

Integrating bioenergy and food production on degraded landscapes in Indonesia for improved socio-economic and environmental outcomes

Syed Rahman¹, Himlal Baral¹

¹Center for International Forestry Research (CIFOR), Bogor, Indonesia (sumonsociology@yahoo.com; h.baral@cgiar.org)

Growing bioenergy crops is a promising solution to meet the need for energy security, income security and land restoration. This paper assesses the socio-economic and environmental benefits of agroforestry systems based on nyamplung (*Calophyllum inophyllum* L.) in the Wonogiri district of Central Java, Indonesia. Data was collected through field observations and focus group discussions (FGD) involving 20 farmers who intercrop nyamplung with maize, paddy and peanuts, and utilize the species in honey production. Calculating each crop's net present value (NPV) demonstrates that when grown as monocultures, staple crops paddy and peanuts lead to negative profitability, while maize generates only a marginal profit; yet honey production utilizing nyamplung produces a NPV nearly 300 times greater than maize. However, when utilizing nyamplung, honey is also the commodity most sensitive to decreases in production, followed by nyamplung-peanut and nyamplung-paddy combinations. While decreases in production have little effect on the NPVs of paddy, peanuts and maize, these annual crops can only be cultivated for a maximum of six years within the nyamplung's 35-year cycle, due to canopy closure after this time. Nyamplung-based agroforestry systems can provide economic, social and environmental gains on different scales. However, when considering the high profit potential of nyamplung combined with honey production, further research is needed to improve and develop bee husbandry practices so this becomes a viable option for local farmers.

Study on the performance of forest tending subsidies in China

Yukun Cao¹, Hongge Zhu¹, Xiangyue Liu¹, Tianbo Wu¹, Weiwei Jia¹, Dan Zhou¹

¹Northeast Forestry University, Harbin, China (cyklk@163.com; honggebill@163.com; 1335759586@qq.com; 136433355@qq.com; jiaww2002@163.com; 1328262702@qq.com)

In order to protect natural forest resources, the Chinese Government has spent a lot of money on forest tending subsidies for the state-owned forests in Heilongjiang Province. In methodology, data collected by the sampling techniques from forest tending subsidy areas, and site inspections carried out at the various forest nurseries located at key state-owned forest region in the Heilongjiang province. Considering the aspects of ecology, economy and society, we used the methods of qualitative and quantitative analysis, which has calculated and compared the effects between the increment of ecological value and the amount of investments, and put forward relevant policies and suggestions. Conclusions: (1) From the ecological, social and economic perspectives, the paper analyzed the positive impact on the implementation of forest tending subsidy policy on the key state-owned forest regions in Heilongjiang province; (2) The degree of forest-laborers' participation in forest tending needs to be improved, but they are satisfied with the policy of forest tending subsidies; (3) The values of carbon fixation and oxygen release have increased, and the economic value of biodiversity assessed as 66.158 billion yuan, that is 152 times higher than investment of the same period.

Diameter distribution of indigenous trees as possible criterion for indicating stable adapted species in semi-arid rangelands

Edward Mengich¹, Joseph Macharia², Ralph Mitloehner³, Daniel Too⁴, Gabriel Muturi⁵

¹Kenya Forestry Research Institute, Rift Valley Eco-region Research Programme, Londiani, Kenya; ²Department of Botany, Egerton University, Njoro, Kenya;

³Institute of Silviculture, Georg-August University, Goettingen, Germany; ⁴Department of Natural Resources, Egerton University, Njoro, Kenya; ⁵Kenya Forestry Research Institute Headquarters, Nairobi, Kenya (emengich3@hotmail.com; jmmacharia@egerto.ac.ke; rmitloe@gwdg.de; dktoo@egerton.ac.ke; gabrielmuturia2012@gmail.com)

Declining woody vegetation and climate change are major drawbacks to livelihoods in semi-arid rangelands. Efforts to reverse their impacts through tree planting have been slow due to poor selection criteria for adapted species. This study assessed diameter distributions of indigenous trees as possible criteria for indicating adapted species in these areas. Study sites were identified at Nthangu, Kathonzweni and Kibwezi forests of Makueni County, Kenya using existing vegetation, agro-climatic maps and Landsat Images. The sites have mean annual rainfalls of 974 mm, 700 mm and 616 mm, respectively, and moisture indices of 49%, 35% and 32%. Data were collected by establishing 2500 m² sample plots and assessing tree diameters at breast height (DBH) and DBH distributions. Shapiro-Wilk test was applied on species that occurred in two of the sites to determine normality of their DBH distributions. T-tests were conducted to determine if mean DBHs differed significantly. Statistically significant differences were declared at p<0.05. Mean DBH was higher at both Kibwezi (7.6 cm) and Kathonzweni (6.4 cm) than at Nthangu (4.6 cm). Most ecologically important trees were characterized by high populations of juvenile individuals and near-perfect inverted J-shaped distributions. This indicated regenerating, sustainable and stable populations that were adapted to respective sites. Indigenous trees adapted to Nthangu were *Searsia* spp., *A. hockii* and *Diospyros mespiliformis*. At Kathonzweni, they were *C. collinum*, *C. apiculatum* and *A. tortilis*. At Kibwezi, they were *A. tortilis*, *A. mellifera* and *C. africana*. These were candidates for enrichment planting to rapidly rehabilitate degraded sections of these sites.

DI1: AGROFORESTRY FOR ECOSYSTEM SERVICES

Assessment of indicators of ecosystem services across a gradient of land uses in Southern Brazil

Lucilia Maria Parron¹, Junior Ruiz Garcia², Nerilde Favaretto², Claudia Maria Branco de Freitas Maia¹, George Gardner Brown¹, Denise Jeton Cardoso¹, Vanderley Porfirio-da-Silva¹

¹Embrapa Florestas, Colombo, Brazil; ²Universidade Federal do Paraná, Curitiba, Brazil (lucilia.parron@embrapa.br; jrgarcia1989@gmail.com; nfavaretto@gmail.com; claudia.maia@embrapa.br; george.brown@embrapa.br; denise.cardoso@embrapa.br; vanderley.porfirio@embrapa.br)

Ecosystem services (ES) are the benefits people obtain from ecosystems. The conversion of forests to production systems can have large effects on ES delivery. The aim was to assess how agricultural systems can be managed to maximize the supporting, regulating and provision of ES across of land uses and soil management in *Campos Gerais*, Southern Brazil. We used a set of indicators to assess the strength of ES delivery: soil organic carbon (SOC) and nitrogen (SON) stocks, nitrous oxide emissions and methane oxidation, aboveground carbon stocks, nitrate, ammonium and phosphorus leaching, water infiltration and drainage, diversity of soil fauna, grain, pastures and timber yields. We compared ES from the Native Forest (NF), Eucalyptus Plantation (EP) and systems which employed no-tillage soil management: No-Tillage (NT), Crop-Livestock only (CL) and Agroforestry Crop-Livestock-Tree (CLT). Among the land uses, NF presented greater complexity and the delivery of ES. EP was the second at SOC stocks, water infiltration and soil fauna richness. CLT and CL provided more ES than NT. Shadow of the trees in CLT promotes the well-being to the livestock, however it difficults the recovery of the damages caused by grazing and trampling.

Trees in CLT reduce soil erosion, increase soil quality and C sequestration. Agricultural residues provide biomass for land recovery in NT, CL and CLT, but they do not improve the stability of aggregates and the retention of water into soil. CLT as part of multifunctional landscape can be a viable agroforestry land use option that, in addition to providing food security, it offers a number of ES.

Changes in ecosystem carbon stocks from the conversion of disturbed forest to oil palm plantation in the Peruvian Amazon

Natalia Málaga Durán^{1,2}, Hergoualc'h Kristell¹

¹CIFOR, Lima, Peru; ²TU Dresden, Dresden, Germany (natalia.malaga.duran@gmail.com; k.hergoualc'h@cgiar.org)

Land use, land use change and forestry in Peru is the main contributing sector to national GHG emissions (51%). While Peru has pledged to reduce GHG emissions, oil palm plantations are currently under expansion in the Amazon at the risk of forest conversion. The study aimed to characterize the structure and composition of remnant disturbed forests adjacent to oil palm plantations in the Peruvian Amazon, to determine the carbon stock change from such transition. The research was based on full inventories performed in four disturbed forest and six oil palm stands. The latter ones using a space-for-time substitution approach (stand ages 1,4,7,15,23, 28) to assess the carbon stock change over a rotation period. All carbon pools were measured and compared over the land use transition. Previous forest practices linked to logging activities showed a negative effect in composition and structural parameters of the forest, e.g. the mean basal area was 22 (SE 1.4) m² ha⁻¹. Overall, converting disturbed forests to oil palm plantations resulted in a carbon debt scenario; the carbon stock changed from 140.7 (SE 5.8) Mg C ha⁻¹ in forests to a time-averaged carbon stock of 74.3 (SE 2.2) Mg C ha⁻¹ in oil palm plantations. Above ground carbon was the main contributing pool; followed by soil organic carbon and necromass. This research contributes to the sustainable management of forest landscapes under a climate smart strategy, as it concludes, in terms of carbon footprint, that disturbed forests should be excluded from the conversion to oil palm production.

Collective construction of multifunctional landscapes / Construção coletiva de paisagens multifuncionais

Mariella Camardelli Uzêda¹, Elaine Fidalgo², Julian Wilmer³, Rodrigo Alves⁴

¹Embrapa Agrobiologia, Seropédica, Brasil; ²Embrapa Solos, Rio de Janeiro, Brasil; ³Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brasil;

⁴Universidade Federal do Paraná, Curitiba, Brasil (mariella.uzeda@embrapa.br; elaine.fidalgo@embrapa.br; julian_willmer@hotmail.com; rodrigo@zhouse.com.br)

Na escala da paisagem, a agrobiodiversidade é responsável por inúmeros serviços ecossistêmicos como a qualidade da água, a polinização e o controle de pragas. A intensificação ecológica consiste em manter a produção agrícola, conservando a agrobiodiversidade, usufruindo dos serviços ecossistêmicos. O processo de condução da investigação está amparado em métodos participativos de pesquisa, iniciados há 10 anos na Bacia Hidrográfica do rio Guapi-Macacu (Rio de Janeiro), junto ao assentamento São José da Boa Morte. Os resultados representam um importante conhecimento sobre espécies arbóreas e práticas de manejo adaptativo, voltados a: 1. Projetar e testar sistemas agrícolas resilientes baseados na biodiversidade local; 2. Aumentar a segurança alimentar, resgatando cardápios tradicionais baseados em recursos locais; 3. Estudar os serviços ambientais de intensificação ecológica avaliando o papel do elemento arbóreo para a presença de agentes de controle biológico e polinizadores (abelhas, vespas e aves). Os resultados deste trabalho representam uma importante contribuição no processo de adequação dos sistemas produtivos às mudanças climáticas e conservação da biodiversidade, principalmente no sentido de tornar a biodiversidade um recurso concreto do ponto de vista da unidade produtiva e para a soberania alimentar das famílias agricultoras, além de permitir aos produtores maior autonomia na seleção de tecnologias que melhor atendam às necessidades locais, a fim de colaborar com o processo de recuperação da resiliência de paisagens degradadas.

Ungulates affect ecosystem functioning and mediate biodiversity and ecosystem services in Mediterranean oak woodlands

Miguel Nuno Bugalho¹, Xavier Lecomte², Maria Conceição Caldeira²

¹Centre for Applied Ecology, School of Agriculture, University of Lisbon, Lisbon, Portugal; ²Forest Research Centre, School of Agriculture, University of Lisbon, Lisbon, Portugal (migbugalho@isa.ulisboa.pt; xlecomte@isa.ulisboa.pt; mcaldeira@isa.ulisboa.pt)

Ungulate herbivores are rapidly expanding across their geographical areas of distribution. By consuming vegetation, ungulate herbivores reduce plant biomass, change plant species composition and may negatively affect regeneration of tree species. Through effects on vegetation, therefore, ungulate herbivores affect ecosystem functioning and mediate trade-offs between biodiversity and ecosystem services. Here, we describe a long-term (over 14 years) browsing and grazing exclusion experiment to assess how a wild ungulate (red deer *Cervus elaphus* and fallow deer *Dama dama*) population affected trade-offs among plant diversity, ecosystem functioning and ecosystem services of a Mediterranean oak woodland of Southern Portugal. Deer halted shrub encroachment into the ecosystem and, through reduction of the competitive shrub cover, increased the diversity of the grassland understory. Through changes in plant species composition deer also led to increased soil moisture and temperature which accelerated rates of litter decomposition and nutrient cycling. Additionally, by reducing shrub cover, deer decreased the aboveground vegetation carbon stocks but also the probability of severe wildfires. This may ultimately enhance adult oak survival and indirectly benefit long-term ecosystem carbon storage. Biodiversity and ecosystem services trade-offs need to be considered when considering ecosystem management, including decisions related with ungulate ecology and management.

Forest gardens increase the resilience of farming enterprises

Kamal Melvani^{1,2}

¹Neo Synthesis Research Centre, Polgasowita, Sri Lanka; ²Charles Darwin University, Darwin, Australia (neosynth@sltnet.lk)

Traditional farming enterprises challenged by increased climate variability stay resilient because they are tree-dominated, and farmers have acquired skills in adaptive land management from ancestors or local experience. Although farming enterprises are well studied, land management practices and landscape patterns underlying their adaptive capacity are less explored. Using mixed methods, this study investigated 85 farming enterprises across nine locations of Sri Lanka's Intermediate zone to understand which land use contributes to their adaptive capacity and best fulfills household needs. Farming enterprises incorporate On- and Off-farm components. On-farm comprises land uses including forest gardens (FGs), paddy, cash crops, swidden plots, plantations and livestock. Off-farm mainly involves employment. Locations were investigated by their socioeconomic determinants, water availability and rainfall variability, and land uses characterised and compared by area, age, tenure, agrobiodiversity and utility benefits. Results revealed that most farmers were female and had primary