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Agroeconomic viability of irrigated common bean production by small farms in the micro-region of Ceres, Goias state, Brazil

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Abstract

The objective of this study was to determine the economic viability of common bean production by small farms in the micro-region of Ceres, Goias state, Brasil. Common beans are grown in three different seasons: 1st season (summer, during rainy season), 2nd season (late summer until autumn, with last rainfall) and the 3rd season (winter, with irrigation). The 3rd season (winter, with irrigation) represents the season with the greatest ability to increase production, since area is available, and irrigation enables production in several areas of Cerrado region in Brazil. Ceres micro-region in Goias state represents one of those potential expansion areas to grow common beans. Therefore, within the Ceres micro-region, including the municipalities of Ipiranga de Goias, Rialma and Ceres, we monitored the cropping systems used by three farmers (one in each municipality). Those farmers actively interact with researchers doing on-farm research in their farms. The information about cropping systems allowed us to assess the economic viability of those cropping systems using indicators like production costs (total and average), profitability and break-even point. All farmers received US$ 60 to 65 per 60 kg bag of common beans. The results indicate that: (a) The drip irrigated common bean production system, interspersed with the production of green maize, developed by the farmer of the municipality of Ipiranga de Goiás, led to an increase of family income. The common bean break-even price was US$ 51.39/60 kg bag. (b) For common bean producers in the municipality of Rialma who used the conventional irrigation system to distribute sprinklers in the production system, the break-even price for common beans was US$ 21.28/60 kg bag. (c) The irrigated common bean producer, in the municipality of Ceres, who used the no-tillage system to grow irrigated beans, obtained the break-even price of US$ 37.66/60 kg bag. Considering these break-even prices, all three farmers had a positive profit with common bean production under irrigation during the winter season.

Key words: Production costs. Economic efficiency. Break-even point.

1. Introduction

Beans are a staple protein component of the Brazilians' diet. According to estimates by Embrapa Rice and Beans (2018), the apparent average per capita consumption of common beans was estimated in 2017 at 15.0 kg/inhabitant/year. Considering the last two decades, there is a downward trend in apparent per capita consumption, after reaching 18.8 kg/inhabitant, in 1996.

The common bean is cultivated in three planting seasons (1st cropping season during early summer, 2nd cropping season in late summer and early autumn, and 3rd cropping season during winter months in tropical areas of Brazil. While 1st and 2nd seasons are rainfed, the 3rd season is grown with irrigation. Cropping takes place on varied types of soil, climate, cropping systems – single and intercropped.

National production of common bean (*Phaseolus vulgaris* L.) in 2017 was 2.6 million tonnes, harvested at 1.7 million hectares, with an average yield of 1,553 kg / ha. Production of the first season represented 45.91%, the second season, 33.54% and the third season, 20.55% of this total production. In the average of 2015, 2016 and 2017, the sum of the 1st and 2nd seasons of common bean represent 80.0% and 88.3% of the production and the total area harvested, respectively. The 3rd season represents an average of 11.7% of the area and 20.0% of the national production of common bean (Embrapa Rice and Beans, 2018).

A large part of the production is used for the self-consumption of the families, especially in the regions where smaller areas of cultivation predominate. On the other hand, even small bean producers sell part of their production. The prices received by the producers, despite the oscillations, have been profitable to the producers, stimulating them to remain in the activity (Silva & Wander, 2013).

The profitability of bean producers has varied considerably over the years, mainly as a result of price fluctuations (Wander & Silva, 2014).

Price fluctuations contribute to producers benefiting from the sale of beans or to consumers benefiting from the purchase of the product, depending on the success or failure of production (Silva & Wander, 2018).

Price adjustments occur asymmetrically along the production chain. Producer price hikes are quickly passed on to consumers, while price falls to producers take 2-3 months to be passed on to consumers (Assunção, 2015; Ferreira, 2001; Souza et al., 2016).

Goiás is an important bean-producing state in Brazil. The prices and competition of the product from other states have created fierce competition for local production (Assunção & Wander, 2014).

Large-scale commercial production stands out in municipalities such as Cristalina (GO), Sorriso (MT) and Primavera do Leste (MT) (Wander & Assunção, 2015).

The opportunity to increase family income, along with the family farmers of the Ceres micro-region, specifically the municipalities of Ipiranga de Goiás, Rialma and Ceres, was prospected and diagnosed by the socioeconomic survey carried out by Embrapa Rice and Beans in variety validation farms, in the period from planting to post-harvest of irrigated common bean in the 3rd cropping season (winter) of 2018.

The farm validation trials represent a participatory technology transfer action, considering farmers' knowledge and perception regarding the new varieties. Experiences of irrigated bean production were developed with family farmers in the mentioned municipalities, with the active participation of rural extension, farmers' representation (Union), Federal Institute of Technology and Embrapa, in three consecutive years.

The value added to common bean cultivation was due to the more rational use of inputs and management aimed at a more sustainable production.

Thus, in small farms with areas of up to 20 hectares, producers challenge the regional reality, with grain crops, in the case of corn and beans. There, areas with small slopes predominate, original 'Cerrado' vegetation, acid soils and low to medium fertility, with dry winter period, with high temperatures and low humidity during the day.

The alternative of producers with ability to grow common bean was to mobilize the available resources, as part of the land, electricity and water, whose source comes from streams, to use in the off season, with the expectation of successful production. The agricultural systems explored were the rotation and / or consortium of beans with corn (grain or green) fruit plants, such as watermelon and pineapple, already verified the economic viability in the region.

Goiás is an important bean-producing state. According to Assunção et al. (2017), one of the ways to improve the competitiveness of beans produced within the state of Goiás would be the development of public policies that would establish conditions for the competitiveness of culture.

The local producers have access to technical information made available by the official extension agency Emater Goias and have support and information from the Farmers' Union of of Ceres municipality, the state level Federation of Farmer Unions FETAEG and the local Campus of Federal Institute of Technology, in Ceres municipality. All partners share the knowledge generated by the implementation of varietal validation plots.

It is noteworthy that these producers are incipient in irrigated agriculture, so they make technical mistakes in the operation of the production system, which will cost the final cost, reducing or even neutralizing the expectation of profitability.

The electrical energy used for pumping water in the slope compensation is also not measured by a properly installed network transformer, and connections are made that share the residential electricity consumption bill.

The study showed that common bean producers in the region seek to aggregate income to the final activity that is the production of milk and/or fruits & vegetables. In this way some of them formed pasture and plant the green corn, which is sold and used for food and in the silage for feeding own herds or for marketing to other farmers. In the meantime, they also plant, in an intercalated way, the irrigated common bean during the 3rd cropping season (winter).

The objective of this study was to establish a price equilibrium point for the commercialization of beans in the post-harvest period, based on a survey of the factors that make up the irrigated production system of the "winter" crop, in the Ceres microregion, specifically in the municipalities of Ipiranga de Goiás, Rialma and Ceres, in the state of Goiás. This was established in the perspective of these producers being able to manage their property, conferring profitability with the irrigated common bean business.

2. Methodology

The analysis of the irrigated common bean break-even price, i.e. the lowest selling price for no loss, was based on the survey of the operational costs of the three different bean cropping systems using irrigation, in the 3rd cropping season, by family farmers, in the Ceres microregion, especially in the municipalities of Ipiranga de Goiás, Rialma and Ceres, in the state of Goiás. Costs of common bean and corn production systems as a basis for factor prices paid by producers, in in April 2018. The diagnosis made with the producers and local technicians of Emater Goias obtained technical agroeconomic information from variety validation plots on-farm. The conventional sprinkler irrigation system was monitored at the properties located in the municipalities of Rialma and Ceres. Being that in Rialma the common bean cultivation occurs in a conventional system of soil preparation, crop rotation, using improved and traditional bean varieties. In Ceres, the cultivation system was in no-tillage, using improved bean varieties. In Ipiranga de Goiás, given the situation where the producer is also a dairy farmer, the maize consortium was implanted, and improved common bean varieties were planted, intercropped in plots with maize. In this farm, drip irrigation and conventional soil preparation were used.

3. Results and Discussion

The producer who developed the common bean crop, in a system interspersed with the production of green corn, in the municipality of Ipiranga de Goiás, developed a better alternative to increase the family income, even if it was insipid. The yield of 23 bags of 60 kg of common bean was obtained in a planted area of 0.9 hectare, and the rest of the available agricultural area, that is, 1.6 hectares were occupied to produce 260 hands of green corn and 18 tons of silage. This diversification adopted by the producer allowed an economic and financial gain, with the opportunity to expand the business of agriculture, producing grains, silage and milk. Green maize was sold for the manufacture of bananas and used for silage production to feed dairy cattle at the farm.

When conducting drip irrigation, with the water being made feasible by the use of the electric motor pump located at the edge of the water course, at a distance of approximately 200 meters, there was great energy expenditure for using the residential power grid.

However, the dripping system made it possible to save electricity, which represented 8.94% of the final operational cost of the consortium production system. In this system consortium around 1,825 kWh were used with water pumping, costing at US$ 271.25 the final cost, that is, the equivalent of 5.29 bags of 60 kg of beans. The final operational cost of the bean production system consorted with maize was US$ 3,042.53. The production cost of the beans was US$ 1,182.03 and corn was US$ 1,860.50. The producer worked with an expectation of favourable prices and obtained an equilibrium price for common bean, of US$ 51.39/bag of 60 kg. The average price of the 60 kg bag of beans in the region's market at harvest time ranged from US$ 30.21 to US$ 65.41 (Table 1).

Table 1. Operational cost of drip irrigated bean intercropped with green maize in family agriculture in the municipality of Ipiranga de Goiás, state of Goiás, in 2018.

Inputs/ Operations and Services	Specification	Unit *	Quantity	Total costs used		
				(US$)[1)]	Equivalence – beans[2)] (60 kg bags)	Partic. (%)
Conventional soil preparation				**271.87**	**5.29**	**8.94**
Seeding (seeds and fertilizer):						
Certified bean seeds	BRS[3)]	kg	50.00	120.83	2.35	3.97
Certified corn seeds	AG 1051	kg	15.00	131.40	2.56	4.32
Certified corn seeds	BRS 3046	kg	10.00	60.42	1.18	1.99
Seed treatment + Fertilizing				614.73	11.95	20.20
Total planting				**927.38**	**18.04**	**30.48**
Crop management:						
Electricity for irrigation water pumping		kWh	1,825	271.87	5.29	8.94
Crop protection (bean and corn) and fertilizing via irrigation				955.17	18.59	31.39
Total crop management				**1,227.04**	**23.88**	**40.33**
Harvest (green maize + dry beans) + cost of maize silage				**616.24**	**11.99**	**20.25**
Total operational costs[4)]				**3,042.53**	**59.20**	**100.00**

[*] Notes: kg = kilogram; kWh = Kilowatt-hour

[1)]Based on factor prices available on local market hired human labor and hired machinery. Exchange rate for US-Dollar: US$ 1.00 = R$ 3.3104, in April 01, 2018.

[2)]Based on break-even price of US$ 51.39 received by farmers for 1 bag of 60 kg of beans.

[3)]Valid for bean varieties BRS Estilo, BRS Pitanga, BRS Agreste, BRS FC402, and BRSMG Realce.

[4)]Cost of production of 23 bags of 60 kg of beans + 15,600 green maize cobs + 18 tons of silage, on 2.5 hectares, being 0.9 hectare of common bean and 1.6 hectare with maize intercropped with forage grass.

In the municipality of Rialma, the common bean producer, who used the conventional irrigated sprinkler distribution system for the cultivated area, also benefited from the increase in family

income, by adopting the conventional planting system, but practicing annual rotations with other crops of grains and fruit, such as corn, watermelon and pineapple, and this rotation has contributed to increase crop yields and soil quality. Excellent yield was achieved, i.e. 90 bags of 60 kg on 1.5 hectares, at a cost of US$ 1,915.21. The prices of the product also favored the profitability, given the quality of the product offered to the consumer. The lowest price to dispose of the product without losses, at harvest time, was US$ 21.28/bag of 60 kg. This producer was able to sell its production above the expectation margin of US$ 65.41/bag of 60 kg. In this cropping system around 1,764 kWh were used by conventional irrigation with the use of water pumping, represented 13.72% of the final cost of production. The cost of electricity was US$ 262.81, or the equivalent of 12.35 bags of 60 kg of beans (Table 2).

Table 2. Operational cost of 90 bags of 60 kg of irrigated common bean, in 1.5 hectares, with sprinklers conventionally distributed in family agriculture, in the municipality of Rialma, in the state of Goiás, in 2018.

Input/ Operations and Services	**Specification**	**Unit ***	**Quantity used**	(US$)[1)]	**Total costs used**	
					Equivalence – beans[2)] (60 kg bags)	**Partic.** (%)
Conventional soil preparation				**540.00**	**7.67**	**8.52**
Planting (seeds and fertilizer):						
Seeds (not certified)	Rouxinho Paraná	kg	40.00	60.42	2.84	3.15
Certified seed	BRS Esteio	kg	40.00	60.42	2.84	3.15
Seed treatment + fertilizing				284.55	13.37	14.87
Total planting				**405.39**	**19.05**	**21.17**
Crop management:						
Electricity for irrigation water pumping		kWh	1,764	262.81	12.35	13.72
Crop protection (pesticides + application)				784.83	36.88	40.98
Total crop management				**1,047.64**	**49.23**	**54.70**
Harvest				**299.06**	**14.05**	**15.61**
Total operational costs[3)]				**1,915.21**	**90.00**	**100.00**

* Notes: kg = kilogram; kWh = Kilowatt-hour

[1)]Based on factor prices available on local market hired human labor and hired machinery. Exchange rate for US-Dollar: US$ 1.00 = R$ 3.3104, in April 01, 2018.

[2)]Based on break-even price of US$ 21.28 received by farmers for 1 bag of 60 kg of beans.

[3)]Valid for bean varieties BRS Estilo, BRS Pitanga, BRS Agreste, BRS FC402, and BRSMG Realce.

[4)]Cost of production of 90 bags of 60 kg of beans on 1.5 hectare.

The 3rd cropping season common bean family producer in the municipality of Ceres used the no-tillage system and used the conventional irrigated sprinkler distribution system for the cultivated area on his farm and sought to use the technologies available for family farming. The break-even price obtained, given the financial expenditure with the production system was US$ 37.66/bag of 60 kg. This price also favored it to the detriment of the quality of the beans harvested and, most probably, did not operate at a loss, in relation to the commercialization of 90 bags of 60 kg, since the lowest price in force in the local market stood at US$ 30.21/bag of 60 kg. The total operating cost of the production system of this cultivated area of 2.0 hectares was US$ 3,389.32. In this production system around 3,690 kWh were used in the pumping of water for conventional irrigation, represented 16.22% of the final cost of production. The cost of electricity for irrigation was US$ 549.78, or equivalent to 14.60 bags of 60 kg of beans (Table 3).

Table 3. Operational cost of production of 90 bags of 60 kg of irrigated common bean in 2.0 hectares, with sprinklers conventionally distributed, under no-tillage system, in family agriculture, in the municipality of Ceres, in the state of Goiás, in 2018.

Inputs/ Operations and Services	Specifications	Unit *	Quantity used	(US$)[1)]	Total costs used	
					Equivalence – beans[2)] (60 kg bags)	Partic. (%)
Area preparation (cleaning and desiccation)				**126.87**	**3.37**	**3.74**
Planting (seeds and fertilizer):						
Seeds (not certified)	BRS Pitanga + BRS Esteio	kg	70.00	99.69	2.65	2.94
Certified seeds	BRSMG Madrepérola	kg	20.00	30.21	0.80	0.89
Seed treatment + Fertilization						
Total planting				**966.65**	**25.67**	**28.52**
Crop management:						
Electricity for irrigation water pumping		kWh	3,690	549.78	14.60	16.22
Crop protection (pesticides + application)				1,027.07	27.27	30.30
Total crop management				**1,576.85**	**41.87**	**46.52**
Harvest				**718.95**	**19.09**	**21.21**
Total operational costs[3)]				**3,389.32**	**90.00**	**100.00**

[*] Notes: kg = kilogram; kWh = Kilowatt-hour
[1)]Based on factor prices available on local market hired human labor and hired machinery. Exchange rate for US-Dollar: US$ 1.00 = R$ 3.3104, in April 01, 2018.
[2)]Based on break-even price of US$ 37.66 received by farmers for 1 bag of 60 kg of beans.
[3)]Valid for bean varieties BRS Estilo, BRS Pitanga, BRS Agreste, BRS FC402, and BRSMG Realce.
[4)]Cost of production of 90 bags of 60 kg of beans on 2.0 hectares.

4. Conclusions and Outlook

The study of agroeconomic technical indicators of irrigated common bean (*Phaseolus vulgaris* L.), based on the equilibrium price and cost of irrigation of the production systems, made possible by agro and socioeconomic technical diagnosis, with small producers in the Ceres microregion , especially in the municipalities of Ipiranga de Goiás, Rialma and Ceres, in the state of Goiás, allows us to conclude that:

- The drip irrigated common bean production system, interspersed with the production of green maize, developed by the producer of the municipality of Ipiranga de Goiás, led to an increase in family income. The bean break-even price was be US$ 51.39/bag of 60 kg.
- For bean producers in the municipality of Rialma who used the conventional irrigation system to distribute sprinklers in the production system, the lowest price to dispose of the product without losses would be US$ 21.28/bag of 60 kg.
- The irrigated common bean producer, in the municipality of Ceres, who used the no-tillage system to grow irrigated beans, obtained the break-even price of US$ 37.66/bag of 60 kg.

The use of electric energy in the irrigation through pumps installed in the capture of reservoir waters (streams / dams) and the electric power network itself does not fully favour the saving of electric energy in the municipalities studied. It is suggested that an effort be made by associations of the region's producers to mobilize in the installation of an electric power network that favours irrigation in family agriculture.

Embrapa is not an institution that defines product prices, but favours producers, with economic indicators that support decision making, such as the point of balance between production costs and productivity. The producers that count on Emater's technical assistance are more directed to the market.

In the current context of family farming in Goiás, it is suggested to introduce restrictions on the use of irrigation water, aiming at the sustainability of bean production, with actions of greater use (efficiency in management), mainly because it is a good that shows exhaustion of natural sources.

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