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Utilization of diversity in land use systems:
Sustainable and organic approaches to meet human needs

Economic viability of crop livestock integration under irrigated conditions in Goiás State, Brazil[a]

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Abstract
On one hand, intensification of production systems is required to raise food production, on the other hand, rotation schemes become more and more relevant regarding the sustainability of the land use. In many countries crop livestock integration is being considered as one important strategy to improve productivity in a sustainable way. In the central region of Brazil there are many central pivot irrigation systems installed, which need to be used all over the year to be rentable. The aim of this study was to analyze the economic viability of crop livestock integration under irrigated conditions in Goiás State (Brazil). Four different levels of crop livestock integration were tested: (1) only cultivated pasture (only livestock across the year); (2) cultivated pasture during summer and irrigated common beans during winter (livestock from November to Mai); (3) maize and grass intercropping during summer and irrigated common beans during winter (livestock from November to Mai); and (4) maize during summer and irrigated common beans during winter (only crops; no livestock). The costs include depreciation of irrigation system and fences, inputs and operations (hours at commercial rates). The revenues include pasture renting and commercializing grains (maize and beans). The Benefit-Cost-Ratio (BCR) was used to compare the economic viability each level of crop livestock integration. Considering the four levels of crop livestock integration tested, only one was economically viable: using cultivated pasture during summer and common beans during winter, which obtained a BCR of 1.03. The evaluated levels of crop livestock integration, under the tested conditions, have limitations regarding their economic viability and need to be further researched.

Key words: agro pastoral system, pasture crop integration, irrigation farming, economic feasibility

1 Background and Objective of the Study

On the one hand, the intensification of farming systems is necessary to increase food production; on the other hand, crop rotation improves the sustainability. The integration of crops and livestock in rotation patterns represents a way to recover degraded natural or cultivated pastures as well as to improve soil conditions resulting in higher yields. In this context, the adoption of no-tillage systems and the integration of crop and livestock represent important strategies for tropical regions in order to sustain agricultural production (KLUTHCOUSKI et al., 2004).

Some studies already showed the economic viability of crop and livestock integration under non-irrigated conditions (MUNIZ, 2007; MUNIZ et al., 2007; NDUBUISI, 1999).

In the Brazilian central region there are many central pivot irrigation systems that need be used over the whole year to justify the investments. The main objective of this study was to assess the economic viability of crop and livestock integration in irrigated areas in the Brazilian state of Goiás.

2 Methods

The study area is located in the Santo Antonio de Goiás municipality of Goiás state, Brazil, and is represented by a central pivot irrigation system with 24 hectares, divided into four quarters:

- Quarter 1: Cultivated pasture only over the whole year;
- Quarter 2: Cultivated pasture during summer and irrigated common beans of cultivar 'BRS Supremo' during winter;
- Quarter 3: Maize of cultivar 'AG 7000'and *Brachiaria brizantha* grass intercropping during summer and irrigated common beans of cultivar 'BRS Supremo' during winter;
- Quarter 4: Maize 'AG 7000' during summer and irrigated common beans of cultivar 'BRS Supremo' during winter.

The fertilization consisted of 400 kg/ha of NPK (04-30-16) for maize; for beans 400 kg/ha of NPK (05-30-15) and 222 kg/ha of urea were used. The urea was applied to beans via irrigation system.

The costs were calculated based on the coefficients (inputs and operations) and transformed to one hectare. Scale effects will not affect the results since for all operations the costs of hired machinery were considered.

The revenues were obtained considering the commercialization of harvests (maize and beans) and the rents for pasture.

In quarter 1 no inputs were used during the study period, as the pasture was implemented earlier. However, the investment was taken into account in form of depreciation. The revenue of this quarter was calculated based on the average rate paid for rented pastures in the region.

In quarters 2 to 4 the costs were related to depreciation, inputs and operations; the revenues were generated through market prices for maize and beans as well as average rate paid for rented pastures.

With the costs and revenues, the benefit-cost-ratio (BCR) was calculated.

The data was collected during 12 months considering the seasons of summer 2005/2006 and winter 2006.

3 Results and Discussion

Quarter 1 (pasture over the whole year) had higher costs that its revenues, losing R$ 44.12/ha/year. Therefore, the BCR was bellow 1.0, indicating the unsuitableness of this treatment for investment purposes. Investment and related depreciation represents the only cost in the system (Table 1).

Table 1: Revenue and costs per hectare of cultivated pasture only over the whole year (=quarter 1).

Item	Unit	Quantity	Value per unit (R$)	Total (R$)
Revenues				
Pasture rent	Days/animal unit	530	0.57	302.10
Costs				
Depreciation				
Fences	months	12	5.02	60.26
Pasture	months	12	23.83	285.96
Sum of costs				**346.22**
Net profit				-44.12
BCR				0.87

Source: Field research.

In quarter 2, the inputs, depreciation and operations represented 74.51%, 14.20% and 12.29%, respectively. The revenues were higher than the sum of costs by R$ 48.92, generating a BCR of more than 1.0, indicating that the system is economically viable and suitable for investments (Table 2).

Table 2: Revenue and costs per hectare of cultivated pasture during summer and irrigated common beans during winter (=quarter 2).

Item	Unit	Quantity	Value per unit (R$)	Total (R$)
Revenues				
Pasture rent	Days/animal unit	400	0.57	228.00
Beans	kg	2,019	0.73	1,468.15
Sum of revenues				1,696.15
Costs				
Depreciation				
Fences	months	12	5.02	60.26
Irrigation system	months	12	14.47	173.61
Inputs				
Herbicide 2,4-D	litre	0.7	16.38	11.47
Herbicide Roundup	litre	3.2	12.40	39.68
Seed treatment	litre	0.21	43.00	9.03
Bean seeds	kg	70	3.50	245.00
N-P-K fertilizer	kg	400	0.76	305.44
Insecticide Cruiser	litre	0.11	1,200.00	126.00
Herbicide Gramoxone	litre	1.0	69.38	69.38
Spreader-sticker Adesil	litre	0.3	15.80	4.74
Nitrogen fertilizer (urea)	kg	222	0.91	202.02
Insecticide Actara	litre	0.1	381.20	38.12
Acaricide Vertimec	litre	0.3	133.26	39.98
Electricity of irrigation	Kwh	1,500	0.08	120.00
Operations				
Pesticide spraying	Hours/tractor	1.5	37.80	56.70
Seeding beans	Hours/tractor	1.0	48.60	48.60
Bean harvest	Hours/combine	1.5	64.80	97.20
Sum of costs				**1,647.23**
Net profit				48.92
BCR				1.03

Source: Field research.

In quarter 3 the costs related to inputs, operations and depreciations represented 82.05%, 11.58% and 6.36% of the total costs, respectively. The total costs were higher than the revenues by R$ 270.93/ha/year and the BCR was bellow 1.0 (Table 3).

Table 3: Revenue and costs per hectare of maize and grass intercropping during summer and irrigated common beans during winter (=quarter 3).

Item	Unit	Quantity	Value per unit (R$)	Total (R$)
Revenues				
Maize	kg	4,092.5	0.21	862.84
Beans	kg	2,192	0.73	1,593.95
Sum of revenues				2,456.78
Costs				
Depreciation				
Irrigation system	months	12	14.47	173.61
Inputs				
Maize seeds	kg	25	9.50	237.50
Brachiaria grass seed	kg	13	5.00	65.00
Fertilizer	kg	409	0.59	239.67
N-fertilizer (urea)	kg	200	0.91	181.56
Herbicide Sanson	litre	0.5	123.29	61.65
Herbicide Atrazina	litre	3.0	15.80	47.40
Herbicide Roundup	litre	3.2	12.40	39.68
N-P-K fertilizer	kg	400	0.76	305.44
Seed treatment	litre	0.21	43.00	9.03
Bean seeds	kg	70	3.50	245.00
Herbicide Gramoxone	litre	1.0	69.38	69.38
Insecticide Cruiser	litre	0.11	1,200.00	126.00
Spreader-sticker Adesil	litre	0.3	15.80	4.74
Nitrogen fertilizer (urea)	kg	222	0.91	202.02
Herbicide Flex	litre	1	85.99	85.99
Herbicide Fusilade	litre	0.75	97.00	72.75
Herbicide Basagran	litre	0.5	65.61	32.81
Insecticide Actara	litre	0.1	381.20	38.12
Acaricide Vertimec	litre	0.3	133.26	39.98
Electricity of irrigation	Kwh	1,500	0.08	134.48
Operations				
Seeding maize	Hours/tractor	1.0	48.60	48.60
Pesticide spraying	Hours/tractor	1.5	37.80	56.70
Maize harvest	Hours/combine	1.0	64.80	64.80
Seeding beans	Hours/tractor	1.0	48.60	48.60
Bean harvest	Hours/combine	1.5	64.80	97.20
Sum of costs				**2,727.71**
Net profit				-270.93
BCR				0.90

Source: Field research.

A similar result was obtained in quarter 4, where the participation of inputs, operations and depreciation in total costs was 81.62%, 11.86% and 6.52%, respectively. The costs reached R$ 2,662.71/ha/year and the revenues R$ 2,457.09/ha/year, resulting in an yearly loss of R$ 206.62/ha/year and a RBC of 0.92 (Table 4).

Table 4: Revenue and costs per hectare of maize during summer and irrigated common beans during winter (=quarter 4).

Item	Unit	Quantity	Value per unit (R$)	Total (R$)
Revenues				
Maize	kg	4,125	0.21	868.69
Beans	kg	2,183	0.73	1,587.40
Sum of revenues				2,457.09
Costs				
Depreciation				
Irrigation system	months	12	14.47	173.61
Inputs				
Maize seeds	kg	25	9.50	237.50
Fertilizer	kg	409	0.59	239.67
N-fertilizer (urea)	kg	200	0.91	181.56
Herbicide Sanson	litre	0.5	123.29	61.65
Herbicide Atrazina	litre	3.0	15.80	47.40
Herbicide Roundup	litre	3.2	12.40	39.68
N-P-K fertilizer	kg	400	0.76	305.44
Seed treatment	litre	0.21	43.00	9.03
Bean seeds	kg	70	3.50	245.00
Herbicide Gramoxone	litre	1.0	69.38	69.38
Insecticide Cruiser	litre	0.11	1,200.00	126.00
Spreader-sticker Adesil	litre	0.3	15.80	4.74
Nitrogen fertilizer (urea)	kg	222	0.91	202.02
Herbicide Flex	litre	1	85.99	85.99
Herbicide Fusilade	litre	0.75	97.00	72.75
Herbicide Basagran	litre	0.5	65.61	32.81
Insecticide Actara	litre	0.1	381.20	38.12
Acaricide Vertimec	litre	0.3	133.26	39.98
Electricity of irrigation	Kwh	1,500	0.08	134.48
Operations				
Seeding maize	Hours/tractor	1.0	48.60	48.60
Pesticide spraying	Hours/tractor	1.5	37.80	56.70
Maize harvest	Hours/combine	1.0	64.80	64.80
Seeding beans	Hours/tractor	1.0	48.60	48.60
Bean harvest	Hours/combine	1.5	64.80	97.20
Sum of costs				**2,662.71**
Net profit				-206.62
BCR				0.92

Source: Field research.

Obviously these are preliminary results, as they are base on data of one year only. The research is going on in order to check if these results can be verified over different years.

4 Conclusions

The crop and livestock integration in irrigated areas can be viable considering pasture during summer and irrigated beans during winter season.

Due to the short time considered, additional studies are necessary to verify the obtained results.

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