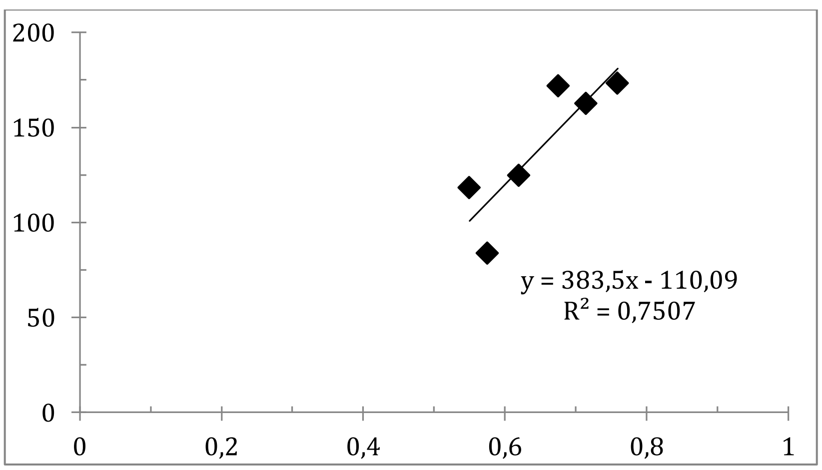
The awareness of the importance of tree in ecological stability and productive pastures have motivated the creation of alternatives aiming at harmonizing forestry with livestock production systems. The silvopastoral systems (SSP) is a way to combine the production of forests with livestock, besides ensuring more favorable conditions for pastures and livestock, also enables the diversification of products in the same unit area, adding, thereby economic value to rural property through logging and its derivatives (Ribaski; Rakocevic, 2002). Solar radiation is the most important factor in determining plant growth rates and productivity (Bernardes et al., 1999).

Material and Methods

The experiment was carried out in EECF Anhembi-SP-Brazil. The climate is Cwa according to the Koepen classifications. Eucaliptus trees (COP-1377) were planted in 2011 in alleys spacing 24 and 42 m by 2 m in the rows. *B. decumbens* was presented between the alleys. This requires a 0.25m2 wooden mold, where they were collected at a distance of 7.5, 10.5, 13.5, 19.5 m the grass to dry on stove and then calculate the total dry matter. Solar radiation was determined according com mathematical model proposed by Bernardez[1] (2015).

Results and Conclusions

Fig 1. Grass dry matter (g.m^{-2}) as a function of the available irradiation –IR.



Preliminary data indicate a strong dependence of the total dry matter availability of solar radiation. However it is necessary to assess the gains from agricultural enterprise due to improved cow comfort and forestry production.

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RIBASKI, J. and RAKOCEVIC (2002) CBSAF. BERNARDES, et al (1999) *In:* CBSAF: 14-16 p

[1]Marcos Silveira Bernardes (2015) – personal communication.

Modifying the monoculture systems of the developed world

Jhinmy Karc Hemeryth

Grass biomass accumulations in an agroforestry system eucalyptus: the role of radiation

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Raising Brangus steers on natural pasture developed after irrigated rice crop in the Pampa biome of Rio Grande do Sul state, Brazil

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Introduction

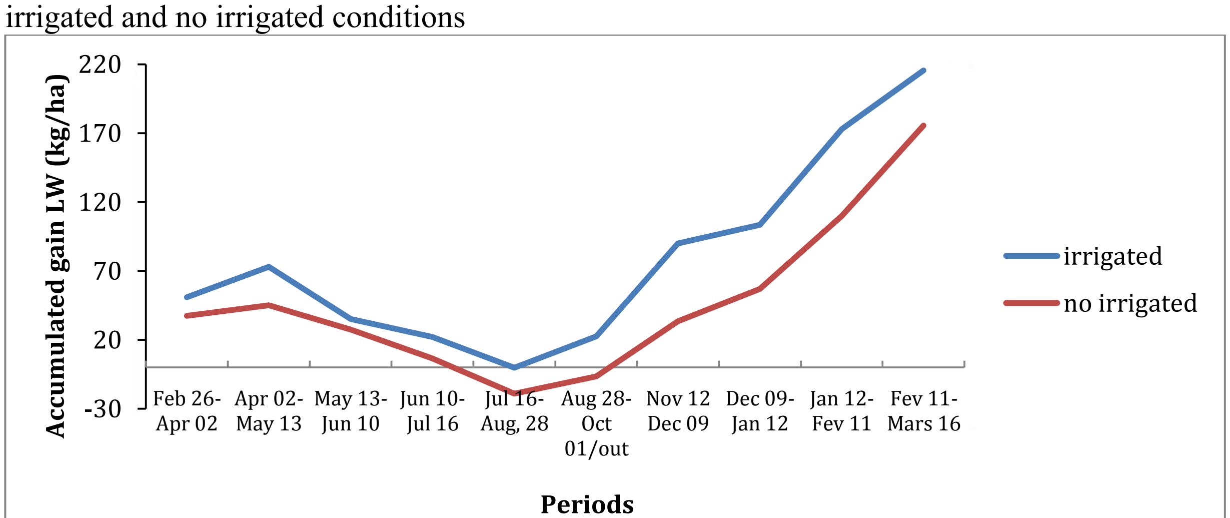
The traditional systems of exploitation with beef cattle in the Pampa biome of Rio Grande do Sul presents historically low rates of productivity and profitability due, mainly, to the inadequate management of natural pastures. In this way, these areas have been occupied by crops that offer more attractive economic income. However the soils and climate of this region favor the environmental degradation of lands exploited with annual cultivated plants. The present work compares the weight gain of Brangus steers in irrigated native pasture paralleled with non-irrigated area, in integrated crop-livestock systems.

Material and Methods

The field experiment was conducted at the Embrapa Pecuária Sul Research Centre, Bagé (31°22'S, 53°59'W, 176 m asl). This land was exploited with rice crop eight years ago (grown season 2000/2001). Two experimental units of two ha each one were established on recovered native pasture. One of the units was irrigated by intermittent surface flood irrigation, using the same features as those used for irrigation of the rice crop. The need for irrigation was determined by the soil penetration resistance (over 2000 kPa measured by digital penetrometer) at a depth of 7.5 cm. The other unit was not submitted to irrigation. The two treatments were grazed by Brangus steers, with a forage allowance of 12 kg of dry matter (DM) per 100 kg of live weight (LW) (DM at 12% of LW), in the period between February 26, 2009 and March 16, 2010.

Results and Conclusions

Fig.1 Accumulated Live Weight (LW) gain (kg/ha) of Brangus steers in native pasture under both irrigated and no irrigated conditions



At the end of the trial period, the gain of live weight (LW) on the unit with irrigation was 216 kg per ha, while in the unit without irrigation the gain was 175 kg per ha. The increase of LW per hectare differed (P>0.01) by T-test considering steers as experimental units. The irrigation of natural pasture allowed greater availability of forage, higher stocking rate and higher gain of LW per ha than natural pasture without irrigation.

Joao Batista Beltrao Marques

Raising brangus steers on natural pasture developed after irrigated rice crop in the Pampa biome of Rio Grande do Sul state, Brazil

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Intercropping of super short-cycle soybean with sorghum forage and brachiaria under integrated crop livestock forest system

Kleberson Worslley SOUZA[1]*, Juliane Cristina Pereira CALAÇA[2], Felipe Alves dos SANTOS[2], Walter Quadros RIBEIRO JUNIOR, Maria Lucrécia G. RAMOS[2], Arminda M. CARVALHO[1], Lourival Vilela[1]
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Introduction: The integrated crop-livestock (ICL) and crop-livestock-forest (ICLF) systems are potential alternatives to improve land use efficiency. There is socioeconomic and environmental gains. Especially to better take advantage of the rainy season in regions with shorter rainfall period. However, there is little information about the use of forage grasses intercropped with super short-cycle soybeans. The objective of this study was to evaluate the production of super short-cycle soybeans intercropped with Urochloa (Brachiaria) and sorghum forage.

Material and methods: The experiment was carried out in the experimental area of Embrapa Cerrados during the 2012/2013 harvest. The experimental design was a randomized block design. The experiment was established with the planting of super short-cylce soybean BRS 7580 and later (48 days) the seeding of forage sorghum BRS 655 and *Urochloa brizantha* cv. Piatã (syn. *Brachiaria brizantha*) in different plots between soybean lines for the intercropped treatments. These treatments was established in ICLF system (plant trees spacing 4 x 4m and spacing between alleys of 12 m). Was evaluated the production of the systems and the use of plant growth regulator. Plant tissue samples were collected from the forage species to evaluate neutral detergent fiber (NDF), acid detergent fiber (ADF) and in vitro dry matter disappearance (IVDMD). Soil samples were collected in layers of 0-5, 5-10, 10-20, 20-40, 40-60 cm depth for soil organic carbon and nitrogen forms evaluate among the systems. Soil samples under Cerrado native vegetation were used as reference. The data were submitted to variance analysis by SISVAR statistical program and the averages compared by Tukey test at 5% probability.

Results and conclusions: There was no significant difference between the soybean productivity in monocropping and intercropped systems. Urochloa showed higher production in monocropping system than intercropped with soybean. There was not difference of productivity between treatments with sorghum in monocropping or intercropping system. The use of plant growth regulator did not change the productivity in any systems. Higher crude protein contents was presented by treatments with Urochloa intercropped with soybeans. There was no difference between intercropped or monocropped sorghum forage for IVDMD, ADF and NDF. On the other hand, the treatment with monocropped Urochloa showed higher content of NDF and ADF and lower IVDMD than treatments intercropped. There was no significant differences in any of the depths between intercropped and monocropped treatments to the amount of organic carbon and total nitrogen. In general, the ammonium content in all treatments showed a uniform distribution. There was no detectable nitrate in soil under Cerrado. Intercropped treatments had higher nitrate values than monocropped at all depths.

Kleberson Worslley Souza
Intercropping of super short-cycle soybean with sorghum forage and brachiaria under integrated crop livestock forest system
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Modeling impact of shadow on grain yield under crop-livestock-forest integrated systems

Lourival VILELA[1]*, Karina PULROLNIK[1], Darliane C. SANTOS[2], Kleberson W. SOUZA[1], Robélio L. MARCHÃO[1],
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Introduction Agroforestry systems can be classified as agrisilvicultural (crops and trees), silvopastoral (pasture/animals and trees) or agrosilvopastoral (crops and pasture/animals and trees) systems. In Brazil, the agroforestry variant named integrated crop-livestock-forest system is becoming more and more popular (Vilela et al., 2011). In this method, several crops intercropped with pastures are planted in alleys between hedgerows of trees. The objective of this study was to evaluate the impact of shadow provided by alley cropping of eucalyptus (*Eucalyptus urograndis* and *Eucalyptus cloeziana*) on grain yield of soybean and sorghum cultivated between alleys.

Material and Methods The treatments consisted of two systems of arrangement of trees, with plant trees spacing of 2 x 2 m and spacing between alleys of 12 (S12) and 22 m (S22). A control plot without trees (full sunlight) was used as a reference. The experimental design was a randomized blocks with three replications. The sequence of cultivation between alleys was soybean crops in 2010/2011 , 2011/2012 and 2012/2013 agricultural years and in succession to soybean in the 2013 off-season growth the sorghum was cultivated intercropped with *Urochloa brizantha* (syn. *Brachiaria brizantha*) cv. Piatã.

Results and Conclusions A significant decrease in grain yield was observed due to the presence of trees in alleys and the reduction was more drastic in the alleys with 12 meters row spacing. Grain yield reductions in relation to the full sunlight area (reference) were 16 % and 51 % in the systems S22 and S12, respectively. Despite grain yield is similar to full sunlight in the center of the spacing between alleys in the S22, it reduces dramatically towards the margins.

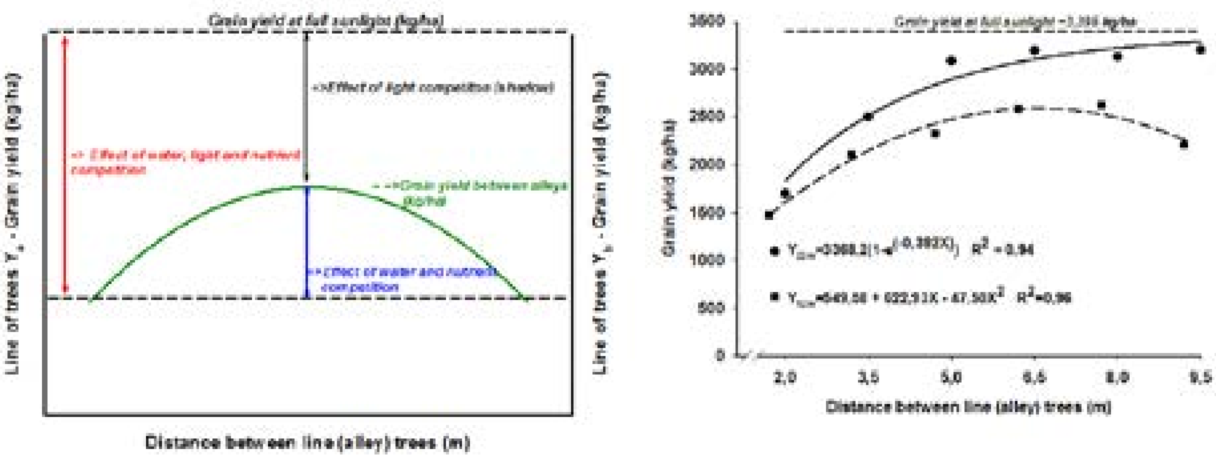

Fig. 1. Theoretical model proposed to illustrate the competition between annual crops and trees in ICLF systems (left) and numerical models showing an decrease in grain yield from the margin to center in alley cropping (right)

Reference cited Vilela et al. (2011) Pesq. Agropec. Bras. 46(10):1127-1138.
Acknowledgements To technicians and field workers at the Embrapa Cerrados Centre who diligently maintained this large experiment.

Lourival Vilela

Modeling impact of shadow on grain yield under crop-livestock-forest integrated systems

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Corn and grass productivity on different distances to eucalyptus rows

Miguel M. GONTIJO NETO[1]*; Eduardo de P. SIMÃO[2]; Ramon C. ALVARENGA[1]; Edson A. dos SANTOS[3]; Ivan J. WENDLING[3]; Emerson BORGHI[1]
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Introduction The Cerrado biome is responsible for most of the food production in Brazil. However, due to improper soil management, besides other damaging agricultural practices, extensive crop areas and pasture are degraded in this region. The direct planting system and the crop-livestock-forest integration (ILPF) are interesting soil management practices and they aim to achieve soil productive capacity recovery, product diversification and the income raise.

Material and Methods

The study was conducted in an experimental area which belongs to Embrapa Milho e Sorgo, Sete Lagoas County, Minas Gerais State, on the following geographical coordinates: latitude 19º29' S and longitude 44º10' W and altitude 708 m. The soil was classified as typical dystrophic Red Latosol (Oxisol). The current study aims to measure the productivity after intercropping corn and brachiaria ruziziensis (*Urochloa ruziziensis*) seeded between eucalyptus rows (*Eucalyptus urophylla* cv GG100). Eucalyptus rows were deployed in October 2011 and spaced 15x2 meters from each other. In October 2014, the intercropped corn and grass were seeded by the direct planting system, 1.0 m away from the eucalyptus line. The other lines were spaced every 0.7 m. Lines 1, 3, 5, 7 and 9 were evaluated and they were 1.0, 2.4, 3.8, 5.2 and 6.6 m respectively distant from the eucalyptus line. The productivity of corn grains and the grass biomass were evaluated on different tier distances in four repetitions. Data were submitted to regression analysis and the models were adjusted based on regression significance coefficient by Student's t-test ($P<0.05$) and the determination coefficient.

Results and Conclusions

The corn grains productivity (kg ha^{-1}) was directly affected by the distance between the corn lines and the eucalyptus rows ($\hat{y} = 401.3 + 690.1*x$; $R^2 = 0.98$), whereas grass production was not affected by the distance from the tier ($\hat{y} = 200.3$ kg ha^{-1}).

Acknowledgements

To Embrapa, CAPES-PNPD, FINEP and all research scientists, technicians and field workers at the Embrapa Maize & Sorghum Centre who diligently maintained this large experiment for over 6 years.

Miguel Marques Gontijo Neto

Corn and grass productivity on different distances to eucalyptus rows

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Leaf Growth of C_4 forage species according to shading of trees and nitrogen

Tiago C. BALDISSERA[1,2], Laíse da S. PONTES[3], Raquel S. BARRO[4]*, André F. GIOSTRI[2], Betina R. C. dos SANTOS[3], Anibal de MORAES[2], Paulo C. F. CARVALHO[4]
[1]Epagri - EE Lages, SC, Brazil; [2]UFPR – Programa de Pós-Graduação em Produção Vegetal, Curitiba, PR, Brazil; [3]IAPAR, Ponta Grossa, PR, Brazil; [4]UFRGS – Depto. Plantas Forrageiras e Agrometeorologia, Porto Alegre, RS, Brazil. E-mail address of presenting author*: raquelbarro@gmail.com

Introduction Forage species growing under trees are affected by changes in the understory, mainly related to light depending on tree species, tree density and tree management. Further, the response to shading depends on the forage species and on soil fertility, especially nitrogen (Paciullo et al. 2011). A better understanding about plant responses to interactive shading and N availability is essential to enhance our ability to forecast management practices and biomass production in order to ensure sward persistence and a sustainable production.

Material and Methods Leaf growth rates (kg dry mass ha^{-1} day^{-1}) measured in monocultures of C4 forage species (Ac – *Axonopus catharinensis*; Bb – *Brachiaria brizantha* cv. Marandu; Mm – *Megathyrsus maximus* cv. Aruana; Ha – *Hemarthria altissima* cv. Flórida; Cc – *Cynodon* spp. Tifton-85) were compared in a randomized block design, with three replicates in 2011 and 2012 at IAPAR – Ponta Grossa, PR, Brazil, within two systems, i.e. open swards *vs*. under trees of *Eucalyptus dunnii* (simulating an integrated crop-livestock system, ICLS – average shade ~ 40-50%), and two levels of N supply (zero vs. 300 kg N ha^{-1} $year^{-1}$). Swards were harvested when reached 95% of light interception (cutting frequency). Residual mass was defined as 50% of initial height (cutting intensity).

Results and Conclusions There was no interaction between shade and N supply on leaf growth rates on all species. The response to the shading was specie-dependent. Results indicated that Bb, Mm and Cc had a decrease on rates in the understory, while the opposite was observed for Ac. *H. altissima* maintained the same growth rates of leaves in both systems. The N supply helps the maintenance of a satisfactory development and growth of forages species in the understory of trees.

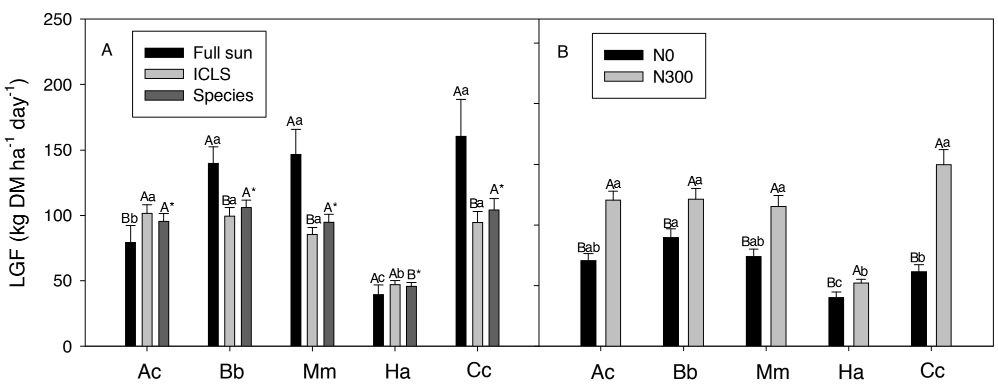

Fig. 1. Leaf growth rates of each species in each system (A) and in response to nitrogen (B). Means with the different capital letters differs systems, means with different lowercase letters refers to the species nested into the system. Capital letters with * is the mean of the two systems per species. Comparison was done by the Tukey test (P>0.05).

References cited Paciullo et al. (2011). R. Bras. Zootec. 40:270-276.

Acknowledgements Authors acknowledge the technical cooperation agreement (SAIC/AJU nº 21500.10/0008-2) between IAPAR and Embrapa. Research was supported by CNPq (Repensa).

Raquel Santiago Barro

Leaf growth of c4 forage species according to shading of trees and nitrogen

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Sorghum grain yield intercropped with palisade and Congo grass in two row spacings

Joilson SODRÉ FILHO[1], Robélio L. MARCHÃO[2]*, Arminda M. de CARVALHO[2], Lourival VILELA[2], Ricardo CARMONA[1]. [1]Universidade de Brasília, CP 04508, 70910-970 Brasília, DF, Brazil. [2]Embrapa Cerrados, CP 08223, 73301-970, Planaltina, DF, Brazil.
E-mail address of presenting author*: robelio.marchao@embrapa.br

Introduction Agricultural systems based in one or two crops, which normally lead to environmental and economic problems, have been common in the Brazilian Cerrado region. Alternative agricultural systems, including crop rotation mainly with forage species, intercropping and no-tillage systems are potentially interesting options to solve these problems. The use of perennial forage species in intercropping agricultural systems has also the advantage to produce large amount of biomass, which keeps the soil surface continuously covered and recycles nutrients (Crusciol et al., 2011). Besides, it can create adequate conditions for no-tillage systems in tropical soils. In this sense, the present study aimed to evaluate the sorghum grain yield growned off-season and intercropped with two forage grass species.

Material and Methods The experiment was carried out at Planaltina, DF, Brazil, during 2010 - 2011. The sorghum was sown in march, in two row spacings (50 and 70 cm), intercropped with palisade grass (*Urochloa brizantha* cv. Marandu) or with Congo grass (*Urochloa ruziziensis*). Statistical analysis was carried out considering a 2x3 factorial design with four replications, using a general linear mixed model (PROC GLIMIX) in the SAS 9.4 software.

Results and Conclusions The results showed a significative effect of forage species, year and interaction between year and sorghum row spacings (table 1) on grain yield. The higher grain yield was observed in 2010 at the 70 cm row spacing. At the row spacing of 50 cm, the sorghum grain yield was higher only in 2011, when weather conditions were adverse to the off-season crop. The presence of the forage intercropping species reduced sorghum grain yield, regardless the row spacing used. The highest sorghum grain yield occurred in the absence of Palisade and Congo grasses. It was concluded that the most adequate row spacing depends on the climate conditions for cultivation during off-season. At this period, when water is a restraining factor, larger row spacings provide less competition. Even though intercropping Palisade and Congo grasses significantly reduced sorghum grain yield, this crop system is interesting for dual purpose activities: cattle grazing during off-season or increasing soil biomass for the no-tillage system.

Table 1. Sorghum grain yield at two row spacings intercropped with Palisade or Congo grass, in 2010 and 2011.

Row spacing (cm)	Grain yield (kg ha^{-1})		Intercropping species	Grain yield (kg ha^{-1})
	2010	2011		
70	3774.84a	2070.03b	None	3345.51a
50	2872.65b	2389.58b	Palisade Grass	2587.15b
Mean	3323.74A	2229.80B	Congo Grass	2397.66b

Means followed by different letters (lowercase in columns and uppercase on the mean) shown significant differences by Tukey-Kramer test at 5% probability level.

Reference Crusciol et al. (2011) Pesq. Agropec. Bras. (46)10:1234-1240.

Acknowledgements To Embrapa (projet nº 02080100300) and all technicians and field workers at the Embrapa Cerrados Centre, who diligently conducted this experiment.

Robélio Leandro Marchão
Sorghum grain yield intercropped with palisade and congo grass in two row spacings
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Animal production in different integrated crop-livestock systems in a lowland of Southern Brazil

Sarah H. LOCHMANN[1*], Thiago BARROS[2], Amanda P. MARTINS[1], Felipe C. CARMONA[2], Danilo M. SANTANNA[3], Ibanor ANGHINONI[1], Julia S. MOMBELLI[1]
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Introduction To achieve higher lowland use efficiency in Brazilian Southern, a region commonly used for rice production, the livestock activity during the winter period (in succession to summer crops) is a sustainable alternative (Anghinoni et al., 2013). Thus, this study aimed to evaluate the animal production in the second winter grazing period of a long-term experiment that approaches different integrated crop-livestock systems.

Material and Methods

The experiment was implemented in March 2013, in Corticeiras Farm (Cristal county, Rio Grande do Sul State, Brazil). It is a long-term experiment, and the evaluation period of this study was the winter season of 2014. The treatments were distributed in randomized blocks with three replicates, being: T1 - ryegrass / soybean / ryegrass; T2 - ryegrass + white clover / Sudan grass / ryegrass + white clover; T3 - ryegrass + white clover + birdsfoot trefoil / succession field (native pasture) / ryegrass + white clover + birdsfoot trefoil. The grazing method adopted was continuous with variable stocking, beginning when the pasture reached a sward height of 15 cm (on average) and ending according to the further summer crop. The animals were weighed fasted at the beginning and at the end of trial period. The data was submitted to analysis of variance and Tukey test at 5% significance.

Results and Conclusions

Fig.1 – Animal production in ICLS during the winter 2014 in southern Brazil.

Treatment	Average daily gain (kg animal^{-1})	Gain (kg ha^{-1})	Stocking rate (kg ha^{-1})	Grazing days	Next Crop
1	0.42 a	128 b	570 b	113	Rice
2	0.40 a	151 b	536 b	140	Soybean
3	0.54 a	283 a	798 a	140	Succession field

1 - ryegrass / soybean / ryegrass; 2 - ryegrass + white clover / grass Sudan / ryegrass + white clover; 3 - ryegrass + white clover + birdsfoot trefoil / succession of field / ryegrass + white clover + birdsfoot trefoil. Means followed by different letters in the column differ statistically by the Tukey test (5%).

It was concluded that there was no difference regarding average daily gain among the treatments. However, the T3 presented a higher stocking rate and gain per hectare as compared to the other treatments.

References cited

Anghinoni et al. (2013). Tópicos em ciência do solo. 8: 325-380.

Acknowledgements

To Agrisus, CNPq and CAPES for the financial and scholarship support.

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Soil mechanical resistance to penetration (SMRP) in an Oxisol under different integrated crop/livestock systems (CLS)

Silvio T. SPERA[1]*, Ciro A. S. MAGALHÃES[2]; Austeclínio L. de FARIAS NETO[2]; Gabriele WOLF[3]; Karoline C. DORNELAS[3]
[1,2]Embrapa Agrosilvipastoral, CP 343, 78550-970, Sinop, MT, Brazil; [3]Agricultural Engineering, UFMT *campus* Sinop, MT, Brazil. E-mail of presenting author*: silvio.spera@embrapa.br

Introduction The high values of SMRP indicate reduction of soil water infiltration and high levels of soil erosion. Integrated CLS include forest and pastures. The SMRP of soils managed with CLS can be affected by cattle trampling (Fontaneli et al., 2010). However, by taking advantage of the fertilizers residues applied in annual crops, pastures cropped in these systems have greater vegetative growth and root, which may favor the mitigation effect of trampling. The forest dry leaves and living roots can increase the SOM of these systems, improving soil structure.

Material and Methods

The experiment was established in a randomized block design with 4 replications. The CLS production systems evaluated are: 1. Forest eucalyptus; 2. Annual crop in no till soybean followed by corn intercropped with *Brachiaria brizantha* cv. Marandu; 3. Pasture; 4. Annual crop-pasture (2 yrs. each); 5. Pasture-annual crop; 6. Annual crop-Forest; 7. Pasture-forest; 8. Annual crop-pasture-forest; 9. Pasture-annual crop-forest; 10. Annual crop+pasture-forest. The SMRP measures were taken to 40 cm depth with a Falker electronic penetrometer.

Results and Conclusions

After a 3-yr period continuous cropping differences between the treatments were observed (Fig. 1). The lowest SMRP values in 0-5 cm layer are results of the crop sowing operations, formation of large amounts of root mass in pastures and the accumulation of leaves of eucalyptus trees. The SMRP values are below the critical levels. After 3-yr is not yet possible to distinguish the effects of soil use and management on the SMRP; the effect of the scarifier is perceived still until the treatment 1 in 30 cm deep; the treatment showed 3 highest values of SMRP due traffic compression.

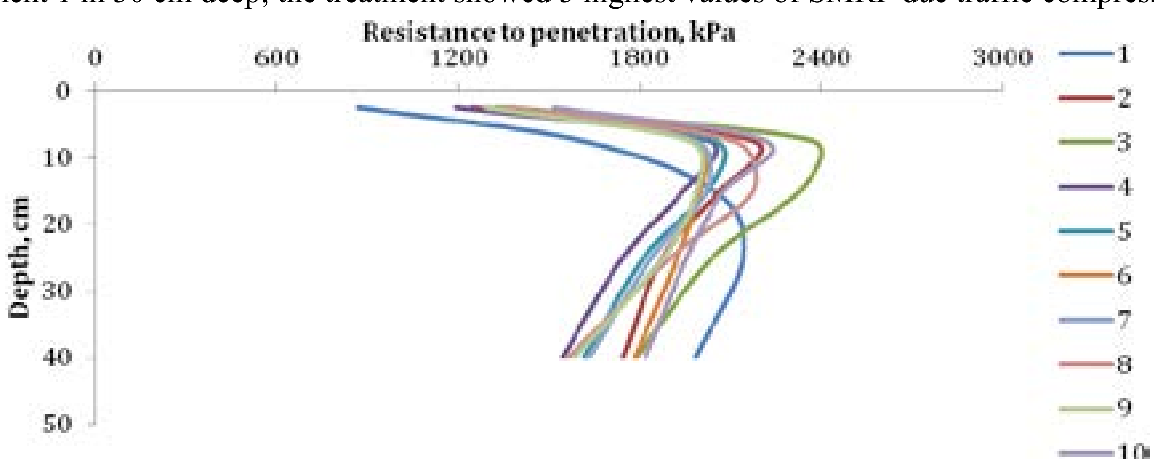

Fig. 1. The SMRP at 40 cm depth under different CLS 4 yrs. after establishment. Data are means of 4 replicate of 20 points/plot. 1. Eucalyptus; 2. Annual crop; 3. Pasture; 4. Annual crop-pasture (2 yr each); 5. Pasture-annual crop; 6. Annual crop-Forest; 7. Pasture-forest; 8. Annual crop-pasture-forest; 9. Pasture-annual crop-forest; 10. Annual crop+pasture-forest.

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Acknowledgements

To Embrapa, CNPq, and all research scientists, technicians and field workers at the Embrapa.

Silvio Tulio Spera

Soil mechanical resistance to penetration (SMRP) in an oxisol under different integrated crop/livestock systems (CLS)

AMMZ

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Performance of winter pasture species in different integrated crop-livestock systems in lowlands of Southern Brazil

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Introduction

The introduction of winter forage species in succession to rice cropping in lowlands of Southern Brazil is an option for the productive system diversification (Moraes et al., 2014). This region is characterized by irrigated rice monoculture and fallow periods. Thus, the winter forage species can promote nutrient recycling, the basis to the occurrence of conservation practices and crop-livestock integration adoption by farmers. Species such as ryegrass, white clover and birdsfoot trefoil are adapted to this environment. Thus, this study aimed to evaluate the dry matter accumulation in different combinations of pasture submitted to bovine grazing animals.

Material and Methods

A long-term experiment started in March 2013, in Corticeiras Farm, Cristal County, Rio Grande do Sul State, Brazil. The area was tilled and lime was applied. After this, the treatments were seeded. The study period was the second winter of the trial, in 2014, and in the summer period different crops alternate within each treatment, being (1st winter season / 1st summer season / 2nd winter season): T1 – annual ryegrass (AR) / soybean / AR; T2 – AR + white clover (WC) / Sudan grass / AR + WC; T3 – AR + WC + birdsfoot trefoil (BT) / succession field / AR+ WC + BT, arranged in a randomized block design with three replicates. The grazing method adopted was continuous with variable stocking, aiming to maintain an average pasture height of 15 cm. The end of grazing period varied in each treatment due to the subsequent summer crop. The pasture attributes evaluated were: initial and residual dry matter (DM) and DM accumulation. The DM accumulation rate was evaluated every 28 days in grazing exclusion cages. Data were submitted to analysis of variance and Tukey test at 5% significance.

Results and Conclusions

Table 1. Dry matter accumulation in different pastures in Southern Brazil

Treatment	Initial dry matter (kg ha^{-1})	Residue forage (kg ha^{-1})	Dry matter accumulation (kg ha^{-1})	Grazing days	Next crop
1	1139,2A	1061,3B	3349,5B	113	Rice
2	1507,3A	1196,1B	5372,0A	140	Soybean
3	1874,0A	3005,8A	5784,3A	140	Succession field

Treatments 2 and 3 were those who presented the highest DM accumulation during the trial period. Furthermore, in both treatments the number of grazing days was also superior to Treatment 1. Regarding the residue forage, Treatment 3 showed the highest value.

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Acknowledgements
To Agrisus, CNPq and CAPES for the financial and scholarship support.

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Implementation of different integrated crop-livestock systems in lowlands of Southern Brazil: an animal production approach

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Introduction

The introduction of integrated crop-livestock systems (ICLS) is an alternative to rice monoculture in lowlands of Southern Brazil (Anghinoni et al., 2013). During the winter period, the establishment of pastures with livestock emerges as one of the main options for land use due to the existence of forage species adapted to this edaphoclimatic environment. In this study we evaluate the animal production in the first winter grazing season of a long-term ICLS experiment with pastures that present different botanical compositions.

Material and Methods

The experiment was installed in March 2013, in the Corticeiras Farm, Cristal County, Rio Grande do Sul State, Brazil. After soil tillage and correction (liming), the treatments were implemented, being: 1) Annual ryegrass (AR) succeeded by rice; 2) AR succeeded by soybean; 3) AR + white clover (WC) succeeded by Sudan grass; and 4) AR + WC + birdsfoot trefoil succeeded by native summer pasture species (succession field), preceding distinct summer crops. The grazing began on July 3rd, and the end of grazing season was performed according to subsequent crop. The grazing method was continuous with variable stocking to reach an average pasture height of 15 cm. The steers were weighed fasted in and out of the trial period and the data were subjected to analysis of variance and Tukey test at a 5% significance level.

Results and Conclusions

Table 1. Animal production in different winter pastures on the implementation of integrated crop-livestock systems in lowlands of Southern Brazil

Treatment	Average daily gain (kg animal^{-1})	Gain (kg ha^{-1})	Stocking rate (kg ha^{-1})	Grazing days	Next crop
1	0.67 a	340 c	1140 a	92	Rice
2	0.73 a	470 a	1014 b	126	Soybean
3	0.63 a	373 bc	957 b	126	Sudan grass
4	0.65 a	419 ab	970 b	139	Succession field

Means followed by different letters in the column differ according to the Tukey test (5%).

The average daily gains were similar in all treatments, with the highest yields per area being observed in Treatments 2 and 4, and the highest stocking rate in the Treatment 1.

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Acknowledgements

To Agrisus, CNPq and CAPES for the financial and scholarship support.

Thiago Barros

Implementation of different integrated crop-livestock systems in lowlands of southern Brazil: an animal production approach

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Strategic supplementation for Nellore steers in tropical pastures at the end of rainy season

Eduardo da Costa EIFERT [1]; Cláudio Ulhôa MAGNABOSCO[1]; Marcos Fernando Oliveira e COSTA [2]; Letícia Mendes de CASTRO[3]; Ludmilla Costa BRUNES[3]; Mariana Márcia Santos MAMEDE[3]; Hélvio dos Santos ABBADIA[1]
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Introduction Perennial tropical pastures grow in the rainy season, however, its quality declines later in the season with increasing of fiber and reduction of protein availability, thus, animal performance decreases. Alternatively, rich-protein supplements can be used to increase the weight gain and maximize the use of forage. The aim of this study was to quantify the weight gain of Nellore bulls supplemented at the end of the rainy season.

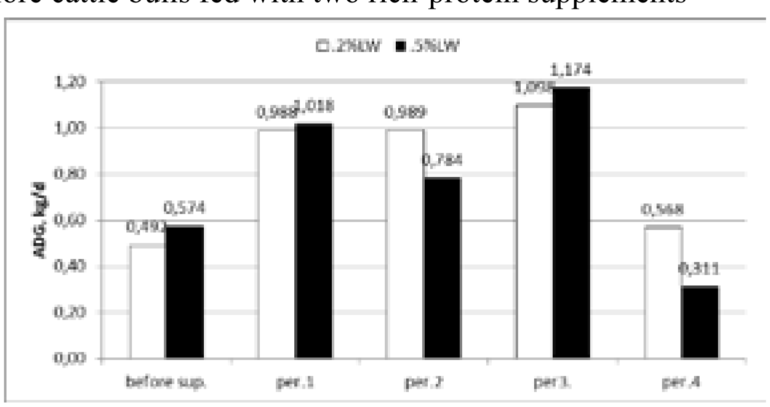
Material and Methods

The pastures are located at Embrapa's Rice and Beans Research Center, near the city of Santo Antônio de Goiás - GO, Brazil, and they consisted of *Brachiaria brizantha* BRS Marandu and BRS Piatã in monoculture. It was an integrated crop-livestock system, where every three years crops of rice, soy or corn were replaced by pastures in the fourth year. The data were collected from 82 Nellore bulls, with 12 months of age and 284 kg of live weight (LW). The pastures were management in a rotational system, with 2500 – 4000 kg/ha of forage allowance. The weights were measured at intervals of 14 days, after a 20-day handling and feeding adaptation. Two groups of animals were fed with a rich-protein-mineral supplement, at 0.2 and 0.5% of LW (0.60 and 1.50 kg/d) between march-01-2012 and may-17-2012. After the experiment, which lasted 60 days, the animals were finished in feedlot.

Results and Conclusions

The performance data before the supplementation period and the four supplementation periods of 14 days each is presented in Figure 1. It was not observed differences (P>.05) in ADG (Average Daily Gain) between the supplements, but the supplementation increased the ADG about 1.0 kg/d. In the last period of supplementation, due to the fact that the animals were in another pasture area, with a very high forage mass, but very low protein levels and high levels of fiber, the ADG reduced to similar values to before the supplementation. The supplementation enabled an increase in the ADG and the bulls gained 30 kg prior to termination period. This increase in live weight can reduce the feedlot period and hence the expenses involved.

Fig. 1. Performance data before supplementation and in four supplementation periods of 14 days each, of Nellore cattle bulls fed with two rich-protein supplements



Intensive beef and dairy production – the need for diversification

Eduardo da Costa Eifert

Strategic supplementation for nellore bulls in tropical pastures at the end of rainy season

APJK

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Evaluation of the economic feasibility of milk production on sorghum hybrid annual pasture aiming crop-livestock integration

Flávia Fernanda SIMILI[1*], Isabel Fernandes Pinto VIEGAS[2], Vera Lúcia CARDOSO[2], Maria Lúcia Pereira LIMA[1], Maria Izabel Merino de MEDEIROS[2], Ricardo Andrade REIS[3].
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Introduction In tropical regions, such as central Brazil, sorghum hybrids (SH) can be planted off-season during February or March, after soybean, corn or other annual species is harvested, in order to provide feed for grazing ruminants. Characteristics of these SH include, fast establishment and vegetative growth, great rusticity, low soil fertility demand, as well as cutting and grazing management facilities and can be an alternative grass in crop-livestock integration systems. The aim of this study was to evaluate the economic feasibility of grazing milk production systems using SH with or without supplementation.

Material and Methods The experiment was conducted for three consecutive years (2004, 2005, 2006) at the Experimental Station of the Agência Paulista de Tecnologia dos Agronegócios (APTA) in Ribeirão Preto, Brazil using crossbred cows (Holstein x Gir). The climate is tropical with dry winter. SH sowing was performed on March in both experimental years, after corn harvested, under the no-tillage system, using 12 kg seed/ha of the SH (*S. bicolor* x *S. sudanense*) 1P400, by Dow Agrosciences. Planting costs included: herbicide, insecticide, planting fertilizer, seed, labor and time machine (forage cost). Concentrate cost refers to the amount of 3kg concentrates/cow/day, which was the only supplementation provided to cows. Two treatments were evaluated. 1. Only SH forage and 2. SH forage plus concentrate supplementation. Feeding costs per period were obtained according per year, according to the following grazing period; 141 days (2004); 94 days (2005) and 47 days (2006); stocking rate 1.20; 0.53 and 0.87, respectively.

Results and Conclusions

Productivity and economic feasibility of grazing milk production systems in Southeast Brazil depend on milk production level of animals, stocking rate, and period length of forage production, during autumn and winter seasons, which is directly related to the rain distribution. SH forage production was negatively affected by the low rain precipitation in the two last years. Average daily milk production for the three years respectively were, 15.83; 16.10 and 16.41 kg/UA/day, for supplemented cows and 14.16; 14.89 e 12.30 kg/UA/day, for non-supplemented cows. The highest milk production was obtained when cows were supplemented. The highest revenue was obtained for non-supplemented cows. In the present study, concentrate supplementation provided in the diet did not result in favorable results, probably milk production level of cows. SH may be considered a feasible alternative of annual grass source in crop-livestock integration systems.

Table 1 – Feed cost, income of sale milk and profit milk production in Sorghum hybrid.

	SH without supplementation			**SH** with supplementation		
R$/ha/day	**1º ano**	**2º ano**	**3º ano**	**1º ano**	**2º ano**	**3º ano**
Feed cost (A)	2.67	4.14	7.60	4.17	4.65	8.22
Income of sale milk(B)	8.02	4.22	4.96	9.03	4.57	6.71
Profit (B-A)	5.35	0.08	-2.64	4.86	-0.08	-1.51

Exchange rateUS$1.00: R$ 2.88; 2.61 and 2.15 to 2004; 2005 and 2006, respectively. Planting costs R$/ha: 376.52; 389.30 and 357.07; Concentrate cost R$/kg: 0.48; 0.36 and 0.29 to 2004; 2005 and 2006, respectively.

Acknowledgements: To FAPESP for the financial support.

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Cattle production on pastureland during dry season at integrated crop-livestock systems on the Cerrado of Maranhão

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Introduction The Cerrado of Maranhão has stood out in the production of grains in cropland areas. Although intensely managed during the cropping cycle, these areas remain idle or underutilized for longer periods in the dry season. An alternative for the more efficient use of these areas is the use of integrated crop-livestock systems. This system is characterized by diversification, rotation, intercropping and / or succession of agricultural and livestock activities within the farm, resulting in a single system with mutual benefits. This study aimed to evaluate the production of young cattle in an integrated crop-livestock system in Maranhão, during the dry season.

Material and Methods

The work was carried out at Santa Luzia Farm, in São Raimundo das Mangabeiras, MA. The farm is located at 6º49'48"S and 45°23'52"W, with an altitude of 475 m. The stocking rate and weight gain of 1500 Nellore under integrated crop-livestock systems were evaluated from 2007 to 2013, during the grain crop fallow, in the dry season. Grazing areas were derived from the simultaneous cultivation (intercrop) of corn and *Brachiaria ruziziens* (CRUCIOL, 2011). After the harvest of the maize, animals were introduced and remained in the area for 120 days receiving an extra multiple mixture composed of 40 % corn, 25% soybean protein, 3% livestock urea, 14% of sulfur bloom and 0,7% micronutrients.

Results and Conclusions

Tab. 1: Cattle yield in integrated crop-livestock systems at Santa Luzia Farm, MA . 2007-2013.

year	Stocking Rates (AU/ha)	weight gain (@/animal/period)	weight gain (@/ha/period)
2007	2,24	3,8	8,5
2008	2,26	4,16	9,32
2009	2,43	3,0	7,32
2010	2,2	4,6	10,1
2011	2,2	4,18	9,2
2012	3,2	4,0	12,8
2013	2,3	4,84	11.13
Average	**2,4**	**4,08**	**9,80**

The initial average weight of animals was 12.7 @ with an average stocking rate of 2.4 AU / ha. The average weight after 120 days was 17.54 @, resulting in an average weight gain of 9.8 @ / ha during the dry season. The average cost of production was 3.1 @ / ha providing a net income of 6.7 @ / ha. The results indicate the feasibility of producing cattle in the off-season (dry season) in integrated crop-livestock systems in Maranhão State.

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Performance of crossbred cattle in a Crop-Livestock Integration System

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Introduction

The Brazilian livestock has sought greater productivity in a sustainable manner, through modern systems that reduce the financial and productive risks, such as the crop-livestock integration system (CLI).

Material and Methods

The experiment was conducted at Embrapa Maize and Sorghum, located in Lagoas-MG, Brazil (19º28'S, 44º15'W and 732 m altitude), from July 2013 to May 2014. The CLI system was implemented in a 24-ha area with rotation and intercropping of corn, soybean, sorghum, and pasture (*Panicum maximum* cv. Mombaça). The calves weaned at seven months of age belonging to two breed groups — 21 ½ Angus × ½ Nellore (AN) and 10 ½ Charolais × ¼ Angus × ¼ Nellore (CAN) — were divided in a completely randomized design. Animals were fed mineral and protein supplementation *ad libitum* during the rainy and dry seasons, respectively. The weight-gain means were compared by Tukey's test at 5% probability.

Results and Conclusions

The animal productivity was 858 kg live weight per hectare (ha), with an average stocking rate of 3 AU/ha. The forage allowance varied from 5.7 to 23.13 kg DM/100 kg live weight. The forage crude protein contents ranged from 8.7 and 17%. Breed group CAN obtained a higher average daily gain (ADG) and consequently higher final weight (Table 1). The inferior performance shown by CAN animals is explained by the fact that they had ¾ taurine blood, which has lower adaptability to tropical conditions. Cruz et al. (2009) also found a lower ADG for crossbred animals of continental origin (Simmental × Nellore) compared with other crosses. Another explanation for the inferior performance of CAN animals in this study may be the genetic effect of the Charolais bull used with the Angus × Nellore females to originate the CAN crossbreed. The bull had an expected progeny difference (EPD) for low weight at birth; however, its tested offspring (CAN) showed also low yearling weight.

Table 1. Average daily gain (ADG), average initial weight (WI) and average final weight (WF) of animals ½ Angus × ½ Nellore (AN) and ½ Charolais × ¼ Angus × ¼ Nellore (CAN) in CLI system

Variables	AN	CAN	CV(%)
WI (kg)	157.20 a	151.93 a	10.68
WF (kg)	381.73 a	309.46 b	7.09
ADG (kg/animal/day)	0.7332 a	0.5236 b	9.98

Different letters in the same row differ by Tukey test at 5%, CV: coefficient of variation

Animals from breed group AN showed superior performance as compared with those from the CAN breed group in the CLI system.

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Ramon Costa Alvarenga

Performance of crossbred cattle in a crop-livestock integration system

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Agriservices - Service Design Applied to ICLF

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Introduction

The primary sector coexists with the rise of precision agriculture, where the main problem is regulating the distribution of inputs and resources since the main agricultural production is modeled. This new trend integrates primary and tertiary sectors in line with engineering service, resulting in the introduction of agriservices as business strategy, control and rationalization of resources. The agriservices supported by science services offer innovative perspectives to agribusiness, where new processes strengthen and expand the possibilities coming from the integrated crop-livestock-forest (ICLF). However, these services need to go through a systematic design process so they achieve goals such as precise control of process time, synchronized insertion and direct reinforcement to business processes (Dutra et al, 2014). This paper discusses the role of agriservices in ICLF and the application of a framework of service engineering to provide the design. A case study on commercialization of agricultural equipment is presented.

Material and Methods

In this work we cover some concepts of service systems and we explore their impact in the modeling process of agribusiness cases. We use a framework named SoftDISS (Software Design for Information System Service) to model a case study on commercialization of agricultural equipment.

Results and Conclusions

The new service orientation (agriservice) supported by service science offers innovative perspectives to agribusiness. New processes supported by information systems strengthen and expand the possibilities arising from ICLF and together with the resources of information and communications technology (ICT) enable the displacement of the implementation of these new services to large urban centers also allowing the use of existing human and material resources.

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Yield and environmental services potential of eucalyptus under ICLF systems

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Introduction

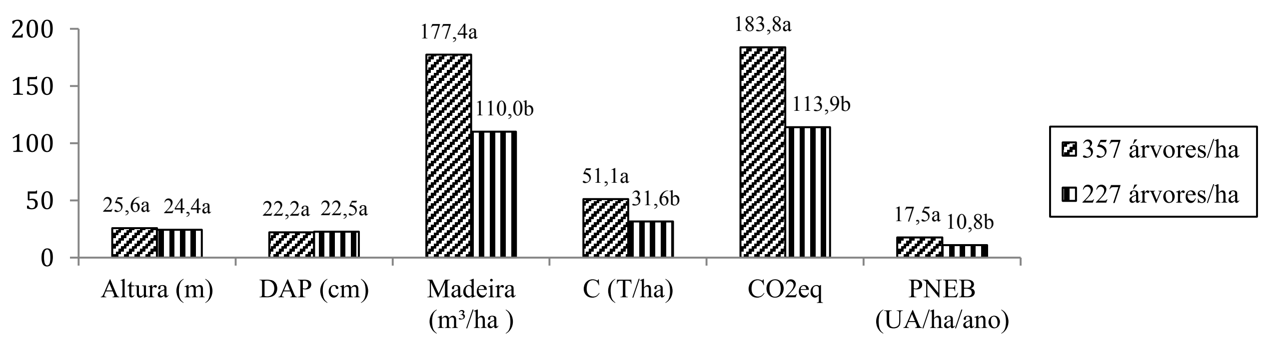
Many Brazilian economic sectors like energy, industrial processes, agriculture and forestry as well as the ones involving land use change and waste management have been closely monitored regarding greenhouse gases emissions (GHG). Especially for agriculture, there is demand for in-depth studies regarding alternatives for both, reducing emissions and improving carbon sinks. Goal of this work was to assess yields and potential for environmental services of two arrangements of eucalyptus trees under an ICLF system.

Material and Methods

A trial was carried out at Embrapa Beef Cattle Experimental Station in Campo Grande, MS. Experimental design was random blocks with two treatments (tree density of 357 trees/ha and 227 trees/ha) with four repetitions. Following soybeans cultivation, *Brachiaria brizantha* cv. BRS Piatã was used as cattle pasture between *Eucalyptus urophylla* x *Eucalyptus grandis*, clone H 13 rows. The tree component was evaluated at month 72, assessing the: height, diameter at breast height (DAP), wood volume per plant, wood volume per hectare, carbon sequestered by trees (following methodology proposed by Kanda et al. (2004), carbon equivalent (CO_2 eq.) (IPCC, 2006) and the tree potential to compensate GHG from cattle, considering that one animal unit (450 kgLW) produces 1,88t CO_2 eq./year).

Results and Conclusions

Fig. 1. Mean values for height, diameter at breast height (DAP), wood volume per hectare, carbon accumulation on stem (C), CO_2eq. and compensation potential for GHG emissions from cattle (PNEB) of 72 months old eucalyptus trees in a ICLF system with two tree densities.



The different tree arrangements did not influence individual tree arrangement up to 72 months after planting. The system with higher tree density shows higher wood yield per area and higher potential for environmental services from ICLF systems.

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To Embrapa, CNPq and FUNDECT.

André Dominghetti Ferreira
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Nitrogen fertilizer application and N_2O emissions in maize-cover crops with potential use for crop-livestock integrated systems in the Cerrado region

Arminda M. de CARVALHO[1]*; Márcia de S. VERAS[2]; Thais R. COSER[1], Maria Lucrécia G. RAMOS[2], Luciano de A. PINHEIRO[1]; Rafael R. SILVA[2]; Eduardo CAVALCANTE[2]; Letícia P. da SILVA[2]; Cristiane Lira Santana[2] Alexsandra D. de OLIVEIRA[1]
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Introduction Globally, about 60% of total N_2O emissions come from agriculture, mainly by the intensive use of fertilizers, soil disturbance and incorporation of crop residues. Soil conservation practices such as the use of no-tillage, require adequate crop rotation for the production and maintenance of soil surface cover and nutrient cycling. The decomposition of plant residues is one of the factors responsible for the emissions of N_2O from soil because it provides a significant source of nitrogen and carbon. The objective of this study was to quantify N_2O fluxes in maize production system in succession with cover crops with and without the application of sidedress N.

Material and Methods

The study was conducted at Embrapa Cerrados, Planaltina, Federal District (S 15º36'37,5 "and W 47º44'36,8"), central region of Brazil. The experimental plots were established as a randomized complete block in a split-plot design with three replications under no-tillage system cultivated with maize in succession with *Brachiaria ruziziensis, Canavalia brasiliensis and Pennisetum glaucum* with and without the application of sidedress N. Sidedress N application was applied twice at a rate of 65 kg N ha^{-1} each time (total application of 130 kg N ha^{-1}. Cerrado native was used as a reference. N_2O emissions were evaluated during maize growing season and a period of 160 days (from November, 2013 to April, 2014) using closed static chambers. Cumulative N_2O emissions were calculated by linear interpolation between adjacent sampling dates using Sigma Plot software.

Results and Conclusions

The application of N fertilizer resulted in higher cumulative N_2O emissions (Table 1) and *B. ruziziensis* showed significantly greater emissions (1.2 Kg N ha^{-1}) than *Pennisetum glaucum* (0.69 Kg N ha^{-1}) in N fertilized plots. No differences were observed between cover crops in N unfertilized plots. N_2O cumulative emissions from soil under Cerrado native were pratically null. The quality of *B. ruziziensis* residues, that have low ratio of lignin:N (Carvalho et al., 2012) favour N_2O emissions from soil when N is applied as sidedressing. Therefore, results indicate that the effectiveness in mitigating N_2O emissions will depend on input and quality of residues. However, increases in CO_2 uptake by the cover crop and of carbon stored in the soil needs also to be considered when evaluating N_2O mitigating processes (Abdalla et al., 2013).

Tabela 1: Soil N_2O cumulative emissions during maize growing season in succession with cover crops, with and without the application of sidressing N.

Cover Crops[(1)]	+ N		-N	
	-----------kg N ha^{-1}-----------			
Brachiaria ruziziensis	1.20	aA	0.57	aB
Canavalia brasiliensis	0.86	abA	0.38	aB
Pennisetum glaucum	0.69	bA	0.28	aB
Cerrado native	0.03			
CV (%)	18			

[(1)]Means followed by the same lowercase letter in columns and uppercase letter in line do not differ by the Tukey test at 5% probability.

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Carvalho et al. (2012) **Crop & Pasture Science**

Effects of continuous swine manure application on N_2O emission from an Andosol vegetable field in central Japan

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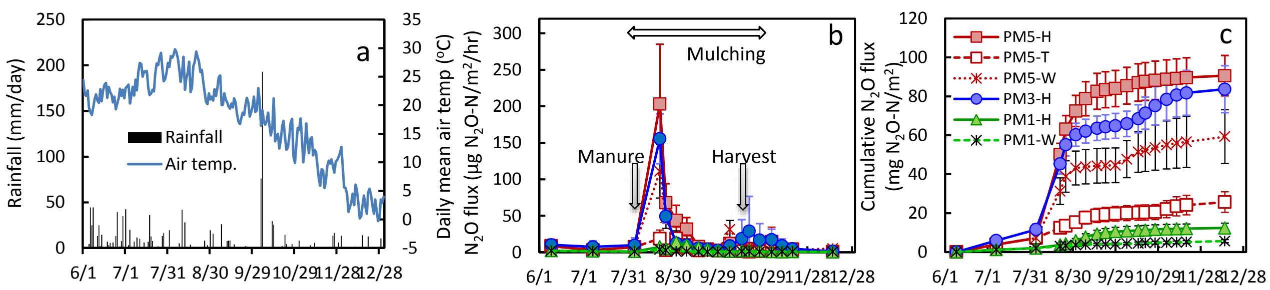
Introduction Long-term manure applications not only increase soil organic carbon but also change organic matter quality such as increasing labile carbon proportion. This may lead to changes in nitrogen mineralization and so as the emission of N_2O. While mitigation greenhouse gases (GHG) through increasing sequestration of carbon in soils by manure applications, the trade-off with N_2O emission is an issue to concern. We measured CO_2 and N_2O emissions from an Andosol vegetable field with applying swine manure for 1–5 years in central Japan. The purpose of this study was to quantify the potential effects of continuous swine manure application on N_2O emission.

Material and Methods

The experiment was conducted on a cultivated Hydric Hapludand Andosol (WRB) in central Japan (36°16′33″N, 140°19′30″E, 13.3°C MAT, and 1350 mm yr^{-1} MAP) from June 4, 2014 to June 4, 2015. Plastic mulching was adapted to the two-season lettuce production (white-black mulch film for autumn, and black mulch film with plastic tunnel culture for spring). Three manure treatments, each 350 cm×300 cm plot with two replicates, were PM1 (1 year), PM3 (3 years) and PM5 (5 years), all receiving 200 and 400 kg N ha^{-1} as swine manure for every autumn and spring, respectively. GHG fluxes were then measured intensively with static chambers at three conditions (each four chambers): mulching ridge with (H) and without plant holes (T) and the bare furrow (W).

Results and Conclusions

Fig. 1. Changes in environmental factors (a: rainfall and air temperature), the N_2O from different treatments (b) and their cumulative amount (c) from June 6 through December 15, 2014 on a cultivated Andosol. The treatments showed in text (Error bars represent standard error, n=4).



Following the swine manure application (August 11, Fig. 1b), PM3 and PM5 showed a remarkable peak on N_2O emission (PM5-H&W, PM-3-H), while N_2O emitted from PM1-H&W were much lower. Cumulative N_2O emitted through mulching film (PM5-T) was about 30% of that through mulch film with opening holes (PM5-H). N_2O flux from the bare furrow (PM5-W) was also greater as PM5-H, indicating the importance of accounting for N_2O emitted from adjacent furrow to the total N_2O emission from soil covered with mulch film. By the percentage of mulched ridge for H (20%) and T (80%), and the percentage for mulched ridge (51%) and furrow (48%), the weighted total N_2O (mg N m^{-2}) for autumn lettuce were estimated to 48.8±29.1 for PM5 and 45.1±26.0 for PM3, while the weighted N_2O emission from PM1 was only 13% of them. We will also discuss changes in CO_2 emission and the potential effectiveness of mulching on reducing N_2O bursts associated with intensive rainfall events.

Ayaka W. Kishimoto-Mo

Effects of continuous swine manure application on N2O emission from an andosol vegetable field in central Japan

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Carbon balance for agroforestry systems in the Southeastern Brazil

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IntroductionAgroforestry systems have an important role for the mitigation and compensation of greenhouse gas (GHG) emissions. They can be an alternative to reduce the carbon footprint of animal production systems and increase carbon sequestration. The main objectives of this study were to estimate GHG emissions and aboveground carbon storage in silvopastoral and agrosilvopastoral systems in Southeastern Brazil and to estimate the number of trees necessary to offset these emissions.

Material and Methods

The study was conducted in four agroforestry systems, located in Viçosa, State of Minas Gerais, Brazil. The System 1 was planted in December 2007 and it was composed of maize (*Zeya mays*) + pasture (*Brachiaria decumbens*) + eucalypt clone - 8x3m (*Eucalyptus saligna*). The System 2 e 3 were planted in December 2009 and they were composed of: System 2: Bean (*Phaseolus vulgaris*) + pasture (*B. decumbens*) + eucalypt clone - 8x3m (*E. urophylla* X *E. grandis*) and System 3: Pasture (*B. decumbens*) + eucalypt clone - 9x1m (*E. urophylla* X *E. grandis*). The System 4 was planted in November 2009 and it was composed of pasture (*B. decumbens*) + eucalypt clone - 12x3m (*E. urophylla* X *E. grandis*). GHG emissions were calculated regarding production, storage and transportation of agrochemicals (pre-farm) and farm activities such as fertilization and machinery operation (on-farm), according to the methodology recommended by IPCC. The livestock production system used in the farms was beef cattle with one animal unit per hectare. Field data from the different systems was collected between July and August of 2012. For all systems, we quantified aboveground tree and grass biomass, and carbon stock.

Results and Conclusions

GHG emissions for the different agroforestry systems ranged from 2.81 t CO_2e ha^{-1} to 7.98 t CO_2e ha^{-1}. The number of trees required to neutralize these emissions ranged from 17 to 44 trees ha^{-1}(Table 1).

Table 1: Emission, carbon stock, carbon balance and trees to offset in the systems

System	Emission (t CO_2e ha^{-1})			Carbon Stock (t CO_2e ha^{-1})	Balance (t CO_2e ha^{-1})	Trees to offset	Total trees	Surplus trees
	On-farm	Pre-farm	Total					
1	7.61	0.37	7.98	200.14	192.16	17	424	407
2	4.10	0.15	4.25	41.86	37.61	39	388	349
3	3.92	0.12	4.04	94.33	90.29	44	1031	987
4	2.71	0.10	2.81	21.78	18.97	35	267	232

Thus, it is concluded that it is possible to offset emissions from agricultural activities adopting the planting of trees in the systems.

Acknowledgements

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Carlos Moreira Miquelino Eleto Torres

Carbon balance for agroforestry systems in the southeastern Brazil

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Carbon storage in three silvopastoral systems with different genetic materials

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Introduction The National Climate Change Policy was created (PCCN) to assist the meeting of targets for greenhouse gas emissions reductions established by the Brazilian government. One of the instruments of PCCN is the Agriculture Program Low Carbon that encourages adoption of sustainable production systems such as agroforestry systems (BRAZIL, 2010). In order to contribute to the government, more accurate values in meeting the targets for reducing greenhouse gas emissions, further studies are necessary on carbon storage in Agroforestry Systems. Thus, the objective of this study was to compare the carbon storage potential of three genetic materials for the same growing conditions.

Material and Methods
The study was conducted in three silvipastoral systems with 8 years and spacing 6x4 m, located in Porto Firme – Minas Gerais, Brazil. The forest inventory of the tipe census was conducted. All the trees had their circumferences measured at 1.30 m height. We collected the heights of three trees per diameter class and a hypsometric equation was developed to estimate the height of the others trees. For volumetric estimate were fitted allometric equations based on Schumacher and Hall model(1933). To determine the wood density, a borehole was made in 30 cm height in five trees, randomly chosen in each of the systems. The carbon storage was estimated using 0.47 factor, proposed by IPCC (2006).

Results and Conclusions
The carbon storage for the different systems ranged from 41.48 $tC.ha^{-1}$ to 50.10 $tC.ha^{-1}$ (Table 1), and the System C was that had the highest value. This can be explained due to the higher volume of wood for clone c, and density of wood similar to the other clones. Thus, the clone C is the most recommended for planting in the region, if we analyze the carbon storage.

Table1: Comparison of the results of the systems studied.

System	Spacyng (m)	Clone	Volume ($m^3.ha^{-1}$)	Density ($g.cm^{-3}$)	Biomass ($t.ha^{-1}$)	Carbon ($t.ha^{-1}$)
1	6x4	A	186.51	0.4732	88.25	41.48
2	6x4	B	205.20	0.4445	91.40	43.00
3	6x4	C	229.50	0.4641	106.50	50.10

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Acknowledgements
We gratefully acknowledge financial support for this study from FAPEMIG, CNPq and CAPES.

GHG emissions and C sequestration

Carlos Moreira Miquelino Eleto Torres

Carbon storage in three silvopastoral systems with different genetic materials

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Greenhouse Gas fluxes from beef cattle grazing systems in the tallgrass prairie

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Introduction Under a changing climate, the sustainability of beef production is uncertain and the impact it has on climate change itself is not well known. We do know that greenhouse gases (GHG), such as methane (CH4), carbon dioxide (CO2), and nitrous oxide (N2O) are expected in this system. Knowing the concentration of the gases over time would allow for interpretation of the overall impact of beef grazing systems on GHG's.

Material and Methods

Gas samples were obtained from three treatments at the Konza Prairie Biological Station, a long term ecological research area that focuses on fire, grazing, and climatic variability. Each had a cow-calf operation at the same stocking rate and different burning regimens. These regimens included yearly burning, and burning every three years on offset years.

Results and Conclusions

The 2014 derived data implies a net uptake of CH4, some uptake of N2O, and continuous emission of CO2. This is different from other agricultural practices because the grazing systems lack the input of fertilizer and therefore absorb more CH4 than they emit, in addition to some N2O. Statistical analysis of the data showed significant interactions ($p<0.05$) between date and treatment for all three gases. This indicates that the effect of treatment was different over sampling dates. These findings provide evidence that the resilience of beef production can be enhanced through different management practices but also that grazing systems provide a sink for GHGs such as CH4 and possibly N2O.

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Charles W. Rice

Greenhouse gas fluxes from beef cattle grazing systems in the tallgrass prairie

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Brazilian Agribusiness - Greenhouse Gas Emission Profile and public policies for GHG mitigation

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Introduction Historically, the second larger greenhouse gas emitter in Brazil was the forest sector. After years of command and control policies together with a stronger monitoring, the forest sector is now the third GHG emitter, with the agribusiness sector ranked as the second. This presentation will aim at presenting the agribusiness profile and the existing public policies

Material and Methods

The presentation will use the Reference Report of the agribusiness sector for the Third National Communication of Brazil to the UNFCCC and the Low Carbon Agriculture Plans as the public policies aiming at mitigating GHG.

Results and Conclusions

Sectors	1990	1995	2000	2005	2011	2012	Variation	
	Gg CO_2eq						1995-2005	2005-2012
Energy	187.739	227.604	298.611	328.377	407.544	446.154	44,3%	35,9%
Industrial Process	52.537	63.065	71.674	77.943	86.173	85.365	23,6%	9,5%
Agribusiness	303.772	335.775	347.882	415.724	449.853	446.445	23,8%	7,4%
Forest	815.965	1.940.420	1.343.136	1.179.067	310.486	175.685	-39,2%	-85,1%
Waste	29.061	33.677	38.517	41.887	48.139	49.775	24,4%	18,8%
TOTAL	**1.389.074**	**2.600.543**	**2.099.820**	**2.042.998**	**1.302.195**	**1.203.424**	**-21,4%**	**-41,1%**

Fonte: MCTI, Estimativas anuais de emissoes de gas de efeito estufa.

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Cintia Mara Miranda

Brazilian agribusiness - greenhouse gas emission profile and public policies for GHG mitigation

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Nitrous oxide emission factors for urine and dung deposited on grazed pastures in Southern Brazil

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Introduction

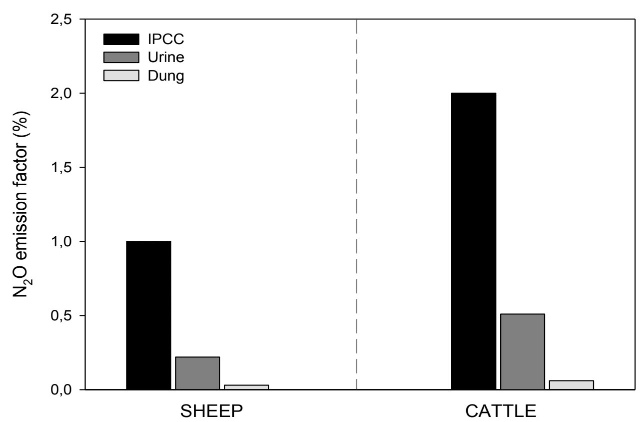
Grazed pastures has great impact on global N_2O emissions for providing sources of N by animal`s excreta. In subtropical environments as in southern Brazil, there is little information over the emission factors (EF) of N_2O grazing animals excreta (urine and dung), and if these EFs are according to the IPCC guidelines (Sheep 1% and Cattle 2% for total excreted N on pastures). In a two different grazing systems in Southern Brazil (sheep integrated crop-livestock system - ICLS and cattle in natural grassland), we conducted field trials to evaluate the N_2O emission factors (EF) for urine and dung from sheep and cattle deposited on grazed pastures under subtropical conditions.

Material and Methods

Field experiments were installed in an ICLS and natural grassland areas at the experimental station of Federal University of Rio Grande do Sul. The ICLS trial was set in a 3 short field trials in the 2009, 2010 and 2013 years (about 40 days each) with soil deposition of different sheep urine doses and dung. Natural grassland trial was carried out in a 1-year trial (2013/14) with single cattle urine and dung dose applied on soil under two herbage allowance. In both experiments, we have control treatment, with no N excreta addition. Soil N_2O fluxes were measured by static chamber technique and the N_2O concentrations determined by gas chromatography analysis (GC-Shimadzu 14A).

Results and Conclusions

Fig. 1. Direct N_2O emission factors for sheep and cattle excreta.



In ICLS trials, soil N_2O fluxes varied from -47 to 976 g N_2O-N m^{-2} h^{-1}, and in the all trials were observed emission peaks until 16 days only after urine application. In 1 year-trial, N_2O emission peaks were observed up to 40 days after urine treatment application. The average EF for sheep dung (0.03%) was lower than sheep urine (0.22%). The same was found in 1-year trial, EF from cattle urine was of 0.51%, much higher than dung (0.06%). In addition to lower EF values for subtropical region of Brazil than IPCC values, our results evidenced that distinct values of EF should be applied for urine and dung from sheep and cattle.

Diego Fernandes de Bastos

Nitrous oxide emission factors for urine and dung deposited on grazed pastures in southern Brazil

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Three years of integrated crop-livestock-forest system did not change soil C stocks in the Brazilian Amazon region

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Introduction
Soil conservation practices have been considered as an important key factor to increase soil C stocks. In the tropics, tree-based land use systems are expected to have higher soil C sequestration potential than crop agricultural systems.
Material and Methods
The sampling areas were located on experimental field at the Embrapa Agrosilvopastoral Research Center (11°51'S, 55°35'W; 384 m asl) in Sinop-MT, Brazil, with mean annual temperature of 25˚C and precipitation of 2.550 mm. Treatments comprised 3 years cultivation of: eucalyptus plantation; no till system with soybean crop, followed by corn intercropped with *Brachiaria brizantha* 'Marandu'; *B. brizantha* pasture; integrated crop-livestock-forest (ICLF) system; and native forest as a control area. Soil samples were taken in the first 30 cm depth for determination of total C and N contents. Stocks of C and N were estimated on the basis of an equivalent soil mass as described by Sisti et al. (2004).
Results and Conclusions

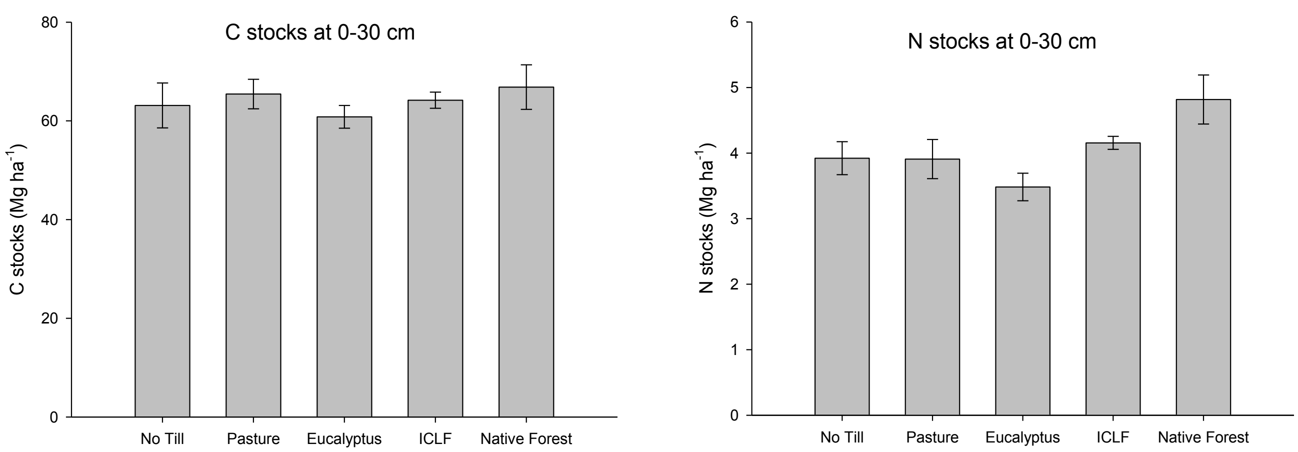

Fig.1. C and N stocks in soil under different land use systems in the 0-30 cm layer. Vertical bars represent the standard error (n = 4)

Three years of integrated crop-livestock-forest system did not change soil C stocks, however N stocks were higher than eucalyptus plantation. This result indicates that ICLF could be promising to improve soil nutrient cycling. Furthemore, longer time period is required to identify the effects of conservation practices to contribute to increase soil C stocks.
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Eduardo da Silva Matos

Three years of integrated crop-livestock-forest system did not change soil C stocks in the Brazilian Amazon region

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Carbon balance in two farm with silvopastoral systems at Porto Firme, Minas Gerais, Brazil

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Introduction

The tree component of silvopastoral systems works as potential carbon sinks., However, although there are already some studies about quantification of carbon in such systems, there is still lack of information on the carbon balance in them, given the wide variety of possible arrangements in terms of species, spacing, developed activities, etc. Therefore, in order to contribute to the promotion of public policies within the Low Carbon Agriculture Plan (ABC) of the Brazilian government, carbon balance was evaluated in two farms with silvopastoral systems (Brasil, 2011).

Material and Methods

The study was conducted in two farms with silvopastoral systems (Eucalyptus + Brachiaria) in Porto Firme, in the Zona da Mata Mineira, Brazil. Forest aboveground biomass was estimated in the *Eucalyptus grandis* x *Eucalyptus urophylla* clone, at 60 and 96 months, spaced 6 x 4 and 8 x 4 m, respectively. We used the indirect method for the forest biomass quantification . GHG emissions were derived from agricultural activities (nitrogen fertilization) and livestock (enteric fermentation and manure management). Emissions were estimated based on IPCC Guidelines for National Inventories of Greenhouse Gases.

Results and Conclusions

The systems of the two farms had positive carbon balance (Figue 1).

Figure 1 - Annual carbon balance in two farms with silvopastoral systems in Porto Firme, MG

Farm	Spacing	Age (months)	IMACO$_{2q}$ (t CO_{2e} ha^{-1} ano^{-1})	Emissions (t CO_{2e} ha^{-1} ano^{-1})	Balance (t CO_{2e} ha^{-1} ano^{-1})
1	6 x 4	60	22,07	1,16	+ 22,45
2	8 x 4	96	20,75	1,21	+ 19,54
Mean			**22,18**	**1,18**	**+ 20,99**

In Silvopastoral System of Farm 1, at 60 months and 6 x 4 m spacing a surplus of 22.45 t CO_{2e} ha^{-1} yr^{-1} corresponding to 321 trees was observed. In the Farm 2, at 96 months and spacing 8 x 4m, the surplus was of 19.54 t CO_{2e} ha^{-1} yr^{-1}., Corresponding to 130 trees. Thus, it is concluded that the silvopastoral systems and the ability to be carbon neutral, contribute effectively to neutralize emissions from other activities and thereby reduce the concentration of greenhouse gases in the atmosphere.

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Eliana Boaventura Bernardes Moura Alves
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Carbon growth dynamic and carbon offset potential of the tree component in agroforestry systems at Viçosa, Minas Gerais, Brazil

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Introduction

Due to the government and farmers demand for production models that allow a positive carbon balance, there is a growing need for further studies related to carbon storage potential in agroforestry systems. Thus, the aim of this study was to determine carbon growth dynamic and carbon offset potential of the tree component in agroforestry systems at Viçosa, Minas Gerais, Brazil.

Material and Methods

The study was conducted in agroforestry systems, whose total area is divided into 5 areas implemented between 2007 and 2009 and with different compositions of agrosilvopastoral and silvopastoral systems. The agrosilvopastoral systems are: System 1 (2007): Maize (*Zeya mays*) + pasture (*Brachiaria decumbens*) + eucalypt clone - 8x3m (*Eucalyptus saligna*); System 2 (2008): Bean (*Phaseolus vulgaris*) + pasture (*B. decumbens*) + eucalypt clone - 8x3m (*E. urophylla* X *E. grandis*); System 3 (2009): Bean (*P. vulgaris*) + pasture (*B. decumbens*) + eucalypt clone - 8x3m (*E. urophylla* X *E. grandis*). The silvopastoral systems are: System 4 (2008):Pasture (*B. decumbens*) + eucalypt clone - 8x3m (*E. urophylla* X *E. grandis*); System 5 (2009):Pasture (*B. decumbens*) + eucalypt clone - 8x3m (*E. urophylla* X *E. grandis*). In 2012, 2013 and 2014 a random sampling was conducted and the volume of the stand was determined by the Schumacher and Hall model. In order to determine the carbon growth dynamic level of settlement, the models Gompertz and Logistic were adjusted.

Results and Conclusions

It was found that the logistic model was the best in describing the carbon growth behavior, at the level of settlement, in the agroforestry system and was estimated that this growth will stabilize at approximately 125 t C ha^{-1} near to 130 months (Table 1).

Table 1: Parameters, correlation and residual standard error for Logistic and Gompertz models for carbon growth

Logistic					Gompertz				
α	β	γ	$r_{\hat{y}y}$	$s_{y.x}$	α	β	γ	$r_{\hat{y}y}$	$s_{y.x}$
125.6680	31.8411	0.0478	0.8307	11.3350	215.0337	1.5880	0.0190	0.8325	11.2781

Both models showed similar correlation coefficient ($r_{\hat{y}y}$) and residual standard error ($s_{y.x}$). However, the curve behavior and biological interpretation were determinants factors for choosing the model. Based on the logistic model, it was also found that the maximum mean annual increment of carbon in settlement occur near the 96 months, with 11.88tC ha^{-1} year^{-1}. Thus, it was concluded that carbon storage by tree component has the potential to contribute to the mitigation of greenhouse gas emissions from the farm.

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To FAPEMIG and CNPq for financial support. And the professor and producer Lino Roberto Ferreira to make their property available to the research.

Eliana Boaventura Bernardes Moura Alves

Carbon growth dynamic and carbon offset potential of the tree component in agroforestry systems at Viçosa, Minas Gerais, Brazil

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Variability of Nitrous Oxide and Methane emissions from soils under Eucalyptus forests in the Cerrado (Brazilian savanna)

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Introduction: *Eucalyptus* sp is one of the most promising genuses to provide forest canopy for Integrated crop-livestock-forest systems in the Brazilian savanna - Cerrado. Despite the high carbon sink potential in Eucalyptus timber, little is known about green house gases emissions from this category of forest, such as nitrous oxide (N_2O) and methane (CH_4). In this context, the purpose of this study was to evaluate the small-scale spatial variation of N_2O and CH_4 soil emissions from soils under Eucalyptus forests in the Cerrado.

Material and Methods

The study was performed at the rural settlement Quebrada dos Neres, Paranoá – DF, Brazil in a Clayey Oxisol (Typic Haplustox). The experiment was carried out on two eucalyptus forests (*Eucalyptus urophylla* x *Eucalyptus grandis*) denominated treatments: EAC 1528 clone planted in 2011 (**Eucalyptus 1**) and GG100 clone planted in 2009 (**Eucalyptus 2**). Treatments were disposed in three pseudo-plots in which soil fluxes of N_2O and CH_4 were evaluated by four static manual chambers laid out in pairs both within the row and inter row spacing. Air sampling events of N_2O and CH_4 fluxes were performed from Jan-Feb/2014 and samples were analyzed by gas chromatography.

Results and Conclusions

Tab. 1. Greenhouse gases monitoring in eucalyptus forests: mean, mean standard deviation (SD) and confidence intervals for row (A and B) and inter row spacing (C and D) positions.

Parameters	Eucalyptus 1				Eucalyptus 2			
	---------------------------- $N\text{-}N_2O$ $\mu g\ m^{-2}\ h^{-1}$ --							
	A	B	C	D	A	B	C	D
Mean	1.29	3.85	0.48	-0.46	4.36	2.33	4.20	4.45
SD	1.05	2.94	0.60	1.54	2.97	1.43	2.03	13.35
CI 95%	-1.9 to 8,4	-0.8 to 13.3	-3 to 18	2.6 to 12.9	-0.6 to 2.9	0.1 to 10.8	-4.6 to 5.4	-4.2 to 22.9
	- ---------------------------- $C\text{-}CH^{4}$ $\mu g\ m^{-2}\ h^{-1}$ --							
Mean	-78.07	-87.66	-33.39	6.17	-21.12	-14.22	-25.23	-22.21
SD	21.36	20.97	11.26	29.88	17.29	10.60	16.25	10.70
CI 95%	-113 to -35.3	-49.9 to 7.6	-117.8 to -57.5	-28.9 to 0.5	-77 to 10	-51.5 to 1	-75 to 58	-34.8 to -5

Overall results evidenced spatial variations, low N_2O and generally negative CH_4 flux rates. These findings indicates that soils from three and a half to to six years old Eucalyptus forests act as a CH_4 sink and it is imperative to identify biological underlying controls of site spatial variability to accurately quantify ecosystem fluxes.

Acknowledgements: To Embrapa

Fabiana Campos Ribeiro

Variability of nitrous oxide and methane emissions from soils under eucalyptus forests in the Cerrado (Brazilian Savanna)

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N_2O emissions from integrated crop-livestock system with sorghum as the off-season crop

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Introduction Integrated crop-livestock systems have been adopted in several agricultural regions of Brazil. However, due to climatic and economic conditions of each region, this production system can vary regarding the crop-pasture sequences and the use of tillage and no-tillage methods. Therefore, studies that monitor the benefits of integrated systems such as the accumulation of soil organic matter and the mitigation of greenhouse gases (GHGs) are essential to characterize the different biomes. Nitrous oxide (N_2O) is a major GHG and its concentration in the atmosphere has increased due to the use of nitrogen (N) fertilizers in agriculture and the deposition of urine and excreta of animals raised on pasture. The objective of this study was to evaluate fluxes of N_2O emissions and mitigation potential in an integrated crop-livestock system compared with continuous crop systems in the Cerrado biome.

Material and Methods The experiment was conducted at Embrapa Cerrados (Planaltina-DF) in a long-term experiment established in 1991 as a randomized block design. The treatments were: continuous crop system under no-tillage (NT), continuous crop system under conventional tillage (CT), integrated crop-livestock system under no-tillage (ICL) and Cerrado native as a reference (CER). Measurements of N_2O emissions started in 03/21/2014, after the soybean harvest and the planting of *Sorghum bicolor* (BRS 332) in the off-season. For the ICL and NT systems, *S. bicolor* was intercropped with Piatã (*Brachiaria brizantha* cv. Piatã). At *S. bicolor* planting, the experimental plots were fertilized with 20 kg N ha^{-1}, 150 kg P_2O_5 $ha^{-1}$and 80 kg K_2O ha^{-1}. At the side-dressing application (4/24/14), the plots received 80 kg N ha^{-1} in the form of urea. Closed static chambers were used for measurement of N_2O flux and the concentrations of N_2O were determined by gas chromatography.

Results and Conclusions. The highest values of N_2O fluxes were observed after fertilization events (planting and side-dressing), which are indicated by the arrows in Figure 1A. These peaks also tend to coincide with rainfalls that raised the water-filled pore space (WFPS) to values between 60 to 75%, favoring the production of N_2O by nitrification or denitrification (Figure 1). The CT, after the application of fertilizers, showed increases of N_2O fluxes approximately 67% higher than those from the other systems. The higher emissions in CT were possibly influenced by the conventional tillage operations, and consequently the decomposition rate of soybean residues (CRUVINEL et al., 2011), that have a low C:N ratio. Thus, these finding indicate that NT and ICL can mitigate N_2O emissions from agricultural soils.

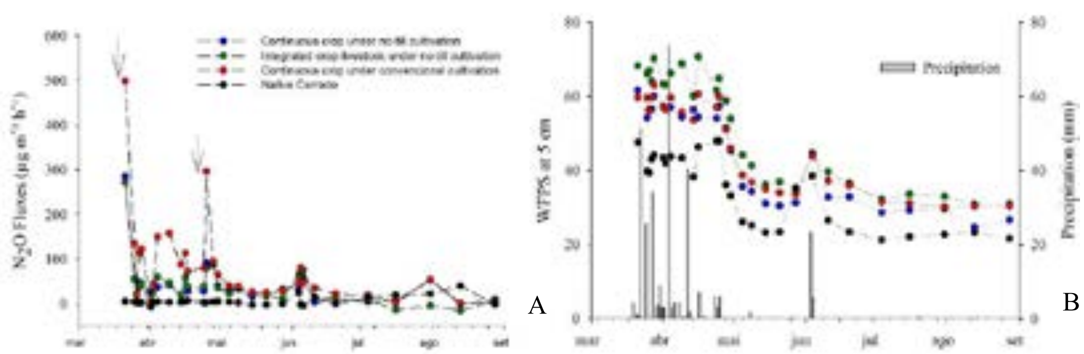

Figure 1. A. N_2O fluxes in the off-season period for different management systems in the Cerrado biome. B. Water filled pore space (%) and daily rainfall (mm).

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Atmospheric Emissions of Greenhouse Gases from Manure and Nitrogen Fertilizers

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Introduction Increasing demand for food and agricultural products directly relates to increased GHG emissions, particularly for the three primary gases associated with agriculture [nitrous oxide (N_2O), carbon dioxide (CO_2), and methane (CH_4)]. Commercially available enhanced-efficiency N fertilizers such as those containing nitrification inhibitors, urease inhibitors, and slow-release fertilizers can potentially increase the N-use efficiency by crops and reduce N losses. Therefore, alternative nitrogen fertilizers that produce low greenhouse gas (GHG) emissions after application are needed to improve N use efficiency and to reduce the impacts of agricultural practices on climate change.

Materials and Methods

Two-year field experiments were conducted in which corn was grown for grain on a Crider silt loam soil in Kentucky, USA (36^O 59'25'' N; 86^O 26'37'' W). We quantified and compared growing season fluxes of N_2O, CH_4, and CO_2 resulting from application of 168 kg N ha^{-1} from six inorganic chemical N fertilizers and poultry manure (based on 55% N availability of manure for plant uptake). The nine treatments evaluated in this study consisted of, dry granular urea (46% N), liquid urea-ammonium nitrate (UAN) (28% N), ammonium nitrate (NH_4NO_3) (34% N), ESN (ESN is a controlled-release polymer-coated urea, 44% N), SuperU (46% N), UAN + AgrotainPlus (28% N), poultry litter (3% N), poultry litter + AgrotainPlus (3% N), and a control treatment that received no chemical fertilizer or poultry litter. We quantified and compared growing season fluxes of N_2O, CH_4, and CO_2 resulting from applications of different N fertilizer sources in a no-till corn (*Zea mays* L.) production system. Greenhouse gas fluxes were measured during two growing seasons using static, vented chambers.

Results and Conclusions

ESN delayed the N_2O flux peak by 3 to 4 weeks compared to other N sources. No significant differences were observed in N_2O emissions among the enhanced-efficiency and the traditional inorganic N sources except for ESN in 2009. Cumulative growing season N_2O emission from poultry litter was significantly greater than from inorganic N sources. The N_2O loss (2yr average) as a percentage of N applied ranged from 0.69% for SuperU to 4.5% for poultry litter. The CH_4-C and CO_2-C emissions were impacted by environmental factors such as temperature and moisture more than the N source. There was no significant difference in corn yield among all N sources in both years. Site specifics and climate conditions may be responsible for the differences between the results of this study and some of the previously published studies. Our results demonstrate that N fertilizer source and climate conditions need consideration when selecting N sources for greater use efficiency and to reduce GHG emissions.

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Nitrous oxide and methane emissions from beef cattle feedyard pen surfaces in the High Plains of Texas

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Introduction Accurate estimation of greenhouse gas (GHG) emissions, including nitrous oxide (N_2O) and methane (CH_4) from open-lot beef cattle feedlots is an increasing concern given the current and potential future reporting requirements for GHG emissions. Research concerning N_2O and CH_4 emission fluxes from the manure management system at feedlots, however, has been very limited.

Material and Methods
This study was conducted to quantify the N_2O and CH_4 flux rates from pen surfaces at two commercial beef cattle feedlots in the High Plains region of Texas during 2013. Fluxes from pen surfaces were measured using 219 mm i.d., non-flow-through non-steady-state (NFT-NSS) chambers on 25 sampling days at 12:00 pm (US Central Standard Time) during spring and fall, in five 5-d measurement campaigns. Ten chambers were arranged in two rows of five, strategically covering representative areas of the pen, including areas near feedbunks and water troughs of a recently vacated pen. Headspace samples were collected from the chambers at 0, 10, 20 and 30 min using 20 ml polypropylene syringes, transferred to evacuated 12 mL Exetainer vials, and analyzed using a gas chromatograph. From the N_2O and CH_4 concentrations, flux densities were calculated using the Quad method.

Results and Conclusions
Nitrous oxide fluxes varied considerably across the pen surface, generally being higher on manure mounds and at the toe slope of manure mounds. Nitrous oxide and methane fluxes generally increased with increasing manure pack temperature. Results showed the expected spatial and temporal variability within pens and were in the same range as those recorded by other investigators. Reflecting the prevailing dry conditions during the campaigns, many N_2O and CH_4 flux rate measurements were very low and towards to lower end of recorded ranges.

Mean N_2O fluxes for each 5-d campaign were 0.46 [0.00-7.26], 0.02 [0.00-0.07], 2.09 [0.03-7.69], 2.10 [0.00-12.50], and 0.38 [0.00-3.71] mg N_2O m^{-2} h^{-1}, respectively. Methane fluxes were generally low under the dry conditions experienced during the study but were considerably higher from moist areas and somewhat higher over manure mounds. Mean CH_4 fluxes for each 5-d campaign were 0.93 [0.00-14.90], 10.57 [0.00-127.86], 8.99 [0.00-116.13], 0.24 [0.00-3.74], and 0.34 [0.00-1.60] mg CH_4 m^{-2} h^{-1}, respectively. Further ongoing work is investigating flux rates in other seasons and identifying contributing factors.

Acknowledgements
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Soil carbon stocks in integrated crop-livestock-forest and integrated crop-livestock systems in the Cerrado region

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Introduction The land use change is considered the second leading cause of carbon (C) emissions after fossil fuel consumption. The integrated crop-livestock (ICL) and crop-livestock-forest (ICLF) system associated with no-tillage are considered suitable alternatives to improve land use efficiency and reduce greenhouse gas (GHGs) emissions. The objective of this study was to evaluate the adoption of ICL and ICLF systems on the evolution on soil carbon stocks in the Cerrado region.

Material and Methods
The study was conducted at Embrapa Cerrados Research Center, Brasília, DF, Brazil. The soil was classified as Oxisol. The experiment was established in 2009 in a randomized complete block design with three replicates. The treatments consisted of two systems: ICL and ICLF (plant trees spacing of 2 x 2 m and spacing between alleys of 22 m). The sequence of cultivation the systems were soybean crops in 2009/2010 , 2010/2011 and 2011/2012 agricultural years and in succession to soybean in the 2012 off-season growth the sorghum was cultivated intercropped with *Urochloa brizantha* (syn. *Brachiaria brizantha*) cv. Piatã. In 2012 and 2014 soil samples (0-5, 5-10 cm, 10-20, 20-30, 30-40, 40-60, 60-80, 80-100 cm depth) were collected in three replicates from the treatments to characterize bulk density and carbon contents measured by elemental analysis . An adjacent native area of Cerrado vegetation were sampled as a reference. C stocks were calculated using equivalent soil mass approach according Sisti et al. (2004).

Results and Conclusions
The interaction between the treatments was not significant. Comparing stocks from 2012 to 2014 there was a significant increase of 9.51 Mg ha^{-1}(p < 0.10) in the ICL treatment. ICLF system also presents an increase of 6.72 Mg ha^{-1} in the soil C stock. The soil C stock in Cerrado was 199 Mg ha^{-1}. After the fifth year with agriculture in both systems, despite experimental area was previously occupied by low productivity pasture, the C stock was smaller than the original condition in the Cerrado.

Table 1. Evolution of soil C stocks up to 100 cm depth under ICL, ICLF from 2012 to 2014.

System	Soil C Stocks (Mg ha^{-1})	
	2012	2014
ICL	137,85	146,76
ICLF	139,61	146,33
Mean	138,43 b	146,54 a

Means in the same line followed by the differents letters are significantly different at p < 0.10 according to Tukey test.

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GHG emissions and C sequestration

Kleberson Worsley Souza

Soil carbon stocks in integrated crop-livestock-forest and integrated crop-livestock systems in the Cerrado region

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Soil carbon and nitrogen content under rotation of corn/cover crops with potential use for integrated crop−livestock systems in the Cerrado region

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Introduction The soil management associated with certain agricultural practices such as crop rotation and cover crops, such as preconized in no tillage system (NTS), promotes significant changes in the dynamics of soil organic matter (Moreti et al., 2007). The integrated crop-livestock (ICL) system can be an important alternative to pasture recovery, increasing straw production for NTS and improving soil chemical, physical and biological characteristics. The objective of this study was to assess the carbon and nitrogen levels in the soil under NTS with cover crops use in the Cerrado region.

Material and Methods The work was carried out at the Embrapa Cerrados Research Center, Planaltina, DF, Brazil. The soil is an Oxisol. In the agricultural year 2005-2006 started the experiment of cover crops /corn rotation. The following cover crops were interspersed in the off season: *Canavalia brasiliensis* (C.B.), *Triticum aestivum* (T.A.), *Cajanus cajan* (C.C.), *Mucuna pruriens* (M.P.), *Pennisetum glaucum* (P.G.), *Crotalaria juncea* (C.J.), *Sorghum bicolor* (S.B.), *Urochloa ruziziensis* (syn. *Brachiaria ruziziensis*) (U.R.), *Raphanus sativus* (R.S.), and spontaneous vegetation (S.V.). Corn was cultivated with and without N topdressing fertilization. Soil samples were collected at depths of 0-5, 5-10; 10-20; 20-40; 40-60; 60-80 and 80-100 cm. The soil sampling was carried out in the year of 2012, after cover crops cutting and before sowing corn. Soil carbon and nitrogen analysis was carried out with elemental analyzer.

Results and Conclusions:

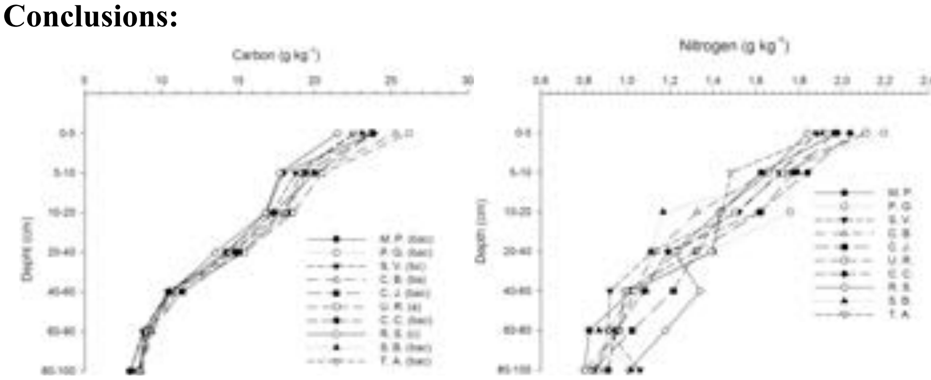

Fig.1-Soil carbon and nitrogen content (g kg^{-1}) under different treatments of cover crops. Different letters among the treatments showed significant difference at 5% probability by Tukey test.

There was a significant difference (p<0.05) among treatments for carbon content. The treatment with *Urochloa ruziziensis* obtained the highest carbon values. Spontaneous vegetation and *Raphanus sativus* showed smaller soil C values. These results demonstrate that pastures or cover crops such as *Urochloa,* since that follows good agronomic practices have potential to increase soil carbon content. Low lignin contents and the amount of aerial and root biomass produced (Carvalho et al., 2012) of *Urochloa ruziziensis* should favor this accumulation of soil C. Soil nitrogen contents did not showed significant variation.

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Luís Fernando Stone
Enzyme activity as quality indicator of soil under agroforestry systems in the Brazilian Cerrado
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Enzyme activity as quality indicator of soil under agroforestry systems in the Brazilian Cerrado

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Introduction Agroforestry production systems (APS) can be considered a way to produce causing low environmental impact. Besides, APS can be advantageous over conventional agricultural management, since they can offer increased productivity, economic benefits, and more diversity by increasing the possibilities of use a greater number of crops in an economic way. In this presentation, we report the effects of 4 years of two APS installed in the Brazilian Cerrado on soil enzyme activity.

Material and Methods

Two APS with focus on the production of grains (common bean and maize) and energy (sunflower and sesame) were installed in an area of grain production (16°29' S, 49°17'W, 787 m alt) at the Embrapa Rice and Beans Research Center, Santo Antônio de Goiás, in 2010. The trees composing the APS were: angico, baru, aroeira, cagaita, angelim, farinha seca, ingá, and pequi. Grain and energy crops were sown in the tree interlines after crotalaria, sorghum and fallow, as soil covering. Soil samples were taken in 0-20 cm layer, in the plots and in the tree lines, and total enzyme activity (FDA), b-glucosidase and acid phosphatase were determined as described by Ferreira et al. (2011) and compared to those under the native vegetation.

Results and Conclusions

Over a 4-year period, the treatments in continuous cropping APS with energy crops showed lower differences among them, but higher differences from the forest as compared to APS with grain crops (Fig. 1). Within the plots of grain crops (Fig. 1B), treatments with crotalaria and maize tended to group together, while common bean after sorghum and fallow formed another group.

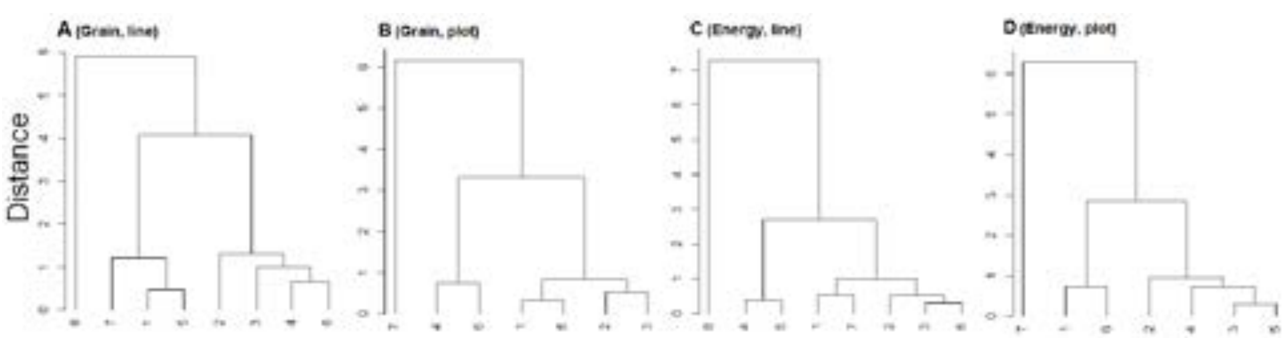

Fig. 1. Clustering dendrogram of treatments under APS for grain production (A and B) and energy (C and D). Treatments in the line of trees (A and C): 1- angico/baru, 2- aroeira/baru, 3- aroeira/cagaita, 4- angelim/cagaita, 5- angelim/pequi, 6- farinha seca/pequi, 7- ingá and 8- forest. Treatments in the plots of grain APS (B): 1- crotalaria/maize, 2- crotalaria/bean, 3- sorghum/maize, 4- sorghum/bean, 5- fallow/maize, 6- fallow/bean, and 7- forest. Treatments in the plots of energy APS (D): 1- crotalaria/sesame, 2- crotalaria/sunflower, 3- sorghum/sesame, 4- sorghum/sunflower, 5- fallow/sesame, 6- fallow/sunflower, and 7- forest. Data are means of 4 replicates.

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Nitrous oxide and ammonia emissions from N fertilization of maize crop under no-till in a Cerrado soil

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IntroductionThe low natural fertility of Oxisols in the Cerrado region makes some crops in this region very dependent on high rates of synthetic N-fertilizers, which are of growing environmental concern as a major source of N_2O emissions in agriculture.

Material and Methods

In a field experiment, we quantified direct N_2O emissions and NH_3 volatilization (a source of indirect N_2O emissions) from surface-applied N fertilizer on a no-till maize (*Zea mays* L.) crop in Cerrado biome. We used four fertilizers at a rate of 120 kg N ha^{-1} as topdress-N (V4-V6 growth stage), which were regular urea, urea+zeolite, calcium nitrate and ammonium sulfate, and a non-top-dressed control.

Results and Conclusions

Table 1. N_2O emission from N-fertilizers applied to no-till maize in an Oxisol in the Cerrado region and the respective estimates of the fraction of the fertilizer N lost as N_2O.

Treatment	Cumulatedemission (mg N_2O m^{-2})	Cumulated Emission/yield (g N_2O Mg^{-1} grains)	Emissionfactor (kg N-N_2O kg^{-1} N-fertilizer)
Ammonium sulfate	113±14 a	171±19 a	0.0027±0.0008 a
Calcium nitrate	102±14 ab	162±24 a	0.0020±0.0006 a
Urea+zeolite	97±4 ab	149±5 a	0.0020±0.0002 a
Urea	81±13 ab	127±23 a	0.0013±0.0005 a
Control	64±4 b	108±8 a	-
Mean	91	144	0.0020
	Confidence interval (α = 0.05)		(0.0014-0.0026)

Means (± standard errors) followed by different letters are significantly different based on Tukey's HSD test (α = 0.05).

The total N losses as volatilized NH_3 ranged from 2.2% (calcium nitrate) to 4.5% (urea+zeolite). The N loss as volatilized NH_3 from urea was very low (3.2%), with no significant difference between urea+zeolite, ammonium sulfate and calcium nitrate. Significantly higher cumulated N_2O emissions were observed with ammonium sulfate than with the control. No significant differences among fertilizers were found for emission factor (EF), which was 0.20% on average (0.14-0.26%), indicating that use of IPCC default EF (1.00%) would substantially overestimate N_2O emission. Free drainage and acidity of Oxisols and occurrence of dry spells, known as '*veranicos*', are characteristics of Cerrado biome that may naturally mitigate N_2O emissions.

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Marcio dos Reis Martins
Nitrous oxide and ammonia emissions from N fertilization of maize crop under no-till in a Cerrado soil
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Changes in the humification degree as soil organic matter decomposes

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Introduction Climate change is a serious issue nowadays and can impact agricultural production worldwide, especially in Brazil. Aiming at developing a sustainable agricultural production and mitigating the emission of greenhouse gases, the Brazilian government has established the National Policy on Climate Change (NPCC) and the Low Carbon Agriculture Plan (ABC). Also, renowned research institutions such as Embrapa and the ARS-USDA have shown concern in the subject and have been coordinating major projects such as Fluxus, Pecus and Saltus (Embrapa) and GRACEnet (ARS), conducting several long-term field experiments in crop, livestock and forestry. However, field studies are labor intensive and expensive and require a long monitoring period. A more viable alternative to assess the impacts of production systems in greenhouse gas emissions is through modeling and simulation. The advantage of using models is to test various scenarios such as, changes in land use, reduced precipitation and increased temperature. The modeling is, therefore, an important tool for assessment of environmental impacts and can be used for decision-making and for credit line such as the ABC Plan. Despite their advantages, C-process models generally divide the soil organic matter (SOM) according to the decomposition rate in in three compartments: active, slow and passive, whose contents cannot be measured directly. Because of these limitations, the main purpose of this work was to evaluate the relationship between decomposition rate and evolution of SOM humification degree in incubation experiments with controlled temperature and humidity conditions.

Material and Methods

The soil sample used in the experiment was collected from the surface (0-10cm) of native vegetation at Embrapa Southeast Livestock, São Carlos, SP, Brazil. The sample was sieved at 2 mm and homogenized. Since the sample was wet, no pre-incubation step was necessary. The sample was divided into 65 flasks of 100 g each, 5 replicates for 13 soil analyses, corresponding to one time period (1, 2, 4, 7, 12, 18, 25, 33, 39, 45, 53, 66, and 84 days after the incubation). For each soil analysis, CO_2 emission was collected with a syringe from the replicates and measured by a FTIR analyzer. The replicate soil samples were ground and sieved at 100 mesh for carbon analysis by dry combustion and for the analysis of laser induced fluorescence spectroscopy (LIFS) to evaluate the humification degree (H_{FIL}) of SOM, described in Milori et al. (2006).

Results and Conclusions

In this experiment, we found that H_{FIL} increased 8% in relation to the beginning of the experiment, while the soil emitted 780 ppm of CO_2 during the same period. The average CO_2 emission and H_{FIL} increase rates were ~2 ppm/h and ~2 H_{FIL} unity/h, respectively, meaning that each ppm of CO_2 emitted corresponded to the increase of one H_{FIL} unity. Since most of the organic matter was fresh, the amount of CO_2 emitted is mainly the result of the decomposition of the active compartment. Knowing the mass lost during this period, we may infer the conversion rate of active into slow SOM compartments. Further analyses are required to better understand the conversion between all compartments.

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Acknowledgements

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Paulino Ribeiro Villas Boas

Changes in the humification degree as soil organic matter decomposes

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NITROUS OXIDE EMISSIONS IN EUCALYPTUS PRODUCTION UNDER MONOCULTURE AND INTEGRATED SYSTEMS IN SINOP /MT

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Introduction The main cause of climate change is the increase in greenhouse gases (GHG) emissions caused by activities such as agriculture, and nitrous oxide (N2O) is one of the main gases emitted by these activities. Therefore, the objective of this study was to evaluate N2O emissions of Eucalyptus urograndis under monoculture and integrated production systems.

Material and Methods

The study was conducted in the experimental area of Embrapa Agrosilvopastoral, Sinop, MT and consisted of monoculture forest (F) with the hybrid Eucalyptus urograndhis (H13) and integrated systems combining pasture and crop to the F. Nitrous oxide samples were taken once a week, from November 2013 to October 2014 by the closed static chamber technique, the concentrations were determined by a gas chromatograph and the fluxes were calculated. During the sampling period, the internal temperature of the camera was measured, using athermo- hygrometer. The rainfall data were provided by the local weather station.

Results and Conclusions

It was recorded a decrease in the emissions from the rain period to the dry season. In the relationship between monthly flow and precipitation, it was observed that the largest emissions occurred during the rainy season. Smaller flows were observed in the dry season, that was also the period with higher internal temperature rates inside the camera. The temperature did not influence the emissions directly, since its variation was small. It was possible to verify that system integration and eucalyptus monoculture can serve a good alternative N2O mitigation.

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Renato de Aragão Ribeiro Rodrigues

Nitrous oxide emissions in eucalyptus production under monoculture and integrated systems in Sinop/MT

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Enteric methane emission of Nellore cattle in extensive grazing or integrated systems

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Introduction

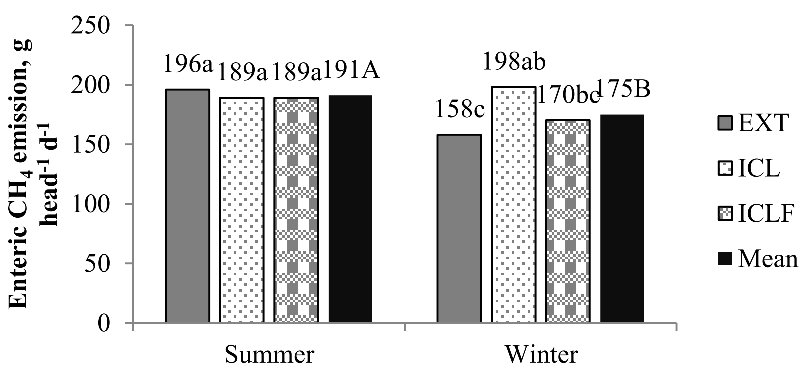
Brazilian beef cattle production is primarily based in grazing systems which in general present low productivity as a result of extensive monoculture pastures. Integrated systems come up as alternatives to overcome this scenario which in turn may have impacts on agricultural greenhouse gas emission. The aim was to evaluate the enteric methane emission of beef cattle grazing extensive pastures (EXT), integrated crop-livestock (ICL) and crop-livestock-forest systems (ICLF) in two seasons.

Material and Methods

The experiment was carried out at Embrapa Beef Cattle Research Center, in Campo Grande, MS, Brazil (20°24' S, 54°42'W, 560 m asl) in 2014. Treatments included: EXT – *Brachiaria decumbens,* established in 1992/1993, ICL – 3 years *Brachiaria brizantha* cv. BRS Piatã, following no-till soybean crop and ICLF - 3 years *Brachiaria brizantha* cv. BRS Piatã, following no-till soybean crop, in an area with 227 trees/ha, *Eucalyptus urophylla x E. grandis* planted in 2009. Twelve Nellore heifers (471±8 kg live weight, 3 years old) were randomly allotted to one of six paddocks (1 to 1.5 ha), two paddocks per treatment and had the enteric methane measured throughout two seasons (February 2014, Summer and August 2014, Winter), using the SF6 tracer gas technique, according to Primavesi et al. (2004). Season and treatment effects were analyzed using a mixed model with repeated measures and means were compared using Tukey-Kramer adjusted test ($p<0.05$).

Results and Conclusions

Fig. 1. Least square means for enteric methane (CH_4) emissions of Nellore heifers in different grazing systems and seasons (significant treatment x season effect, $p<0.05$).



Daily enteric methane emissions by beef cattle in grazing systems are greater in the summer than in the winter and differences between monoculture extensive pastures and integrated systems are pronounced only in the dry season.

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Rodrigo da Costa Gomes

Enteric methane emission of nellore cattle in extensive grazing or integrated systems

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Litter deposition in ICLF systems cultivated in the Cerrado region of Brazil

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Introduction

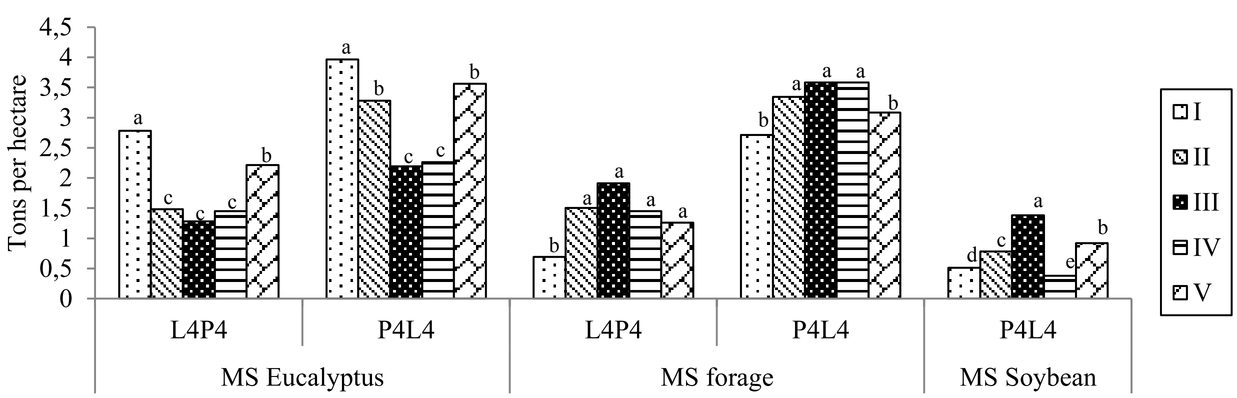
Plant residues on soil surface are commonly called litter, and it is important source to soil organic matter pool and nutrient cycling. Trees can be arranged in intercropping planting systems as rows, and often widely spaced to allow adequate crop yields in their understory. Litter deposition usually is variable, being plant senescence dependent, and soil fertility and humidity status. The objective of this study was to evaluate the amount of litter remained in five parallel transects established between single rows of eucalyptus in ICLF systems, cultivated in the Cerrado region of Brazil, with crops or pastures as intercropping.

Material and Methods

A trial was carried out at Embrapa Beef Cattle Research Center, Campo Grande, MS (20^o 26' S, 54^o 43'W, 530 m asl). The experiment was a RCBD, in split plot design, with an ICLF system composed by trees of *Eucalyptus urophylla* x *Eucalyptus grandis* (clone H13), in spatial arrangement of 14m x 2m (357 trees/ha), with two treatments, a) L4P4 (soybean cropping for 4 years followed by four years of pasture under grazing: litter was collected one year after forage establishment; and b) P4L4 (pasture under grazing four years followed by soybean cropping for 4 years: litter was collected after the 1st year of soybeans cropping in rotation with pasture). Litter sampling had eight replicates. Pasture forage under grazing was *Panicum maximum* cv. Massai. Litter samples were collected in five parallels transects lines (I to V) between rows of the eucalyptus, using a 1m² sampling square. The first transect was at 2m from eucalyptus plant rows and remaining transects spaced approximately 2.5m. After collection, samples were separated in: eucalyptus, forage and soybean residues, dried in a forced-air oven at 65°C, until constant weight, in order to calculate dry biomass, and subsequent quantity of litter material deposited in tons per hectare.

Results and Conclusions

Fig.1. Mean values of litter material (MS) in different crop-livestock-forest systems.



Results obtained show a pattern variation in litter deposition from the different sources of materials depending on distance from the tree rows. After the 1st crop of soybean there is a general increasing in the litter deposition in the respective ICLF system.

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To EMBRAPA, CNPq and FUNDECT for support and funding.

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Enteric methane emissions of Canchim steers in five crop-livestock-forest integrated system

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Introduction The adoption of integrated systems has increased in recent years, as the economic and environmental benefits are obtained by the best use of the area throughout the year and recovery of degraded areas. Moreover, these systems ensure animal welfare and provide better quality food, thus a differentiated feed efficiency. It is important to evaluate the effect of forage quality on enteric methane emissions. The objective of this study was to measure the enteric methane emission of Canchim cattle (synthetic breed 5/8th Charolaise) in crop-livestock-forest integrated systems.

Material and Methods

The study was conducted at Embrapa Southeast Livestock Centre, Canchim Farm, located in São Carlos, SP. A total of 30 castrated males of Canchim breed, with an average age of 18 months and average weight of 335 kg distributed in 5 grazing systems: intensive grazing (IGS), silvopastoral (SPS), integrated crop-livestock (ICL), integrated crop-livestock-forest (ICLF) and extensive grazing (EXT) systems. The systems were conducted with two experimental areas of approximately 3 hectares each, divided into 6 paddocks in which respect a period of occupation of six days and rest for 28 days, except extensive grazing in the pasture was continuous. The measurement of enteric methane occurred in February 2015, using the SF_6 tracer technique. This assessment was carried out for 5 consecutive days for 24 hours each. The concentrations of CH_4 and SF_6 were determined by gas chromatography to estimate CH_4 flow. Data was analysed using the PROC MIXED procedure of SAS (Statistical Analysis System, version 9.3) and averages were compared using Tukey's test with significant differences at $P < 0.05$.

Results and Conclusions

Table 1. Enteric methane emissions in the different systems.

Variable	Treatments*					Mean	*P*
	IGS	SPS	ICL	ICLF	EXT		
Live weight (kg)	333.2	333.0	342.7	343.7	327.2	336.0	*0.9290*
CH_4 (g/d)	198.1	202.1	198.4	180.3	190.1	198.83	*0.8760*
CH_4 (kg/yr)	72.3	73.8	72.4	65.8	69.4	72.58	*0.8762*
CH_4LW (gCH_4/kgLW)	0.596	0.610	0.579	0.527	0.586	0.593	*0.7417*

*IGS: intensive grazing; SPS: silvopastoral; ICL: integrated crop-livestock; ICLF: integrated crop-livestock-forest; EXT: extensive grazing

There were no significant differences in animal live weight and daily methane emissions between the evaluated systems in the summer season. Further analysis should correlate emissions and stocking rates, daily weight gain, forage quality and dry matter intake.

Acknowledgements
To Embrapa, CNPq and all research scientists, technicians, students and field workers at the Embrapa Southeast Livestock Centre who diligently maintained this large experiment in the PECUS Project.

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Soil carbon contents in integrated crop-livestock and crop-livestock-forest systems in the Brazilian Cerrado

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Introduction

Pasture and soil degradation in recent years has been main constraints at conventional systems to animal and grain production in Brazil. Soil carbon and organic matter preservation in these soils are very important for sustainable productivity. In this presentation, we report the results of 6 years of integrated crop-livestock and crop-livestock-forest systems on soil carbon contents in a clayed Oxisol of the Brazilian Cerrado.

Material and Methods

The field experiment was carried out in an area of degraded pasture (20° 26' S, 54° 43'W, 530 m asl) at Embrapa Beef Cattle Research Center, Campo Grande, MS, Brazil since 2008/09. Details in Oliveira et al. (2012), and Pereira et al. (2014). Treatments included ICL (integrated crop-livestock, no trees), ICLF14 (integrated crop-livestock-forest with single line of trees, 14 m apart) and ICLF22 (lines of trees 22m apart). Soybeans were cultivated conventionally in 2008/09 and no-till in 2012/13. Grazed pastures of *Brachiaria brizantha* cv. BRS Piatã were cultivated between eucalyptus trees, after soybeans. Two transects lines, composed by 10 single soil samples/transect, were taken yearly in May-June, to 20 cm depth, and analyzed for total C in an autoanalyser (Sumika/Shimadzu).

Results and Conclusions

Table 1. Soil C contents to 20 cm depth under different integrated systems 6 years after establishment. Data are means of 8 replicates/treatment/year.

System	Years							
	2008	2009	2010	2011	2012	2013	2014	Means
				g C /cm3				
ICL	2,19a	2,34a	2,39a	2,46a	2,68a	2,57a	2,69a	**2,47a**
ICLF14	1,56b	2,07b	1,88b	1,98b	2,03b	2,08b	2,01b	**1,95b**
ICLF22	1,83c	2,35a	2,21a	2,18b	2,51a	2,30c	2,33c	**2,24c**
Means	**1,86**	**2,26**	**2,16**	**2,21**	**2,41**	**2,31**	**2,35**	**2,22**

Over a 6 years period, soil under ICL, showed highest values of total C content as compared with ICLF14 or ICLF22 (Table 1). ICL system (no trees) had less competition for light, water and nutrients, and provided greater source of organic matter for soil carbon, than grass/pasture combined with trees. Grass biomass and animal production were greater in ILC as reported in cited papers.

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Manuel Claudio Macedo
Soil carbon contents in integrated crop-livestock and crop-livestock-forest systems in the Brazilian Cerrado
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Methane emissions of Nellore heifers on integrated crop-livestock-forest systems in the Brazilian Cerrado

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Introduction

To evaluate and design the greenhouse gases mitigation strategies for cattle production systems we need to measure the enteric methane emission (ECH4). The objective of this study was to estimate the Nellore heifers ECH4 associated to *in vitro* dry matter digestibility (IVDMD) and dry matter intake (DMI) of pastures in different integrated crop-livestock-forest systems (ICLFS).

Material and Methods

We used Nellore heifers (295 ± 35 kg of live weight) grazing *Brachiaria (Urochloa) brizantha* CV Piatã under three different types of ICLFS (lat -15.604088°; long:-47.713837°). The trial period last from Apr/2013 to Feb/2014, with evaluations performed on central months of autumn, winter, spring, and summer. The treatments were ICL with: six years old pasture (control) – ICLS6; one year old pasture – ICLS1, and; one year old pasture established under *Eucalyptus urograndis* trees in a north-south orientation and spacing between rows of 22m (417 trees.ha^{-1}). Six testers animals were used for each treatment. A factorial 3x4 design (treatments and periods) was set in a completely randomized design. Tukey test ($P<0.05$) was used to compare means in a year base. ECH4 was measured using the SF6 tracer gas technique (Primavesi et al., 2004). Dry matter intake (DMI) was estimated using LIPE® fecal marker in association with IVDMD of pasture samples simulated by hand pulling. The grazing pressure was set to 10% for all treatments.

Results and Conclusions

The lowest IVDMD observed for ICLS6 depressed DMI by the animals (Table 1). Despite the differences on IVDMD and DMI, the ECH4 did not differ among treatments. The average ECH4 per animal was 45.57 kg.year^{-1}, close to the IPCC (2006) estimates for young beef cattle animals (42 kg.year^{-1}). The animals on ICLSF1 were more efficient on the use of the diet than the animals raised in a 6 years old pasture (ICLS6). The IVDMD of the pastures influenced the DMI but did not affected the crude emission of CH4 by Nellore heifers on integrated systems.

Tab.1. *In vitro* dry matter digestibility (IVDMD), dry matter Intake (DMI) and enteric methane emissions (ECH$_4$) on different integrated crop-livestock-forest systems (ICLFS).

Treatment	IVDMD	DMI		ECH$_4$			
	(%)	(kg.day^{-1})	(% of LW*)	(g.day^{-1})	(kg.year^{-1})	(%IGE**)	(g.kgDMI^{-1})
ICLS1	57.93^{A}	6.47^{A}	2.27^{A}	124.12	45.30	5,90^{AB}	19.39^{AB}
ICLFS1	58.56^{A}	6.89^{A}	2.31^{A}	125.35	45.75	5,48^{A}	18.00^{A}
ICLS6	50.25^{B}	5.07^{B}	1.74^{B}	125.12	45.67	7,40^{B}	24.29^{B}
Mean	55.58	6.14	2.11	124.86	45.57	6.26	20.56
CV (%)	6.12	11.34	17.57	23.26	23.26	23,26	29.98

*Live weight, **Gross energy intake = Ym

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N_2O fluxes using the flux-gradient method and a tunable diode laser trace gas analyzer in an integrated crop-livestock system in the Brazilian Cerrado

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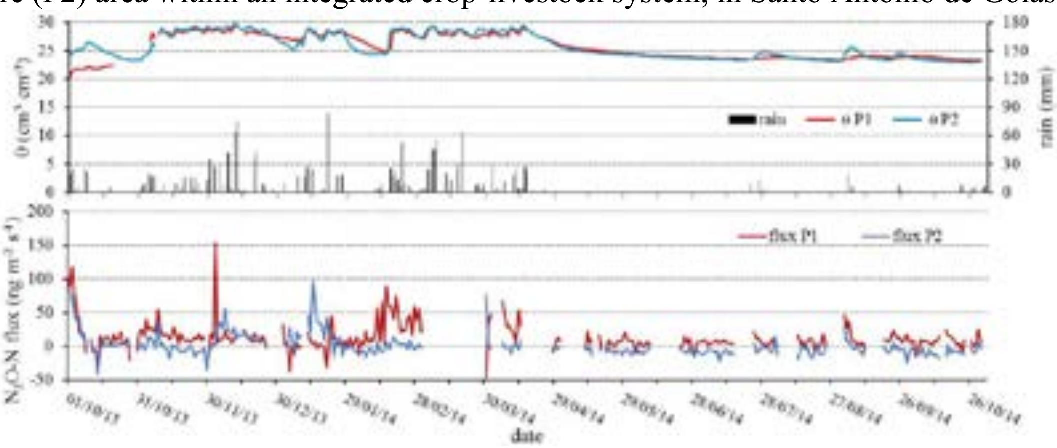
Introduction The integrated crop-livestock (iCL) system comply with many conservation objectives, such as the recovery of degraded pasture, the intensification of agricultural production per unit area and agricultural production intensification. The potential of mitigating greenhouse gases emissions is another important characteristic of the system (Salton et al., 2014). In this study, measurements of N_2O fluxes measured using infrared absorption spectrometry and the flux-gradient method are presented.

Material and Methods The N_2O concentrations were measured in two plots of an iCL system located at Fazenda Capivara, in Santo Antônio de Goiás, GO, Brazil. The soil was a clay Rhodic Ferralsol (Oxisol), using a tunable diode laser trace gas analyzer (TGA200, Campbell Sci.). The measurement period presented here (Oct 2013 to Oct 2014) included a rainy and a dry season, typical of the regional climate. The fluxes calculated using the flux-gradient method were obtained in a soybean–fallow area (P1) and in a 3-years-old pasture (P2), along with rainfall and soil water data.

Results and Conclusions

Fig. 1. N_2O fluxes (B) and soil water and precipitation (A) at a soybean/fallow (P1) and at a 3-years-old pasture (P2) area within an integrated crop-livestock system, in Santo Antonio de Goiás, GO.



Throughout the presented measurement period, a greater emission of N_2O-N was observed during the rainy season, from Oct 2013 to Mar 2014, compared to the dry season (Fig. 1A and 1B). This observed variation of fluxes, mainly depending on soil water content, is expected due to its influence on soil microbial activity and inorganic N availability (Glenn et al., 2010). In P1, after soybean harvest, the daily mean fluxes (8.887 ng m^{-2} s^{-1}, error: 1.029) were higher than in P2, under pasture (-5.963 ng m^{-2} s^{-1}, error: 0.652). Comparisons of fluxes for longer periods will be important to be able to make adjustments in iCL management (e.g. rotation) to reduce its N_2O emissions.

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Acknowledgements to Embrapa (02.11.05.001; 01.11.01.002; 01.10.06.001.06.04), CNPq (562601/2010-4), FAPEG and CAPES.

Selma Regina Maggiotto

N2O fluxes using the flux-gradient method and a tunable diode laser trace gas analyzer in an integrated crop-livestock system in the Brazilian Cerrado

ANXH

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Enhancing resilience of beef grazing systems for sustainable production

Dan DEVLIN[1], Jean L. STEINER[2], Charles W. RICE[1*], Xiangming XIAC[3], Ali SALEHE[4], Peter TOMLINSON[1], Andy COLE[5], Prasanna GOWDA[5], Corey MOFFET[6,], Amber CAMPBELL-HIBBS[1].
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Introduction Ruminant livestock provide meat and dairy protein that sustain health and livelihoods for much of the world's population. Grazing lands that support ruminant livestock provide numerous ecosystem services, including provision of food, water, and genetic resources; climate and water regulation; support of soil formation; nutrient cycling; and cultural services. In the USA southern Great Plains, beef production on forages is a major economic activity. The region's climate is characterized by extremes of heat and cold and extremes of drought and flooding. Grazing lands occupy a large portion of the region's land significantly impacting carbon, nitrogen, and water budgets. To understand vulnerabilities and enhance resilience of beef production, a multi-institutional Coordinated Agricultural Project (CAP), 'the grazing CAP', was established. Integrative research and Extension spanning biophysical, socioeconomic, and agricultural disciplines address management effects on productivity and environmental footprint of production systems. Knowledge and tools being developed will allow farmers and ranchers to evaluate risks and increase resilience to dynamic conditions. The knowledge and tools developed will also have relevance grazing lands from semi-arid and sub-humid regions of the world.

Acknowledgements
Funding provided by USDA to Project No. 2012-02355 through the National Institute for Food and Agriculture's Agriculture and Food Research Initiative, Regional Approaches for Adaptation to and Mitigation of Climate Variability and Change.

Charles W. Rice
Enhancing resilience of beef grazing systems for sustainable production
AP2X
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Methodology for climate risk assessment of maize intercropped with Brachiaria in the Cerrado of Brazil

Fernando Antônio Macena da Silva[1]; Balbino Antônio Evangelista[2]; Marc Corbeels[3]; Thaise Sussane de Souza Lopes[1]

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Introduction The cultivation of forage-cereal intercrops entails competition between the two crops for nutrients, light and mostly water in the Cerrado of Brazil. Considering water as the main limiting factor, this study aimed to develop a method to identify the areas in a given region of the Cerrado where climate risk (rainfall) for sowing maize (*Zea mays*) intercropped with brachiaria (*Brachiaria brizantha*) is low.

Material and Methods

The study was conducted in the State of Goiás, using the crop growth model SARRA to determine the optimal dates for sowing maize intercropped with brachiaria (Baron and Clopes, 1996). The following variables were used: seasonal rainfall, potential evapotranspiration, duration of the phenological stages of the maize crop, and the soil water holding capacity of three soil types (sand, loam and clay). The model calculated an index of satisfaction of crop water requirements (ISWR) for each phenological stage over a series of growing seasons. A situation (climate x soil x maize cultivar) was considered as having a low climate risk for the cultivation of the maize-brachiaria intercrop if 80% of ISWR values were > 0.55 at flowering and grain filling stage of maize, and if 80% of the ISWR values were > 0.60 at the stage of germination/establishment of brachiaria. With the use of a geographic information system (GIS) it was possible to map this climate risk information for the cultivation of the maize-brachiaria intercrop.

Results and Conclusions

The method used in this study allowed the definition of areas and periods of climatic risk for the cultivation of maize intercropped with brachiaria for each of the sub-regions of the State of Goiás. Planting dates with low climate risk are concentrated between the months November and January, while regions with sandy soils are those with higher climate risk. Figure 1 is an example of results from our modelling approach, showing the optimal sowing dates of an early maturing maize cultivar on clay soils intercropped with brachiaria in the different sub-regions of the State of Goiás.

Figura 1. Optimal sowing periods for maize (early maturing cultivar on clay soils) intercropped with brachiaria in the State of Goiás.

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Fernando Antônio Macena Silva

Methodology for climate risk assessment of maize intercropped with brachiaria in the Cerrado of Brazil

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Annual ryegrass roots dry matter in an integrated crop-livestock system as affected by ovine grazing intensity and summer crop succession

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Introduction

The integrated crop-livestock systems (ICLS) are being highlighted nowadays due to its potential to increase agriculture sustainability, especially regarding soil impacts. The crop root development is a process closely related to it. Thus, this study aimed to evaluate the annual ryegrass roots dry matter as affected by ovine grazing intensity and summer crop succession in an ICLS trial.

Material and Methods

The experimenthas been conducted since 2003at the Agronomic Experimental Station of UFRGS (Eldorado do Sul County, Rio Grande do Sul State, Brazil).The treatments were distributed in a randomized block design, with fourreplicates, and consisted of different grazing intensities (moderate and light, which represent 2.5 and 5.0 times the lamb consumption potential, respectively) on the winter season. The pasture specie used was annual ryegrass (*Loliummultiflorum*), provided by reseeding. On the summer season, the same area was divided and two crop successions were tested: soybean/soybean and soybean/corn. The roots dry matter was evaluated sampling two annual ryegrass plants per plot, by monolith method (10x10x40 cm).

Results and Conclusions

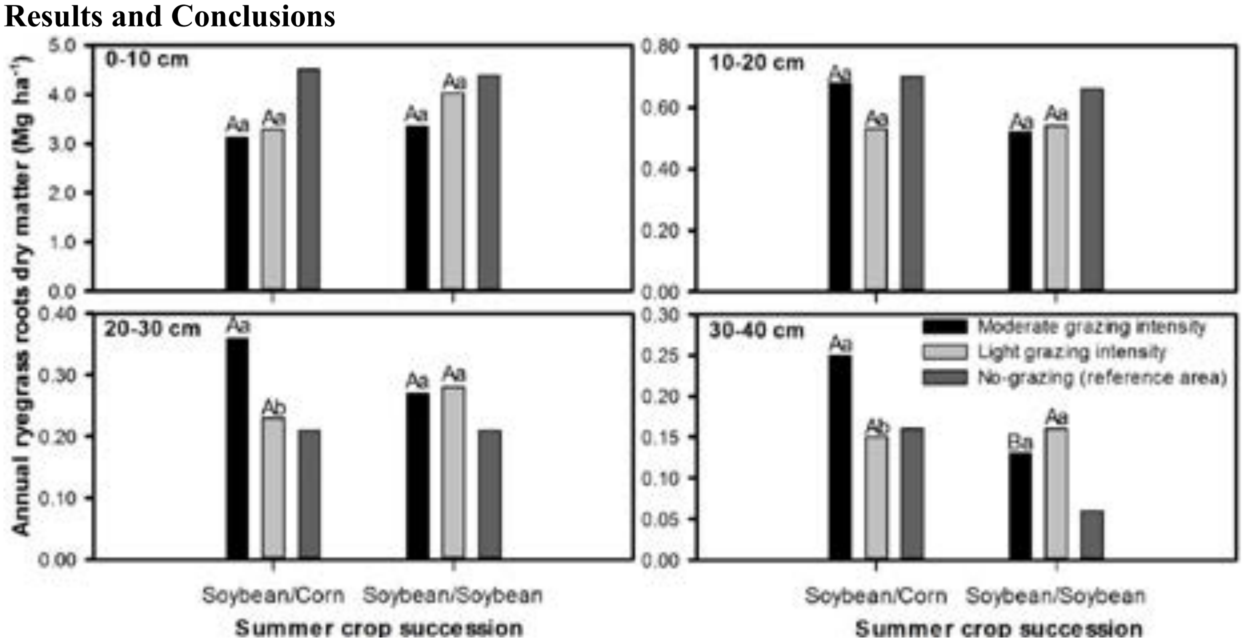

Fig. 1. Annual ryegrass roots dry matter in different soil layers [0-10 (a), 10-20 (b), 20-30 (c) and 30-40 cm (d)] in an integrated crop-livestock system as affected by ovine grazing intensity and summer crop succession. Tukey test at 5% significance: uppercase and lowercase letters distinguish summer crop succession and ovine grazing intensity, respectively, in each evaluated soil layer.

The difference between the summer crop succession and ovine grazing intensity occurred in subsurface soil layers (20-30 and 30-40 cm, Fig. 1). The moderate grazing intensity resulted in higher values of root dry matter in these soil layers when the soybean/corn succession is used. Furthermore, in 30-40 cm soil layer, under moderate grazing intensity, the succession soybean/corn presented higher root amounts as compared to soybean/soybean system.

Fernando Arnuti

Annual ryegrass roots dry matter in an integrated crop-livestock system as affected by ovine grazing intensity and summer crop succession

ANZN

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Support for low carbon agriculture - able to adapt to observed climate change in the perspective of 2030 and 2050 (LCAgri)

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Introduction. Agriculture in Europe constitutes the second largest greenhouse gas emitting sector after the energy sector (Kuikman at al., 2013). The direct emissions of greenhouse gases (GHG) from agriculture in Europe account for 10.1%, in Poland 9.1% (2012) (KOBIZE, 2014). On one hand, agriculture is the most important source of nitrous oxide (N2O), that originates mainly from fertilizer use, and covers about 50% of agricultural GHG emission. On the other hand, carbon sequestration (capture) in soils should be considered. Estimates performed by Faber et al. (2012) showed that Polish agriculture could reduce the GHG emissions by about 30% within the 2030 perspective by changes in the production technologies. Eurostat (2011) pointed out that development of cost-effective mitigation measures involving GHG emission or nitrate leaching reductions require strong statistical relations that can only be obtained by a farmer surveys. There is still a considerable gap in understanding of cropping system responses to climate feedbacks and farming practices. A realistic assessment of GHG emissions from land used areas in various scales (from individual farm to the entire country), is indispensable for proper decision-making policies (Gibbons et al., 2006). One of the main challenges is to diminish the uncertainty of GHG emission evaluation, which can be done by delivering reliable data of the year to year variability in climate and the resultant changes in management practices.

Materials and Methods. The essential element of the project is the implementation of most effective mitigation practices by 8 experimental farms of IUNG-PIB. Conducted studies will be the base for the carbon footprint certificates of GA-ZAP for the fertilizers production and application. The results of the studies will be used for programming climatic activities of Common Agricultural Policy and for the development of GHG EA methodology of National System of GHG Emission and Inventory.

Results and conclusions. To fill these challenges, the LCAgri project was developed. The main objective of the project is to improve resources use efficiency by implementing innovative low carbon farming practices and promotion sustainable use of mineral fertilizers by farms in Poland. Existent agricultural practices will be evaluated under present climatic conditions and using climatic scenarios for 2030 and 2050 time horizons. Greenhouse gas emission assessment (GHG EA) will be performed for the fertilizers in the life cycle on fertilizer production level for the GA-ZAP factory and on the farm level for the representative group of farms (for presently used management practices) and for the experimental farms of IUNG-PIB (for recommended low carbon practices). GHG EA for the most promising practices will be verified with regard to field measurements. Additionally, technical and economic efficiency of low carbon practices will be assessed, in terms of adaptation to climate changes. LCAgri project results will be disseminated to a broad audience including farmers, consumers, policy makers, and selected educational units such as agronomy schools. Furthermore, based on the project results a scientific network beyond the project consortium will be developed for knowledge sharing and development.

Magdalena Borzecka-Walker

Support for low carbon agriculture - able to adapt to observed climate change in the perspective of 2030 and 2050 (lcagri)

ATKB

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Horizontal distribution of the soybean yield in crop-livestock-forest integration system

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Introduction

The crop-livestock-forest integration system increases the diversity, along with environmental sustainability, of both sectors. At the same time it provides opportunities for increasing overall production and economics of farming. The objective of this study was to evaluate the horizontal distribution of the yeld of soybean crops in exclusive systems and integrated systems of crop-livestock-forest (ICLF).

Material and Methods

The experiment was conducted at Sinop/MT, evaluating the following treatments: 1) crop with soybean during the main season and maize intercropped with *Brachiaria brizantha* during the second season and 2) Crop-livestock-forest system established with eucalyptus provisions in triple lines (3,5 x 3,0 m East-West orientation), space between the forest component with soybean crop (main season) and maize intercropped with *B. brizantha* (second season). The experiment used a randomized block design with four replications. In the integrated system with forest component, samples were collected in four equidistant transects per treatment in the transverse direction of the lines of forest species, at the distances of 3, 6, 10 and 15 m on both sides (north and south faces).

Results and Conclusions

Significant differences were not verified in the agronomic characteristics of soybean, no difference in productivity was verified comparing the exclusive and integrated systems (Fig 1.). Therefore, it is plausible to say that the strip of trees inside the integrated system did not affect the productivity of the agricultural component (soybean) on the second year of the system implementation.

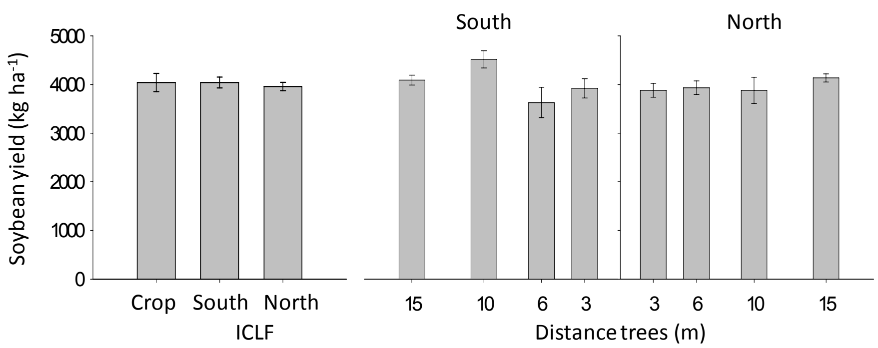

Figure 1. Soybean yield (BRSGO 8560 RR) in exclusive system and on the south side and north side of the eucalyptus triple lines (East-West orientation) in the crop-livestock-forest integration system (ICLF).

Acknowledgements

To Embrapa, CNPq and CAPES

Resilience of mixed farming systems in a future of increasing climatic changes

Maurel Behling

Horizontal distribution of the soybean yield in crop-livestock-forest integration system

AMN4

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Infestation Levels of the Burrower bug *Scaptocoris* sp. (Hemiptera: Cydnidae) in Integrated Production Systems in Central Brazil

Fabricia Z. V. TORRES[1*], José R. VALÉRIO[1], Ewerton C. LIRA[1], Glenda M. WEIS[1], Marlene C. M. OLIVEIRA[2], Manuel C. M. MACEDO[1], Alexandre R. ARAÚJO[1]
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Introduction

The burrower bug *Scaptocoris* sp., an important pasture pest in Brazil, is a soil and polyphagous insect. In addition to grasses, such insect attacks several other host plants, including high-value crops; some, being used in integrated production systems. Since little is known about the dynamics of this pest in these systems, the aim of this work was to compare populations of this insect in an area with different integrated crop-livestock-forest systems.

Material and Methods

The studied area is a long-term experiment underway at Embrapa Beef Cattle since 1993. The experiment has the following integrated systems (S) and subsystems (T): **S1** - Continuous pasture [*Brachiaria decumbens* cv. Basilisk, without legume and fertilization (T1); without legume but, with fertilization (T2A) and; with both, legume and fertilization (T3L)], **S2** - Continuous tillage [soybeans, conventional tillage (T4); conservation tillage (T5) and; direct tillage (T6)]; **S3** - Pasture 4 years, tillage 4 years [currently millet, with eucalyptus (T7) and without eucalyptus (T8)]; **S4** - Tillage 4 years, pasture 4 years [currently *Panicum maximum* cv. Massai, with eucalyptus (T9) and without eucalyptus (T10)] and; **S5** - Tillage 1 year, pasture 3 years [(currently *Brachiaria brizantha* cv. Piatã, without corn (T11) and with corn (T12)]. A degraded pasture area of *B. decumbens* is being used as control. With regard to the occurrence of the burrower bug in such systems, an initial sampling was performed during October 2014, with four sampling points per treatment (paddock size of 0.7 ha), comprising a total of 172 points. At each sampling point, the soil was drilled to a depth of 60 cm, in layers of 20 cm. The removed soil was processed and the number of insects recorded. The occurring specimens were classified either as nymph or adult.

Results and Conclusions

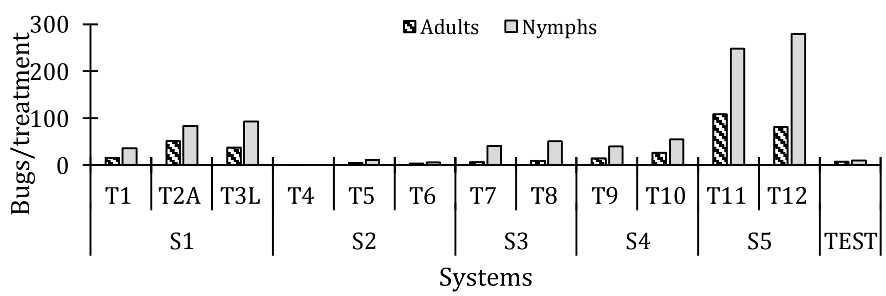

Fig. 1. Burrower bug nymphs and adults collected in different crop-livestock-forest integration systems

The burrower bug was present in the whole experimental area. Higher numbers, however, were registered only in the S5 system (Tillage 1 year, pasture 3 year). No differences were observed in its subsystems (with and without corn). The infestations observed in the other treatments were lower and comparable. Additional information will be obtained with further samplings (two in the rainy season and two in the dry season) during the next two years.

Acknowledgements: Embrapa Gado de Corte, CNPq, Fundect and Unipasto.

Fabrícia Zimermann Vilela Torres

Infestation levels of the burrower bug scaptocoris sp. (hemiptera: cydnidae) in integrated production systems in central Brazil

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Monitoring Spittlebug Populations (Hemiptera: Cercopidae) in Integrated Production Systems in Central Brazil

Fabricia Z. V. TORRES[1*], José R. VALÉRIO[1], Ewerton C. LIRA[1], Glenda M. WEIS[1], Marlene C. M. OLIVEIRA[2], Manuel C. M. MACEDO[1], Alexandre R. ARAÚJO[1]
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Introduction

Little is known about the dynamics of insect pests in forest crop livestock integration systems, including pasture spittlebugs. These insects are considered key pests of forage grasses, important plants in the composition of these integrated systems. The objective here was to monitor infestations by this group of insects in an experiment with different integrated production systems.

Material and Methods

The area focus of this study is a long-term experiment underway at Embrapa Beef Cattle since 1993. The experiment has the following integrated systems (S) and subsystems (T): **S1**- Continuous pasture [*Brachiaria decumbens* cv. Basilisk, without legume and fertilization (T1); without legume but, with fertilization (T2A) and; with both, legume and fertilization (T3L)], **S2**- Continuous tillage [soybeans, conventional tillage (T4); conservation tillage (T5) and; direct tillage (T6)]; **S3**- Pasture 4 years, tillage 4 years [currently millet, with eucalyptus (T7) and without eucalyptus (T8)]; **S4**- Tillage 4 years, pasture 4 years [currently *Panicum maximum* cv. Massai, with eucalyptus (T9) and without eucalyptus (T10)] and; **S5**- Tillage 1 year, pasture 3 years [(currently *Brachiaria brizantha* cv. Piatã, without corn (T11) and with corn (T12)]. A degraded pasture area of *B. decumbens* is being used as control. Spittlebug infestation levels were monitored only in those treatments which included forage grasses (S1, S4, S5 and Control). Nymphal as well as adult populations were sampled monthly (Feb. and Mar. / 2015), registering the numbers of masses of spume, produced by the nymphs, per square meter and, the number of adults caught in ten sweeps.

Results and Conclusions

Nymphal and/or adult infestations were recorded in almost all sampled systems except S4, which includes *P. maximum* cv. Massai. This cultivar is known for its resistance to the spittlebugs through antibiosis. Higher population levels were observed in the subsystems that make up the treatment S1, which has *B. decumbens* cv. Basilisk. This cultivar is known for its susceptibility to this group of insects. There were quite bulky spume masses, typical of the spittlebug nymphs of the genus *Mahanarva*, in the S5 system, which has *B. brizantha* cv. Piatã. Despite being initial data, they show the importance of including spittlebug resistant grasses in integrated production systems.

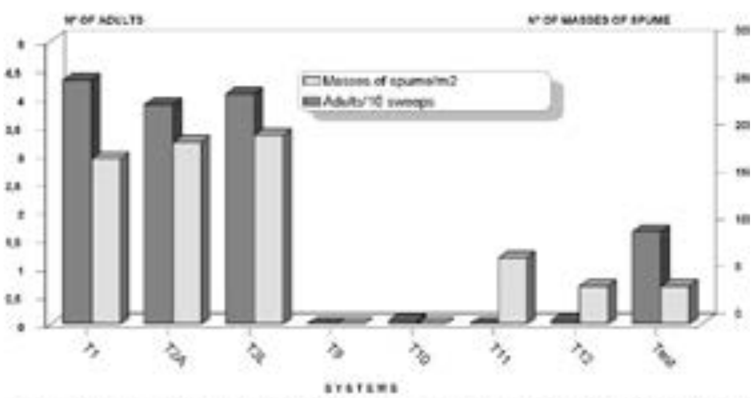

Fig.1. Average infestation levels of masses of spume and adults of spittlebug

Acknowledgements: Embrapa Gado de Corte, CNPq, Fundect and Unipasto.

Fabrícia Zimermann Vilela Torres

Monitoring spittlebug populations (hemiptera: cercopidae) in integrated production systems in central Brazil

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Allelopathic potential of rice lines (*Oryza sativa*) for recovery degraded pastures

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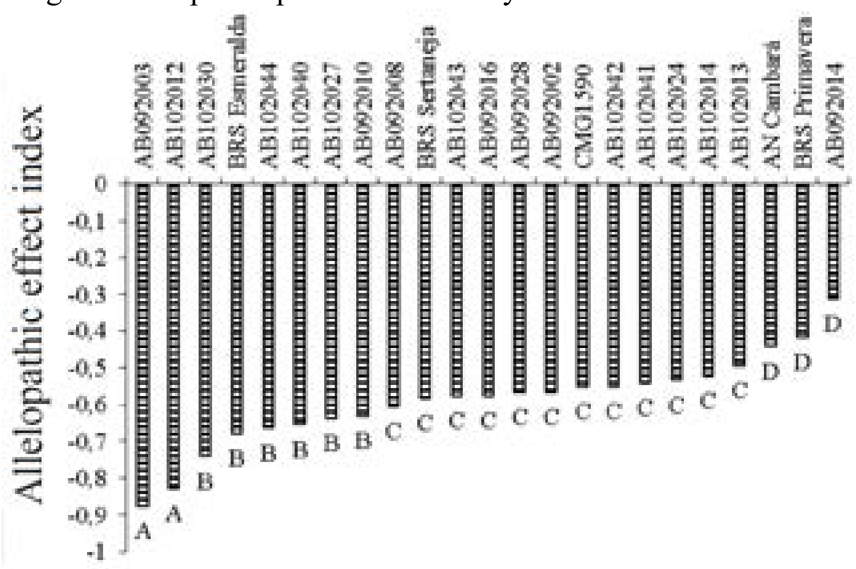
Introduction One of the most important and frequent causes of the degradation of the pasture in the Amazon is the weed infestation. At the same time, the depletion of soil fertility and the incorrect pasture managing complete the major factors of loss sustainability of these agroecosystems. In this sense, the use of rice crops to indirectly recovery the pasture, using its allelopathic attributes can be an interesting strategic to provide suppression of important weeds in pastures lands in Brazil.

Material and Methods

In order to evaluate the allelopathic response of twenty-three genotypes of rice, from the breeding program of Embrapa, on the weed plant *Borreria verticillata* (L.) G. Mey, an experiment was carried out. This specie is widespread in Brazil, especially in pastures lands in Amazonia and Savanna regions. The effect of the aqueous extracts of the genotypes on germination percentage (PG), germination speed index (GSI), mean germination time (GMT) and the allelopathic effect index (AEI) of seeds of B. verticillata were evaluated in a bioassay under controlled conditions (Salam et al., 2009).

Results and Conclusions

Fig. 1. Allelopathic potential of twenty-three cultivars of rice



* Means followed by the same letter do not differ by Scott Knott test at 5%

It was observed that the rice extracts negatively influenced the seedling vigor *B. verticillata* and inhibited seed germination of the weed specie.

The highest allelopathic effect were obtained from the cultivars AB092003 and AB102012.

The genotypes AN Cambará, BRS Primavera and AB090214 provides minimum allelopathic effect on the seeds of the weed plant. All cultivars increased the time of germination of weed. The studied weed species is highly sensitive to allelochemicals present in rice. The selective breeding of rice cultivars with greater allelopathic activity may represent an integrated control strategy of weeds for pasture recovery by intercropping that culture with forage plants in crop-livestock systems.

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Acknowledgements Embrapa and Capes

Frederico José Evangelista Botelho

Allelopathic potential of rice lines (oryza sativa) for recovery degraded pastures

APN4

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Residual activity of herbicides from the imidazolinone chemical group used in different cultivate of irrigated rice, in the crop-livestock integration

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Introduction The crop-livestock integration is critical to the growth of the productive system and to a more sustainable agriculture. In this context, the rotation and succession of crops, with the system of direct seeding, play an important role, since they provide the recovery of soils and reduce the occurrence of weeds, pests and diseases. The use of the Clearfield® technology as well as the use of herbicides of the imidazolinone group, aiming the selective control of red rice in rice cropping, are feasible and efficient tools in weed control. However, the persistence of these herbicides in soil can jeopardize the development of the crops or pastures grown in rotation or succession. The purpose of this research was to evaluate the residual effect of formulated mixtures imazethapyr and imazapyr + Imazapic on winter forage ryegrass, white clover and birdsfoot sown in succession irrigated rice three cultivars in the production system Clearfield®.

Material and Methods

The field experiment was conducted at the Embrapa Temperate Climate Research Center on hydromorphic soils (31° 48' 51” S, 52° 28' 21” O), during two periods. In the first period, was considered the rice as the main culture, and in the second stage was considered the pasture composed by ryegrass, white clover and birdsfoot as alternative for autumn and winter, sown in succession rice cultivars after glyphosate application. The experimental design was of blocks at random, in factorial outline 3 x 4, with four repetitions, where the factor A was composed by three cultivate of rice (IRGA 424, BRS Sinuelo CL and Puitá INTA CL), being to cultivate IRGA 424 no resistant the technology Clearfield® of production of irrigated rice, the cultivate BRS of first generation and cultivate Puitá INTA CL of second generation. The factor B was composed by the herbicides imazapir + imazapique (140 g.there is -1), imazapir + imazapique (280 g.there is -1), imazetapir + imazapique (1,0 L.there is -1) and the witness. The experimental units were constituted of portions of 24 m^2, with dimensions of 6 m of length and 4 m of width. The stature and covering of the pasture, green mass and mass of the matter dries of the aerial part and forage production evaluations were accomplished to the 60, 75 and 90 days after the emergency (DAE), in samples containing the three species of the consortium.

Results and Conclusions

The results show that the plant species tolerant feature is the residue group of the imidazolinone herbicides, and herbicide and depending on the dose used, its development was affected. The rice cultivars exhibit different physiological responses the formulated mixtures, producing different levels of straw, influencing the forage species in succession. For the variables stature, covering and green mass, it was possible to verify that the residual effect of the studied herbicides influences negatively in the development of the pastures. In relation to the mass of the dry matter of the species significant difference of the treatments was not observed with residue of those herbicides in relation to the witness. The mixture herbicide imazapyr + Imazapic had higher residual activity when compared to imazethapyr + Imazapic.

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Carfentrazone-Ethyl effect on the performance of Urochloa ruziziensis in oversowing system for ILPF

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Introduction The purpose of this study was to evaluate phytotoxicity Diquat, Paraquat and different dosages of Carfentrazone - ethyl on the performance of *Urochloa ruziziensis* in livestock farming system integration.

Material and Methods The experiment was conducted in Nova xavantina- MT in agricutural year 2013/2014 in oxisol. Seven treatments: control, diquate, paraquat, 10g, 20g, 30g and 40g of Carfentrazone - ethyl. The application of all products was conducted with soybean phenological stage R7 were evaluated at 7 and 14 days after application to phytotoxicity and numbers of tillers per square meter of forage at 28 percent coverage.

Results and Conclusions The Carfentrazone-ethyl showed greater potential to be used in the *U. ruziziensis* after soybean system (overseeded system) due to lower phytotoxicity features, higher tillering the m² and the highest percentage of coverage.

Effect of the treatments under *U. ruzizizensis*

Treatments	N° of Seedlings	N° of tillers		% of Ground
	0 DAA^{ns}	7DAA**	14 DAA**	couver**
Control	16,75 a	3,77 a	3,80 a	86,00 a
Diquat	16,50 a	1,89 b	2,13 cd	27,50 bc
Paraquat	12,75 a	1,73 b	2,09 d	6,25 c
Carfent. 10g	18,25 a	3,85 a	3,34 abc	74,50 ab
Carfent. 20g	16,75 a	3,55 a	3,37 abc	78,50 ab
Carfent. 30g	16,25 a	3,86 a	3,66 ab	67,50 ab
Carfent. 40g	19,50 a	2,26 b	2,61 abc	52,50 ab

The doses of the 10g of the Carfentrazone – ethylic presented the better results for the application for to acquire the better results referent to the fitotoxidez and the tillers numbers, the great dose was found around of the 12,04g.

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Severity of Asian rust in soybeans grown in crop-livestock-forest systems at Barra do Garças, Mato Grosso, Brazil

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Introduction: The objective of this research was to evaluate the interactions among integrated forest plantations and annual crops, mainly in soybean crop that is widely used in this system, in order to evaluate the severity of disease in this case.

Material and Methods: The experiment was conducted at the Technology Reference Units of EMBRAPA, in partnership with the "Fazenda Brazil" (AFB), located in the municipality of Barra do Garças, MT, Brazil. Experimental area consisted of soybean crop cultivated between rows (lines) of eucalyptus. The rows were single, double and triple (with one, two or three rows of eucalyptus). Each treatment consisted of six distances, that were the collection points: 2 m, 4 m, 6 m, 8 m, 10 m, 12 m, in each plot. The positions were measured from the edge of the rows to the center.

Results and Conclusions: The system with double lines had the highest percentage of rust severity and the simple lines shows lowest value, for the distance of 2 m. For the distance of 6 m also there was statistical differences, where the triple lines had the highest percentage of rust severity and the double and single lines did not differ.

Table 1: Severity of rust in soybean cultivated in crop-livestock-forest systems.

Distance of rows (m)	Lines of trees						Avarege
	Single, %		Double, %		Triple, %		
2	1.64 (±0.37)	c	20.84 (±1.25)	a	5.88 (±0.56)	b	9.45 (±2.24)
4	1.74 (±0.52)	a	1.04 (±0.22)	a	2.52 (±0.39)	a	1.77 (±0.27)
6	1.36 (±0.50)	b	0.24 (±0.24)	b	4.28 (±0.75)	a	1.96 (±0.54)
8	0.12 (±0.08)	a	0.16 (±0.12)	a	1.08 (±0.27)	a	0.45 (±0.15)
10	2.30 (±0.52)	a	0.61 (±0.38)	a	1.60 (±0.40)	a	1.50 (±0.30)
12	1.08 (±0.34)	a	0.16 (±0.10)	a	0.24 (±0.16)	a	0.49 (±0.16)
Average	1.37 (±0.20)		3.84 (1.43)		2.60 (±0.40)		2.61 (±0,50)

Soybean plants nearest the eucalyptus lines had higher rust severity. At the conditions of this research, it seem that the environment due to eucalyptus plants can favor the development of Asian rust in soybean in this crop system.

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Influence of cropping systems on epigeal coleopteran predators

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Introduction

Generalist Coleopteran predators are major regulators of pest populations. Therefore, studies about the influence of cropping systems on the structure of the community of these predators are important to enhance their preservation in a landscape and conserve their local natural biological control service. In this study, we evaluated the effect of different monocultures and an integrated cropping system (with soybean, livestock and eucalyptus) on the community of epigeal coleopteran predators.

Material and methods

The study was conducted during the 2014/2015 cropping season in an experimental field located in Sinop-MT, Brazil, (11^{0}51'43''S, 55^{0}35'27''W and 384 m altitude). The cropping systems evaluated were: 1) soybean monoculture, 2) integrated crop-forestry system (soybean cultivated between rows of eucalyptus), 3) eucalyptus monoculture, and 4) palisade grass monoculture (pasture). Eucalyptus in the crop-forestry system was planted in three strips, each containing three rows of eucalyptus. Strips were spaced 30 m apart. The experiment was a randomized complete block design with four replications and plot size was 1 ha for the soybean and eucalyptus monocultures and 2 ha for the others. Insects were collected from 5 pitfall traps per plot in a single transect crossing the eucalyptus strips. The traps were 5 m apart in each transect and kept in field for 24 hours. The samples were taken every 30 days in the dry season (September-October) and every 15 days during the rainy season (November-February). We used canonical variables to investigate the differences of the total of coleopteran predators collected between the cropping systems.

Results and conclusions

A total of 121 coleopteran predators belonging to five families (Carabidae, Elateridae, Coccinelidae, Staphylinidae and Anthicidae) and 27 morphospecies were collected. Activity-density of total coleopteran predators differed among the cropping systems (F=2.33, p=0.04 Wilk's Lambda), with the highest activity-density/cropping system in the soybean monoculture (56) and the lowest in the pasture monoculture (8). The Anthicidae family differed among the cropping systems (F=8.14, p = 0.01) with the highest activity-density in soybean monoculture (10). The Carabidae family had the highest activity-density of all of the families (65% of the collected insects) and also had the highest richness (15 morphospecies); however, there were no differences in carabid activity-density among the cropping systems (F=2.52, p = 0.11) as well as no differences among the cropping systems in the activity-density of Coccinelidae, Elateridae or Staphylinidae (F=0.57, p= 0.65; F=1.61, p= 0.24; F=1.87, p= 0.19), respectively. Thus, soybean monoculture provided the best environment to coleopteran predators probably due to the amount of herbivores in this culture. However, soybean integrated with forestry had less number of predators than monoculture probably due to the eucalyptus strips where the traps collected a less number of predators.

Acknowledgment: Fundação de Amparo à Pesquisa de Mato Grosso for the scholarship to S.K.A.B.

Rafael Major Pitta

Influence of cropping systems on epigeal coleopteran predators

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Gastrointestinal nematodes control in lambs finished in three different systems

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Introduction Verminosis is a major constraint in sheep production on pasture, especially for weaned lambs which the immune system is not completely developed, leading to decreased productivity and reflecting negatively on economic efficiency of the activity. Drenching sheep with different pharmacological active ingredients have provided ineffective controlling in infections, so practices in association with environmental control have been recommended.

Material and Methods

The trial had place at Embrapa´s Midwest Regional Center of Goats and Sheep, Terenos – Mato Grosso do Sul. A total of 48 lambs of the Pantanal genetic group of both sexes, averaging 17.43 kg of body weight at weaning were used. After deworming (monepantel 1 mL to 10 kg), the lambs were randomly assigned to three treatments: Paiaguás-grass after soybean and Piatã-grass in Livestock-Crop System (LCS); an intent dewormed pasture kept five months stockpiled (STOCK) with nosheep grazing; feedlot in a restricted diet (CONF) with sorghum silage as roughage. Lambs in all treatments were fed a 2% of body weight energy-protein concentrate (15% CP and 70% TDN). FEC (egg counts per gram of faeces) exams were taken every 20 days.. Data were log transformed as log (x) +1.

Results and Conclusions

FEC was not different in both weaning (P> 0.12) and finishing periods (P> 0.44) for the three systems studied (Table 1).

Table 1. Number of eggs per gram of faeces (FEC) in lambs during the finishing period.

Systems	FEC average	
	Weaning	Finishing
LCS	3.15 ± 0.15	0.35 ± 0.19
STOCK	3.40 ± 0.14	0.66 ± 0.18
CONF	2.89 ± 0.17	0.31 ± 0.19

According at Pegoraro et al. (2008) the distribution of infective larvae in pastures grazed by sheep does not change even varying available forage to animals and grazing methods, nevertheless pasture renewal or renovation should result wormless. Considering FEC not differing between treatments, the results may attest the environmental control of verminosis when pasture are maintained ungrazed by sheep for five months long, and if the lamb finishing at pasture with supplementation occurs during the dry season.

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Sergio Giovanni Espinosa Villafuerte

Gastrointestinal nematodes control in lambs finished in three different systems

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Cover crops under water variable regime for integrated crop / pasture systems in the Brazilian Cerrado.

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Introduction: Cerrado from Central Brazil has few viable options of species to be used like cover crops, mailny with the additional option of grain production and forage in the off-season. We aimed to evaluate the biomass and grain composition for alternative and anual cultivation in integrated crop-pasture under variable water deficit.

Material and Methods: Amaranth, forage millet and quinoa were submitted to four irrigation levels (line source modified): 100 mm (inferior); 220 mm (below middle); 320 mm (upper middle) and 355 mm (superior) in experiment conduced from june to october of 2013. Sixty days after emergence, during flowering period, the biomass was collected for mineral and organic determination of the componentes (SILVA & QUEIROZ, 2012). At the end of the cicle, grain production and polyphenol content (Folin-Ciocalteau) were determined.

Results and Conclusions: Forage millet did not produce grain during off-seanson (winter), otherwise the biomass and its composition stood out in comparison to amaranth and quinoa, primarily to support the water deficit (Tab. 1). Despite amaranth had demonstrated to be more productive in higher depths of irrigation, quinoa has better functional quality (polyphenols). These cover crops can be used, alternatively, in off-season to crop-pasture integration for forage and grain production.

Tab. 1. Composition of cover crops biomass (60 days after emergence) and grain production at the end of cycle.

Species	Water depths	Green matter (ton/ha)	Dry matter (ton/ha)	Grain 13% humidity (ton/ha)	Polyph enols	Ash (%)	Organic matter (%)	Hemi cellulose (%)	Cellulose (%)	Lignin (%)
Millet	Superior	69.87 a A	12.79 a A	-		9.62	90.38	29.19 a A	33.21	4.77
	Upper middle	67.09 a A	12.27 a A	-		10.35	89.65	30.02 a A	33.67	4.54
	Below middle	61.76 a A	12.35 a A	-		8.62	91.38	28.72 a A	32.46	4.58
	Inferior	42.33 a A	10.65 a A	-		6.20	93.80	29.01 a A	29.52	3.57
	Mean	60.26	12.01	-		8.70 b	91.30 a	29.24	32.22 a	4.36
Amaranth	Superior	80.48 a A	9.50 a B	2.66 a A	40.53 b B	20.53	79.47	15.00 b C	24.92	5.08
	Upper middle	86.22 a A	8.84 a A B	2.59 a A	35.37 c B	19.39	80.61	17.64 a b B	21.44	4.61
	Below middle	68.42 a A	8.83 a A B	1.30 b A	34.96 c B	15.66	84.34	17.31 a b B	22.89	5.36
	Inferior	17.89 b B	2.91 b B	0.28 b A	56.38 a B	15.77	84.23	19.68 a B	20.63	4.13
	Mean	63.25	7.52	1.71	41.81	17.84 a	82.16 b	17.41	22.47 b	4.80
Quinoa	Superior	65.24 ab A	8.96 a B	1.82 a B	93.87 c A	18.88	81.12	20.72 a B	24.48	3.73
	Upper middle	71.83 a A	10.86 a b B	1.50 a B	101.11 b A	19.68	80.32	19.26 a B	24.25	4.59
	Below middle	38.46 bc B	6.52 a b B	1.11 ab A	111.37 a A	17.71	82.29	18.92 a B	26.25	3.90
	Inferior	17.20 c B	3.39 b B	0.14 b A	99.18 b A	16.51	83.49	19.08 a B	23.36	3.50
	Mean	48.18	7.43	1.14	101.38	18.20 a	81.80 b	19.50	24.58 b	3.93
Geral average		57.23	8.99	1.43	71.60	14.91	85.09	22.05	26.42	4.36
VC (%) plots		13.08	18.24	27.59	2.65	19.17	3.36	6.63	11.41	17.35
VC(%) subplots		19.01	16.90	25.64		14.00	2.45	6.99	14.48	33.91

Means followed by the same letter do not differ statistically from each other, lower case compare the unfolds of water depths to each species and upper case compare the species unfolded to the water depths, by Tukey test at 5% of probability.

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Acknowledgements: To Embrapa, CAPES, IF Goiano e IFB.

Adilson Jayme-Oliveira

Cover crops under water variable regime for integrated crop / pasture systems in the Brazilian Cerrado.

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Drought tolerance of millet for integrated crop/pasture systems in the Brazilian Cerrado.

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Introduction: Millet (*Pennisetum glaucum* (L.) R. Br.) is a traditionl crop in West Africa with exceptional adaptation to abiotic stresses (water, temperature and luminosity) and can be used as soil covering, nutrient recycling, forage, ingredient to animal and human food (Pereira Filho, 2013). With this work we aim to evaluate drought tolerance of millet for the integrated crop-pasture system.

Material and Methods: Forage millet was planted during water and submitted to four depths of irrigation (line source modified): 100 mm (inferior); 220 mm (below middle); 320 mm (upper midlle) and 355 mm (superior) in experiment conducted from may to october of 2014. Ten plants of each plot were collected with their respective tillers.

Results and Conclusions: The forage millet did not produce grains during offseason (winter), however statistical analysis of biometric variables indicated a pronounced tolerance to drought, because most of the measurements of inferior depth did not differ from the upper depths (Tab. 1), including total mass of shoots. For integrated crop-pasture system, millet presents promising for cultivation in the offseason as cover crop or for forage supply.

Tab. 1. Biometric data of millet.

Water depth	Plant height (cm)	Number of leaves/tiller	Leaf area (cm2)	Leaf area (cm2)/tiller	Number of tillers
Upper middle	145.97 a	14.96 a	254.63 a	24.76 a	10.28
Superior	142.75 ab	13.94 ab	231.76 a	18.41 ab	12.59
Below middle	135.25 abc	12.71 ab	220.48 a	17.80 ab	12.39
Inferior	118.62 bc	9.26 bc	207.63 a	17.19 b	12.08
Variation coef(%)	25.37	56.98	60.91	52.61	
Water depth	**Stem mass ratio/total(%)**	**Height/stem ratio**	**Total stem mass(g)**	**Total shoot mass (g)**	**Number of ears**
Upper middle	65.08 a	21.08 a	77.80 a	126.00 a	6.70 a
Superior	63.28 ab	18.87 ab	61.40 ab	96.80 ab	5.92 a
Below middle	60.28 ab	17.39 ab	61.40 ab	94.80 ab	4.43 ab
Inferior	59.20 ab	16.70 b	50.80 ab	80.80 ab	3.96 ab
Variation coef(%)	12.61	30.70	39.36	31.74	85.83

Means followed by same letter are not statistically different by Tukey test at 5 % probability.

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Acknowledgements: To Embrapa, CAPES, IF Goiano e IFB.

Forage production and soybean grain yield as affected by life cycle of soybean cultivars intercropped with *Brachiaria brizantha*

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Introduction

Agriculture and livestock integration is a sustainable practice that improves both crop yield and pasture recuperation/formation. However, to achieve success it is important to identify crop cultivars more adapted to intercropping with grasses. Therefore, the objective was to evaluate grain yield of soybean [*Glycine max* (L.) Merr.] cultivars with different life cycles as affected by palisadegrass [*Brachiaria brizantha* (Hochst. ex A. Rich) Stapf] intercropped in the same furrow at different depths, in a no-till system, as well as dry matter production of palisadegrass pasture.

Material and Methods

Experiments were performed during two growing seasons, on a Typic Haplorthox, at Botucatu, São Paulo State, Brazil. The experimental design was a randomized block, arranged in a 2 × 4 factorial scheme, with six replications. Treatments consisted of two cropping systems (sole cropped soybean; soybean and palisadegrass intercropped) and four soybean cultivars (super-early cycle [Monsoy 6101], early cycle [Embrapa 48], normal cycle [BRS 133], and late cycle [Emgopa 313]).

Results and Conclusions

Life cycle duration of the soybean had a marked effect, and only early cycle soybean were successful intercrops (Table 1). Intercropping palisadegrass with super-early or early soybean cultivars were viable options to crop-livestock integration, because they did not affect both soybean or palisadegrass yield. In addition, with these cultivars, it was possible to cultivate grain and then afterward more time for cattle (*Bos taurus* and *Bos indicus*) grazing in the same area, providing greater revenue compared to sole soybean cropped or in the intercropping with longer cycle cultivars.

Table 1. Grain yield of soybean cultivars sown sole cropped or with intercropped palisadegrass and forage production

Characteristic	Cultivars†				Average
	Monsoy 6101 (SE)	Embrapa 48 (E)	BRS 133 (N)	Emgopa 313 (L)	
Crop systems	Grain yield, Mg ha^{-1} – First growing season				
Sole cropped	2.41aC‡	2.53aC	3.11aB	3.66aA	2.93
Intercropping	2.53 aA	2.56aA	2.65bA	2.02bB	2.44
Average	2.47	2.54	2.89	2.84	
	Grain yield, Mg ha^{-1} – Second growing season				
Sole cropped	3.01aC	3.31aC	3.68aB	4.29aA	3.57
Intercropping	3.20aAB	3.42aA	3.03bB	2.47bC	3.03
Average	3.10	3.37	3.35	3.38	-
	Forage production (Palisadegrass yield, Mg ha^{-1})				
1º GS§	17.2 A	18.7 A	15.5 B	12.5 C	
2º GS	18.8 A	19.6 A	14.9 B	13.1 C	

† SE (super-early cycle), E (early cycle), N (normal cycle), and L (late cycle). ‡ Values followed by the same letter, uppercase horizontally or lowercase letter vertically, are not signifi cantly different at $p \leq 0.10$ according to Tukey test. §GM - Growing season

Integrated systems and biodiversity

Adriano Stephan Nascente

Forage production and soybean grain yield as affected by life cycle of soybean cultivars intercropped with brachiaria brizantha

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Soil microarthropod populations under crop-livestock-forestry integration in Amapá savanna - Brazilian Amazon

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Introduction

The soil fauna presents a huge potential as a bio-indicator of soil quality, this because its abundance and wealth are susceptible to changes in their management and use. The CLF integration aims at synergistic effects among the components in de agroecosystem. Upgrading biodiversity approving new niches and habitats to meso-orgnisms, very important for soil enrichment and recycling of nutrients.

Material and Methods

The experiment was conducted at the experimental area of the savanna of Embrapa Amapá, located “00°22’55” e 00°24’30”N, e 51°01’40” e 51°04’10” W, Macapá -AP. The soil in the area is Oxisol, medium texture, with high acidity and low fertility characteristic of Amapá savanna areas. The climate is rainy Ami-Tropical, with an annual average rainfall of 2.260 mm concentrated between the months January to July. In 2010 were installed planted seven plots (90 x 60 m) and each received a combined treatment with maize (*Zea mays* L.) and subsequent *Brachiaria ruziziensis* (MB) and a tree species and agricultural species. In MBG treatments - Gliricidia (*Gliricidia sepium*) and MBT - Tachi-white (*Sclerolobium paniculatum*) trees were planted in single rows, with 2 x12 m spacing and, MBE -Eucalyptus (*Eucalyptus urograndis*) dual in -line, with spacing of 2 x 2 x 10 m. The cornfield experiment was conducted in the harvest in 2013. The soil sampling for the assessment of soil meso-organisms was performed in 2014 in the depth 0-5 cm of systematic collection of samples at distances of 1,5 m and 6,0 m lines and trees, in the rainy season and one in the dry season. For the extraction of meso-organisms laboratory used the Berlese Tullgreen apparatus. Data were subjected to the analysis of variance, and means were compared by the t test (LSD), at 1% probability.

Results and Conclusions

Eleven Arthropoda orders found, Acari were the most abundant independent of the season and treatment. In decreasing order: Collembola and Hymenoptera were abundant in the rainy season and dry season respectively. The rainy season had higher abundance of meso-organisms (966) that the dry season (213) ($P = 0.0001$). In the rainy season, treatments intercropped with trees CLF had greater abundance of meso-organisms in intercropping CL, except for the MBE. O índice de diversidade de Shannon variou entre 0,18 e 0,52, valores considerados baixos em relação aos observados em cerrado *sensu stricto* e cerrado ralo do Planalto Central do Brasil. In the rainy season we observed a greater abundance in the distance of 6.0 m in all treatments with tree ($P = 0,0016$), though in the dry season the abundance was similar in both assessed distances. Treatments differed in abundance ($P = 0.0042$) only in the rainy season. MBG and MBT were higher than MBE and MB. The seasons and production systems influence on the variation of fauna density, species richness and Shannon Winner index for edaphic meso-organisms.

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To Embrapa and all technicians and field workers at Embrapa Amapá Research Centre involved in the evaluation.

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Abundance of earthworms, enchytraeids and nematodes in different land use systems in Planaltina, DF, Brazil

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Introduction

Soil organisms are an integral part of ecosystems, of the soil formation process and are responsible for ecological functions and services such as nutrient cycling, pest and diseases control, decomposition of organic matter and maintenance of soil structure. The abundance and activity of soil organisms in productive soils depend on management practices and also the physical and chemical characteristics of soils, being a critical component for plant growth. Considering the need for indicators to soil quality and maintenance of biodiversity, as well as the lack of studies on soil fauna in the Cerrado region, the aim of this study was to evaluate the abundance of earthworms, enchytraeids and nematodes present in different systems of land use.

Material and Methods

The study was conducted at Embrapa Cerrados Research Centre, Planaltina, DF, Brazil. Land use types included integrated crop-livestock-forestry system (ICLF), grazed pasture with 3 years (P3), monoculture of grazed *Leucaena leucocephala* (L), monoculture of *Eucalyptus* sp. (E), grazed pasture with 6 years (P6) and natural vegetation of Cerrado *sensu stricto* (C). Five soil monoliths (25 cm x 25 cm x 10 cm depth) were sampled from each area by the TSBF method (Anderson e Ingram, 1993). Earthworms were handsorted from the monolith and an aliquot of 300 ml (v/v) was withdrawn from the remaining soil to determine the nematodes abundance by Jenkins (1964) method. For the enchytraeid abundance determination, soil was sampled with a volumetric ring (5 cm x 5,6 cm) and the organisms were extracted according to ISO 23611-3/ 2007 with the hot wet method. One way ANOVA followed by Tukey's test at 1% and 5% significance using the Assistat program version 7.7 was performed.

Results and Conclusions

The average values of abundance of earthworms varied from 0 to 381 individuals/square meter (ind/m^2), of enchytraeids from 51 to 1528 ind/m^2 and of nematodes, from 2227 to 5581 individuals per 300g of soil. The abundance was statistically different only for the earthworms, between ICLF and E systems. There is a tendency, in the evaluation of preliminary data of increased density of earthworms and enchytraeids according to the systems conservation and nematode density increase to more degraded systems, perhaps due to less competition in the ecosystem and the presence of phytoparasitic nematodes. The results suggest ICLF system provides more favorable conditions for earthworm populations, which are considered ecosystem engineers.

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Angela Pereira Bussinguer

Abundance of earthworms, enchytraeids and nematodes in different land use systems in Planaltina, DF, Brazil

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Feeding activity of soil invertebrates in a Crop-Livestock-Forest System in Cerrado region measured with bait lamina method

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Introduction The establishment of sustainability indicators in integrated production systems is important for the valuation of ecosystem services. The bait lamina method has been used in soil ecology research to study the effect of anthropogenic activities on soil functions as an indicator of habitat function or, indirectly, of nutrient cycling in the soil (Römbke, 2014). This method consists of plastic sticks with holes filled with bait material, which are inserted in the soil. The amount of opened holes is taken as a measurement of the feeding activity after a period of time, indicating the activity of soil fauna and, consequently, the soil quality. Despite the simplicity of the method, it is still scarcely used in the tropics. In crop-livestock-forest systems (CLFS), a common question has been how to carry out the soil sampling in an integrated system with forest and pasture components, where there are differences within the system such as the shading of the trees. Therefore, our objectives were to evaluate the potential of bait-lamina method in a crop-livestock-forest system in Cerrado biome and to evaluate whether the feeding activity of soil invertebrates differ within the microhabitats in that system. The data presented here are still preliminary.

Material and Methods

The study was carried out at Embrapa Cerrados Research Center, Planaltina, DF, Brazil, in a plot of CLFS of 1,34 ha composed of *Eucalyptus urograndis* with *Brachiaria brizantha* cv. Piatã between alleys (silvopastoral system with plant trees spacing of 2 x 2 m and spacing between alleys of 22 m). Bait lamina purchased from terra protecta GmbH Germany (Kratz, 1998), were placed at 9 points, three of them at the middlemost alley distant 10 meters from each other (Tree), and the other 6 points were 5m (Inter) and 10m (Brac) downwards, in parallel to the tree alleys. A set of 14 bait laminas was placed at each point up to a depth of 8 cm in the soil and removed 12 days later. Laminas placed at a monoculture of *Eucalyptus* clones were used as a reference. The opened holes (eaten bait) were counted and the feeding activity estimated for each treatment up to 8 cm in depth at every 2 cm.

Results and Conclusions

The percentages of opened holes, i.e. eaten baits obtained in each treatment were 77,8 (Tree), 82,3 (Inter), 76,4 (Brac) and 60,4 (Euca). The biggest difference of eaten baits was observed between Inter and Euca, however the feeding activity was not different statistically among the treatments (ANOVA, $p > 0,05$). The feeding activity at the different depths did not show significant differences either, although the lower percentage of opened holes in the depth of 6-8 cm in Euca suggests a reduction in the activity. The experiment should be repeated exposing the bait lamina for a shorter period, in order to obtain about 50% of bait consumption and, consequently, a better contrast between the treatments. A higher number of laminas would also improve the data in order to confirm the present results. Overall, the method has shown a good potential as a quick and simple tool for soil quality evaluation.

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Enchytraeids (Oligochaeta, Enchytraeidae) as soil quality indicators in integrated systems in Paraná State

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Introduction Soil organisms can be useful to measure the sustainability of a system as bioindicators since they can respond quickly to changes in the environment. The enchytraeids are edaphic microannelids which play a role in the organic matter decomposition. The knowledge on these worms is still scarce in Brazil, but they are found worldwide and have been used as bioindicators of soil quality and contamination in Europe. Our objective was to evaluate the potential of the enchytraeid worms as indicators in different land use systems.

Material and Methods

Five different systems were assessed in Ponta Grossa County, Paraná State, Southern Brazil: Integrated Crop-Livestock (ICL) with 7 years, Integrated Crop-Livestock-Forest (ICLF) with 7 years, *Eucalyptus* plantation (EU) with 20 years, No-till System (NT) with 30 years and Native Pasture (NP). The sampling and extraction of worms followed ISO 23611-3: 2007). Ten soil samples were collected per plot (50 m x 100 m), totalizing 30 points per system. The worms were extracted from each soil sample by a hot wet method for 3h 30 minutes and counted under a stereomicroscope. The worms were identified in vivo to genus level in only 2-3 of the 10 samples of each plot from warm season. Samplings were performed once at the end of the cold season (August-September 2012) and once at the end of the warm rainy season (April 2013). The data were submitted to univariate ANOVA and mean test Tukey ($p < 0.05$) and to multivariate Principal Component Analysis (PCA).

Results and Conclusions

The enchytraeid abundance was clearly season-dependent, showing a total of 364 individuals in the cold season and 3514 in the warm season. In the cold season, worms were absent in 62% of the samples, against 11% in the warm season, probably as a reflex of its drier condition. Among the different systems, enchytraeids in ICL and ICLF were more abundant than in NP and EU in both seasons (ANOVA; Tukey, $p < 0.05$). In turn, the abundance in NT was as high as in the integrated systems in the warm season when there was a crop growing, but lower in the cold/drier season, when no crop was growing at the moment of the sampling. The highest genus richness was found in NP (5) and NT (5) followed by ICL (4), ICLF (3) and EU (3). The genus *Enchytraeus*, which is probably common in areas with higher degree of disturbance, composed 50% or more of the worms identified in each system, except in EU. The Principal Component Analysis (PCA) separated the systems in three groups: EU, NP and the more conservationist systems (ICL, ICLF and NT). The latter group was associated to the higher enchytraeid abundance and genus richness, NP, to the *Achaeta* genus and EU to no one of the biological variables measured. This separation is explained by the principal component (PC) 1 (70,2%) and PC 2 (18,4%), where PC 1 was represented mainly by enchytraeid abundance data. We conclude that enchytraeids were sensitive to the land use systems studied and may be good indicators of soil quality.

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Cintia Carla Niva

Enchytraeids (oligochaeta, enchytraeidae) as soil quality indicators in integrated systems in Paraná state

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Microbial biomass carbon dynamics in soil under crop-livestock-forest in northern of Mato Grosso, Brazil

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Introduction

The agricultural systems constant change is directly associated with the search for managements to maintain productivity levels, but which are more sustainable as possible. The different managements adoption have become increasingly applied practices, which requires technical knowledge to confirm its viability. The objective was to evaluate the microbial biomass carbon (MBC) dynamics in different managements: Crop-Livestock-Forest integration systems, soybean/pasture rotation and native forest, in Brazilian Cerrado.

Material and Methods

The study was conducted with soils from Embrapa Agrossilvipastoril Technology Reference Unit, located in Gamada farm (10º33'29"S 55º57'11"W). We evaluated three integration systems composed of simple (ICLF1), double (ICLF2) and triple (ICLF3) eucalyptus lines, allocated to 20m of each other and arranged in 5 ha. Between the plants lines/rows were conducted crop soybean-corn-pasture in rotation and, after three growing seasons was implanted pasture with grazing, these systems were compared with soybean/pasture rotation and native forest-Cerrado. The collection was held at 0-0.2m depth, in Mai 2009, 2010, 2011, 2012 and 2013. The MBC was quantified according to Jenkinson and Powlson (1976).

Results and Conclusions

The MBC in integration soils were more stable compared to other management systems, with the exception of ICLF3 that started at levels far below the others but could achieve the same values in the 4th year of evaluation and maintained in the 5th year (Fig.1). Moreover, the soybeans/pasture rotation system decreased in value over the years. The native forest presented MBC crescent increase in the four years of assessment and returned to other media in the last one.

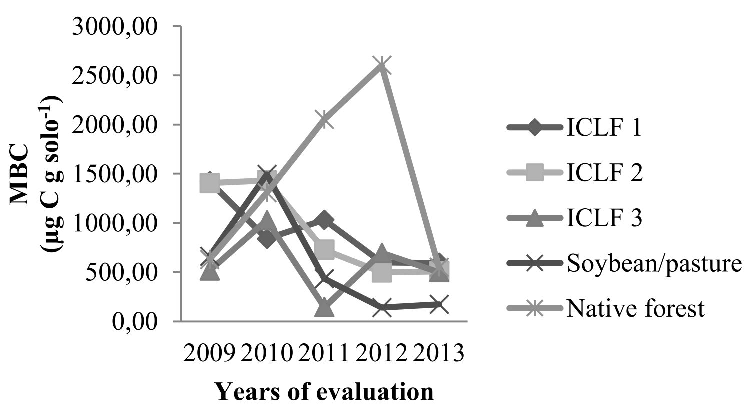

Fig. 1. Microbial biomass carbon (MBC) dynamics in soil under three different integration Crop-Livestock-Forest (ICLF) compared to soybean/pasture rotation and native forest.

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Enzyme activity as quality indicator of soil under agroforestry systems in the Brazilian Cerrado

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Introduction Agroforestry production systems (APS) can be considered a way to produce causing low environmental impact. Besides, APS can be advantageous over conventional agricultural management, since they can offer increased productivity, economic benefits, and more diversity by increasing the possibilities of use a greater number of crops in an economic way. In this presentation, we report the effects of 4 years of two APS installed in the Brazilian Cerrado on soil enzyme activity.

Material and Methods
Two APS with focus on the production of grains (common bean and maize) and energy (sunflower and sesame) were installed in an area of grain production (16°29' S, 49°17'W, 787 m alt) at the Embrapa Rice and Beans Research Center, Santo Antônio de Goiás, in 2010. The trees composing the APS were: angico, baru, aroeira, cagaita, angelim, farinha seca, ingá, and pequi. Grain and energy crops were sown in the tree interlines after crotalaria, sorghum and fallow, as soil covering. Soil samples were taken in 0-20 cm layer, in the plots and in the tree lines, and total enzyme activity (FDA), b-glucosidase and acid phosphatase were determined as described by Ferreira et al. (2011) and compared to those under the native vegetation.

Results and Conclusions
Over a 4-year period, the treatments in continuous cropping APS with energy crops showed lower differences among them, but higher differences from the forest as compared to APS with grain crops (Fig. 1). Within the plots of grain crops (Fig. 1B), treatments with crotalaria and maize tended to group together, while common bean after sorghum and fallow formed another group.

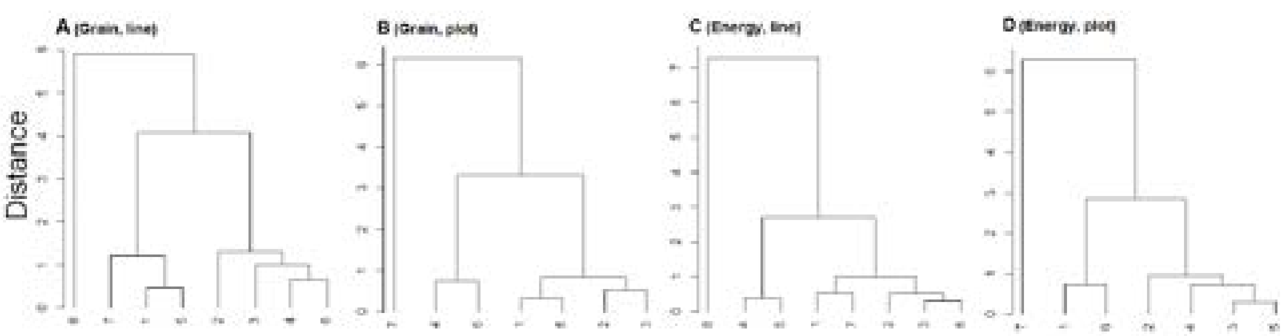

Fig. 1. Clustering dendrogram of treatments under APS for grain production (A and B) and energy (C and D). Treatments in the line of trees (A and C): 1- angico/baru, 2- aroeira/baru, 3- aroeira/cagaita, 4- angelim/cagaita, 5- angelim/pequi, 6- farinha seca/pequi, 7- ingá and 8- forest. Treatments in the plots of grain APS (B): 1- crotalaria/maize, 2- crotalaria/bean, 3- sorghum/maize, 4- sorghum/bean, 5- fallow/maize, 6- fallow/bean, and 7- forest. Treatments in the plots of energy APS (D): 1- crotalaria/sesame, 2- crotalaria/sunflower, 3- sorghum/sesame, 4- sorghum/sunflower, 5- fallow/sesame, 6- fallow/sunflower, and 7- forest. Data are means of 4 replicates.

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Integrated crop-livestock-forest system presents a different soil microbial structure in comparison to other land uses

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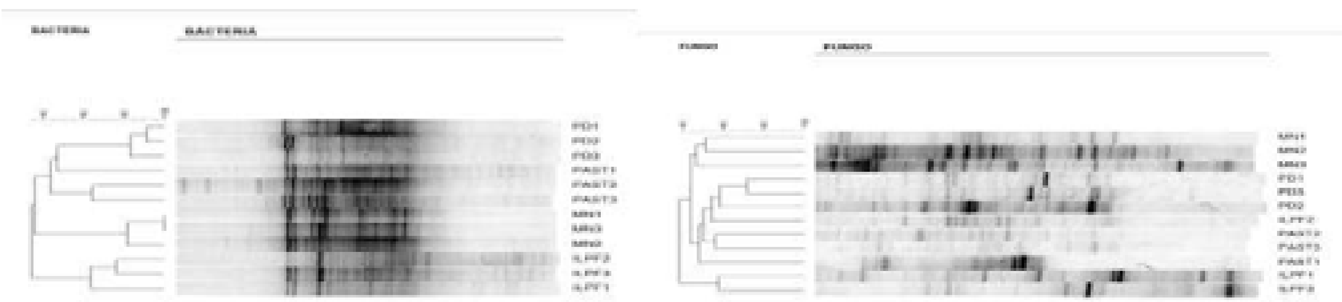
Introduction Soil organic matter (SOM) conservation is essential for environmental services maintenance, especially in tropical agroecosytems where this component is essential for soil fertility, structure and biological activity. Soil microorganisms are the main driver of nutrient cycling, since key processes, such as C and N mineralization, N immobilization, xenobiotics decomposition, denitrification and others are mediated by them. However when the agroecosystems are manipulated, these active components of soils are impacted, changing the carbon and nutrient dynamics. Therefore, the monitoring of the microbial communities is a good tool to indicate changes in soil dynamics. Our objective was to characterize the soil microbial communities under different land uses by using denaturing gradient gel electrophoresis.

Material and Methods

The study was carried out in the Municipality of São Raimundo das Mangabeiras (Cerrado Biome), Maranhão State. Treatments included (i) pasture of *Brachiaria brizantha* in monoculture, (ii) no-till cropping system (soybean-maize), both installed in 2005, (iii) integrated crop-livestok-forest system (*B. brizantha*, eucalyptus and soybean-maize) and a (iv) native vegetation. Soil samples were taken at 10 cm of depth for molecular analysis in 2013.

Results and Conclusions

Figure 1 shows the dendrograms of soil bacteria and fungi communities from different land uses (PD: no-till, PAST: pasture, ILPF: integrated crop-livestok-forest and MN: native vegetation).



The DGGE patterns clustered both bacterial and fungal community into three different groups: i. No-till and pasture, ii. Native and iii. integrated crop-livestok-forest (with exception of one sample of integrated crop-livestok-forest in fungal screening). Pastures and no-till system sampled tend to present similarity on their communities structures probably due the incorporation of grazing areas into the areas of PD. The distinct pattern present in the integrated crop-livestok-forest samples suggests that arboreal component plays an important role in structuring the microbial community. Additional studies should be done to confirm this hypothesis.

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Long-term soil microbial biomass in conventional tillage, no tillage and crop-livestock systems

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Introduction

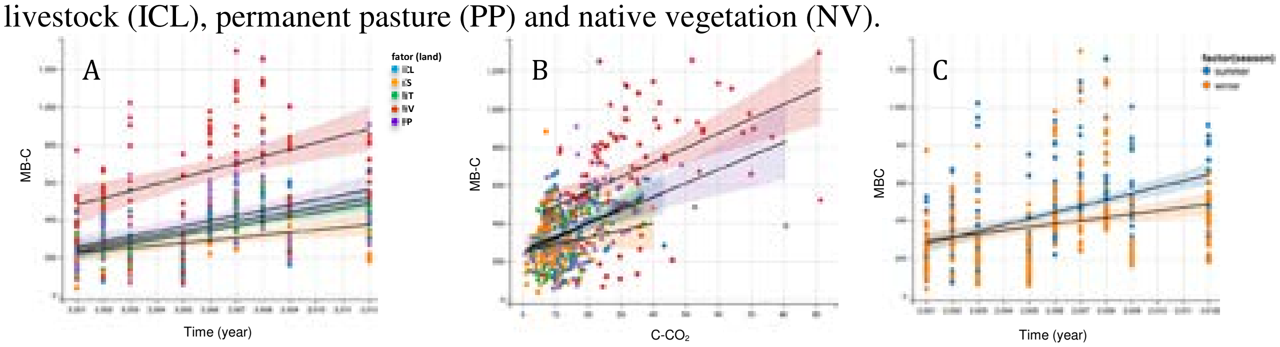
Incorporation harvest residues and mineral soil also offers promise for improving long-term C storage. Soil microbial biomass can improves soil quality but it also has implications for global carbon cycle since soils are the largest terrestrial reservoir of carbon (Stockmann et al., 2013). Compared to native soil, agricultural land use inevitably leads to a decrease in organic carbon and increased emissions of carbon dioxide into the atmosphere (Lal, 1997).

Material and Methods

We measured the soil microbial biomass carbon (MB-C) during 10-yrs in different cropping systems in summer and winter seasons production in the Cerrado (savannah) biome, using a method fumigation extraction technique. Soil samples were collected from an experimental field design of Embrapa Western Agriculture. Soils from a adjacent native vegetation were collected and using with reference compare with the other cropping systems. Analysis of variance was performed using the general linear model.

Results and Conclusions

Fig. 1. Soil microbial biomass carbon (MB-C) (A), MB-C vs basal respiration (B) and MB-C under summer and winter seasons (C) under conventional systems (CS), no-till (NT), integrated crop-livestock (ICL), permanent pasture (PP) and native vegetation (NV).



Here we show that microbial biomass carbon (MB-C) always showed highest ($p<0.05$) values in native vegetation and increase in no-tillage, integrated crop-livestock and permanent pasture after year 2006 compared CS (Fig. 1A). Additionally, MB-C *vs* basal respiration showed high activity in NV, and lower activity in CS (Fig. 1B). The MB-C result in increase ($p<0.05$) under summer season than winter season after soil sampling in year 2005 (Fig. 1C). Take together our results showed that the incorporation of plant residues in long-term would preferentially stimulate soil microbial biomass in native vegetation, no-tillage, crop-livestock and permanent pasture preferentially in summer season. This may have occurred because smaller among of carbon being lost by soil respiration over 10-yrs of monitoring microbial biomass carbon.

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Long-term soil microbial biomass in conventional tillage, no tillage and crop-livestock systems
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The match between microbial community structure and soil properties is modulated by land use type and sample origin within an integrated agroecosystem

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Introduction It is of global concern to adopt measures to mitigate land degradation caused by agricultural production systems. One of the strategies proposed is to replace degraded pastures with agrosilvopastoral systems, which integrate three different land-use types: crop production, pasture and forestry plantation (denoted ICLF). However, little is known about the differences between ICLF and other land use types in terms of their impact on soil microbial community structure. In this study, we tested the hypothesis that introducing ICLF as replacements for degraded pastures leads to a change in the response of phenotypic composition of the soil microbial community to individual soil chemical variables.

Material and Methods The study was conducted in one of the ~203 technology reference units in ICFL (http://www.cnpgl.embrapa.br/nova/silpf) of the Brazilian Agricultural Research Corporation (Embrapa) on the Boa Vereda farm located within the municipal limits of Cachoeira Dourada, Goiás, Brazil (18°27'43.19"S, 49°35'58.53"W). Distance matrices based on individual soil chemical properties and individual soil microbial variables were correlated by Procrustes analysis and these relationships yielded vectors of residuals depicting these correlations (matches) (Lisboa et al., 2014a). These vectors were used as univariate response variables in an ANOVA framework in order to investigate how the match sizes (the strength of correlation/covariance) between individual soil chemical properties and individual soil microbial variables vary across land use types (levels: ICLF; degradated pasture; improved pasture; and a native cerrado fragment) and also across sample origin within ICLF (levels: soil samples under the influence of the exotic tree forest stand (canopy); soil samples under influence of the pasture; samples within the transition between the forest stand and the pasture). For more details please see Lisboa et al. 2014b).

Results and Conclusions While the strength of the correlation between soil microbial structure variables and phosphorus availability was typically land use type dependent, the response of the microbial structure to exchangeable base cations was mainly affected by the sample origin within ICLF. Finally we concluded that increases in the heterogeneity of vegetation within integrated crop, pasture and forestry systems are an important driver of microbial community response to environmental changes, and may be one means by which to increase the sustainability of tropical agroecosystems.

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Acknowledgements To Conv. CAPES-Embrapa, Embrapa (02.11.05.001; 01.11.01.002; 01.10.06.001.06.04), CNPq (562601/2010-4) and all researchers, technicians and field workers who were involved with the CARBIOMA project. To Dr. Abílio Pacheco (Boa Vereda farm).

Francy Junio Gonçalves Lisboa

The match between microbial community structure and soil properties is modulated by land use type and sample origin within an integrated agroecosystem

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Weed occurrence in sustainable cropping systems in Brazilian Cerrado

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Introduction Weeds are becoming widespread as a result of abuse in use of herbicides as sole method for its control, which resulted in selection of herbicide-tolerant weed species and evolution of resistant biotypes. Integrated cropping systems help reducing weed selection factors by favoring weed suppression by cultural means. In this brief report we aim to identify the main weed species which still constitute problems in crops grown under integrated cultural systems.

Material and Methods

The experiment was installed in 2009 at the area of Embrapa Western Agriculture, Ponta Porã, MS, Brazil (22° 32' 56" S 55° 38' 56" W), 680 m asl, in Oxisol soil. Treatments are listed at Table 1. Assessments of weed occurrence were performed in the early post-emergence of the 2011/12 cropping season, in completely randomized design. A quadrat with 0.5 m side was released randomly 10 times in each area, and weeds inside were counted and collected for determination of dry mass, being estimated the density, frequency, dominance and importance value of each species in each cropping system.

Results and Conclusions

The overall most important weed species in the area were *Bidens pilosa*, *Commelina benghalensis*, *Digitaria horizontalis* and *Raphanus sativus*; there was change in the species of individuals according to management type, being broadleaved species predominant (Table 1). Results show that farmers have to adopt species which provide soil coverage throughout the year, as the intercrop maize + *B. ruziziensis* or maize + *B. brizantha*, planted among forest trees always when possible.

Table 1. Importance value (%) for weed species reported in areas submitted to different uses.

Weed Species	1-NTSa	2-NTSb	3-CTS	4-Forestry	5-ICLa	6-ICLb	7-ICLFa1	8-ICLFa2
Amaranthus viridis		8.84						
Avena sativa			5.91				17.5	
Bidens pilosa	35.2	42.3	8.6					
Brachiaria brizantha				10.1	29.7			
Chamaesyce prostrata						10.0		
Chloris elata				65.1				
Commelina benghalensis					23.3	37.1		
Conyza bonariensis				16.3			33.4	
Cyperus rotundus								
Digitaria horizontalis		10.7				42.8		5.15
Euphorbia heterophylla	34.5							
Leonotis nepetifolia					6.55			
Raphanus sativus	20.5	18.8	68.2		34.0	10.0	44.3	94.8
Others	7.04	19.2	17.2	8.35	6.37		4.65	

Treatments (crop sequence from 2009-2011): **1-NTSa** =S/W/S/M/S; **2-NTSb** =S/W/S/(M+Br)/S; **3-CTS** =S/A/S/M/S; **4-Forestry** =E; **5-ICLa** =S/X/X/X/S; **6-ICLb** =S/W/S/(M+X)/X; **7-ICLFa1** =(E+S)/(E+A)/(E+S)/(E+M+Br)/(E+S); **8-ICLFa2** =(E+S)/(E+A)/(E+S)/(E+M+Br)/(E+S). **S** = soybean, **M** = maize, **Br** = *B. ruziziensis*, **X** = *B. brizantha* cv. Xaraés, **E** = *Eucalyptus*, **A** = oat, **W** = wheat. **NTSa/b** = no-till planting system (agriculture-only) with distinct crop successions; **CTS** = conventional soil tillage system (agriculture-only) with distinct crop successions; **ICLa/b** = integration crop-livestock; **ICLFa/b** = integration crop-livestock-forest. For ICLF, numbers "**1**" and "**2**" represent, respectively, evaluations in the rows of *Eucalyptus* and in the crops planted between these rows.

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Weed infestation and similarity in sustainable cropping systems

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Introduction

Integrated production systems such as crop-livestock make possible to produce with sustainability, being also an important approach for weed management. Costs with herbicides are increasing and farmers urge for most economical planting systems whose cultural effect helps herbicides in controlling weed species. It is widely known that herbicides work better in less infested areas, compared to those with dense weed canopy, due to a better leaf coverage by the time of herbicide application, among other factors. We aimed to assess weed infestation in distinct cropping systems.

Material and Methods

The experiment was installed in 2009 at the area of Embrapa Western Agriculture, Ponta Porã, MS, Brazil (22° 32' 56" S 55° 38' 56" W), 680 m asl, in Oxisol soil. Treatments are listed at Figure 1. Assessments of weed occurrence were performed in the early post-emergence of the 2011/12 cropping season, in completely randomized design. A quadrat with 0.5 m side was released randomly 10 times in each area, and weeds inside each quadrat were counted and collected for determination of dry mass.

Results and Conclusions

The level of weed infestation depends on the planting system; crops which accumulates smaller dry mass, or whose dry mass has low C:N ratio, promoted high infestation levels. After soybean harvest, cultivation of maize intercropped with *B. brizantha* in the second cropping season, between rows of *Eucalyptus* (ICLF), proved to be the option with the greatest potential to reduce weed incidence in integrated production systems.

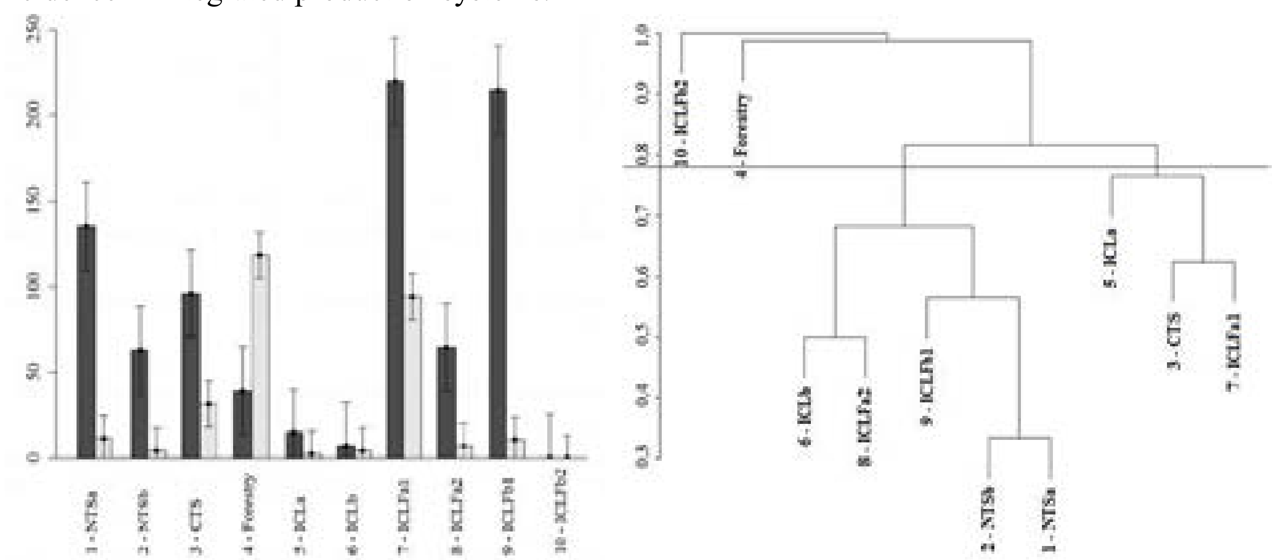

Figure 1. (A) - number of individuals (■ - m^{-2}) and dry mass (■ - g m^{-2}) of weeds as a function of planting system; (B) - Cluster analysis by dissimilarity of infestation based on the UPGMA method. Treatments (crop sequence from 2009-2011): **1-NTSa** =S/W/S/M/S; **2-NTSb** =S/W/S/(M+Br)/S; **3-CTS** =S/A/S/M/S; **4-Forestry** =E; **5-ICLa** =S/X/X/X/S; **6-ICLb** =S/W/S/(M+X)/X; **7-ICLFa1** =(E+S)/(E+A)/(E+S)/(E+M+Br)/(E+S); **8-ICLFa2** =(E+S)/(E+A)/(E+S)/(E+M+Br)/(E+S). **S** = soybean, **M** = maize, **Br** = *B. ruziziensis*, **X** = *B. brizantha* cv. Xaraés, **E** = *Eucalyptus*, **A** = oat, **W** = wheat. **NTSa/b** = no-till planting system (agriculture-only) with distinct crop successions; **CTS** = conventional soil tillage system (agriculture-only) with distinct crop successions; **ICLa/b** = integration crop-livestock; **ICLFa/b** = integration crop-livestock-forest. For ICLF, numbers "**1**" and "**2**" represent, respectively, evaluations in the rows of *Eucalyptus* and in the crops planted between these rows.

Integrated systems and biodiversity

Germani Concenco

Weed infestation and similarity in sustainable cropping systems

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Soil enzymes and microbial biomass carbon monitoring in an integrated crop-livestock-forest agroecosystem in the Cerrado region.

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Introduction

Integrated crop-livestock-forest agroecosystems (ICLF) are considered one of the best alternatives to recuperate degraded pastures and to avoid deforestation in the Cerrados region, where approximately 25 million hectares of cultivated pastures are in some stage of degradation. In order to stimulate their adoption by farmers, ICLF policies were included as one of the pillars of the Brazilian governmental program for low carbon emission agriculture.

Considering the diversity and complexity of ICLF systems there is growing interest on their impacts on soil quality under tropical conditions. Since selected soil microbial attributes can work as early indicators of changes in soil quality, we have monitored the dynamics of microbial biomass carbon (MBC) and soil enzymes activities in the forest, and crop/livestock components of an ICLF system established in the Cerrados region.

Material and Methods

The study area was located at the Embrapa Cerrados Research Center, Planaltina, DF, Brazil. The soil is a clayey Typic Dystrophic Red Latosol. The experiment was established in 2009 in a randomized complete block design. For this study, soil samples (0 to 10 cm depth) were collected from the treatment where *Eucalyptus cloeziana* was planted in 7 rows with a 22m spacing between the tree stands. Soybean was cultivated between the tree stands from 2009 to 2012. In February 2012, after soybean harvesting, plots were sown with a mixture of sorghum / *Brachiaria brizantha* (syn. *Urochloa brizantha)* cv. BRS Piatã as intercrops. Since then the area is under brachiaria pasture. Soil sampling was performed in the rainy seasons of 2011, 2012 (January and May) and 2013. A native cerrado area was included as the reference for the original soil conditions.

The microbial attributes evaluated were microbial biomass carbon -MBC (Vance et. al, 1987),) and the activity of soil enzymes, β-glucosidase (BG) and arylsulfatase (Tabatabai, 1994). Soil organic matter (SOM) was determined by the Walkley-Black method.

Results and Conclusions

As already observed previously, in relation to the native cerrado area, there were significant reductions in soil MBC, SOM, acid phosphatase and arilsulfatase activities in the areas with eucalyptus and soybean/pasture. In the other hand, increased levels of β-glucosidase activity were observed in the eucalyptus area as compared to the native cerrado.

In May 2012, after the pasture establishment, MBC, β-glucosidase and arylsulfatase activities increased by 78%, 90% and 60%, respectively, evidencing the ability of brachiaria Piatã to stimulate soil biology. These results also show the ability of these microbial indicators in responding to changes in the management system, since the organic matter content remained the same.

The monitoring of the eucalyptus area has shown a trend with time of increasing arylsulfatase activities.

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Vance et al. (1987). Soil Biol. Biochem

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To Embrapa, CNPq, and FAPDF.

Integrated systems and biodiversity

Ieda Carvalho Mendes

Soil enzymes and microbial biomass carbon monitoring in an integrated crop-livestock-forest agroecosystem in the Cerrado region

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SOIL ENZYMES ACTIVITIES IN CERRADO´S GRAIN-CROPS FARMING SYSTEMS WITH BRACHIARIA.

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Introduction

Already observed for temperate conditions, soil enzyme measurements also have great potential as soil quality indicators in the tropics due to their sensitivity, responding faster to shifts in management practices than parameters like soil organic matter. The ease of measurement and low cost of soil enzyme assays also make them very attractive as part of a soil quality index.

The expansion of the soybean/corn double crop system in the Cerrados region, has been possible due to the adoption of no-tillage and the use of short-cycle soybean varieties. More recently, the integration of deep-rooted grasses into these double-crop farming systems, either as cover-crop or pasture for the cattle during the dry/winter season, is also an option that has been adopted successfully, allowing for a third harvest. The presence of brachiaria grasses in the agricultural systems increases the input of plant residues and provides soil protection during the dry season, favoring a more biologically active edaphic environment.

We evaluated the activity of soil enzymes in a grain-crop production system with a winter fallow, brachiaria grass as a cover-crop after soybean harvesting and where second-harvest corn is either cultivated alone or intercropped with brachiaria grass.

Material and Methods

The study area was located in Rio Verde, GO, Brazil in an area that had been under no-tillage with annual grain crops for 20 years. The soil is a clayey Typic Dystrophic Red Latosol. The experiment was established in 2007, in a randomized complete block design with four replicates. For this study, soil samples (0-10 cm depth) were collected from the following treatments: i) brachiaria (*U. brizantha* cv. Marandu) as a cover-crop after soybean harvest; ii) second-harvest corn cultivated alone, iii) second-harvest corn intercropped with brachiaria (*Urochloa ruziziensis)* and iv) winter fallow after the soybean harvesting. Soil sampling was performed in December, 2014 at the soybean flowering stage. The soil enzymes evaluated were β-glucosidase, arylsulfatase and acid phosphatase (Tabatabai, 1994), related to the C, S and P cycles respectively.

Results and Conclusions

The greatest enzymes activity levels were observed in the treatment with *U. brizantha* as a cover crop, after soybean harvest. In the other hand, the treatments under fallow and with second-harvest corn cultivated alone presented the lowest enzyme´s activities. Significant increases in β-glucosidase (40%), arylsulfatase (50%) and acid phosphatase (23%) activities were also observed in the system where second-harvest corn was intercropped with *U. ruziziensis,* as compared to the treatments under winter fallow and with second-harvest corn cultivated alone. These results show the capacity of brachiaria grasses to stimulate soil biology under the Cerrados conditions and confirm the ability of β -glucosidase and arylsulfatase to detect changes in the management system.

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To Embrapa, CNPq, FAPEG and FAPDF.

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Forage production and crude protein of *Urochloa plantaginea* submitted to different levels of the NPK fertilizations with or without nitrogen fertilization in covering under irrigation in crop-livestock integration

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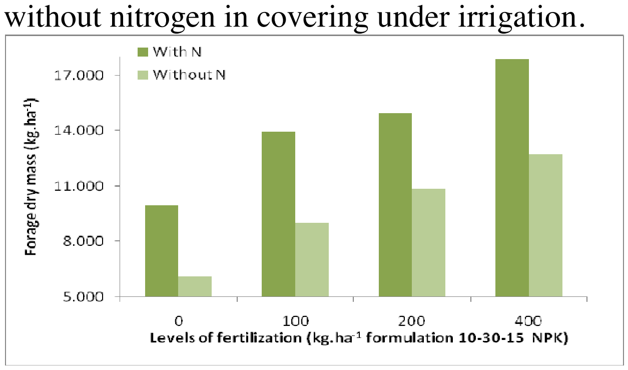
Introduction The agricultural integrated systems of production are considered efficient, when they optimize the resources economical and mainly biological available in the property. The use of grassy of spontaneous growth in different integrated crop-livestock (ICL) systems makes possible the pastejo in times of lack of pasture in the South of Brazil. Among those species, it stands out the Alexander grass (Urochloa plantaginea) that has been used as pasture in the rotation areas after summer cultures. The objective of the work was to quantify the production of dry mass and the Crude Protein of Alexander grass, under different levels of fertilization with NPK, with or without nitrogen fertilization and under irrigation.

Material and Methods The field experiment was installed in area of spontaneous growth of Alexander grass, in succession the corn and soy cultures, irrigated by aspersion in lineal system at the Embrapa Temperate Climate Research Center on hydromorphic soils (31st 49' S, 52nd 27' O). The Treatments consisted of 4 levels of fertilization: 0, 100, 200 and 400 $kg.ha^{-1}$ of the formulation 10-30-15 (N-P_2O_5-K_2O), and: zero or 45 $kg.ha^{-1}$ of nitrogen fertilization in covering, disposed in blocks with four repetitions and paddocks of 6 x 4m. The irrigation was adjusted to maintain the soil in field capacity. The fertilization was applied in 28/12/2012 and the samplings of the dries mass of forage were accomplished between 09/01 and 26/03 of 2013. The samplings were accomplished at the level of the soil, when the pasture reached 35 to 40 cm of height. After the samplings the portions were matched leaving a residue of 12 cm. The samples were dry to 65°C, heavy to quantify the forage dry mass and led to the laboratory of animal nutrition of Embrapa Temperate Climate for analysis of Crude Protein (%CP).

Results and Conclusions

Fig 1. Forage production of the *Urochloa plantaginea* in function of NPK fertilization with or without nitrogen in covering under irrigation.



The forage production increased with the levels of the NPK fertilizations in agreement with the equations Y=10.978 +18,36x (R2=0,918) and Y= 6.916 + 15,89x (R2=0,922), with or without application of nitrogen in covering respectively. The CP were 10% and 7,3% in the respective treatments with or without nitrogen fertilization, arriving to 12% with nitrogen fertilization and 200 $kg.ha^{-1}$ there is of NPK. The forage production and CP indicate that plant can be an alternative of the grass in systems of ILP, without damage the cultures in rotation and/or succession.

Acknowledgements
To Embrapa, CNPq and FAPERGS for the offer of the structures physical and bags for conduct of the experiment.

Jamir Luís Silva da Silva

Forage production and crude protein of urochloa plantaginea submitted to different levels of the npk fertilizations with or without nitrogen fertilization in covering under irrigation in crop-livestock integration

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Native species for integration crop-livestock-forest in Planosols in the "Canal do Sertão" influence region in Alagoas, Brazil.

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Introduction

Alagoas semiarid region is characterized by low rainfall and shallow soils, hindering the activities related to agriculture. Alagoas Government is building the "Canal do Sertão", which carries water from the São Francisco River for this entire region, both for human consumption and for irrigation and livestock. However, according to the Agro-Ecological Zoning of the State of Alagoas - ZAAL (Embrapa, 2012), most of the Canal do Sertão chute ever built, is over Planosols. Their potential for agricultural use is considered restricted, depending on the depth of the horizon "B plânico", which drastically restricts drainage. Usually, agricultural use is made with subsistence crops and pastures. The major limitations to agriculture are related to restricted drainage; limited effective depth; stoniness and / or rockiness; presence of cemented horizons; sodicity and salinity; susceptibility to erosion; beyond the restrictions of natural fertility and regional water deficit. In this context, the establishment of an iLPF system using native species with multiuse potential (fodder, timber, medicinal) naturally occurring in local Planosols, will expand the prospects for sustainable use of this region. Thus, this study aimed to identify native species with the potential to form an iLPF model suitable for the soil and climatic conditions of Alagoas semiarid region.

Material and Methods

The prospection of native species with the potential to form the iLPF was carried out in three locations on Planosols of Alagoas semiarid region. With the assistance of woodsmen and local farmers sought to species that cattle selected for grazing in times of high food availability. Soil (up to the height of the emergence of B plânico) and plant tissue sampling were performed at each location, in order to associate quality characteristics of plants with soil properties.

Results and Conclusions

The tree species "feijão bravo" (*Capparis flexuosa*), "mororó" (*Bauhinia cheilantha*) and "pau piranha" (*Laetia apetala*) and the herbaceous "marmelada" (*Commelina* spp.) were selected. These species were present in all areas and were unanimously considered due to their forage and medicinal use in the region. The analysis of plant tissue showed that the bromatologic quality and antioxidant activity (total phenols and flavonoids) of selected species varied in function of differences between the soil characteristics observed between Planosols.

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João Gomes da Costa

Native species for integration crop-livestock-forest in planosols in the "Canal do Sertão" influence region in Alagoas, Brazil

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Dung beetles dynamics in open-pastures and silvopastoral systems

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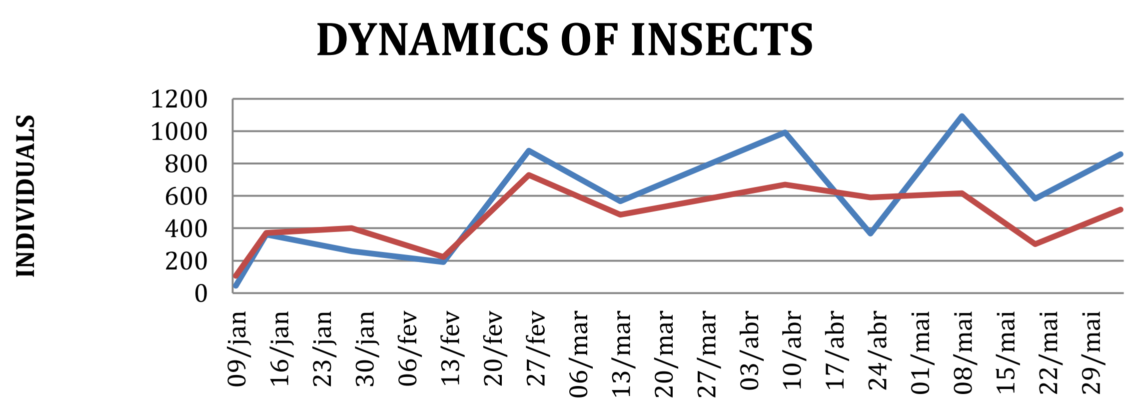
Introduction The cattle dung has great importance in parasitic cycle by serving as a means of maintenance and spread of parasites larvae as helminths and some flies as *Haematobia irritans*. Besides climatological factors, the presence of individuals of edaphic fauna have potential to collaborate to a faster degradation of bovine residuals, reducing the availability of food and protection in the environment, thus interfering in the non parasitic phase of their cycle. Among the factors that interfere with this parasitic dynamic, the major presence of beetles has been shown as beneficial in integrated systems according some previous studies. The aim of this study is to evaluate the effect of silvopastoral system on the edaphic fauna, involving different species of coleoptera during the year seasons.

Material and methods

The assessment follows the methodology described by Campiglia (2002), with "*Pitfall*" traps baited with fresh bovine faeces, spaced at 50 meters apart. Twenty traps in open-pasture (OP) treatment and the same number in the silvopastoral system (SP) were installed, and these, 10 traps are allocated in the pasture among rows and the other 10 under the arboreal canopy. The traps remain in the environment for 24 hours and then the samples are shipped to lab to being classified.

Results and conclusion

11 sampling were held between 09/01 and 03/06; 6,191 beetles were caught in the OP treatment (mean of 309,75/trap), on the other hand, in the SP system, 5,010 insects were caught (mean of 250,5/trap). According T test, means are different between treatments (P value | 0,047929); standard deviation (309,75±110,5445 | OP) and (250,5±67,71341 | SP). *Digitonthophaus gazella* was the most common species in both systems.



	09/jan	14/jan	28/jan	12/fev	26/fev	13/mar	09/abr	23/abr	08/mai	20/mai	03/jun
Open-pasture	45	362	258	192	878	566	992	368	1093	583	858
Silvopastoral	107	372	400	223	729	484	669	591	617	302	516

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Luciano Bastos Lopes

Dung beetles dynamics in open-pastures and silvopastoral systems

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Diversity of invertebrates associated with dung patches in two livestock systems

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Introduction The dung patches represent habitats for invertebrates of sanitary and ecological importance in livestock. The ectoparasites *Haematobia irritans* (horn fly) and others organisms use the feces as place for shelter, reproduction and feeding establishing interactions of competition, parasitism and predation. The silvopastoral system (SPS) is characterized by cultivation of tree species associated to pasture and cattle. The microclimate variation and high diversity of organisms in the SPS contribute to the complexity of ecological interactions in this environment, comparing to conventional grazing system (CGS). This study aimed at evaluating differences in the invertebrate fauna associated with dung patches from cattle raised in SPS and CGS.

Material and Methods

The work was carried out at Embrapa Southeast Livestock located in São Carlos, SP., from 2013 to 2015. During the seasons of year, the invertebrates were sampled in feces of seven or 14 days, excreted by Canchim steer kept on pasture of *Brachiaria decumbens* in the SPS and CGS. The dipterous were sampled through the flotation of pupae present on feces (Marchiori et al., 2001). The pupae were incubated for hatching of flies and parasitoids. The predators and decomposers were sampled in Berlese funnel. Data were submitted to statistical analysis (ANOVA and Student-Newman Keuls, $p<0.05$) and the diversity was estimated by the Shannon-Weaver index (H').

Results and Conclusions

Six fly morphological species were verified in association with feces - Muscidae (3), Sarcophagidae (2) and Fanniidae (1). The horn fly was identified between the Muscidae and the parasitoid *Aphaereta* sp. (Braconidae) was the most common. The predaceous and decomposers fauna was composed by Coleoptera (Scarabaeidae, Histeridae, Anthicidae, Carabidae and Staphylinidae); Diptera (Stratiomyidae); Hemiptera (Anthocoridae); Dermaptera (Labiduridae); Hymenoptera (Formicidae), Isoptera (Termitidae) and Arachnida (Acari and Araneae). The highest densities of dipterous pupae occurred during spring and summer (Table 1). The number of pupae and adults of flies was similar for the both systems. However, the parasitism level of pupae and the diversity of invertebrates were highest on SPS (Table 2). This indicates that the ecological interactions occurring on SPS can contribute for the equilibrium of ectoparasite populations like the horn fly.

Table 1 Means of fly pupae (FP) in function of systems and seasons of year.

Season	Pupae number*	
	SPS	CGS
Winter13	13.0 bc	18.5 ab
Spring13	59.5 a	44.2 a
Summer13	25.9 ab	16.2 ab
Fall14	6.5 c	4.2 b
Winter14	1.9 c	0.0 b
Spring14	75.5 a	100.0 a

Table 2 Means of fly pupae (FP), fly adult (FA), pupae parasitism (PP) and diversity index Shannon-Weaver (H').

System	Variables			H' index	
	FP^ns	FA^ns	PP(%)*	spring	summer
SPS	30.0	10.6	9.3 a	2.5	1.4
CGS	30.5	8.5	1.2 b	2.1	0.5

ns no significance $p>0.05$.
* significance by Student-Newman-Keuls ($p<0.05$).

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Acknowledgements

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Marcos Rafael Gusmão
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SOIL MACROFAUNA IN LAND USE SYSTEMS IN PONTA GROSSA-PARANA STATE, BRAZIL

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Introduction
The soil macrofauna is represented by invertebrates between 2 to 20 mm body width that live permanently in soil or on its surface. Chemical and physical soil properties, management and seasonality can alter the soil macrofauna community. Thus the aim of this study was to assess macrofauna diversity and abundance under different land use systems in order to identify changes in the soil invertebrate community due land management and soil properties.

Material and Methods
Five land use systems were chosen: crop-livestock integration (CLI), crop-livestock-forestry integration (CLFI), grazed native pasture (NP), no tillage (NT) and *Eucalyptus dunnii* plantation (EU) in Ponta Grossa-PR, Brazil. For each system we selected three 50 x 100 m plots and five soil monoliths (25 x 25 cm in 0-10 and 10-20 cm deep) were taken along a central transect in spring (2012). From each layer of the monolith soil samples were removed for chemical and physical analyses. The monoliths were handsorted and the invertebrates were preserved in alcohol 70% and identified in order level. Diversity (order richness, Simpson index and dominance) and abundance were calculated. Duncan tests (5% of significance) and multivariate analysis were performed to assess macrofauna relationships with land use, chemical and physical soil properties.

Results and Conclusions
Table 1. Macrofauna abundance (individuals m^{-2}) and diversity in the 0-20 cm layer in CLI, CLFI, NP EU and NT in Ponta Grossa, Paraná, Brazil, in spring 2012.

Ecological Characteristics	CLI	CLFI	NP	EU	NT
Macrofauna Abundance	566b*	490b	3558a	287b	115c
Order Richness	13	13	13	8	6
Mean Richness (System)	9,00a	8,33a	9,67a	6,00b	4,33c
Dominance (System)	0,30a	0,49a	0,52a	0,40a	0,45a
Simpson (System)	0,70a	0,51a	0,48a	0,60a	0,55a

*Means followed by different letters in line differ by the Duncan's test (p<0,05).

Higher macrofauna abundance was found in NP (3558 individuals m^{-2}), and lower abundance in NT (115 individuals m^{-2}) (Table 1). The lower abundance in NT can be attributed to soil compaction in this system, which causes reduction in pore space and habitat losses for soil macrofauna. Simpson diversity tended to be lower in grazed native pasture, where Isoptera was dominant (Table 1). In degraded systems, the low soil fertility added to the low quantity and quality of litter, the high C / N ratio of plants and the low plant diversity favors some groups, such as Isoptera, which can become pests in degraded pastures. Order richness was higher in grazed systems than the other systems probably due the cattle feces because these represent inputs of organic matter to the soil, which stimulate the soil macrofauna diversity (Table 1). Soil properties, as, P, K, pH, Mg, C, C/N ratio, moist, sand and silt and land use systems influenced soil macrofauna abundance and diversity.

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Soil enzyme activity in early desiccation of degraded pasture

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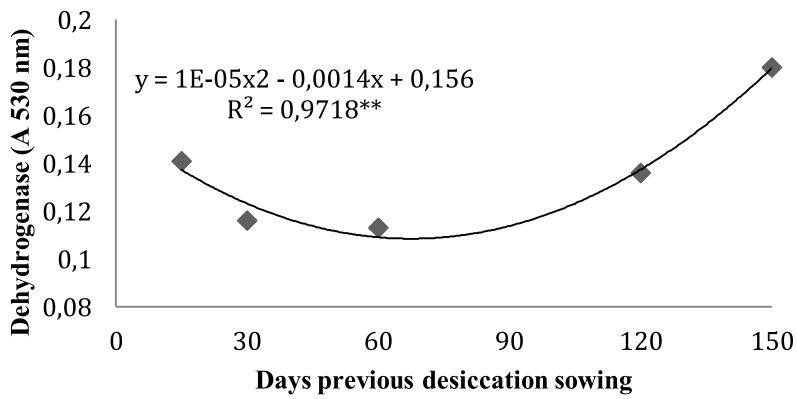
Introduction The enzymatic activity can be used as a biological indicator or as an index of adequacy of environmental sustainability of production systems. Normally, it has a strong correlation with soil organic matter, that is, reflects changes in the amount and quality of organic matter, and reacts faster than the organic matter to the changes that occur in soils.

Material and Methods

The experiment was conducted at the experimental farm of Unoeste (22 28 '25 "S, 51 ° 67' 88" W, 430 m asl). The area was occupied by the specie *Urochloa brizantha* (cv Marandu) with 5 years of implementation, but with low forage production capacity and low animal carrying capacity. The plots consisted of five desiccation times pasture to soybean cultivation (150 DBS - days before sowing; 120 DBS; 60 DBS, 30 DBS and 15 DBS). The desiccation occurred in the application of glyphosate, at a dosage of 5 l ha^{-1}, with spray volume of 250 l ha^{-1}. Soil samples were taken at the time of soybean planting to 10 cm, and the enzyme dehydrogenase activity was estimated according to the methodology Van Os and Ginkel (2001).

Results and Conclusions

Fig. 1. Dehydrogenase enzyme activity in the soil (A 530 nm), subjected to early drying at different times previous to sowing.



The dehydrogenase enzyme activity showed a quadratic behavior is that the drying at 15 DBS was most active, being reduced after this period, and after an increase in desiccation at 150 DBS. There has been interference of desiccation in the enzymatic activity, however, with the passage of time and the degradation of plant material enzyme levels returned to rise.

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Soybean nodulation in early desiccation of degraded pasture

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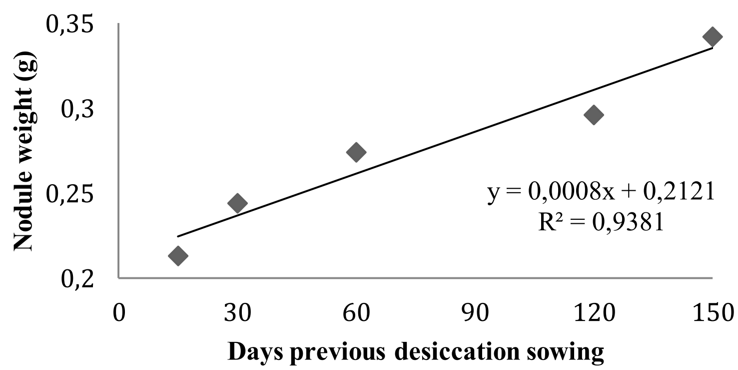
Introduction Through the symbiotic process of fixation of atmospheric nitrogen, created by *Bradyrhizobium* spp., It was possible to expand the areas planted with soybeans, as well as providing the nitrogen incorporation in the system, without for it to farmer invests in nitrogenous fertilizers and consequently the left nitrogen by soybean is harnessed by subsequent cultures in the production system.

Material and Methods

The experiment was conducted at the experimental farm of Unoeste (22 28 '25 "S, 51 ° 67' 88" W, 430 m asl). The area was occupied by the specie *Urochloa brizantha* (cv Marandu) with 5 years of implementation, but with low forage production capacity and low animal carrying capacity. The plots consisted of five desiccation times pasture to soybean cultivation (150 DBS - days before sowing; 120 DBS; 60 DBS, 30 DBS and 15 DBS). The desiccation occurred in the application of glyphosate, at a dosage of 5 l ha^{-1}, with spray volume of 250 l ha^{-1}. At 58 days after sowing of soybean were collected 15 plants per repetition, with four repetitions, totaling 60 plants per treatment for dry mass analysis of nodules on the roots.

Results and Conclusions

Fig. 1 Dry mass nodules on soybean roots, subjected to early drying at different times prior to sowing.



The dry mass of soybean roots of nodes showed increasing linear behavior, according to increased days of desiccation of pasture. Treatment with desiccation at 150 days before sowing enabled better conditions on nodulation of plants when compared to other treatments performed. The physiological processes involving biological nitrogen fixation in soybeans are very complex, with many interactions between the plant and the fixing bacteria. The efficiency of nodulation is mediated by internal factors (phytohormones and availability of assimilates) and external root as temperature, oxygen content in the nodule, organic matter content, water availability, nutrient availability.

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Diversity of epigeous soil macrofauna in spring and summer in two cultivated pasture systems and in the Brazilian Cerrado

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Introduction

The different management practices used in agricultural systems can directly and indirectly interfere in soil fauna diversity, being an important indicator of biological quality of the environment. A trial was established to evaluate epigeous soil macrofauna diversity in different environments and seasons.

Material and Methods

The experiment was carried out in Campo Grande, MS, Brazil (20°27' S, 54°37' W, 530 m altitude). To capture epigeous soil macrofauna specimens, 15 pitfall traps were set (Anderson and Ingram, 1993) at the environments: Cerrado (native Savannah, used as control), pasture grass (*Brachiaria brizantha* cv. BRS Piatã) on an integrated crop-livestock system (ICL) and the same pasture on an integrated crop-livestock-forest system (ICLF) with *Eucalyptus* sp. (227 trees ha^{-1} in single rows). Captures were weekly. Seasons considered were: Spring (October, November and December 2014) and Summer (January, February and March 2015). Specimens collected were taken to the laboratory for identification in large taxonomic groups (orders) and quantification. Statistical analysis was based on completely randomized design with repeated measurements over time.

Results and Conclusions

The overall average number of individuals collected in each environment was: Cerrado (59.07), ICLF (51.27) and ICL (42.17). A total of twenty orders were collected. There was no environment effect by season for the following orders (followed by the respective average number of individuals): Hymenoptera (34.94), Isoptera (1.33), Diptera (0.57), Dermaptera (0.36), Opiliones (0.22), Lepidoptera (0.08), Anura (0.05), Isopoda (0.003), Pulmonata (0.02), Rodentia (0.01) and Squamata (0.005). For the orders Blattodea, Scutigeromorpha and Araneae, season effect was observed, with a higher average number of individuals during the spring (0.93, 0.20 and 2.87, for all environments respectively). For the order Coleoptera there was a higher average number of individuals during the spring in the Cerrado (14.69). Table 1 presents orders whose populations were affected by environment. Pasture on ICL showed difference in average number of individuals in relation to the Cerrado for all the orders. For pasture on ICLF orders Orthoptera, Spirostreptida, Scutigeromorpha and Haplotaxida did not differ from the observed in the Cerrado.

Table 1. Average number of individuals per order, in three environments.

Environment	Order						
	Heteroptera	Homoptera	Orthoptera	Blattodea	Spirostreptida	Scutigeromorpha	Haplotaxida
Cerrado	1,56 A	0,23 B	0,97 B	1,45 A	0,05 B	0,04 B	0,00 B
ICLF	0,56 B	1,41 A	1,58 B	0,30 B	0,62 B	0,17 AB	0,27 AB
ICL	0,67 B	1,31 A	2,33 A	0,45 B	1,26 A	0,21 A	0,65 A

Means followed by the same letter in the column do not differ by Tukey test (p> .05).

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Acknowledgements

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Improvement in the management of no-till in the central-southern-Brazil

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Introduction The soil performs important functions for the maintenance of life. The management practices based on the conservation of soil and water in no till system may improve environmental sustainability.

Material and Methods
The research project of Embrapa Soils called "SoloVivo" (*SoilAlive)* it comes case studies involving no-till cropping in twelve watersheds of six regions of central-southern Brazil, beginning in 2014. The project aims at improving the soil management at areas with no-till by developing indicators to assess soil and water management practices and its environmental effects, at both property's and watershed's scales. Its strategy includes: (i) participatory processes of self-evaluation, adjustment and certification by farmers; (ii) monitoring of farming systems and small watersheds parameters in 12 locations; (iii) long term experiments (around 15 years) in six locations; and (iv) technology transfer through distance education and reference areas for training in no-till systems. "Solo Vivo" should promote interaction among farmers, technicians and researchers in order to assess land management practices, in a participatory approach; and help to achieve the acknowledgement of farmers who manage soil and water considering the soil multifunctionality, in addition to help to preserve the ecosystem services to society.

Results and Conclusions
Between the preliminary results are selection of watersheds and the articulation to effective participation of farmers in the regions of Paranapanema-SP, Londrina-PR, Toledo-PR, Maracaju-MS, Rio Verde-GO and Passo Fundo-RS (Fig 1), as well as the establishment of a network of local and international institutions, which they started up the discussion to improve soil management in watersheds with no-tillage. Between the methods adopted there is the IQP (Participatory Quality Index), that involves several management indicators, and that it was applied in two study sites in 2014: Maracaju-MS and Paranapanema-SP.

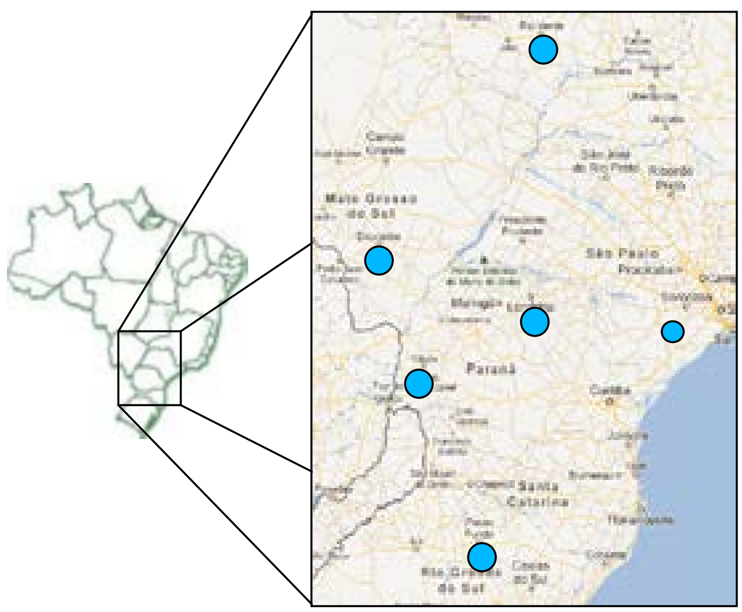

Figure 1. Twelve watersheds with no-till system of central-southern Brazil.

Acknowledgements
Embrapa and Itaipu Binacional

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Alba Leonor Martins

Improvement in the management of no-till in the central-southern-Brazil

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Growth of the *Eucalyptus urograndis*, *Schizolobium parahyba* var. *amazonicum*, *Tectona grandis* and *Ochroma pyramidale* on integration crop-livestock-forest systems in the Amazon Biome

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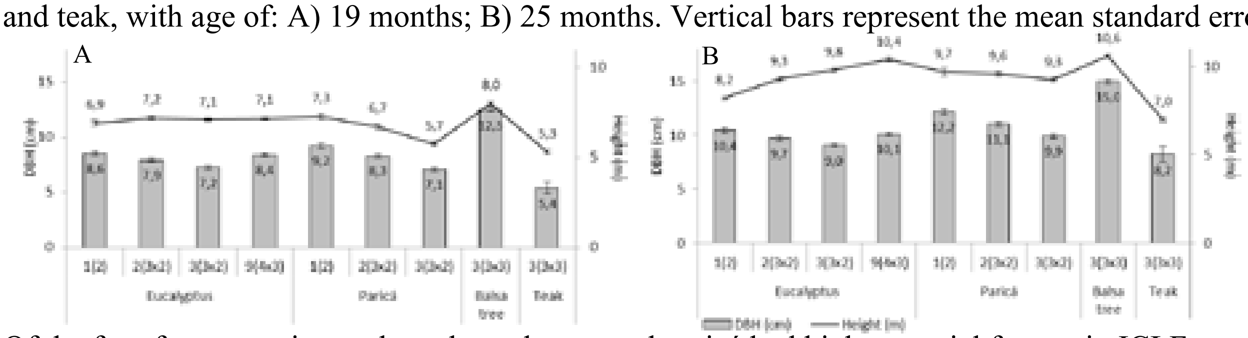
Introduction The forestry component directly affects the quality of the integrated system. In the Amazon Biome little is known about the consequences of the use of native and exotic tree species in integrated systems. The objective of this study was to evaluate the growth in diameter and height eucalyptus (hybrid *Eucalyptus urograndis*), paricá (*Schizolobium parahyba var. amazonicum*), teak (*Tectona grandis*) and balsa tree (*Ochroma pyramidale*), seeking to supply information about the use of these species in crop-livestock-forest integration (ICLF) systems.

Material and Methods

The experiment was conducted in a ICLF system, in the forest-crop phase, in the Technology Reference Unit of the Embrapa, located in Gamada Farm in Nova Canaã do Norte-MT. Were measured the diameter at breast height (DBH) and total height at 19 and 25 months after planting. The treatments with eucalyptus and paricá were distributed in single, double and triple lines, teak and the balsa tree in triple line and treatment with eucalyptus pure stand in 9 lines. The average of DBH and height of each species were compared using the standard error of the mean.

Results and Conclusions

Fig. 1. Averages of the height and diameter at breast height (DBH) of eucalyptus, paricá, balsa tree and teak, with age of: A) 19 months; B) 25 months. Vertical bars represent the mean standard error.



Of the four forest species evaluated eucalyptus and paricá had high potential for use in ICLF systems by the rapid initial growth in diameter and height (Fig. 1) and the morphology of the crown, there has been a decrease in the DBH with the increased number of lines, except in pure stand (at greater spacing between trees), for height, there not have a defined trend. Teak (Fig. 1) showed advantages for use in consortium with agricultural species, by slow growth and low shading until to 25 months. The balsa tree (Fig. 1) in the triple line arrangement was not considered suitable for use in integrated, by the broad development of the crown (4,5 m to 25 months).

Acknowledgements

To the owners of Gamada Farm, the Embrapa Agrossilvipastoril, the participants of the Technology Reference Unit project and those who helped in the field measurements.

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Italian ryegrass establishment on integrated crop-livestock systems: Implications of soybean and maize crop residue

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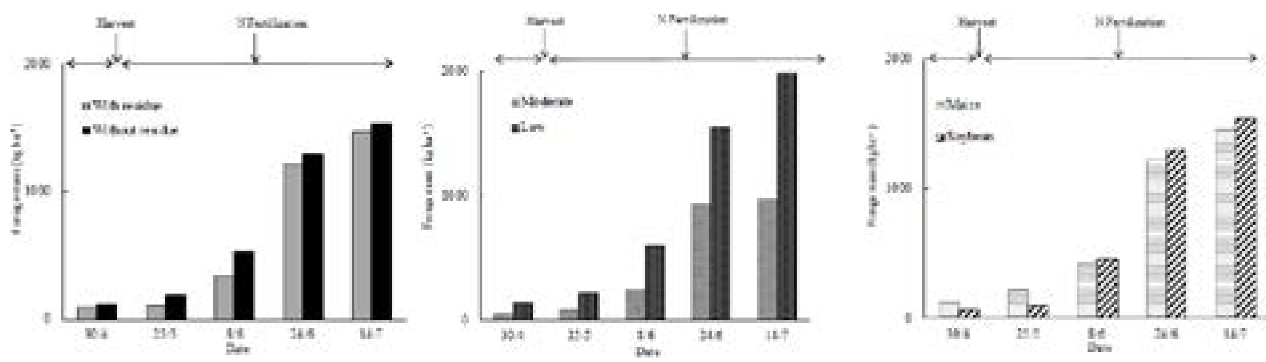
Introduction: The growth and development of Italian ryegrass established by self-seeding in ICLS is influenced by the presence of corn and soybean residues. The maize residue can reduce the time of establishment when compared with soybean residue. The objective of this study was to evaluate how plants ryegrass stemmed from self-seeding with different grazing intensities are established in areas of ICLS under different residue of corn and soybean crops.

Material and Methods

The experiment was conducted at the UFRGS Experimental Station in Eldorado do Sul - RS. The long-term experimental protocol consists in four replicates of 2x2x2 factorial arrangement with no-till. The treatments were two grazing intensities (low and moderate), two previous crops (corn and soybeans) and two residue treatments (with residue and without residue). We evaluated the dry matter of the post-harvest residue of summer crops (corn and soybean), the forage mass, the tiller density and the heights of annual ryegrass pastures during the establishment phase.

Results and conclusions

Significant effects between summer crops (soybean and corn) on the amount of residue (P<0.001) was noticed. During the establishment phase the pasture was effected (P <0.05) in the presence or absence of residue, grazing intensity and summer crops (corn and soybean) in forage mass.



Tiller density was only influenced by the presence of the residue (P <0.05). The height of the previous culture had an effect and interaction between grazing intensity and residue (P <0.05). After the establishment phase of the annual ryegrass the forage mass and tiller density had only effect of grazing intensity (P <0.05). The height at the same stage was affected by grazing intensity and previous culture (P <0.05). The summer crops (soybean and maize) and their residues affect the annual ryegrass by self-seeding during the establishment phase. However at the end of pasture establishment phase there were no effects of summer crops and their residues.

Breno Menezes Campos

Italian ryegrass establishment on integrated crop-livestock systems: implication of soybean and maize tillage residue

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Impact of predecessor crops in bites characteristics from ryegrass (*Lollium multiflorum* LM.) of sheeps in integrated agricultural production system

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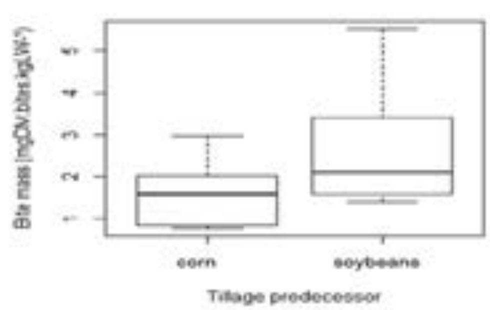
Introduction
The integrated agricultural production systems (SIPA) are based on the rotation of annual grain crops, and annual pasture through direct seeding. It is of a great importance to know whether or not the crop predecessor impacts on the livestock grazing. The objective of this study was to analyze bite mass and bite frequency of sheeps, through the mandibular movements, submitted to pasture phase (*Lolium multiflorum* Lam.) in SIPA subsequent to corn and soybean crops.

Material and Methods
It was established no-till soybeans and corn with previous ryegrass desiccation that sprouted naturally in the following winter, being kept at a height of 18,5 cm. It was realized the harvest of the crops in which all remaining residue was removed. It was observed 6 lambs of Textel breed, equipped with an automatic recorder feeding behavior (IGER-behavior recorder). After the outfit, they were allowed to graze for 45 min. Then, data collected were analyzed by Graze software (RUTTER, 2000). Randomized complete block in a factorial design with four replications. The forage consumed was corrected by the dry matter (DM) content of forage. Statistical analyses were performed by using software R version 3.1.3 (R Development Core Team, 2010) and R studio, with mixed linear models.

Results and Conclusions
Fig.1.Bite mass (mgDM.bites.kgLW^{-1}) of sheeps from ryegrass (Lolium multiflorum LM.) in places where crops predecessors was corn or soybeans.



The bite mass average was 69.45 and it ranges from 17.8 to 332.50 (mgDM.bites.kgLW^{-1}). There was statistical difference ($P=1.705^{-12}$) between bites masses of soybeans and corn treatments. The bite frequency has the average of 69.30 and the variation was from 28.40 to 117.40 (bites min^{-1}). There was no statistical difference in bites frequency between soybeans and corn treatments. The mandibular movements bite mass was more successful after the soybean crop.

Bruna de Gennaro Blanco

Impact predecessor crops in the characteristics bites in ryegrass (lollium multiflorum lm.) for sheep in integrated agricultural production system

AP4P

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The process of choosing a farm as a Technological Reference Unit (TRU) in the Integrated Crop-Livestock Systems (ICLS): the experience in Ribeirão do Boi Territory

William Fernandes Bernardo[1], Marcelo Dias Müller[1], Narliane de Melo Martins[2], Carlos Eugênio Martins[1]*, Pricila Estevão[1]
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Introduction Since 1970s, agricultural research produced many technologies and knowledge that were never properly used by farmers. Various extension methods are designed to increase the adoption of technologies produced in universities and research centers, by farmers. One method is the Technological Reference Unit - TRU- which consists of a farm selected for presentation of technological novelties. The selection of this farm, however, is not a simple task. Therefore, we will present the experience occured at 'Território do Ribeirão do Boi', located in the northwest of Minas Gerais State, Brazil. We will also discuss the criteria for choosing a farm that would constitute an TRU in the Integrated Crop-Livestock Systems (ICLS), a complex technology, concerning to huge agricultural knowledge required for adoption that method.

Material and Methods

In meetings conducted with the inhabitants of the territory Ribeirão do Boi by Bioatlântica Institute (IBIO), ICLS technology has emerged as market opportunity based on the existing tradition in production of eucalyptus, milk and corn. After identifying the proper technology, the TRU, local leaders indicated sixteen farms that have been visited by technicians IBIO, following methodological guidelines of Balbino (2011). Of these, four were chosen for the final selection, by Embrapa Dairy Cattle and IBIO team. The criteria for selection were: a) the possibility of use all ICLS components: crops, livestock (pasture and cow's milk) and forest (eucalyptus); b) the farmer's characteristics; c) motivation and interest of the farmer to use the new technology recommended by the technical team. The guiding principle was homophily: "the degree of similarity of pairs of individuals interacting on some attributes, such as beliefs, values, education and social position" (Rogers & Shoemaker, 1974). The authors explain that "the ideas are transferred with maximum frequency between a source and the similar receiver and homophily", one of the most fundamental principles of human communication.

Results and Conclusions

The farmer chosen for receiving the TRU in his property has its income exclusively from agriculture and is not cosmopolitan, which reduces the suspicion that the implementation and the good results of innovation has aroused from external and privileged interpersonal relationships. In socioeconomic terms, education, scale of production and available resources (tractor and implements) were average among other neighbors, which leaves no doubt about the capacity of adoption by visitors in concerning of the new technology.

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Acknowledgements

Embrapa, IBIO and IEF-MG for the financial support needed for this field work and research.

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The Agroforestry teaching at the Federal University of Viçosa

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Introduction

The formal Agroforestry teaching in Brazil had as important fact the initiatives of the Department of Forestry, Federal University of Viçosa (UFV), in the state of Minas Gerais, in the establishment of discipline called Agroforestry in 1989 and 1999, in graduate and undergraduate levels, respectively (Couto et al., 2004). Since then, and integrated with other UFV departments, the teaching, research and extension of Agroforestry have aroused interest of Undergraduate and Graduate students. Considering that the training of professionals through teaching and research is one of the prerequisites for adequate availability of integrated production systems, the goal of this study was to do an analysis of Agroforestry education at UFV in the last 15 years.

Material and Methods

Based on the students registrations in the disciplines ENF 338 and ENF 645 - called Agroforestry, offered as electives for students of undergraduate courses in Forestry and Agronomy and the Graduate Program in Forest Science, analysis of the number of enrolled students were performed, associated with courses to which they were bound, from 2000.

Results and Conclusions

In the last 15 years, 374 students attended Agroforestry at UFV, 263 were undergraduate students and 111 in graduate level, with an annual average of 25 (Fig. 1). Among the undergraduate students, 143 were of Forestry, 106 of Agronomy and 14 of academic mobility. In the graduate level, 58 master's and 53 Ph.D., linked to Forest Science Courses (70), Animal Science (13), Plant Sciences (12), Agroecology (8), Plant Physiology (4), Soil and Nutrition plants (3) and Botany (1). The greatest demand for Forest Science students is, probably, due to the fact that the discipline is offered by the course. It is noteworthy, the demand of Agroecology Course students, recently created in the second half of 2011. It can be concluded that in the last 15 years the demand by the teaching of Agroforestry has increased.

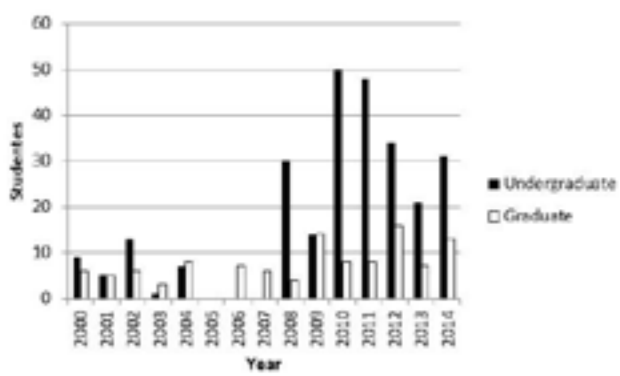

Fig. 1 - Students attended Agroforestry at UFV, in the undergraduate and graduate level.

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Carlos Moreira Miquelino Eleto Torres

The agroforestry teaching at the Federal University of Viçosa

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Extension events of integrated crop-livestock-forest in the Zona da Mata Mineira, Brazil

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Introduction

The Integrated Crop-Livestock-Forest Systems (ICLF) is an alternative to renew degraded pastures in the Zona da Mata region of Minas Gerais state, Brazil, where most pastures are in an advanced state of degradation. The extension events of integrated crop-livestock-forest in the Zona da Mata Mineira, a partnership between the Federal University of Viçosa (UFV) and Technical Assistance and Rural Extension Enterprise from Minas Gerais State (EMATER-MG), are in their eighth edition and aims to disseminate technological innovations about no-till and ICLF.

Material and Methods

In the rural properties of Zona da Mata Mineira, in Minas Gerais state, Brazil, were installed 178 demonstration units, totaling 527 ha, where they were performed 139 field days, reaching an audience of 12,985 participants. In these field days, technological innovations to reform grazing, as well as appropriate management of the grazing and tree component, were presented to producers. Besides, in these field days were presented the integrated systems with grain cropping, forage and trees, based on no-till, aiming sustainable management of grazing areas in the region, predominantly hilly. This proposal is important for the region because there is a predominance of conventional models to tillage, with adoption of plow and harrow, which potentiate negative environmental impacts, such as erosion and gully, with damage to the environment and of financial order. Added to this, we highlight the possibility of diversification of production and income. In the last two years in the field days, interviews were conducted with farmers to assess the acceptance of this technology as a way of recovery of degraded pastures.

Results and Conclusions

Among the 130 participants who answered the questionnaire, 64% were owner of property with area ranging from 15 to 100 ha, that is, small and medium farmers. Of these, 84% had pasture on their properties, mostly in degradation stage. We found that 69% were unaware of ICLF, but when we asked about the interest in implementing the system shown in field days, 87% expressed interest. Another 13% claimed certain difficulties, such as lack of technical support, labor and capital for initial investment. Among those who showed interest in implementing the system, 42% opted for silvopastoral system (pasture and trees) and 58% by ICLF.

Acknowledgements: We gratefully acknowledge financial support for this study from partnership institutions.

Carlos Moreira Miquelino Eleto Torres

Extension events of integrated crop-livestock-forest in the Zona da Mata Mineira, Brazil

AP2D

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Emerging technique for analyzes of soil organic matter

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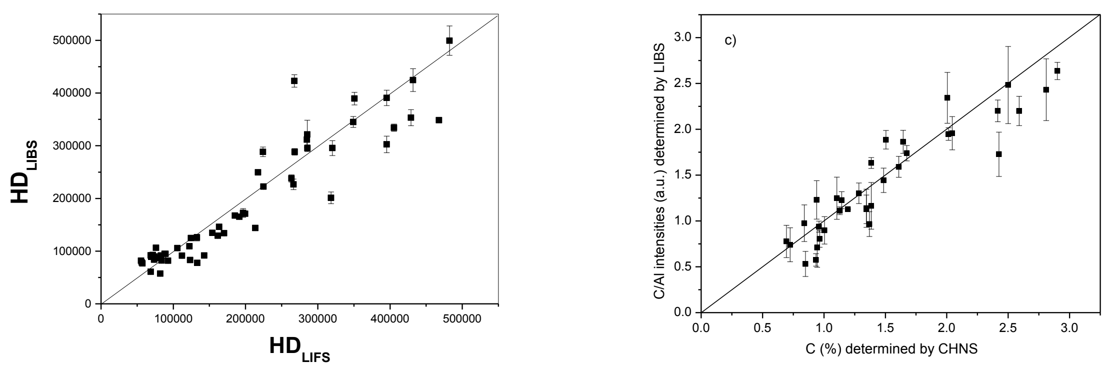
Introduction One of the challenges for the incorporation of agriculture into post-Kyoto agreements is to develop simple and effective methodologies for measuring, monitoring and verifying soil carbon in cropping, farming and land use systems. This work shows the use of Laser-Induced Breakdown Spectroscopy (LIBS) to analyze soil organic matter (SOM) in whole soil samples without sample preparation. Methodologies using LIBS was developed for soil C quantification and evaluation of its stability in soil (humification degree).

Material and Methods

The LIBS spectra were obtained using a system model LIBS2500 (Ocean Optics, USA). This system includes seven spectrometers that provide a resolution of ~0.1nm (FWHM) for the spectral analysis ranging from 188 to 980 nm, a Q-switched Nd:YAG laser at 1064 nm (Quantel, Big Sky Laser Ultra50), an ablation chamber, a lens for laser focalization, and an optical system to collect plasma emission and address it to the spectrometers. A laser pulse of 50 mJ energy and duration of 8 ns was used for all measurements. The laser fluence was 1.2 103 J cm-2 and the diameter of the spot on soil pellets was 73 mm. The delay time (relative to a Q-switch delay) and integration time used were 10 µs and 2 ms respectively, which are instrumental fixed conditions.

Results and Conclusions

Fig. 1. Humification degree (Ferreira et al., 2014) and total carbon in soil determined using LIBS (Segnini et al., 2014).



This new tool for analysis of SOM has several advantages when compared with conventional techniques, such as the reduction of sample preparation, a fast and direct analysis, low cost, and the potential to be accomplished *in situ* using portable LIBS instruments.

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Acknowledgements
To Embrapa, Capes, CNPq, FAPESP

Débora Marcondes Bastos Pereira Milori

Emerging technique for analyzes of soil organic matter

APJB

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world congress on integrated crop-livestock-forest systems

3rd International Symposium on Integrated Crop-Livestock Systems towards sustainable intensification • brasília • brazil • 2015

Initial growth of eucalyptus on integrated crop-livestock-forestry system

Demerson L. A. BARBOSA[1], Leonardo D. T. SANTOS[1], Leidivan A. FRAZÃO[1], Álvaro L. C. VELOSO, David P. GUEDES[1], Samuel A. SANTOS[1], Ricardo T. MENDES[2].

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Introduction

We live in a world energy crisis. In this context, the integrated crop-livestock-forestry systems (ICLF) are a possibility for optimization of agricultural areas. The tree component has fundamental importance in these systems. So, the aim of this study was to compare the initial growth of two eucalyptus genotypes cultivated on ICLF systems in the northern region of Minas Gerais State, Brazil.

Material and Methods

The study was carried out at Barra Farm (15°35' S, 47°30'W, 1200 m asl), located in Francisco Sá, Minas Gerais State, Brazil. The experimental area with 3.2 hectares was divided into two treatments with *Eucalyptus cloeziana* and E.urograndis (*E. urophylla vs E. grandis*). Eucalyptus was planted in double rows of (2x3m) x 14m intercropped with sorghum and pasture. In each treatment were established 12 plots of 130 m^2, distributed randomly, with the inclusion of 24 trees / plot. We evaluated survival rates (S), diameter at ground level (DGL), diameter at breast height (DBH) and total height (H) of trees since December 2012 until October 2014.

Results and Conclusions

Fig.1 - Initial growth (DGL, DBH e H) e survival rates of two eucalyptus genotypes cultivated on ICLF in Francisco Sá, Minas Gerais, Brazil. Data are means of 12 plots (n=12).

Treatments	DGL (cm)		DBH (cm)		H (m)			Survival rate %		
	90 DAT	450 DAT	450 DAT	630 DAT	90 DAT	450 DAT	630 DAT	90 DAT	450 DAT	630 DAT
E. cloeziana	1.11 a	4.06 b	2.45 b	2.75 b	1.10 a	3.19 b	3.38 b	94.10 a	87.15 a	84.72 a
E. urograndis	1.18 a	5.15 a	3.43 a	4.17 a	1.04 a	4.30 a	4.71 a	90.10 a	68.40 b	67.71 b

Means followed by the same letter in column are not different by the Tukey test ($p < 0.05$). DAT: Days after transplanting.

E. cloeziana showed the highest survival rate. However, the highest growth rates in diameter and plant height were observed in E. urograndis which also showed greater resistance to drought period. In a similar study, Pulrolnik et al. (2010) found no differences between these two genotypes in ICLF system.

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Acknowledgements

To FAPEMIG *(Fundação de Amparo à Pesquisa de Minas Gerais)* for the financial support. To *Grupo de Estudos em sistemas de Integração Lavoura-Pecuária-Floresta da UFMG* for the maintenance of the study areas.

Demerson Luiz de Almeida Barbosa

Initial growth of eucalyptus on integrated crop-livestock-forestry system

ANWG

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Mortality and injuries at initial growth of eucalyptus plants on integrated crop-livestock-forestry systems in the northern region of Minas Gerais State, Brazil

David Pessoa GUEDES[1], Leidivan A. FRAZÃO[1], Demerson Luiz de A. BARBOSA[1]*, Álvaro Luis C. VELOSO[1], Célio F. R. FILHO[1], George L. de OLIVEIRA[1], Christian Dias CABACINHA[1].
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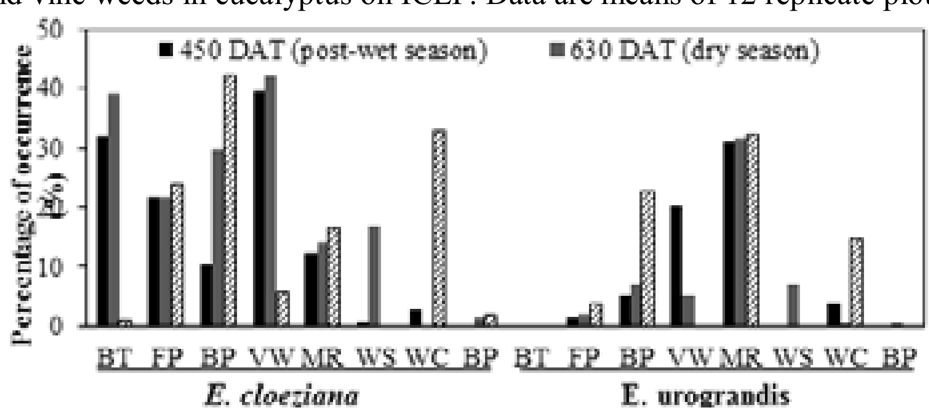
E-mail address of presenting author*: demersonbarbosa@gmail.com

Introduction The integrated crop-livestock-forestry system (ICLF) has been used as an alternative to optimizing production areas in Brazil. The northern region of Minas Gerais is part of Cerrado biome and is characterized by low rainfall and high temperatures throughout the year, so it is important to know about genetic material that can be used in these climate conditions. The aim of this study was to evaluate the mortality and injuries at initial growth of eucalyptus plants on ICLF in Minas Gerais State, Brazil.

Material and Methods
This study was carried out at Barra Farm (15°35' S, 47°30'W, 1200 m asl), located in Francisco Sá, Minas Gerais State, Brazil. The experimental area with 3.2 hectares was divided into two treatments with *Eucalyptus cloeziana* and E.urograndis (*E. urophylla vs E. grandis*). Eucalyptus was planted in double rows of (2x3m) x 14m intercropped with sorghum and pasture. In each treatment were established 12 plots of 130 m^2, distributed randomly, with the inclusion of 24 trees / plot.We evaluate the following parameters at 450, 630 and 790 days after transplanting (DAT): mortality rate (MR), bee attack in trunk (BT), diseases (DE), water stress (WS), forked plants (FP), branched plants (BR), broken plants (BP), weed competition (WC) and vine weeds (VW).

Results and Conclusions
Fig. 1. Percentage of mortality, bee attack, water stress, forked, branched and broken plants, weed competition and vine weeds in eucalyptus on ICLF. Data are means of 12 replicate plots (n=12).



Mortality rate was higher in E. urograndis (32.3%) when compared to *E. cloeziana* (15.3%) due the presence of a large number of termites in the establishment of the area. However, the attack by *Trigona spinipes* (BT), forked and branched plants, and vine weeds contributed to the low initial growth observed in *E. cloeziana*. The attack of *T. spinipes* was due the high concentration of exudate within the surface layer of the epidermis, used for making nests (Caron et al 2013). This injury caused breaking of the apical bud, resulting in the large number of forked plants.

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Acknowledgements
To FAPEMIG *(Fundação de Amparo à Pesquisa do Estado de Minas Gerais)* for financial support. To Barra Farm by the availability of study areas.

Characteristics and challenges of reference technology units in agroforestry system in Paraná State, Southern Brazil.

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Introduction The aim of this work was to present a diagnosis of reference technology units (RTU's) in agroforestry system, implemented on farms in the Paraná State, Southern Brazil. The diagnosis may provide support for the establishment of new technology transfer (TT) action plans by describing the models, the technical conditions and the demands identified in each region.

Material and Methods

The current diagnosis was carried out in May 2011, at RTU's installed with methods described by Dereti et al. (2009) and Porfírio-da-silva & Baggio (2003). In some farms, technical visits were used to collected data from each system, highlighting issues of current technical conditions and management of agro-ecosystems. A specific questionnaire about the different system components and the main technical problems was performed in order to getting data. The georeferencing and areas mapping were also accomplished.

Results and Conclusions

Table 1. Challenges to integration of crop-livestock-forestry system and demands for forestry technologies identified in RTU's diagnoses in the Paraná State, Southern Brazil.

• Planning in agroforestry system • Spacing (in simple lines, double and triple) and orientation of the rows • Quality of seedlings and planting (how to identify quality seedlings) • Recommended species (forest and fodder) • Recommended species in frost occurrence areas • Pruning and Shading intensity • Time of first thinning • Forest inventory to determine thinning intensity (methodology for sampling in integration systems) • Ant control • Management between rows: planning and proper management of ground cover, winter and summer pastures, with improvements in fertilization practices, crop density and decreased erosion • Planting of forest species in order to environmental suitability of the property

There are main demands related to planning, especially to the management of agroforestry system over time (Table 1). One of them is how to proceed and which methodology for pruning and thinning is adequate when systems are in a more advanced state (high age). There are demands for economic analysis and use of technology for degraded areas' recovery. There is a great demand for technological information about the agroforestry system management, which can be developed through the Technology Transfer Programs (technical publications, training and visits on the field).

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Porfírio-da-Silva & Baggio (2003). Como estabelecer com sucesso uma unidade de referência tecnológica em sistema silvipastoril. Colombo: Embrapa Florestas, 26p. (CNPF, Documentos, 83).

Acknowledgements

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Emiliano Santarosa
Characteristics and challenges of reference technology units in agroforestry system in Paraná state, southern Brazil
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Technology transfer in integrated CLF systems: an analysis of Embrapa's actions from January 2010 to April 2015

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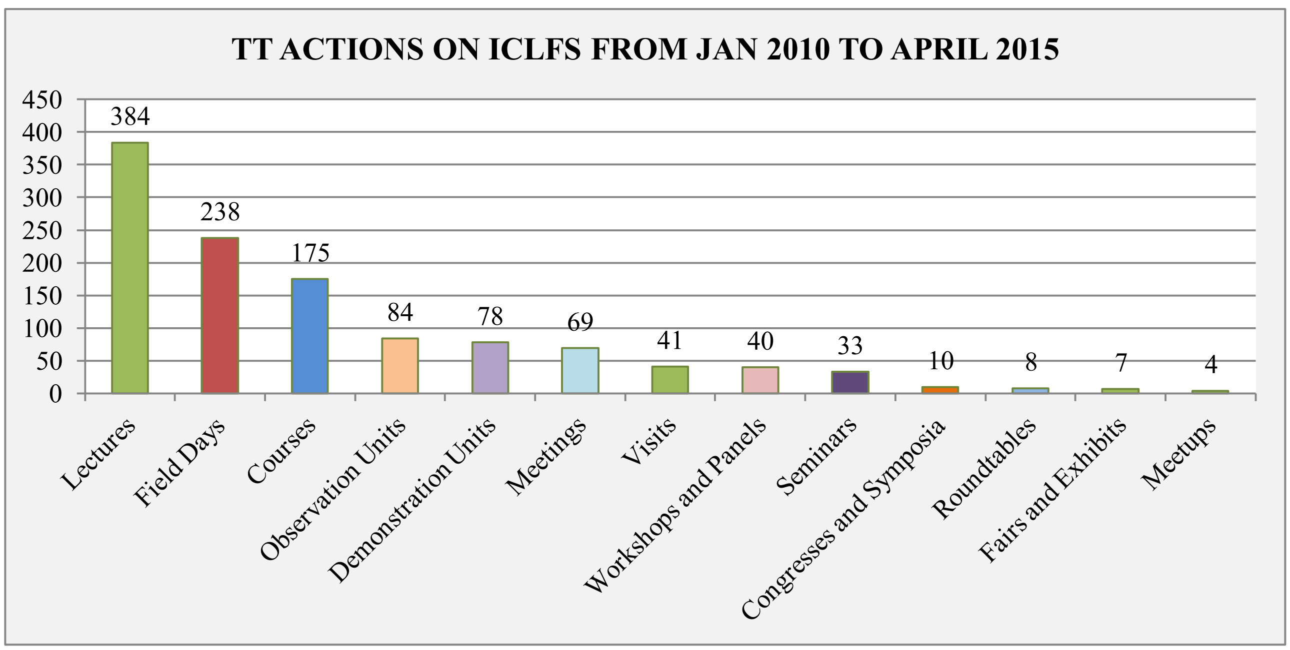
Technology transfer (TT) is an important component of the innovation process, which uses different methodological strategies to facilitate the dissemination and the appropriation of technological solutions. For planning purposes, Embrapa has developed a system called Sieve - Embrapa Events System -, which not only works as a record base but also allows one to organize, follow up on, and evaluate the efficiency and effectiveness of such strategies.

The aim of the present study is to identify and analyze Embrapa's strategies for technology transfer in integrated crop-livestock-forestry systems, using Sieve as an analytical database. For that purpose, a survey was conducted through the system, comprising the period from Jan/2010 to April/2015, using the keywords "CLi", "ICLFS" and "Agroforestry", thus encompassing four possible combinations of components: agropastoral, silvopastoral, agroforestry, and agrosilvopastoral systems.

As a result, the prevalence of the following technology transfer strategies was identified: lectures, field days, and courses, as demonstrated in the graph below.



In view of the above, it is possible to conclude that the efforts devoted to the dissemination and appropriation of technologies developed by research on integrated systems for the promotion of sustainable agricultural and livestock practices are supported by three pillars: technical-scientific knowledge (lectures), investment in areas for the implementation of technologies and visitation (field days), and value-added human capital (courses and training).

Fernanda Oliveira do Nascimento

Technology transfer in integrated clf systems: an analysis of Embrapa's actions from january 2010 to april 2015

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Guidelines and criteria for definition of priority areas for technology transfer actions of crop-livestock-forest integration in Brazil

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Introduction The definition of priority areas for technology transfer actions of ICLF systems is an important step for raising the level of adoption of these systems in Brazil. After defining and mapping the priority areas, the human, financial and institutional resources can be targeted to enhance the technology transfer results.

Material and Methods

First, a search was carried out with experts of the Technology Transfer Network of the ICLF systems (Embrapa) to bring together the regional visions about: opportunities and barriers to adoption; successes and factors that limit the adoption, and the barriers and opportunities for the inclusion of forest component in the ICLF strategy. Following, a workshop was held in March 2015 at Embrapa Environment, Jaguariúna-SP. The meeting brought together 50 experts from 19 Centers of Embrapa and aimed discuss and define the main guidelines to be used for defining priority areas to technology transfer actions in ICLF systems.

Results and Conclusions

The main guidelines were identified and grouped as showed in Table 1.

Table 1. Guidelines to be used for defining priority areas to technology transfer actions in CLF integration systems.

Guidelines
Group I– Agronomic and environmental aspects
1. Areas without environmental restrictions
2. Disturbed areas
3. Degraded Pastures
4. Soil and climate potencial and restrictions
Group II - Socioeconomic aspects
1. Agricultural poles
2. Logistics and infrastructure
3. Demands from civil society
Group III. Legal and institutional policies
1. Institutional Public Policies
2. Presence of institutional actors

Criteria have been defined for each guideline above and will be used in the next steps of this work. Maps of the priority areas for technology transfer actions will be generated applying multi-criteria analysis using GIS (Manzatto et al., 2010; Pereira et al., 2014).

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To Embrapa and ICLF Network .

Ladislau Araujo Skorupa

Guidelines and criteria for definition of priority areas for technology transfer actions of crop-livestock-forest integration in Brazil

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No-tillage Pigeonpea sowing in *Brachiaria decumbens* pasture desiccated with different glyphosate doses

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Introduction

The legumes and grasses intercropping arises as a form to increase the forage production (SILVA et. al., 2007). The no-till sowing of legumes on degraded pasture can promote a low cost pasture recovery, however one concern is about the need of desiccation of pasture to adequate initial growth and establishment of legumes. This study evaluates the use of different glyphosate doses (0 to 5 l ha^{-1}) on *B. decumbens* pasture to no-till sowing of pigeonpea.

Material and Methods

The Pigeonpea (*Cajanus cajan* cv. Super N) was sown in an area (Quartzsandy neosoil) of degraded *Brachiaria decumbens* pasture (16º25'29′ S, 51º09'04′ W, 602 m asl) in December 17th 2014. The sowing used a multi-seeder equipment and seeds was spread superficially using the mechanism of distribution of fine seeds (10.66 kg. ha^{-1}), equivalent to 140.000 seeds.ha^{-1}. The mechanisms of cutting and large seeds distribution were spaced at 0.5 m between line and both used only to cut the straw. The treatments consisted: no desiccant (0 L ha^{-1}) and desiccation, applying 1, 2, 3, 4 and 5 L ha^{-1} of glyphosate doses immediately after sowing. Each treatment had four replicates with 2m x 3m (6m²), in a complete randomized block design. Plant height, leaf number per plant, plant stand, number of twigs and sward height were measured at 6, 8, 10 and 12 weeks after pigeonpea sowing. Analysis of variance was carried out considering the fixed effects of glyphosate doses, days after sowing and blocks. If there is significant treatment effect (P<0.05), Tukey test was applied to means comparison.

Results and Conclusions

The glyphosate dose of 5 L.ha^{-1} promotes a great plant stand, with mean of 1.49 plants per m², differing from other treatments. The glyphosate dose of 5 L.ha^{-1} had more number of leaves and higher pigeonpea height compared to 2 L.ha^{-1} (Table 1). The treatment with no glyphosate powdered (0 L.ha^{-1}) had higher sward pasture height (49.17 cm) at 12 weeks after pigeonpea sowing. The number of twigs did not differed between treatments. Therefore, aiming to obtain a final population of one plant per m², the no-till pigeonpea sowing on pasture can be made without dissecation.

Table 1. Results for pigeonpea plant stand, leaf number and sward pasture height.

Variables	Glyphosate dose (L.ha^{-1})					
	0	1	2	3	4	5
Plant stand (plants m^{-2})	0.83^{b}	0.89^{b}	1^{b}	0.98^{b}	0.79^{b}	1.49^{a}
Leaf number	4.75^{ab}	5.12^{ab}	4.37^{b}	5.44^{ab}	5.50^{ab}	6.12^{a}
Pigeon pea height (cm)	21.59^{ab}	20.62^{ab}	16.81^{b}	19.62^{ab}	21.09^{ab}	23.56^{a}
Sward pasture height (cm)	49.17^{a}	39.58^{b}	33.42^{b}	25.92^{c}	26.33^{c}	21.67^{c}

a, b,c: different letters at the same row means statistical difference in Tukey test (P<0.05).

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Acknowledgements

To Instituto Federal Goiano, Câmpus Iporá for providing area, scholarships and technical assistance. To CNPq for scholarships and financial support.

Soil cover in intercropping of Pigeonpea and *Brachiaria decumbens* established with different doses of glyphosate

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Introduction In pasture fields, the trees and leguminous bush association, improves the animal welfare and can generate agricultural production alternatives, as well, the soil improvement increasing organic matter and the nitrogen per biological nitrogen fixation (BORDIN et al., 2003). This results in soil erosion decrease, fertility addition and nutrients recycle, that add in improving the food nutritional value and biodiversity without animal production losses. The study aimed to evaluate different doses of desiccant on established pastures to Pigeonpea implantation.

Material and Methods

The Pigeonpea (*Cajanus cajan* cv. Super N) was sown in an area (Quartzsandy neosoil) of degraded *B. decumbens* pasture (16º25'29´ S, 51º09'04´ W, 602 m asl) in December 17th 2014. The legume was sown with a multi-seeder on *B. decumbens* perennial pasture field. The sowing was make per seeds spread by streaming (10.66 kg ha^{-1}), equivalent to 140.000 seeds ha^{-1}. The cutting mechanisms and distribution of large seeds were spaced at 0.5 m between line and was used only to cut the straw, without fertilization. The treatments consisted: no desiccant (0 L ha^{-1}) and desiccation, applying 1, 2, 3, 4 and 5 L ha^{-1} of glyphosate doses applied after sowing. The soil cover and pigeonpea stand was evaluated 84 days after sowing. Soil cover was determined by the proportion of pasture, straw and weed. Analysis of variance was carried out considering the fixed effects of glyphosate doses and blocks. If there is significant treatment effect (P<0.05), Tukey test was applied to means comparison.

Results and Conclusions

There was no significant effect of the regressions for desiccant doses. The results were significant better to control, which ground cover was 0%, 26.25%, and 73.75% to weed, straw and pasture, respectively. About the final stand of pigeonpea, no desiccation results in 0.83 plants m^{-2} differing significantly of 5 L ha^{-1} glyphosate (1.49 plants m^{-2}). Significant increase was verified in weed plants and straw (16.25% and 72.50%, respectively) when applied 5 L ha^{-1} glyphosate desiccation doses. Therefore, the treatment with 5 L ha^{-1} of glyphosate eliminates the pasture, elevates costs and promotes emergence of weeds. In conclusion, the implementation of this legume dispenses costs with desiccation.

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To Instituto Federal Goiano, Câmpus Iporá for providing area, scholarships and technical assistance. To CNPq for scholarships and financial support.

Lucas Jorge Santos

Soil cover in intercropping of pigeonpea and brachiaria decumbens established with different doses of glyphosate

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Efficiency of volumetric equations in silvopastoral systems

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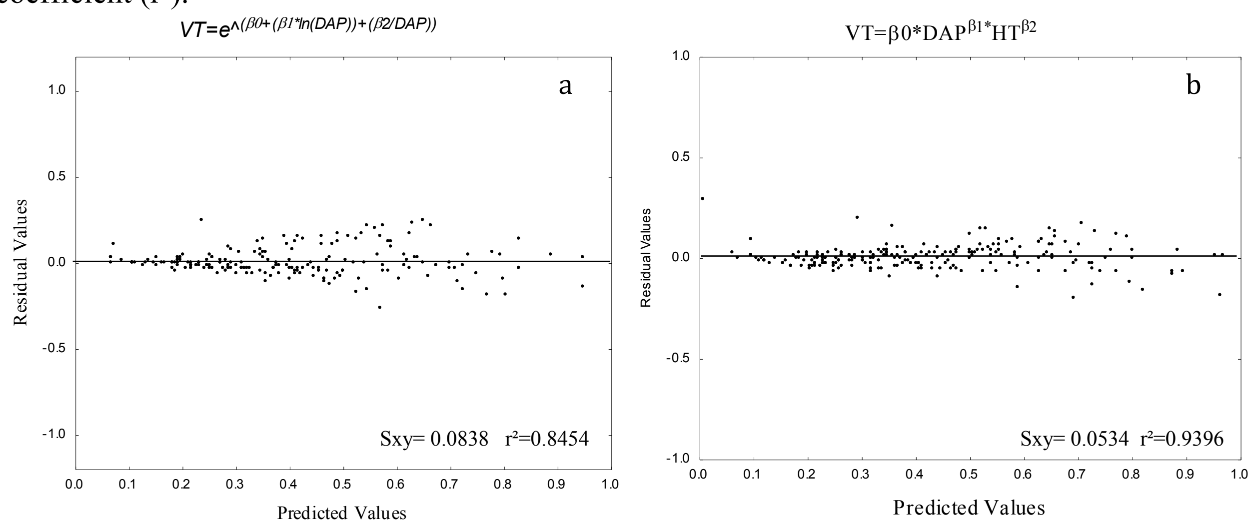
Introduction The main objective of this study was to compare volumetric models of single entry and double entry volumetric models aimed at finding ways that allow making accurate forest inventories and lower costs in silvopastoral systems.

Material and Methods
The data come from five areas studied under silvopastoral systems, deployed between the years 2007 and 2009 in the Farm Triqueda (21 ° 37'37.81 "S 43 ° 17'19.24" W). The data collections were made in the second half of 2013. There have been as tree component two clones of *Eucalyptus ssp* (GG100 and I144) and a hybrid widely planted in the region, the *Eucalyptus urograndis*. We chose to adjust the main volumetric models of simple and double entries used in forestry literature and prove its efficacy from the simultaneous assessment of three criteria: lower standard error, higher coefficient of determination and lower amplitude of residual error.

Results and Conclusions
Fig.1: Residual plots of volume estimates in DAP and Ht function for simple entry model (a) and double entry model (b), with their respective standard error values (Sxy) and determination coefficient (r²).



Based on Sxy and r² parameters, the double entry model was more efficient representation of these data and graphical analysis of the residue can observe that the error amplitude is lower in this model compared with the simple entry model. According to Campos and Leite (2009), double entry model is widely used to estimate forest volumes as it features best setting with unbiased estimates and thus we conclude that based on these results, this model also is precise for use in silvopastoral systems.

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Hypsometric models in silvopastoral systems

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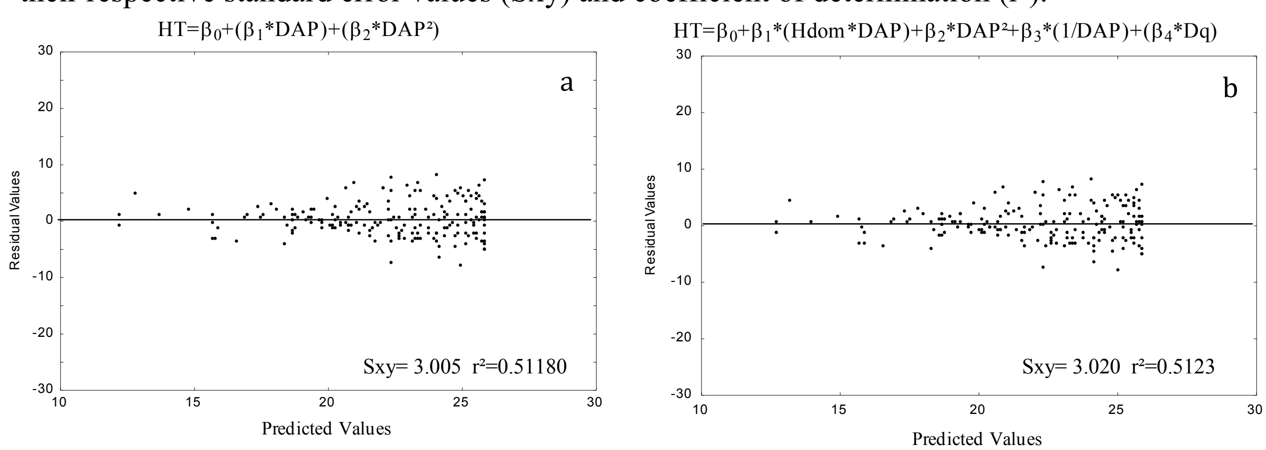
Introduction The use of hypsometric equations that can accurately represent a forest stand has real practical benefits, due the measurement of the height of the trees had difficulties and increases costs and inventory time. The research objective was to evaluate hypsometric models that correlate different variables in ILPFs systems in order to determine which features best setting for use in these systems.

Material and Methods
The data used were obtained in 5 areas under silvopastoral systems in the Triqueda farm (21 ° 37'37.81 "S 43 ° 17'19.24" W) where tree component as have this system, two clones of *Eucalyptus ssp* (GG100 and I144) and a hybrid widely planted in the region, the *Eucalyptus urograndis*. We set two hypsometric models widely used in forestry studies, one with simple entry (DAP) and other with multiple-entries (DAP, quadratic mean diameter and dominant height) and then we evaluated whether the use of them in silvopastoral systems is effective according with simultaneous assessment of three criteria: lower standard error, higher coefficient of determination and lower amplitude of residual error.

Results and Conclusions
Fig.1. Residual plots of height estimates in DAP function (a) and DAP, Dq and Hdom (b), with their respective standard error values (Sxy) and coefficient of determination (r^2).



The results of both models were very similar with respect to the criteria used to assess these. Because they have low r^2 values, high standard error and considerable amplitudes of residual, they have little accurate to estimate the heights in silvopastoral systems studied, which may be a consequence of the wide spread of the trees in the field (CAMPOS and LEITE, 2002). Thus, we conclude that there is need for further studies on this subject in this system in order to test alternative models that best represent.

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Marcela Venelli Pyles

Hypsometric models in silvopastoral systems

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Forage production of *Brachiaria decumbens* intercropped with Pigeonpea established with different glyphosate doses

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Introduction

The low natural fertility of soils in Cerrado is a limiting factor to productivity and sustainability of tropical pastures (Paciullo et al., 2003). The intercrop between legumes and grasses can improve the nitrogen supply, which increase the forage quality and yield (Neres et al., 2012). The present study aims to evaluate the forage mass production of *B. decumbens* and pigeonpea intercropped using different glyphosate doses at the implantation.

Material and Methods

The Pigeonpea (*Cajanus cajan* cv. Super N) was sown in an area of degraded pasture (16°25'29´ S, 51°09'04´ W, 602 m asl, Quartzsandy neosoil), in December 17th 2014. The sowing used a multi-seeder equipment and seeds was spread superficially using the mechanism of distribution of fine seeds (10.66 kg. ha^{-1}), equivalent to 140.000 seeds.ha^{-1}. The mechanisms of cutting and large seeds distribution were spaced at 0.5 m between line and both used only to cut the straw. The treatments consisted: no desiccant (0 L ha^{-1}) and desiccation, applying 1, 2, 3, 4 and 5 L ha^{-1} of glyphosate doses immediately after sowing. Each treatment had four replicates with 2m x 3m (6m²), in a complete randomized block design. The forage production and leguminous stand (number of plants per m²) were evaluated at 84 days after no-tillage of pigeonpea. The fresh matter of forage were determined cutting the pasture at 10 cm height of the ground in 1 m^2 frame. Dry matter was determined after the forage stayed at 65 °C during 72 h. Analysis of variance was carried out considering the fixed effects of glyphosate doses and blocks. If there is significant treatment effect (P<0.05), Tukey test was applied to means comparison.

Results and Conclusions

The glyphosate dose of 5 L.ha-1 promotes a great plant stand (1.49 plants m^{-2}) while the others treatments did not differ between them (1 plant m^{-2}, approximately). The treatment without desiccation showed higher fresh and dry matter production at 84 days after no-tillage of pigeonpea. The others glyphosate doses did not differ in dry matter production (Table 1). Therefore, the establishment of pigeonpea intercropped in *B. decumbens* pasture can be made without desiccation.

Table 1. Fresh matter (FM) and dry matter (DM) production of *B. decumbens* intercropped with pigeonpea established with different glyphosate doses.

	Glyphosate doses (L ha^{-1})						
	0	1	2	3	4	5	CV(%)
FM (g.m^{-2})	4050^a	2100^b	1125^{bc}	380^{bc}	550^{bc}	280^c	58.55
DM (g.m^{-2})	1313^a	662^b	317^b	127^b	164^b	98^b	55.05

a, b,c: different letters at the same row means statistical difference in Tukey test (P<0.05). CV: coeficiente of variation.

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Silvopastoral system with Eucalyptus Urocam - required time of area isolation

Mariane P. CHIAD[1], Alex M. MELOTTO[2], Ana E. da S. LIMA[3], Valdemir A. LAURA[1]*
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Introduction Silvopastoral Systems (SSPs) are a common way to make multiple land use, especially at tropical lands. As inconvenience in implementation, we consider the area´s isolation time so that the trees are no longer subject to injuries by cattle. Planting bigger seedlings can be an alternative, by reducing the isolation time of the area (Baggio & Carpanezzi, 1989). In this study, we evaluated the time necessary for cattle entrance in a SSP implanted with seedlings produced in different size containers.

Material and Methods

The experiment was carried out at Embrapa Beef Cattle, in Campo Grande, Brazil. It was used *Eucalyptus* clonal seedlings Urocam (hybrid of *E. urophyla* x *E. camaldulensis*) produced in containers of 50 mL and transplanted to bigger containers 300, 600, 1,200 and 2,400 mL (treatments), where remained for four months (in greenhouse) before the planting in the field. The design was in randomized blocks with four replications and nine plants/plot. It was evaluated during 24 months, plant height (H) and stem diameter (SD), and set up the growth curves with regression coefficients ($p < 0.05$), for volumes of containers 732 days after planting and it was estimated the time required for the same reached 80 mm SD (regarded as the minimum SD for cattle entrance).

Results and Conclusions

The SD and H were influenced by container volume. At the end of experimental time, the SD varied between 146.6 mm and 166.7 mm. After 320 days of planting, the plants produced in 2,400 mL containers reached the ideal SD for cattle entrance, 71 days before that seedlings produced in 300 mL containers, reaching this diameter to 391 days, increasing system viability compared to the pasture isolation time necessary for cattle entrance (Figure 1).

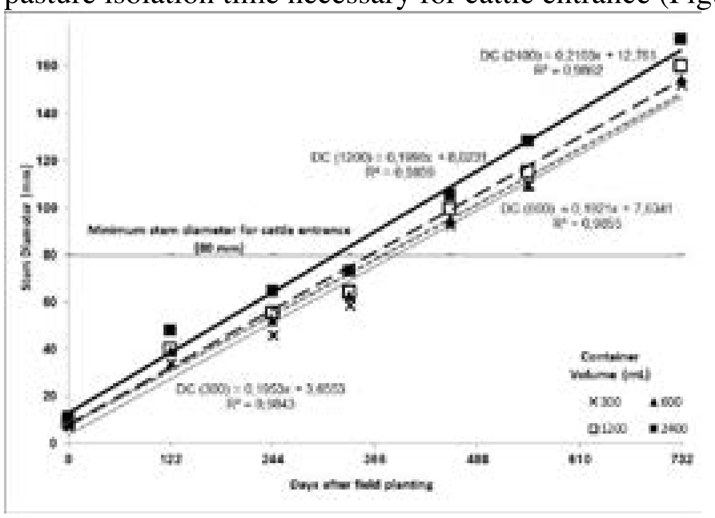

Fig. 1. Eucalyptus Urocam stem diameter, after field planting, in function of the cultivating volume container.

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Valdemir Antônio Laura

Silvopastoral system with eucalyptus urocam - required time of area isolation

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Silvopastoral system with *Corymbia citriodora* - required time of area isolation

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Introduction Silvopastoral Systems (SSPs) are a common way to make multiple land use, especially at tropical lands. As inconvenience in implementation, we consider the area´s isolation time so that the trees are no longer subject to injuries by cattle. Planting bigger seedlings can be an alternative, by reducing the isolation time of the area (Baggio & Carpanezzi, 1989). In this study, we evaluated the time necessary for cattle entrance in a SSP implanted with *Corymbia citriodora* seedlings produced in different size containers.

Material and Methods

The experiment was carried out at Embrapa Beef Cattle, in Campo Grande, Brazil. It was used *Corymbia citriodora* seedlings produced in containers of 50 mL (by direct sowing) and transplanted to bigger containers 300, 600, 1,200 and 2,400 mL (treatments), where remained for four months (in greenhouse) before the planting in the field. The design was in randomized blocks with four replications and nine plants/plot. It was evaluated during 24 months, plant height (H) and stem diameter (SD), and set up the growth curves with regression coefficients ($p < 0.05$), for volumes of containers 732 days after planting and it was estimated the time required for the same reached 80 mm SD (regarded as the minimum SD for cattle entrance).

Results and Conclusions

The SD was influenced by container volume. At the end of experimental time, the SD varied between 96.3 mm and 127.7 mm. After 530 days of planting (almost 18 months), the plants produced in 300 mL containers reached the ideal SD for cattle entrance (Figure 1). Therefore, to avoid the productive idleness in this area, rather than a direct silvopastoral system, the suggestion is to adopt an integrate crop-livestock-forest system, with the cultivation of any annual crop for at least two years and so, thus adding more value to wood.

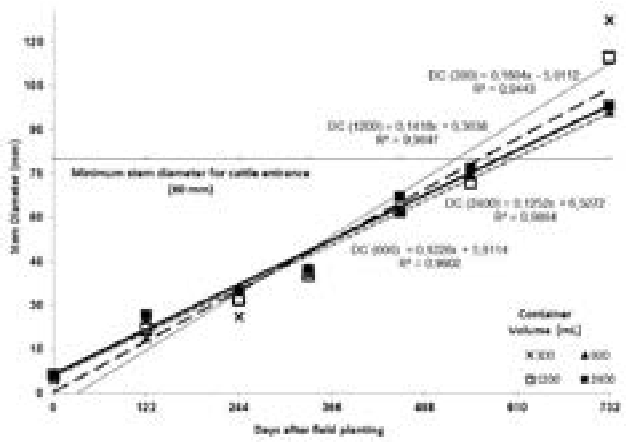

Fig. 1. *Corymbia citriodora* stem diameter, after field planting, in function of the cultivating volume container.

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Baggio & Carpanezzi (1989) Boletim de Pesquisa Florestal, n.18/19, p.17-22.

Acknowledgements

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Valdemir Antônio Laura

Silvopastoral system with corymbia citriodora - required time of area isolation

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Fundamentals of implementing Integrated Crop-Livestock-Forestry systems with eucalyptus trees

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Introduction

ICLF systems are inherently more complex than grain crops and their cycle duration depends mainly on the tree component. In this context, it is essential to correctly implement the system avoiding later management problems that are often irreversible. Attention to the several planning details and caution when defining each implementation step, for each system components can determine success and failure in such initiatives. This summary presents aspects related to the implementation of ICLF systems having eucalyptus as tree component, with particular emphasis on soil preparation, planting, spatial arrangement of trees and pruning/thinning.

Results and Conclusions

Area selection **-** When defining an area for implementing an ICLF system, it is necessary to bear in mind that the site should provide minimum conditions for cultivating annual crops, such as soybeans, maize and sorghum, which require greater soil fertility than most tropical grasses and eucalyptus trees demand. ***Soil preparation and fertilization*** - It is important to observe if the area has a sharp slope, requiring terraces to be built and the adoption of other measures to prevent erosion and soil conservation. Particularly in Brazilian *Cerrado*, soils usually have chemical properties which are unfavorable for cash crops without prior fertilization, once they usually present high levels of exchangeable Al^{+3} and high active acidity (low pH), and low P content. Fertilization with phosphorus at 40 to 50 cm depth at furrowing is very important for eucalyptus. ***Planting seedlings*** **-** In case of planting seedlings grown in tubes, the work can be done manually or by using specialized seedling transplanter machines. Seedling losses should not exceed 5%. ***Spatial arrangement of trees*** **-** It is more common to arrange trees in single or triple rows, in east-west orientation, preferably. To define spacing between trees and rows, one must consider the end-use of wood, like saw timber, lamination, firewood, fence poles, pulp and charcoal. Broader spacing trees grow faster, resulting in logs with wider diameters at the end of the ICLF cycle. ***Grain crops*** **- A**nnual crops in the first and second years amortize part of the initial investment of implementation. In Brazil, traditional crops like soybeans, maize and rice have been successfully used as crop component in the system. ***Grazing forage*** **-** In tropical condition, the species like *Brachiaria brizantha* cvs. Marandu, Piatã and Xáraes, *B. decumbens* cv. Basilisk, *Panicum maximum* cvs. Aruana, Mombaça and Tanzânia, and *P.* spp. cv. Massai, are good options for ICLF systems due to their good shade tolerance. ***Pruning and thinning*** **-** The removal of the lower tree branches and twigs, must be carried out before introducing animals in the system to avoid spoil timber quality. The first pruning is done when tree trunk reaches an average diameter of 6 cm at breast height (DBH), it is removed a maximum of 1/3 of the tree canopy. In 12-14 years, the trees will be clear-cut and the system can restart. ***Closing remarks*** **-** The steps presented above provide initial guidelines for introducing an ICLF system with eucalyptus trees. All orientations presented in this section should be part of a set of guidelines that form a comprehensive project for implementing the ICLF system.

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Ademar Pereira Serra
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Embrapa Agrosilvopastoral: a planned research center to attend integrated systems studies

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Introduction

The evaluation of integrated systems needs to take into account the organization of different roles of the research team as well as work environment. Additionally, the facilities of experimental field and laboratories should allow the proper design for long-term and large-scale researches, transdisciplinarity and data integration.

Material & Methods In 2009 it was planned the strategic agenda of Embrapa Agrosilvopastoral, when several Brazilian institutions were involved. Thus, it was established the main focus of the research center, at the same time that the design of physical facilities were carried out, and human resources were hired according to the defined expertise. The experiments were discussed involving different institutions, in order to allow the attainment of large number of parameters from the long-term and large-scale experiments. Furthermore, the technology transfer activities were planned following the continuous training approach.

Results and Conclusions In July 2012 the research center was inaugurated and started to seek the consolidation of its integration concept – space, employees and scope. The research center runs large field experiments of integrated systems, where several sustainability indexes are being evaluated, reassuring its role as an institution for sustainable development, with social and economic inclusion focused on the reduction of regional inequality

Fig. 1. Large-scale and long-term experimental fied at Embrapa Agrosilvopastoral.

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To all the people who helped to build the presence of Embrapa in Mato Grosso state

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Austeclinio Lopes Farias Neto

Embrapa Agrosilvopastoral: a planned research center to attend integrated systems studies

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Use of the Gantt Chart to plan and control the activity schedule in integrated crop-livestock-forest projects (ICLF)

Camilo CARROMEU[1], Paulo Henrique N. BISCOLA[1], Ademar Pereira SERRA[1], Ronney Robson MAMEDE[1], Davi José BUNGENSTAB[1]*
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Introduction
A complete ICLF system cycle with eucalyptus can last more than twelve years, requiring a series of management activities that need careful long-term planning to reduce project risks. There are several project management techniques that can be adapted and applied for implementation and execution of ICLF projects, one of which – the Gantt chart – here discussed, is a relatively simple tool for designing a project activity schedule that can be decisive for project success.

Results and Conclusions
The Gantt chart was created in 1917 by the industrial engineer Henry Laurence Gantt. In this technique, the schedule of activities is presented as a set of horizontal bars in a timeline. As a result, it is possible to visually monitor the completion of tasks involved and the dependence between the several activities. One of the chart's advantages is that it allows one to rapidly visualize progress of the activities in relation to the plan, therefore allowing improved logistical organization of the project. The chart facilitates visualizing activities that should occur at the same time or in sequence, highlighting those that require the same resource.
Many farmers are able to store information and plan effectively without the need to formalize details on paper or in computer applications. However, even these people are often surprised by the usefulness of these tools because through analysis and description of the various phases and actions of the process, they are forced to answer questions and observe details that enable them to identify problematic aspects that would not have been perceived if they had planned everything only in their minds. For example, if a farmer has only one tractor to irrigate recently planted eucalyptus seedlings and to spray pesticides on the grain crop area, he/she should focus on resolving this possible logistical problem because these two activities can occur at the same time and any minor delay in either of them could lead to major losses (Biscola et al, 2014) .Several project management software solutions using the Gantt chart can be found in the market. Easy-to-use versions can be downloaded from the Internet at no cost and installed in a personal computer, like the here discussed GanttProject, available at http://www.ganttproject.biz/. It is a free open source software with a very intuitive interface. In order to support farmer-entrepreneurs, technicians and consultants in mapping the implementation of their ICLF systems, a basic template was tested and made available for the public. After installing the program, users can download the template file at: www.ilpf.cnpgc.embrapa.br. After downloading the file, with a double click users can open it automatically in GanttProject. In the system interface, the activities are shown in a column on the left and the Gantt chart is shown on the right.
Finally, the use of Gantt chart shows to help preventing problems, especially regarding labor availability, material resources and time, which would otherwise often only be realized at the moment the action is being conducted, causing disruption for farmers and their teams and, in extreme cases, even rendering the process unfeasible.

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Davi José Bungenstab

Use of the gantt chart to plan and control the activity schedule in integrated crop-livestock-forest projects (ICLF)

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Principles for planning and establishing work processes in integrated crop-livestock-forest (ICLF) systems

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Introduction

Planning consists of specifying the objectives to be reached and deciding in advance the necessary and appropriate actions that must be undertaken to achieve them. Entrepreneurs are responsible for collecting and analyzing the information on which the plans and projects are based. When considering the implementation of an integrated crop-livestock-forest system, planning takes up farmers' time and usually entails expenses, including those related to specialized professionals. In this regard, the use of planning methods and tools are crucial for improving effectiveness on this phase of the project and they can be decisive for it´s success.

Planning tools

The first step when implementing integrated crop- livestock-forest systems is to diagnose the business current situation, considering farmer profile and regional characteristics where the farm is located. Project planning can only begin when diagnosis demonstrates favorable conditions. Priority actions should then be submitted to an analysis method that leads entrepreneurs or those in charge of the project to answer the 5W2H questions: *what?, who?, where?, when? why?, how?* and *how much?*. The answers to these questions give an overview on how system implementation actions should be carried out. This is an interactive and simplified method that facilitates forward planning. The answers to these questions distribute the tasks among those who will execute them, register where, when and how they will be executed as well as lists the necessary materials to execute them, with the costs involved. By formalizing planning, this method also helps monitoring what each person is doing on the project and, consequently, allows performance and results to be assessed.

Results and Conclusions

In order to use this tool, a chart has to be prepared with the seven questions in the columns and the actions to be executed in the rows. Especially when using electronic spreadsheets, this chart can be gradually expanded by inserting new rows as larger actions are broken down into more detailed tasks. As a practical example of the use of this method, a planning model was designed for the first and most important steps on real implementation of an ICLF system with eucalyptus in Brazil. As an example, Chart 1 shows the first two lines of such chart. A working template can be downloaded at www.ilpf.cnpgc.embrapa.br/downloads.

Chart 1 – Planning model for the implementation of an ICLF system with eucalyptus in Brazil.

What?	When?	Why?	How?
Checking if the area is suitable for implementing the system	Before system implementation	To avoid problems with the implementation of annual crops and allocation of system's outputs	Farm diagnosis inserted in its regional context, using the guidance of specialized professionals.
Soil sampling and chemical and physical analysis	Before initial soil preparation and annually thereafter.	To monitor soil fertility and to define soil improvement and maintenance and replacement fertilization recommendations.	Ten soil sub-samples should be taken from a homogenous plot, at depths of 0 to 20 cm and 20 to 40 cm, which should then be homogenized, forming a sample of approximately 400 grams, which afterwards is sent to a soil analysis laboratory.

Davi José Bungenstab

Principles for planning and establishing work processes in integrated crop-livestock-forest (ICLF) systems
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The experience factor in operational cycle of semi-mechanized harvest in integrated crop-livestock-forest (iCLF) system with teak

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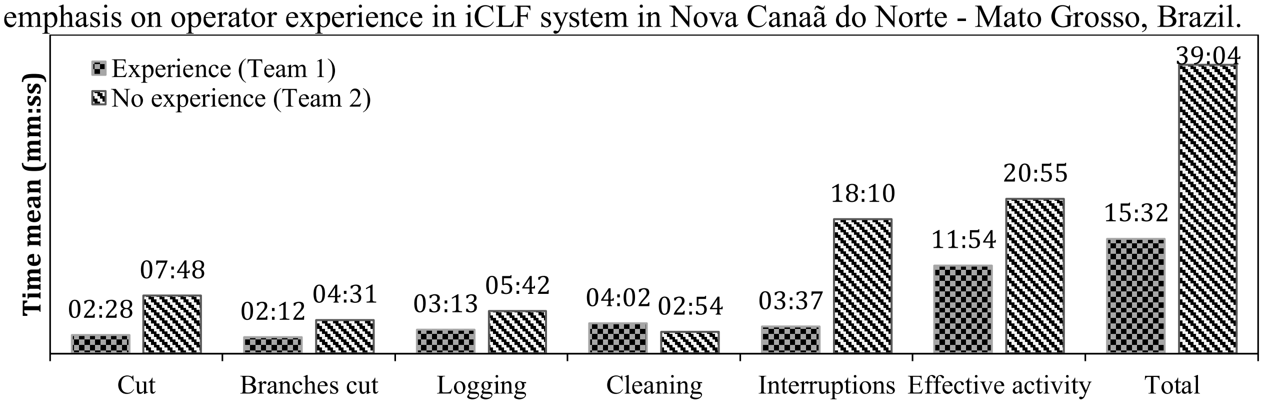
Introduction Investment and planning to reduce costs and duration of the activity, help to increase the viability of the process within the forest market, enabling greater profitability and expansion of the sector (SIMÕES et al., 2010). The experience and qualification factors can directly influence the worker productivity and quality of the semi-mechanized harvest final product.

Material and Methods

The research was conducted in the technological reference unit from Embrapa Agrossilvipastoril, located in Nova Canaã do Norte, Mato Grosso (10º38'13 " S, 55º42'32 " W). The teak florest has 6 years old and was implemented in iCLF system. The teak trees are placed in the field nº 7 with 0.5 ha, arranged in triple tree rows, spaced in 3 m x 3 m between trees and 20 m between the tree rows, with 250 m in length. The time data have been obtained by individual time method. The second systematic thinning was performed by two operators, alternating the chainsaw operator function and chainsaw operator aid. The operating cycle was divided into cut, trimming off the branches, logging, cleaning the area and interruptions. Each step belonging to the operating cycle was timed and recorded by the chainsaw operator aid. 52 cycles were analysed, achieving sufficiency with a sampling error of 25%, being processed from the software R version 3.1.2.

Results and Conclusions

Fig. 1. Mean values corresponding to operating cycle analysis of the second thinning Teak with emphasis on operator experience in iCLF system in Nova Canaã do Norte - Mato Grosso, Brazil.



The mean operating cycle times of the teams 1 and 2 (fig.1) were analyzed using the test "t" for heterogeneous variances at the level of 95% significance. Observing the results, all steps were different. The analysis demonstrated that experience factor affects productivity and total operating cycle time, being team 1 faster and more productive than team 2. Therefore, the experience is a factor that must be taken into account when planning the management of iCLF systems.

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To Embrapa Agrossilvipastoril, who let this work happen with all information and support.

Management issues relevant to components in an integrated system – farm, region, market

Jhonny Moura

The experience factor in operational cycle of semi-mechanized harvest in integrated crop-livestock-forest (ICLF) system with teak

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Optimization of tree arrangements in silvopastoral systems in the Pampa biome

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Introduction

One of the most important decisions before establishing a Silvopastoral System (SSP) is the choice of the spacing and the arrangement of the trees in the field. This decision will affect for years the environmental conditions for the fodder plants growth, since the moment in which the trees are planted up to their harvesting at the end of the rotation. The fodder plants normally show an abrupt reduction of productivity when subjected to radiation levels below 50% (photosynthetically active radiation – PAR). However, the spacing between rows cannot be so great in such a way to compromise the amount and the quality of the forest products intended to be obtained.

Material and Methods

This model of production advocates the use of triple rows of trees in the SSPs, which represents an advance over the older arrangement formed by single rows, extensively used in many localities situated in the Pampa biome (Southeastern region of the Rio Grande do Sul State, Brazil). This new proposed type of arrangement allows an appropriate level of radiation incidence between the tree lines, without reducing drastically the number of trees per unit of area, while maintaining an effective protection of the soil, animals and pasture.

Results and Conclusions

Fig. 1 - Silvopastoral systems composed by native pastures and forest species *Pinus elliottii* and *Eucalyptus grandis*, planted at a) 500 trees/ha and, b) 1,000 trees/ha density.

The assessments at the age of six years showed that the system with 500 trees/ha, established in triple rows (3 x 1.5) x 34 m, allowed a radiation availability of 65% under the canopy of eucalypts (*E. grandis*) and of 90% for pines (*P. elliottii*), when compared to full sunlight. In the system with 1,000 trees/ha, by using also a triple row layout, but a spacing of 14 m instead of 34 m, the correspondent values of radiation for eucalypts and pines under the canopies were 30% and 65%, respectively. In order to avoid an eventual excess of shading during the production cycle of the eucalypts, the farmers can manage the planted trees by means of thinning or even by pruning. The trees that are removed during the thinning procedure can be negotiated in the market, contributing in this situation for the anticipation of the income to the producers, since the projects are normally of a long term duration.

Jorge Ribaski

Optimization of tree arrangements in silvopastoral systems in the Pampa biome

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Financial analysis of Crop-livestock-forest Systems

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Introduction Crop-livestock-forest systems can be an interesting production alternative to farmers, contributing to environmental, social and economic aspects. Therefore it's important to study the systematic use of land with forestry species, agricultural species and animals, which is responsible to create a complex but harmonious system. For being a complex system that uses several cultures and variables, financial analysis becomes an important tool during the process of decision-making and project management.

Material and Methods

The data used in the financial analysis were collected on a farm deployed in the southern state of Goias. The farm has two productive plots, plot I (17 ha) and plot II (25 ha). Both plots were composed of soybean (BRS-GO 8360), eucalyptus (*Eucalyptus grandis* and *Eucalyptus urophylla*), corn (BRS 1030 e BRS 1035) intercropped with bachiaria (*Brachiaria brizantha*) and livestock (animals with an average weight of 242 kg and mixed race). The plots are formed as showed in Table 1.

Tab 1. Characterization of production scenarios analyzed.

Feature	Plot I	Plot II
Number of eucalyptus rows	3	4
Eucalyptus spacing	3 x 3 meters	3 x 3 meters
Line space for crop/livestock	14 meters	22 meters

The financial analysis was performed using annual cost and revenues data of the agricultural crops, livestock and eucalyptus plantation, for both productions scenarios, using traditional methods such as: Net Present Value (NPV) and Annualized Net Present Value (ANPV), using a discount rate of 6% per year. To better understand the system production and development, a risk analysis, using sensitivity analysis, was performed by varying the factors: discount rate, productivity and price.

Results and Conclusions

The economic indicators results indicate that negatives balances occur in the first three years of the project. However, starting at the fourth year the values become positive, showing that it's important to analyze the project as a whole, such as the benefits derived from each activity. The NPV results were R$6118,508 and R$5302,655, respectively to plot I and plot II. While the ANPV values were R$1096,092 and R$949,891, respectively. Positive NPV was obtained for both scenarios, at 7 years, indicating economic viability of the systems. However, plot I had higher ANPV, showing greater profitability to producer. Therefore plot I has better return of the investment. The sensitivity analysis showed that there is a negative relationship between the discount rate and ANPV, before the various possible scenarios for the discount rate; higher crop productivity increased profitability of the system; there was a significant increase in the economic viability of the system, as if the forest products were added; the diverse cultures of the system impacted differently in ANPV and at economic viability of the project. The study imply that systems were economic viable, even when the sensitivity analysis was performed. Besides that highlights the importance of production features and design, in order to satisfy market demands and ensure higher profits to the producer.

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Correlation between soil chemical attributes and soybean and forage yields in a crop-livestock system

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Introduction High crop yield is closely related to the quality of soil, since it occurs when the chemical, physical and biological attributes are in balanced levels and showing good conditions for plant growth. Among the soil chemical properties, organic matter (OM) has been described as the best indicator of soil quality, as it is directly related to various processes occurring in the soil. Thus, this study aimed to evaluate the correlations of soil chemical attributes within three different management zones (MZ) in a crop-livestock system (CLS).

Material and Methods

The study was conducted on a consolidated CLS area of 14,9 ha in Bage city-RS/Southern Brazil, during the agricultural year of 2012/2013. The experimental design was a randomized bloc, using a factorial 3x2, with 8 repetitions. The treatments were defined within 3 MZ (high, medium and low soybean yield) determined by the harvesting map of the previous crop i.e annual ryegrass pasture. In each MZ, eight soil samples were collected from two depths: 0 to 0.10 m and 0.10 to 0.20 m. Soil chemical properties data from different MZ were analyzed ,using the analsys of variance and means were compared by Tukey test (p> 0.05%).

Results and Conclusions

There were no differences between soil chemical properties within the different MZ. Soil OM at 0-0.10 m depth was different within the MZ, showing the lowest content (3.03%) within the low productivity management zone (LPMZ) and the highest content (3.75%) within high productivity management zone (HPMZ). This result followed the patterns of soybean yield of 850 kg/ha within LPMZ and 3,020 kg/ha within HPMZ. These results show that soil OM is a good indicator of soil quality, since this attribute is directly related to chemical, physical and biological factors. In addition, it was observed a positive correlation between the soybean and forage yields, only at the first forage dry matter sampling (r = 0.62).

Table 1 - Correlation analysis between the soybean and forage yields. Bage - RS, 2014.

Crop/pasture	Forage sampling (cuts)			
	1st	2nd	3rd	Total
Soybeans	0,62*	0,06	-0,11	0,22
Forage 1st cut		0,24	-0,14	0,45
Forage 2nd cut			0,26	0,76
Forage 3rd cut				0,69

*Pearson correlation 0.05% significance level.

The results show that the response of different crop yields is distinct within the same area. Thus, when the objective is to evaluate limiting attributes of crop yield, it is necessary to collect a large database and perform a multidisciplinary analysis, as suggested by SANTI et al. (2012), because the soil physical results in higher constraints of pasture production than the soil chemical properties.

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Use of time series to identify crop-livestock-forest integration systems

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Introduction Integrated crop-livestock-forest (CLF) system is regarded as one of the important strategies to ensure agricultural production and livestock in Brazil, without the need for deforestation new areas. The use of vegetation indices (VI) combined with the temporal analysis allows us to identify the vegetation dynamics and the transition between different land uses and land cover (Bradley et al., 2007). The objective of this study is to show the dynamics of land use in areas with CLF systems through temporal profile analysis of VI.

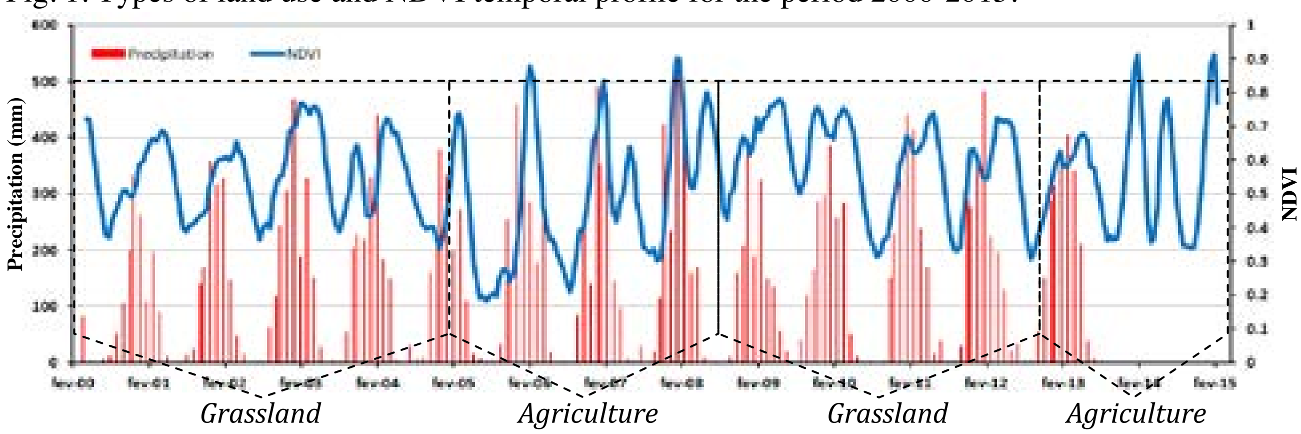
Material and Methods

The study area is located in the micro region of Sinop, municipality of Santa Carmen, State of Mato Grosso, Brazil. The temporal profiles were built from the NDVI vegetation index data, gathered from MODIS sensor, available at the Embrapa Agricultural Informatics (CNPTIA) database at: http: // www.satveg.cnptia.embrapa.br, for the period between 2000-2015. The identification of occupation periods in CLF system was ratified with information collected in the field.

Results and Conclusions

Analyzing the VI profile, it can be noticed the effects of seasonality during the period, resulting in lower values during dry season and higher values during the rainy season (Fig. 1). In the periods 2005-2009 and 2013-2015 changes in the profile were observed, caused by the substitution of pasture by agricultural activity, evidenced by the increase in the average variation between the maximum and minimum values of the index. In these periods, the reduction in the index values was result of land tillage processes and subsequent crop planting, which dramatically reduces the vegetation present in the area.

Fig. 1. Types of land use and NDVI temporal profile for the period 2000-2015.



This land use rotation in the same area has been a strategy used by producers seeking a better use of resources in order to promotes benefit to subsequent activity. Thus, the time series analysis of VI allows the detection of changes in the production system and land use dynamics.

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Marcio Roberto da Silva Melo

Use of time series to identify crop-livestock-forest integration systems

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Biomass and leaf area in eucalyptus clones in crop- livestock-forestry systems : implications for pruning

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Introduction The importance of light entering the CLF system can lead to silvicultural adjustments to control light competition among crops and livestock. This competition can be reduced by species selection, planting configuration and silvicultural treatments application such as pruning, which provide light penetration in the system, besides adding value to wood (FONTAN, 2007).

Material and Methods

Data were collected at Guarantã farm, located in Juara - MT. The clones used are: GG100, H13, VM1, 1277 and I144, deployed in double and triple rows spaced (3.5 x 2.5) 21 m, with 12 months. The biomass shoots characterization were selected two trees samples of each clone, which were slaughtered and had the crown biomass, stem and leaf area were determined in one meter sections on entire shaft

Results and Conclusions

The evaluated clones showed satisfactory growth, enabling small animals presence on first year. All clones analyzed showed the presence of dead branches at 15 months, indicating the necessity to perform artificial pruning before the first year, if the objective is to avoid the presence of dead knots. The biomass distribution and leaf area varied according to the genetic material and planting arrangement, emphasizing the importance of studying the biomass distribution before defining experimental treatments and pruning programs, Fig 1.

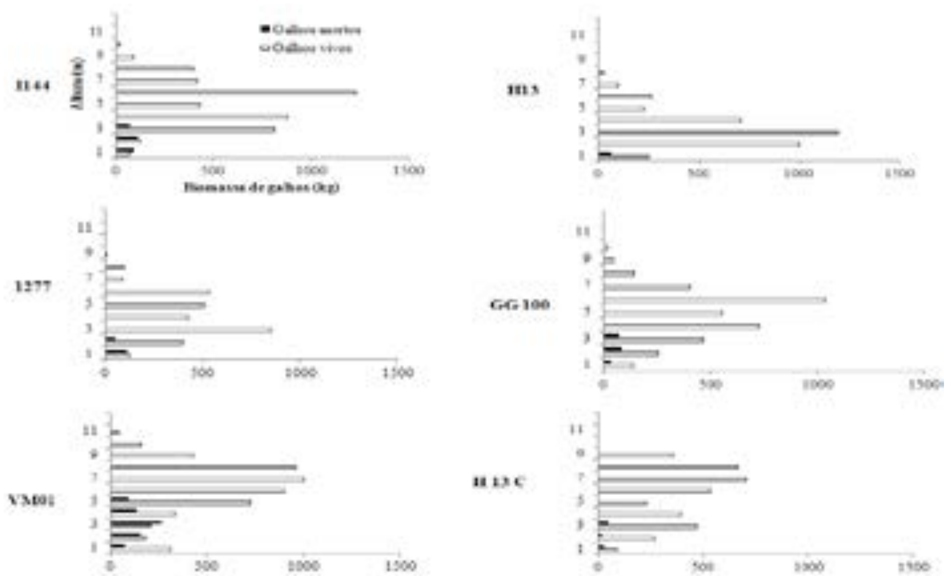

Figura 3. Biomass distribution of branches (kg) in eucalyptus clones canopy, evaluated at 12 months in double and triple rows

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Wood production profitability and beef cattle in livestock-forest integration system in the north of Minas Gerais

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Introduction
Monoculture and inadequate cultural practices in agriculture have caused land degradation and natural resources, according to Macedo (2009). The livestock-forest integration system (LFI) is an alternative of soil uses that objectives attenuate degradation ecosystem problems. Depending on the soil and climate conditions of north of Minas Gerais, became available pasture recuperation using LFI systems.

Material and Methods
The LFI system was installed in an area of 60 hectares of degraded pasture in 2011, at municipality of Montes Claros-MG. The entered of cattle in the area occurred since 3rd until 10th year. The wood harvesting for woodfire occurred in the 6th year, and selected the better 100 trees to sawmill at the 10th year. For economic analysis, we considered the cattle price as R$ 120.00/cattle arroba with 10 arrobas, wood production as 120 m³/ha in the 6th year, R$ 70.00/m³ for woodfire and R$ 100,00/m³ of wood for sawmill, according to local market and interest rates of 8.75% a.a. We used the evaluation criteria Net Present Value (NPV) and Internal Rate of Return (IRR). We verified sensitivity variation of these criteria related to the alteration of 30% up or down, on the prices of wood and cattle with 10 arrobas and in the wood production.

Results and Conclusion
Tab. 1. Net Present Value (NPV) and Internal Rate of Return (IRR) for seven scenarios of economic sensitivity analysis.

		-30%	Real value	30%
Wood production	**NPV (R$/ha)**	104.04	1,123.71	2,143.37
	IRR	9%	15%	20%
Wood price	**NPV (R$/ha)**	- 580.87	1,123.71	2,828.28
	IRR	5%	15%	22%
Price of cattle with 10 arrobas	**NPV (R$/ha)**	468.99	1,123.71	1,778.42
	IRR	11%	15%	18%

The LFI system presented a positive NPV of R$ 1,123.71/ha and an IRR of 15%. When we evaluated variations of 30% up and down on the wood production waited, and in the wood and the cattle with 10 arrobas selling price, we verified the wood selling price is the more sensitive variable, presenting a negative NPV for a down of 30% in the price and a IRR of about 5%, less than the considered interest rates. The arroba price was the less sensitive variable, presenting a positive NPV both to positive and negative variance of 30%. The sensitivity analysis showed that both the cattle production and the selling arroba price decreased 30%, which make this project economically viable. Also, for a positive variation of 30%, it is economically viable for wood selling price too. Thus, the more economically attractive option is the positive variation of 30% of the selling wood price. Finally, it is feasible for farmers deploy LFI system for pasture recovery in the north of Minas Gerais.

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Ricardo Tuller Mendes

Wood production profitability and beef cattle in livestock-forest integration system in the north of Minas Gerais

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Use of remote sensing to detect integrated crop-livestock systems

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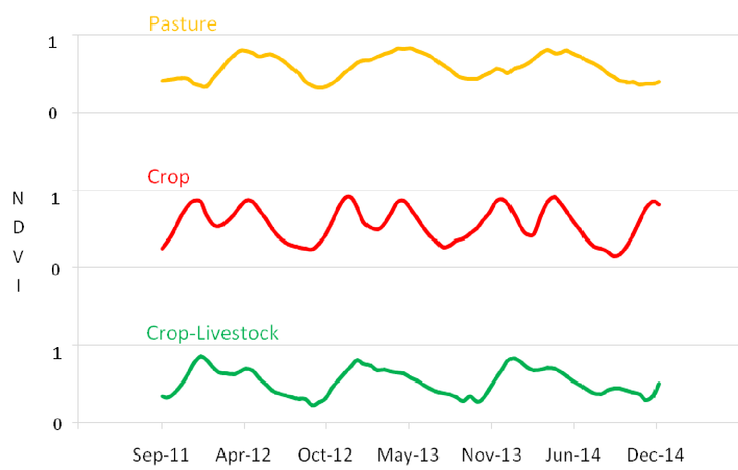
Introduction. Remote sensing techniques are being widely used to map and to monitor agricultural areas. Vegetation indexes (VI) from satellite images have correlation with biomass and, when analyzed temporally, allows monitoring plant development. This study shows the temporal vegetation behavior of different areas with crop, pasture and crop-livestock (CP) integration.

Material and Methods.

The study area is located in Paragominas - PA. The VI chosen was the Normalized Difference Vegetation Index (NDVI), proposed by ROUSE et al., (1973), from MODIS sensor aboard Terra satellite with a 250 m spatial resolution and 16 days temporal resolution acquired at http://www.satveg.cnptia.embrapa.br. Information about the three targets were extracted during the period from September 2011 to December 2014. The profiles were smoothed with the Savitzky-Golay time series filter.

Results and Conclusions

Fig. 1. NDVI time series from Sept 2011 until Dec 2014, for pasture, crop and CP integration



Analyzing the three targets it was possible to notice difference in their behavior (Fig.1). Pasture and crop have a pattern on their annual cycles, the pasture had low values in dry season and rising to the peak during the rainy season. Annual crop can be single cropping (one peak) or double cropping (two peaks) systems. Low values are found when there is no ground cover, and after planting the value increases up to the maximum, then in the senescence and harvesting period the values tend to decrease (WARDLOW et al. 2007). The CP analyzed was Santa Fe system, that has annual cycle, but with different characteristics in comparison to the other two targets, the growing cycle appears similar to the annual crops, falling in the senescence and harvesting. The NDVI value remains greater than agriculture due to the presence of pasture in the same area, which presents a similar gradual decline of pasture area. Thus, it was possible to make a visual differentiation of the targets which is the first step in order to map areas of CP integration.

References cited

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