ISSN 1517-0187

CIRCULAR TÉCNICA

37

Integrated crop-livestock in western Bahia state: the off-season cattle model

Lourival Vilela
Eduardo A. Manjabosco
Robélio Leandro Marchão
Roberto Guimarães Júnior

Planaltina, DF
Março, 2018

Embrapa

Integrated crop-livestock in western Bahia state: the off-season cattle model[1]

Introduction

The growing demand for food, bioenergy and forest products in opposition to the need to reduce deforestation and mitigate greenhouse gas emissions will require solutions that encourage socioeconomic development without jeopardizing the sustainability of natural resources. The intensification of land use in agricultural areas as well as production systems that increase efficiency and resilience may contribute to harmonize these interests. In this scenario, integrated crop-livestock systems (ICL) are an alternative that can promote society's interests.

Increasing specialization of agricultural activities as well as low crop diversification are tendencies that have been observed in the Cerrado biome. Soybean monoculture is still practiced in several farms. Potential consequences of this can be summarized as increasing biotic pressures (diseases, pests, weeds) and resulting long-term sustainability (biological, socioeconomic and environmental) impairment. Major potential benefits of ICL are: improvement of chemical, physical and biological soil properties; reduction of crop diseases, insect pests and weeds; higher plant and animal yields and reduction of production and financial risks resulting from the diversification of activities.

The main objective of ICL is to intensify land use, based on the integration of production system components, with the aim of achieving higher levels of product quality, as well as environmental, social and economic

[1] Lourival Vilela, agronomist, master in Soil Science, Embrapa Cerrados researcher, Planaltina, DF; Eduardo A. Manjabosco, agronomist, Triunfo Farm, Formosa do Rio Preto, BA; Robélio Leandro Marchão, agronomist, Ph.D. in Agronomy (Soil and Water), Embrapa Cerrados researcher, Planaltina, DF; Roberto Guimarães Júnior, veterinarian, Ph.D. in Animal Science, Embrapa Cerrados researcher, Planaltina, DF.

sustainability. Therefore, ICL is presented as a strategy to maximize the use of natural resources, by combining increased productivity with environmental conservation through the intensification of already deforested land use in Brazil. Among the different modalities of integrated systems, crop-livestock integration has been expanding with greater velocity, mainly due to the benefits obtained by grain producers when adopting crop-pasture rotation. This integrated production system consists of the implantation of different productive systems of grains, fibers, meat, milk, agro energy and others, on the same area, through intercropping, sequential or rotational planting. Within the farm, land use alternates, in time and space, between crop and livestock. The potential synergism between pasture and crop components is responsible for many of the benefits of ILP.

In the Cerrado, there are several crop-livestock integration systems which are modulated according to the profile and objectives of the farm. Differences in the systems are due to regional and farm peculiarities, such as: weather and soil conditions; local and regional infrastructure; available technologies and the producer's experience. In this region, three types of crop-livestock integration systems have stood out: (a) livestock farms in which grain crops (rice, maize, sorghum, soybeans) were introduced in pasture areas with the aim of recovering pasture yields; (b) farms that systematically adopted pasture and crop rotation to intensify land use and benefit from the synergism between the two activities; and (c) farms specializing in grain crops, which adopted forage grasses in order to improve soil cover for the no-tillage system, which in the off-season, used forage grasses to feed cattle during the dry season. In an analogy to the second cropping period (planting maize just after the soybean harvest), a quite common practice in some regions in Brazil, this double cropping system with cattle has been named "off-season cattle" or "off-season pasture".

The objective of this study is to present the evolution of the ICL system in terms of sustainable increases in food production per unit area and other benefits at the Triunfo Farm, located in the municipality of Formosa do Rio Preto, in the state of Bahia, Brazil.

Integrated crop-livestock: the “off-season cattle” model

The central objective of the maize consortium with *Brachiaria* grass in the Santa Fé system, both in the first crop and in the second summer crop (off-season maize crop), was to produce forage in the off season (dry period and without irrigation) and soil cover for no-till (Kluthcouski et al., 2000). Because of the perception of benefits of pastures on soybean crop productivity in succession, growers have expanded the use of this system to other areas. The substantial grass yield (up to 10 t/ha of dry mass) has also aroused the interest of producers in using the system in animal feeding, intensifying and diversifying the land use. The expression “Off-season Cattle” refers to cattle feeding (breeding, raising and fattening) by taking advantage of the forages accumulated from the consortium with maize or soybean (grass oversown) after harvesting. Grain and cattle growers usually prefer the fattening of male and female cattle because of its greater profitability.

Brachiaria ruziziensis is the preferred grass by grain producers because it is easier to manage and control and competes less in the consortium when compared to other *Brachiaria* species. A consortium with other forages of the *Brachiaria spp* and *Panicum* genus is also used mainly by cattle ranchers who adopt longer cycles of grazing.

The main “off-season cattle” alternatives used by producers can be seen in Figure 1. The choice of one these alternatives depends on the operational characteristics of the farm such as infrastructure, fences, waterworks, etc. and climatic conditions which are favorable to maize, sorghum and soybean crops.

In western Bahia, climatic conditions restrict the cultivation of a second summer crop, such as corn after the soybean harvest. As a result, in this region, *Brachiaria* in consortium with maize is the most adopted modality of “off-season cattle” – ICL. *Brachiaria ruziziensis* is the forage species most used by the producers of this region. In addition to this modality, *Brachiaria* oversown onto soybean has already been successfully carried out in some farms; however, this practice presents a higher climatic risk in forage establishment.

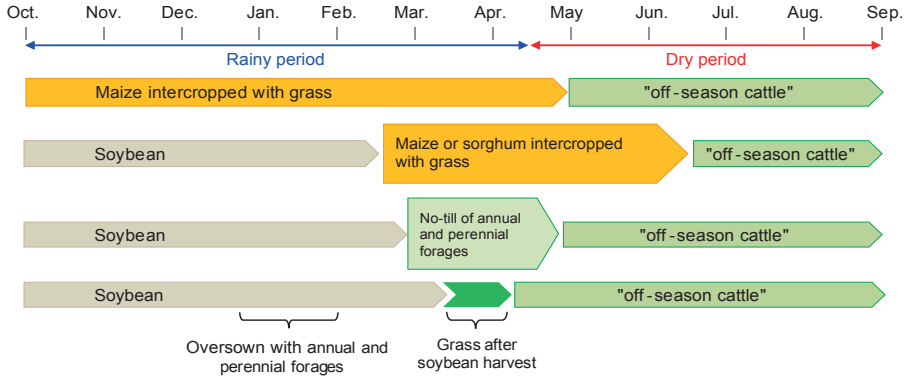

Figure 1. Potential arrangements of integrated crop-livestock in the "off-season cattle" model in different regions of the Cerrado.

The "off-season cattle" model in western Bahia state: the Triunfo Farm case

Results presented below are a good example of double cropping land with cattle in the "off-season cattle" model undertaken in the Meso-region of the Extreme West of Bahia. Such results were obtained from research and validation work carried out in partnership with Triunfo Farm, located at Formosa do Rio Preto county, state of Bahia. The farm's total area is 11,200 ha, of which 75% to 90% are used to grow soybeans. The rest of the land is used to grow maize aiming crop rotation and in most of this area the intercropped planting with grasses is adopted. *Brachiaria ruziziensis* is the main forage used on the farm. In this system, the consortium with *Brachiaria* has a dual objective: production of forage grasses and greater production of straw for the no-tillage system. Red-Yellow Latossols, of medium texture, with high levels of fine, thin sand are predominant soils on the farm. Average annual rainfall is of 1,200 mm, concentrated in the months of November to April.

In the 2009/2010 crop season, Embrapa Cerrados, in partnership with Fazenda Triunfo, implemented a validation area of 200 ha to test two alternatives to the system in use at the farm, which was based on post-emergence grass seeding (in the first cover-fertilization with the use of urea) of the annual crop. In order

to improve the operational planting yield of the crop consortium with pasture, *Brachiaria* seeds were broadcasted just before maize planting. Along with *B. ruziziensis*, preferred by most of the region's producers, the maize consortium with *Brachiaria brizantha* cv. BRS Piatã was introduced in order to diversify the system and to increase forage production potential since monoculture can favor a higher incidence of pest insects. The *Brachiaria* sowing rate was 4 kg/ha of pure germinating seeds, equivalent to "400 cultural value (CV) points" per hectare. Soil chemical characteristics, in the 0 cm to 20 cm layer, were: organic matter = 16 g kg^{-1}; pH (water) = 5.4; P (Mehlich^{-1}) = 19.2 mg dm^{-3}; K (Mehlich^{-1}) = 46 mg dm^{-3}; Ca = 1.4 cmol-dm^{-3}; Mg = 0.6 cmolc dm^{-3}; cation exchange capacity = 5.2 cmolc dm^{-3}; and base saturation = 40%.

After harvesting of corn was complete, liveweight gain of finishing cattle was evaluated together with the soybean yield cropped in succession (2010/2011) over post-grazing residue. To assess the effect of animal trampling, 1 ha area was isolated (fenced) in each corn intercropping system with *Brachiaria*. This area remained without grazing throughout the off-season.

The maize grain yield was 8,400 kg/ha and 9,400 kg/ha when intercropped with Piatã grass and *B. ruziziensis*, respectively. The single maize yield (control) was 9,600 kg/ha (Table 1). The application of herbicide (Nicosulfuron) to suppress initial forage growth was carried out only in the area of the consortium with *B. ruziziensis*. The non-application of herbicide in the area intercropped with Piatã grass explains the lower grain productivity due to greater competition of this species with maize, resulting in greater production of forage mass (Table 1). Due to the absence of regional recommendations of herbicide doses to control initial growth of Piatã grass, only the application of atrazine herbicide for broadleaf weeds control was undertaken. However, in other studies conducted in the region with the use of herbicides (Nicosulfuron and Mesotrione) in reduced doses for suppression (data not shown), the yield of maize intercropped with Piatã grass was similar to that of single crop. In the same studies, Piatã grass showed to be always more productive than *B. ruziziensis*, either in the consortium with the use of reduced herbicide doses aiming at suppression or in single planting.

Table 1. Grain and pasture yield of the consortia Maize (30P70) with two *Brachiaria* species evaluated at post-harvest of corn. Triunfo farm, Formosa do Rio Preto, BA.

System	Grain yield[1]	Forrage dry mass yield
	..... kg/ha	
Single Maize	9,642 a	-
Maize + *B. ruziziensis*	9,459 a[2]	2,677 b
Maize + *B. brizantha* cv. Piatã	8,434 b	5,514 a

[1] Herbicides applied to maize consortia with *Brachiaria*: in the *B. ruziziensis* area were 1.5 kg/ha of atrazine (i.a.) + 0.9 g/ha of nicosulfuron (i.a.); 1.5 kg/ha of atrazine (i.a.) + 0.3 L of mineral oil in the consortium with Piatã grass.

[2] Means followed by equal letters, in the same column, did not differ statistically by the Tukey test ($p < 0.05$).

The forages performance expressed in stocking rate, liveweight daily gain and liveweight gain by area in the semi-confined pasture system (Table 2) indicates the potential for meat production in the off-season (dry season). The carcass-equivalent weight gain of intact (non-castrated) male bovines with the predominance of the Nellore breed was 50.6 kg/ha and 103.2 kg/ha in pasture areas of *B. ruziziensis* and *B. brizantha* cv. Piatã, respectively. From this herd, 29%, 28% and 42% of the animals were slaughtered, respectively, after 70, 112 and 134 days of grazing. The continuous grazing method was adopted with the initial forage supply of 10% (in the dry season there is no plant growth).

The benefits of *Brachiaria* grass straw after grazing on soybean yield in succession can be seen in Figure 2. Soybean yield cropped in no-till over the post-grazing residue was 24% (774 kg or 13 bags of 60 kg each) higher than that obtained in the area without *Brachiaria*. It is worth noting that increases between 300 kg/ha and 600 kg/ha in no-till soybean yield on maize straw intercropped with *B. ruziziensis* have been frequently observed by the producers that adopt this system in the region.

Table 2. Stocking rate and carcass-equivalent weight gain of finishing cattle in off-season pastures of *Brachiaria* established by the consortium with maize in Red-Yellow Latosol, medium texture, in the period from 6/1/2010 to 13/10/2010 (134 grazing days). Fazenda Triunfo, Formosa do Rio Preto, BA.

System	Stocking rate[1]	Weight gain[2]		
	(UA/ha)	(kg/animal/day)[3]	(kg/ha)	(@/ha)[4]
Maize + *B. ruziziensis*	0.73	0.80 b	50.6	3.4
Maize + *B.brizantha* cv. Piatã	1.35	0.98 a	103.2	6.9

[1] Animal unit (UA) of 450 kg live weight adjusted for a 10% supply (10 kg of dry mass/100 kg liveweight/day).

[2] From the twentieth day of grazing, the animals received in feed bunks, 2.5 kg/animal supplementation composed for a mixture of soybean pre-cleaning and corn by-products plus mineral salt with urea (66% soybean + 30% corn + 4% concentrate with 73% TDN).

[3] Means followed by equal letters, in the same column, did not differ by Tukey test ($p<0.05$).

[4] Average carcass yield equal to 54.6%.

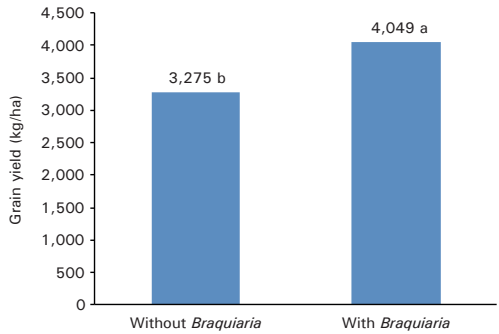

Figure 2. Effect of straw of *Brachiaria* grasses intercropped with corn (*B. ruziziensis* and *B. brizantha* cv. Piatã) on soybean yield cv. M-SOY 8866. Fazenda Triunfo, Formosa do Rio Preto, BA. Means followed by different letters differ from each other by the Tukey test ($p <0.05$).

Nutrients releasing through straw decomposition of maize intercropped with *Brachiaria* is one of the potential benefits of this practice. Results obtained in a study carried out at Fazenda Xanxerê, Correntina, BA, also located in Western Bahia, confirm the potential of nutrient release through straw decomposition of corn intercropped with *Brachiaria ruziziensis* (Santos et al., 2014). In this study, the release of nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) in 110 days was equivalent to 26.5 kg/ha, 17 kg/ha and 61 kg/ha, respectively.

Due to this potential release of nutrients, the effect of reducing fertilizer dose in the area of corn intercropped with *Brachiaria* was also evaluated, taking as reference the doses of fertilizers traditionally used on the Triunfo Farm. In two

conditions of management of *B. ruziziensis*, grazed and non-grazed, soybean yield was evaluated under two fertilization strategies with phosphorus and potassium: (a) pre-planting broadcasting fertilization, without soil incorporation; and (b) in use on the farm (pre-planting broadcasting fertilization, without soil incorporation, plus fertilization in the seed row).

Reduction of 39% in the phosphorus dose and of 33% in the potassium dose did not significantly affect (p> 0.05) soybean yield regardless of the mode of fertilization or *Brachiaria* management (Table 3). These results indicate that it is possible to reduce the amount of phosphorus and potassium applied and to improve the biological and economic efficiency of the nutrients used, especially in an unfavorable context of fertilizers x grains price ratio. Animal trampling, a concern of many grain producers, did not significantly affect soybean yield (p>0.05) (Table 3).

Table 3. Effect of *Brachiaria ruziziensis* management and phosphorus and potassium doses on soybean yield in succession crop.

Fertilizer strategy	*Brachiaria* management		Mean
	Not grazed	Grazed	
	kg/ha		
Broadcast[1]	3,852 ± 228[2]	4,045 ± 60	3,948 a
Broadcast + seed row[3]	3,929 ± 284	4,238 ± 458	4,064 a
Mean	3,891 a	4,142 a	

[1] Pre-planting fertilization: 300 kg/ha of the 00–14–18 (NPK) formula.

[2] Mean ± standard deviation (n = 4, plots of 800 m^2).

[3] Fertilization on the seed row: 150 kg/ha of the 00–18–18 (NPK) formula.

Means followed by equal letters do not differ by Tukey test (p<0.05).

Due to the good results of ICL “off season Cattle” model at Triunfo Farm, a cattle ranch was acquired in a nearby region aiming to meet greater demand for animals in both quantity and quality. On this ranch cattle is bred and raised (Nelore and Nelore crossbred with *Bos taurus*) to be finished in the “off-season cattle” system. The improved genetic potential of the herd associated with adjustments in animal and pasture management provided a significant reduction in slaughter age, from 36 to 24 months, and a 29% increase in average carcass weight, from 202 kg to 261 kg (Table 4).

The grazing management method adopted by Triunfo Ranch aims to preserve approximately 50% of the forage mass accumulated in the maize consortium (Figure 3). Thus, when forage consumption approaches this goal (grazing period varies between 30 and 45 days in 100 ha paddocks), animals are transferred to a new area, forming a "roving" grazing system. Stocking rate in these plots is 2.5 heads per hectare. In 2015 (Table 4), liveweight of the animals at the beginning of grazing was 399.6 kg ± 52.4 kg. Finally, in order to guarantee a mass of litter to cover the soil, introduction and grazing of animals is avoided in areas in which the establishment of the *Brachiaria* was deficient.

Photos: Lourival Vilela

Figure 3. Forage mass before the beginning (5/13/2010) and at the end of grazing (9/21/2010).

Table 4. Herd evolution and animal performance in the "off-season cattle" system in pastures of *B. ruziziensis* established in a consortium with maize, at Triunfo Farm, Formosa do Rio Preto, BA(1).

Year	Head (quantity)	Age at slaughter	Carcass weight	Weight gain	Carcass yield
		(month)	(kg)	(kg/day)	(%)
2010	234	36	202.0	0.872	52.6
2011	358	36	217.5	0.620	52.4
2012	456	30	255.0	1.080	52.9
2013	1285	24	244.5	0.826	52.9
2014	1463	24	249.0	0.658	53.3
2015	1522	24	261.4	0.710	54.5

(1) Source: Triunfo Farm, 2015.

The evolution of the “off season cattle” modality of the ICL system between 2010 and 2015, represented by the increase in the herd at Triunfo Farm, was expressive. The average annual growth of finishing cattle was 45% (Table 4). This herd growth can be considered as an indicator of the biological and economic feasibility of the “off-season cattle” system. In 2015, profitability of finishing cattle in the system was 2.6% per month, according to an economic evaluation carried out by the farm itself.

Final remarks

According to the data of Acompanhamento (2015), Brazil’s maize planted area in the 2014/2015 growing season was 15.8 million hectares (39.2%) in the first summer crop and 60.8% in the second summer crop (“off-season”). In this context, the potential of the “off-season cattle” system in grain producing regions of Brazil is enormous. If the 15.8 million hectares of maize were to be grown in the integrated crop-livestock system, meat production in the off-season, for a productivity level of 3 @/ha of carcass equivalent, would be 711 thousand tons. This yield corresponds to 7% of the 10.1 million tons of Brazilian annual meat production (ABIEC, 2015). At Triunfo Farm, yields ranged from 3.4 @/ha to 6.9 @/ha.

The ICL system in the “off-season cattle” model, in addition to promoting sustainable intensification of production factors within the farm and improving soil cover in the no-tillage system, improves the soil’s physical, chemical and biological properties, as well as reduces the incidence of weeds and controls some of the diseases found in major crops grown in the Cerrado.

References

ABIEC - Associação Brasileira das Indústrias Exportadoras de Carne. São Paulo, 2015. Disponível em: <http://www.abiec.com.br/texto.asp?id=8>. Acesso em: 15 jan. 2015.

ACOMPANHAMENTO da safra brasileira de grãos: volume 2: safra 2041/15: décimo segundo levantamento, set. 2015. Brasília, DF: CONAB, 2015. 134 p.

KLUTHCOUSKI, J.; COBUCCI, T.; AIDAR, H.; YOKOYAMA, L. P.; OLIVEIRA, I. P. de; COSTA, J. L. da S.; SILVA, J. G. da; VILELA, L.; BARCELLOS, A. de O.; MAGNABOSCO, C. de U. **Sistema Santa Fé - Tecnologia Embrapa**: integração lavoura-pecuária pelo consórcio de culturas anuais com forrageiras, em áreas de lavoura, nos sistemas direto e convencional.

Santo Antônio de Goiás: Embrapa Arroz e Feijão, 2000. 28 p. (Embrapa Arroz e Feijão. Circular Técnica, 38).

SANTOS, F. C.; FILHO, M. R. A.; VILELA, L.; FERREIRA, G. B.; CARVALHO, M. C. S.; VIANA, J. H. M. Decomposição e liberação de macronutrientes da palhada de milho e braquiária, sob integração lavoura-pecuária no cerrado baiano. **Revista Brasileira de Ciências Solo**, v. 38, p. 1855-1861, 2014.

Exemplary of this publication available for free at link:
https://www.bdpa.cnptia.embrapa.br/consulta/?initQuery=t

Embrapa Cerrados
BR 020 Km 18 Rod. Brasília/Fortaleza
P. Box 08223
Postcode 73310-970, Planaltina, DF
Phone: (61) 3388-9898
Fax: (61) 3388-9879
www.embrapa.br
www.embrapa.br/fale-conosco/sac

1st edition
1st printing (2018): 30 copies

Printing and finishing
Embrapa Cerrados

Local Publications Committee
Responsible Unit

President
Marcelo Ayres Carvalho

Executive secretary
Marina de Fátima Vilela

Members
Alessandra Silva Gelape Faleiro, Cícero Donizete Pereira, Gustavo José Braga, João de Deus G. dos Santos Júnior, Jussara Flores de Oliveira Arbues, Maria Edilva Nogueira e Shirley da Luz Soares Araujo

Editorial supervision
Jussara Flores de O. Arbues

Translator
Margit Bergerner Leite Guimarães

Biliographic normalization
Shirley da Luz Soares Araújo

Editing of illustrations
Wellington Cavalcanti

Collection graphic design
Carlos Eduardo Felice Barbeiro

Desktop publishing
Wellington Cavalcanti

Cover photos
Lourival Vilela

CGPE 14472