WCCLF 2021

II World Congress on Integrated Crop-Livestock-Forestry Systems

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II WORLD CONGRESS ON INTEGRATED CROP-LIVESTOCK-FORESTRY SYSTEMS

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PREFACE

Promoted by the Ministry of Agriculture, Livestock and Food Supply - MAPA; Brazilian Agricultural Research Corporation - Embrapa; ICLF Network Association; State Secretariat for the Environment, Economic Development, Production and Family Agriculture - SEMAGRO; Federation of Agriculture and Livestock of Mato Grosso do Sul - Famasul; and FB Eventos, the II World Congress on Integrated Crop-Livestock-Forestry Systems (WCCLF 2021) took place on the 4th and 5th May 2021 in a 100% digital format.

The objective of the Congress was to provide a forum for discussion, theoretical insights and practical applications related to technology as well as economic and environmental aspects of mixed agricultural systems that combine integrated production of crops, animals and trees in the same area, having an efficient use of inputs, all being essential for food security in the future.

ICLF is a production strategy that integrates crop, livestock, and forestry farming in the same area, in a consortium, rotated or in succession, so that there is interaction among components, generating mutual benefits.

For two days, we discussed issues related to challenges and opportunities for ICLF systems around the World; solutions and demands from Agribusiness Companies; scenarios and trends of ICLF in the World; current hot topics in ICLF; solutions and demands for ICLF from the farmer's view; Public Policies for Supporting ICLF; and innovation on ICLF systems.

The integrated agricultural production systems can be implemented combining two or three components, according to the particularities of each farm and region. They can also be adopted in small, medium, and large farms, in different biomes, using different crops, livestock and trees species. Among the many benefits of ICLF are increasing total yields of a given area, diversification of income sources, better use of inputs, improvement of soil chemical, physical and biological qualities, along with improvement of animal welfare as well as jobs and income generation. In addition, ICLF systems reduce pressure to clear new areas, it helps to recover degraded low yielding areas while mitigating greenhouse gas emissions, increasing carbon sequestration in soil and biomass. These benefits corroborate with three of the Sustainable Development Goals - SDGs:

- SDG 2 - End hunger, achieve food security and improved nutrition and promote sustainable agriculture;
- SDG 13 - Take urgent action to combat climate change and its impacts; and
- SDG 15 Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

These Proceedings report 166 scientific contributions approved by the scientific committee of the WCCLF 2021 and 18 papers from speakers that also contributed to this publication.

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YES! IT'S POSSIBLE TO PRODUCE SOYBEANS AND CORN IN INTEGRATED CROP-LIVESTOCK-FOREST SYSTEMS AFTER THINNING

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ABSTRACT

In 2011, a large-scale (72 ha) and long-term experiment was established in Sinop, Mato Grosso, Brazil, with the objective of evaluating different grain production systems. All systems with the presence of trees were implanted in the configuration of triple groves eucalyptus with spacing of 3.5 m x 3.0 m x 30 m (270 trees/ha). After the 5th year, we made 2 types of thinning: selective thinning, removing 50% of the trees, maintaining the configuration of triple lines (135 trees/ha); systematic thinning, with removal of the two side lines (90 trees/ha remaining). After the 8th year, the systems that were with triple rank (135 trees/ha) were again thinned, now systematically, leaving 45 trees/ha. Soybeans produced at the same level as the single system in the first three years, while corn only in the first two years. After the first thinning, there was a recovery of grain yield levels for two years for soybean and for one year for corn, in the system with systematic thinning. And after the thinning in 8th year, soybean returned to the levels of the single system as well, at least for 2 years and corn in first year as well.

Key words: sustainable intensification; brazilian agriculture; research in agriculture

INTRODUCTION

The adoption of integrated crop-livestock-forestry systems (ICLF) has increased significantly in recent years, and this is a reflection of the research that has been developed in the last 30 years, in studies conducted in different regions of Brazil (CORDEIRO et al., 2015). At the same time, the demand for new management options of these complex production systems has stimulated research to act in the development and validation of cultural practices aimed at maximizing the productivity of the system as a whole.

In general, in the planning of ICLF systems it is foreseen the use of the area for grain production only in the first years (Magalhães et al., 2019), since from a certain moment, grain yield will be affected by competition for light, water and nutrients between trees and agricultural crops. This means that, depending on the time required for the final cut off the trees, the area will be 5 to 15 years without the cultivation of grains, which can discourage producers from adopting this system.

Thus, the objective of our work is to present the results of soybean and corn grain yield over 10 years of ICLF systems, showing that it is possible to produce grains after two types of thinning.

MATERIAL AND METHODS

The experiment was established in Sinop, Mato Grosso state, Brazil (11°51' S, 55°35' W; 384 m elevation), October 2011. The soil was a Rhodic Hapludox (Soil Survey Staff, 2014), while the climate is tropical wet and dry (Aw) according to the Köppen classification with rainfall concentrated in the summer/autumn and water deficiency in winter/spring. The mean values of annual rainfall and temperature are 1974 mm and 24.7 °C, respectively (SOUZA et al., 2013). More details are described by Magalhães et al. (2019).

The experimental design was a randomized complete block, with ten systems and four replicates. Three of the ten systems were selected to be evaluate in this study. The systems were (i) Single soybean crop system, under full sunlight (C) – soybean cultivated between October and February (first crop); corn with *Braquiaria Brizantha* cv Marandu cultivated between February and June (second crop); (ii) integrated crop-livestock-forestry (ICLFt) - comprising eucalyptus trees (Eucalyptus urograndis clone H13) planted in triple-row groves with 3.0 m intra-row spacing, 3.5 m inter-row spacing and 30 m between groves (overall density of 270 trees ha^{-1}) planted in an east-west orientation, integrated with crop as in C. Selective thinning was performed five years after the establishment of the system leaving only 50% of the trees (135 trees ha^{-1}), but maintaining the configuration of triple rows. The last system (iii) was an integrated livestock-forestry system (ICLFs) - comprising eucalyptus trees planted as in ICLFt, but after fifth year the outer lines were thinned, becoming a ICLF with single rows spaced of 37 m (90 trees ha^{-1}) grazing pasture as in PFS. After eight years, ICLFt also were thinned, converted in single rows (45 trees ha^{-1}) and ICLFs were pruned at 12 m high. Definitions of crop production varied over the years and fertilization are presented in Table 1.

Table 1. Soybean cultivars, corn hybrids, limestone and fertilizers doses used in the period.

Crop	Soybean (October-February)	Corn (February-June)
2011/12	BRS Favorita; 350 kg ha^{-1} NPK 00-20-20	DKB 175VTPRO; 300 kg ha^{-1} NPK 04-30-16 + 300 kg ha^{-1} Urea
2012/13	BRSGO 8560RR; 350 kg ha^{-1} NPK 00-20-20	AG 9010PRO; 300 kg ha^{-1} NPK 04-30-16 + 300 kg ha^{-1} Urea
2013/14	BRSGO 8560RR; Liming 1500 kg ha^{-1}; 350 kg ha^{-1} NPK 00-20-20	DKB 390VTPRO; 500 kg ha^{-1} NPK 04-30-16 + 300 kg ha^{-1} Urea
2014/15	BRSGO 8560RR; 400 kg ha^{-1} NPK 00-20-20	DKB 175VTPRO; 350 kg ha^{-1} NPK 04-30-16 + 222 kg ha^{-1} Urea
2015/16	BRSMG 850RR; Liming 1500 kg ha^{-1}; 400 kg ha^{-1} NPK 00-20-20	DKB 177VTPRO; 350 kg ha^{-1} NPK 04-30-16 + 150 kg ha^{-1} Urea
2016/17	M8210ipro; 90 kg ha^{-1} + 90 kg ha^{-1} KCl	P3431VYH; 350 kg ha^{-1} NPK 10-17-17 + 150 kg ha^{-1} Urea
2017/18	BRS7780ipro; 200 kg ha^{-1} KCl	2B810PW; 250 kg ha^{-1} NPK 08-20-20 + 200 kg ha^{-1} Urea
2018/19	BRS 7380RR; 175 kg ha^{-1} KCl	2B810PW; 500 kg ha^{-1} NPK 06-16-16 + 110 kg ha^{-1} Urea
2019/20	TMG 1180RR; Liming 1650 kg ha^{-1}; 310 kg ha^{-1} NPK 00-20-20 + 70 kg ha^{-1} KCl	2B810PW; 400 kg ha^{-1} NPK 10-20-20 + 300 kg ha^{-1} NPK 20-00-20 + 110 kg ha^{-1} Urea
2020/21	BG 4781ipro; 400 kg ha^{-1} NPK 00-20-20 + 100 kg ha^{-1} KCl	B2620PWU; 400 kg ha^{-1} NPK 04-30-16

In the first five years, the harvest was carried out manually, with mechanical threshing, to determine grain mass and moisture content in kg ha^{-1}, considering a 13% moisture content as baseline. In C system, we harvested 2 lines of 5 meters in length. In systems with trees, evaluations were carried out in transects, also in 2 lines of 5 meters, at 4, 7.5 and 15 m from the rows on the northern and southern sides. From the 6th year, the harvest was carried out mechanically. In system C we harvest 9 lines 21 meters long, while in systems with trees we harvest all lines on the south and north side, every 3 lines of 21 meters each.

The statistical analyses of grain yield data were performed after an evaluation of the normality of the data distribution by the Lilliefors test and the homogeneity of variances by the Hartley, Cochran and Bartlett tests. The means were compared by analysis of variance and Tukey's test ($p < 0.05$). In order to better represent the effect of the ICLF systems on grain yield, the data were relativized, dividing the grain yield of the ICLF systems by the grain yield of the C system, multiplying the result by 100.

RESULTS AND DISCUSSIONS

The soybean grain yield (Figure 1) did not differ in the first three years among the treatments. From the 4th year, the soybean yield was negatively influenced by the eucaliptus, with 87 and 83% of the relative yield in the 4th and 5th year, respectively, when compared to the single soybean system. After the first management of the trees (Figure 1, arrow number 1), the triple eucalyptus rows system, but with removal of 50% of the trees (ICLFt), did not recovered the yield, while the system that was converted to simple rows (ICLFs) recovered the yield at the same levels as system C, for two years. And after the second intervention in trees (Figure 1, arrow number 2) both ICLFt (now as converted to simple rows) and ICLFs had better results, like C system.

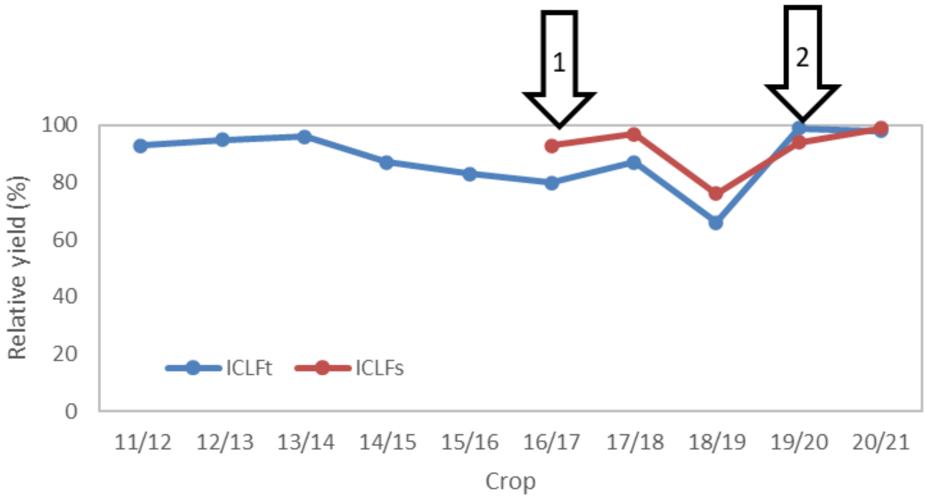

Figure 1. Relative soybean grain yield in two ICLF systems of experiment (arrows shows the moments of eucalyptus thinning).

For corn, cultivated as a second crop after soybean harvest, the yield was negatively influenced by eucalyptus rows with significant reductions (Figure 2) from the 3rd year, with yields of 83, 77 and 72% in the 3rd, 4th and 5th year, respectively relative to the C system. After the first management of the trees, the ICLFs system presented similar yield index to the C system, in the first year only. The ICLFt system, on the other hand, presented dramatic yield losses, with yield indexs of 47% in the 8th year relative to the C system. After the 2nd management on the trees, the ICLFt system switched to simple rows presented similar yield index to C system. The ICLFs, which had a pruning at 12 meters, presented lower yield levels than the C system.

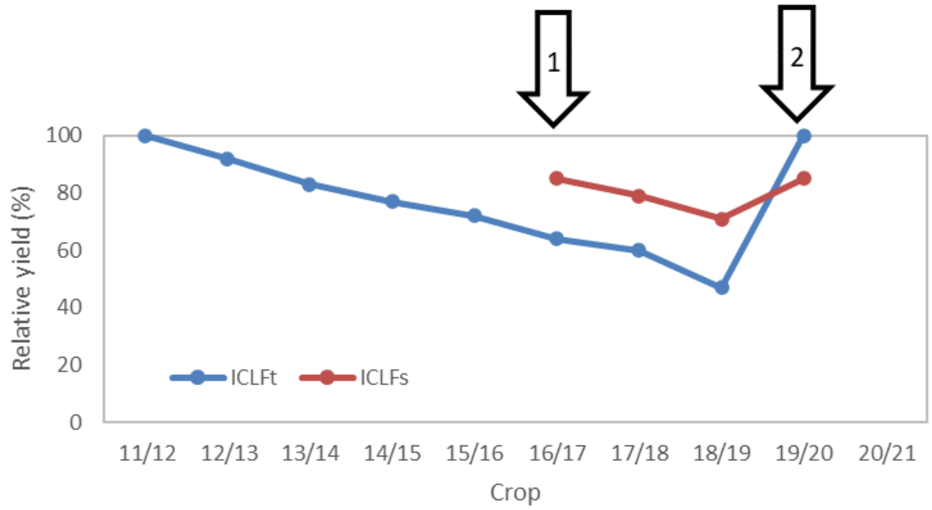

Figure 2. Relative corn grain yield in two ICLF systems of experiment (arrows shows the moments of thinning).

Along the tree's development, the projection of the shadow in the area increases throughout the years (SILVA, 2006; MAGALHÃES et al., 2020). As shown in several studies, there are really negative effects when growing grains, mainly corn, in shaded systems (CARMO et al., 2013; PAULA et al., 2013; TIBOLLA et al., 2019).

To minimize the effects of shading, soy uses morphological strategies such as the production of larger leaves to intercept a greater amount of sunlight, and physiological strategies such as stimulating the use of photosynthetic products for filling grains instead of vegetative growth (WEN et al., 2020).

The results of our study indicate with a good management of eucalypts trees densities on ICLF systems is possible to produce corn and soybeans in similar levels o single crop systems (C systems). It is noteworthy that these interventions are necessary to allow the trees with better potential to add value to the wood have optimal conditions to give maximum economic return at the end of the growth cycle (MURTA JÚNIOR et al. 2020).

CONCLUSIONS

It is possible to produce soy at the same levels as systems without trees for three years and corn for two years in ICLF systems with eucalyptus triple rows spaced 30 meters apart.

The conversion of ICLF systems with eucalyptus triple rows spaced 30 meters apart to single rows after the fifth year allows the production of soybeans for two years, and for one year for corn.

Thinning after 8th year also allows the soybean production in the same levels for the single crop at least for two years (9th and 10th year of experiment). Corn for one year at least.

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