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Added value and profitability in irrigated production in alluvial aquifer: financing scenarios

Valor agregado e rentabilidade na produção irrigada em aquífero aluvial: cenários de financiamento

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ABSTRACT - The Brazilian semi-arid region is a space with very high levels of economic and social inequality. Thus, the study aimed to carry out an economic-social analysis of family-based irrigated production systems, considering financing scenarios and associated with a level of social reproduction. Through structured questionnaires, a detailed survey of information was carried out on family-based irrigated production systems in monoculture and polyculture, representative of local conditions, allowing the analysis of the added value and the farmer's income for the conditions with and without financing in the Pronaf Mais Alimento line of credit. Family-based irrigated production systems in the semi-arid region are severely limited in terms of their economic and social sustainability in a scenario without the support of rural credit. The polyculture production system represents an economically efficient production alternative when associated with the financing scenario. The level of social reproduction for production systems with financing, with a view to economic sustainability, can be obtained with areas of cultivation that represent less than half of those in systems without financing. It is noteworthy that each production system has unique peculiarities, so this study cannot be generalized, but the calculation strategy can be applied and adapted to other properties and regions.

Keywords: Family farming. Production costs. Pronaf. Monoculture. Polyculture.

RESUMO - O semiárido brasileiro é um espaço sob altíssimos níveis de desigualdade econômica e social. Dessa forma, o estudo objetivou analisar os sistemas de produção irrigados de base familiar em aquífero aluvial, considerando cenários com e sem financiamento do Pronaf Mais Alimento e associados a um nível de reprodução social no semiárido brasileiro. Por meio de questionários estruturados, realizou-se um levantamento minucioso de informações de sistemas de produção irrigados de base familiar em monocultivo e policultivo representativos das condições locais, permitindo analisar o valor agregado e a renda do agricultor para as condições com e sem financiamento na linha de crédito do Pronaf Mais Alimento. Os sistemas de produção irrigados de base familiar no semiárido sofrem forte limitação quanto à sua sustentabilidade econômica e social em um cenário sem o apoio do crédito rural. O sistema de produção em policultivo representa uma alternativa produtiva economicamente eficiente quando associado ao cenário do financiamento. O nível de reprodução social para os sistemas de produção com financiamento, tendo em vista a sustentabilidade econômica, é possível de se obter com áreas de cultivo que representam menos da metade em relação aos sistemas sem financiamento. Vale ressaltar que cada sistema de produção possui peculiaridades exclusivas, logo, esse estudo não pode ser generalizado, mas a estratégia de cálculo pode ser aplicada e adaptada em outras propriedades e regiões.

Palavras-chave: Agricultura familiar. Custos de produção. Pronaf. Monocultivo. Policultivo.

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INTRODUCTION

The Brazilian semi-arid region is marked by the concentration of land with average annual rainfall equal to or less than 800 mm, Thornthwaite aridity index equal to or less than 0.50 and annual water deficit percentage equal to or greater than 60% (SUDENE, 2021). Although the semi-arid region is under very high levels of social exclusion and environmental degradation, determining factors for the existing socioeconomic and environmental crisis, the region represents 36.2% of the country's total agricultural establishments. Of this total, 78.8% were characterized as family farming, which corresponds to 37.1% of the segment in Brazil (SILVA et al., 2020).

Inhabitants of the Brazilian semi-arid region are extremely dependent on the water reservoirs available in the region. However, considering the vulnerability in water conservation in these reservoirs, alluvial aquifers are commonly used for irrigated agriculture, presenting themselves as strategic sources of water supply during the dry season (SCHEIBER et al., 2020).

The oldest irrigated perimeters were designed with a view to distributing water by gravity; however, given the scenario of water scarcity that began in 2012, the water supply was interrupted. Thus, irrigating farmers, as a rule, needed to purchase equipment and hire specialized labor to implement the groundwater collection system and, thus, continue their production activities (PEREIRA;

CUELLAR, 2015).

In this context, access to rural credit is a central element in agricultural policy, allowing the increase of production through land yield and production factors, through the monitoring of production costs and evaluation of the profitability of production systems (SANTOS; BRAGA, 2013; BELIK, 2014; CARVALHO et al., 2014).

According to Moreira, Silveira and Motter (2014), Pronaf is a financing program that encourages investment in own and local activities with the objective of promoting the development and sustainability of family farmers, especially low-income farmers, with the central focus of granting lines of credit, enabling access to the market by family farmers.

The concept of sustainable development is one that considers the balance between economic issues, social issues and ecologically sustainable use of natural resources, so the idea of sustainable presents the image of continuity, indicating something capable of being endurable, lasting and conservable. Furthermore, in order to advance towards agricultural sustainability through economic feasibility, information on production costs enables the implementation of economic and/or agricultural policies, aiming to measure the sustainability of an agricultural enterprise in the long term in order to identify advances, bottlenecks and prospects of action (DAMASCENO; KHAN; LIMA, 2011; NHAMPOSSA et al., 2017; ROCHA JUNIOR et al., 2020).

Based on the above, the study aimed to analyze family-based irrigated production systems in alluvial aquifer, through the indicators added value and farmer's income, per family work unit, considering scenarios with and without financing from Pronaf Mais Alimento and associated with a level of social reproduction in the Brazilian semi-arid region.

MATERIAL AND METHODS

The study was carried out in 2018 in the Morada Nova Irrigation Project, located in the municipalities of Morada Nova (70%) and Limoeiro do Norte (30%), at the geographic coordinates 5° 06' South latitude, 38° 23' West longitude and 80 m of altitude. Rainfall in this region has a seasonal character, with insufficiency and irregularity in its distribution, causing relatively low values of annual rainfall, with averages ranging between 500 and 800 mm, combined with high temperature and strong evaporation rate, which ranges from 2000 to 2800 mm year^{-1} – National Institute of Meteorology (SILVA et al., 2010).

Initially, a thorough survey was carried out to collect information on annual production systems in monoculture and polyculture representative of the local conditions, by applying structured questionnaires that allowed obtaining the main characteristics of the property, production systems and irrigating farmer.

The representative production systems consisted of the annual monoculture of rice in two cycles (120 days each), in the first and second half of the year, respectively, and a polyculture, consisting of rice (120 days), maize (120 days) and beans (75 days), cultivated throughout the agricultural year. The soils of the selected production systems were subjected to physical-chemical analyses, whose results were: sandy clay texture, pH of 7.5, ESP of 15.0 and EC_{se} of 2.29 dS m^{-1} for the monoculture and loam texture, pH of 7.9, ESP of 9.0 and EC_{se} of 0.7 dS m^{-1} for the polyculture.

Analyses of water for irrigation from shallow wells (depths below 20 m) were carried out at the Soil and Water Laboratory of the Federal University of Ceará. The quality of irrigation water regarding the risk of salinity and sodicity, according to the classification of Ayers and Westcot (1994), was type C_2S_1 (moderate salinity problem and without sodicity problems) for both production systems.

The surface irrigation method is used in the Morada Nova Irrigation Project, intermittent flood system for rice and furrow irrigation for maize and beans. The irrigation management carried out by the irrigators is empirical, using supplemental irrigation in the first half of the year and full irrigation in the second half, called rainy and dry seasons, respectively.

In the economic-social analysis, the conditions without financing and with financing from Pronaf were considered, according to Moreira, Silveira and Motter (2014).

In the study, it was considered that the farmers used for implementing the enterprise investment credits from Pronaf Mais Alimentos. According to Saron and Hespanhol (2012), Pronaf Mais Alimentos is a line of credit whose purpose is to boost the development of the family-based agricultural system with resources for investments in production infrastructure in rural family properties, which has interest rate of 2.5% per year, which refers to investment with fixed and variable costs – Banco do Nordeste (BNB), reference year: 2018.

The production costs for monoculture and polyculture were obtained from irrigating farmers, with a view to the added value and farmer's income in the production unit, according to the methodology described by Silva Neto (2005).

The added value was initially calculated for one hectare of production, and this area was expanded linearly (Y = aX + b), where the ordinate axis represents the added value and the abscissa axis, the useful agricultural area (UAA), the latter representing the expansion of the agricultural area used for agricultural purposes. The angular coefficient of the line (a) represents the marginal contribution relative to the area, and the linear coefficient (b) represents the fixed capital required to implement the production system.

The added value indicator of a production system aims to analyze the capacity that a production unit has in generating wealth for society, being calculated according to Equation 1:

$$AV = GVP - IC - D \quad (1)$$

where: AV is the added value, in R$; GVP is the gross value of production, in R$; IC is intermediate consumption (monetary value of goods and services, consumed during production cycles, which vary proportionally and not proportionally with scale), in R$; and D is the depreciation of equipment and facilities (monetary value consumed in several production cycles), in R$.

The gross value of production (GVP) was obtained through the product of yield (kg ha^{-1}) by the sales price of the product (R$ kg^{-1}). The depreciation of equipment was obtained by the linear method, considering the useful life, without residual value, for the items financed, according to Equation 2:

$$D = \frac{(Vo - RV)}{UL} \quad (2)$$

where: D is the average depreciation, in R$; Vo is the value at the time of acquisition (year zero), in R$; RV is the residual value, in R$; UL is the useful life of the equipment, in years.

The depreciation of equipment was represented in a constant way, based on the linear method with an annual quota and considering a useful life of ten years. The reference values to obtain the useful life necessary to determine the average depreciation of the equipment used in the production systems were extracted from the specialized literature.

From the added value for each system, the remuneration of the different agents who participated directly or indirectly in production, including farmers' income, was calculated according to Equation 3:

$$FI = AV - IR - W - T \quad (3)$$

where: FI is the farmer's income, in R$; AV is the added value, in R$; J corresponds to the interest rate paid to the banks, in R$; W corresponds to wages paid to workers (temporary or permanent), in R$; T corresponds to taxes and fees paid to the State, in R$.

The interest rate paid to the banks (IR) was calculated according to the Pronaf line that each farmer is in, mentioned above. Wages paid for labor (W) include temporary and permanent workers, considering as permanent the worker who has an employment contract without an established termination, based on the minimum wage as remuneration.

From the calculation of added value (AV) and farmer's income (FI) promoted by the production systems, linear models were created to describe the economic results (added value or income) of the production systems in relation to the useful agricultural area per unit of work (UAA/UW).

RESULTS AND DISCUSSION

Table 1 shows the values of fixed costs (FC), variable costs (VC) and depreciation (D), which together with the gross value of production (GVP) constitute the variables necessary for calculating the Added Value (AV) related to the annual occupation of a lot with the monoculture of rice for the conditions with and without financing in the Pronaf Mais Alimento line of credit, considering the situations of supplemental irrigation (first half) and full irrigation (second half).

Table 1. Fixed and variable costs, depreciation and added value with and without financing corresponding to 1.0 ha of rice production for each cultivation cycle. Base year: 2018.

Discrimination		Production system		Annual
		Supplemental irrigation	Full irrigation	
Fixed cost	Well	2,040.00	2,040.00	4,080.00
	Motor pump	1,350.00	1,350.00	2,700.00
	Piping and implements	2,942.50	2,942.50	5,885.00
	Total	6,332.50	6,332.50	12,665.00
	Financing installment	633.25	633.25	1,266.50
Variable cost	Seeds	375.00	375.00	750.00
	Fertilizers	828.00	1,493.00	2,321.00
	Pesticides	80.00	80.00	160.00
	Electricity	133.33	300.00	433.33
	Harvest	990.00	1,075.00	2,065.00
	Total	2,406.33	3,323.00	5,729.33
	Financing installment	240.63	332.30	572.93
Depreciation	Annual	311.19	311.19	622.38
Production	Gross value (GVP)	6,700.00	7,550.00	14,250.00
AV	With financing	5,514.93	6,273.26	11,788.18
AV	Without financing	-2,350.03	-2,416.69	-4,766.72

*AV = GVP - (FC+VC+D).

Based on the results for monoculture, it is possible to observe that the variable cost of production increased 38.1% with the advent of using full irrigation. Considering that irrigation represents a cost of production that directly and indirectly impacts other variables in the calculation of added value, monoculture under full irrigation obtained an increase of 13.75% for added value, while the GVP obtained an increase of only 12.68% when compared to supplemental irrigation.

Table 2 shows the values of fixed costs (FC), variable costs (VC) and depreciation (D), which together with the gross value of production (GVP) constitute the variables necessary for calculating the Added Value (AV) related to the annual occupation of a lot with polyculture (rice, maize and beans) for the conditions with and without financing in the Pronaf Mais Alimento line of credit.

Table 2. Fixed and variable costs, depreciation and added value with and without financing corresponding to the polyculture of 1.0 ha of production for rice + maize + bean crops. Base year: 2018.

Discrimination		Production system			Annual
		Rice	Maize	Beans	
Fixed cost	Well	920.00	920.00	920.00	2,760.00
	Motor pump	843.33	843.33	843.33	2,530.00
	Piping and implements	1,434.67	1,434.67	1,434.67	4,304.00
	Total	3,198.00	3,198.00	3,198.00	9,594.00
	Financing installment	319.80	319.80	319.80	959.40
Variable cost	Seeds	300.00	568.89	75.00	943.89
	Fertilizers	560.00	816.00	25.00	1,401.00
	Pesticides	80.00	44.44	100.00	224.44
	Electricity	700.00	388.89	166.67	1,255.56
	Harvest	1,145.00	399.00	85.00	1,629.00
	Total	2,785.00	2,217.22	451.67	5,453.89
	Financing installment	278.50	221.72	45.17	545.39
Depreciation	Annual	160.81	160.81	160.81	482.43
Production	Gross value (GVP)	8,350.00	6,411.11	4,250.00	19,011.11
AV	With financing	7,590.89	5,708.78	3,724.22	17,023.89
AV	Without financing	2,206.19	835.08	439.52	3,480.79

*AV = GVP - (FC+VC+D).

The value of the financing installment of the fixed and variable costs refers to the annual installment paid by the farmer to the financing agent, in this case calculated based on the Pronaf Mais Alimento line of credit, which gives the farmer ten years to pay for the investment. It should be emphasized that the financing installment was used for calculating the added value.

The data show that the added value for the monoculture production system is positively impacted by the advent of financing, differing from the production system in polyculture, which even in the absence of financing and when considering the crops separately showed no negativity for added value. Nevertheless, the added value for polyculture with the advent of Pronaf Mais Alimento financing is 44.4% higher than that obtained with the same conditions for monoculture, that is, this economic difference in the amount of R$ 5,235.71 demonstrates that a production system in polyculture associated with a line of credit in which the value of the financing installment is distributed in an economically viable manner over time results in greater financial freedom for the producer.

According to Ferreira, Neumann and Hoffmann (2014), the calculation of the added value through its parameters contemplates the technical and economic efficiency of the agricultural production system and constitutes an element of paramount importance for better understanding the actions adopted by the producer.

The detailing of the production costs in the property makes it possible to quantify its expenditure, evaluate the occurrence of unnecessary operations in plantations and the disbursement made in the purchase of inputs. Such detailing allows an overview of the situation and enables an intervention in costs by evaluating the impact of the item on the cost of production based on its percentage participation.

Production costs involve variable and fixed dividends, which together generate the total cost of the production process. According to Vieira Filho and Silveira (2011), the experience of farmers over time is of paramount importance to promote reduction in production costs and, at the same time, increase in yield, requiring the farmer to also invest in

the capacity to manage resources and in the knowledge of new technologies to better interpret and assimilate new information.

Results obtained by Ney and Hoffmann (2009) indicate that the level of education or scarcity of human capital are factors that compromise the equitable development of the rural environment, which may lead agricultural enterprises not to reach the levels of yield and income necessary for their expansion.

According to Moreira, Silveira and Motter (2014), the financial and entrepreneurial notion is important, but rural extension and technical assistance are fundamental to complement the knowledge of production and financial techniques, with the purpose of ensuring economic, social and sustainable viability in family farming. Fear of debt, bureaucracy and the existence of a previous debt are the main justifications of family establishments when claiming that they do not need financing on their properties (SOUZA et al., 2011).

Pronaf has positive short-term impacts on the agricultural sustainability of family farmers and also long-term sustainability. However, it requires a harmonious combination of the economic and social dimensions of the property and the annual income of the family farmer. Thus, for a long term, an analysis of the cost of investing in technologies in family farming is interesting because it results in higher yield; however, it is important to note that, with higher technological level employed, profit tends to be lower (SERAMIM; ROJO, 2016; PASSOS; KHAN, 2019).

The models of value added (VA) with respect to useful agricultural area (UAA) are represented in Figure 1, making it possible to identify the social contribution of the different production systems studied through the scenarios with and without Pronaf financing and the requirements of area and fixed cost for their implementation. This model makes it possible to identify the types of production units with the greatest difficulties to remain in agricultural activity and their perspectives according to the accumulation dynamics of the agrarian system.

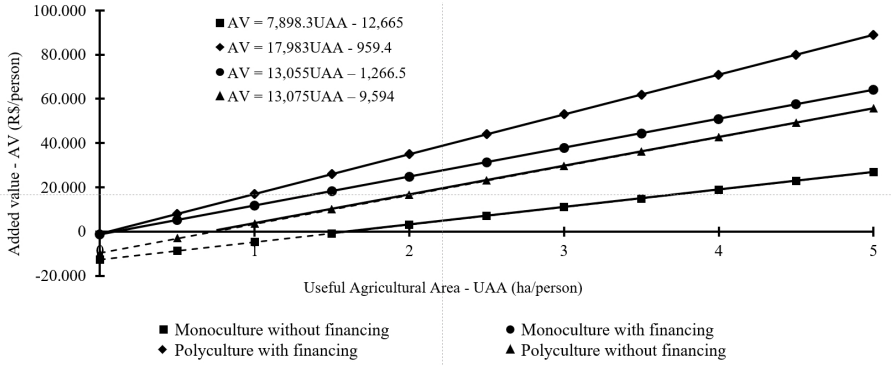

Figure 1. Linear model for the added values of production systems with and without financing in Pronaf.

The results of the linear models for monoculture (rice) and polyculture (rice, maize and beans) production systems without the use of financing constitute a strong limitation to the activity, as they require the highest fixed costs necessary for implementing the enterprises, R$ 12,665.00 and R$ 9,594.00, respectively, thus demonstrating the importance of rural credit as a social instrument for irrigating farmers.

Corroborating this assertion, the production of a monoculture and a polyculture with the use of financing had the highest marginal contributions per unit of area, R$ 13,054.68 and R$ 17,983.29, respectively, which consequently results in higher added values for each hectare in production.

In the study conducted by Capellesso, Cazella and Búrigo (2018), the Northeast Region showed a strong evolution in access to individual registrations in the Pronaf line of credit in the 1996-2013 period.

Thus, it was considered in the present study that the farmers used for implementing and managing the enterprise, investment credits of Pronaf Mais Alimentos, which has interest rate of 2.5% per year in the year in question, 2018, and this investment is destined to fixed and variable costs.

According to the study, the costs related to the implementation of the units vary for each production system and are quite high considering the reality of the region, which shows signs of economic and social vulnerability. In this case, it is worth pointing out that the family farmer does not always have financial resources at the beginning of the process, so access to credit is opportune and indispensable, thus demonstrating the importance of Pronaf for the family farmer.

Table 3 shows the annual interest rate paid by irrigating farmers to the financing agent in the Pronaf Mais Alimentos line of credit in 2018 for 1.0 ha of annual production.

Souza et al. (2013) point out that the fear of debt, bureaucracy and the existence of a previous debt represent the main justifications of family establishments when claiming that they do not need financing in their properties. Thus, in the absence of a Social Bank, the only alternative available to the irrigating farmer is the “middleman”, who finances their production at exorbitant interest rates, practically making the activity unfeasible.

Table 3. Interest rate paid to the financing agent in relation to investment credit of Pronaf Mais Alimentos in 2018 for 1.0 ha of annual production.

	Discrimination	Monoculture	Polyculture
Costs	Fixed cost	12,665.00	9,594.00
	Variable cost	5,729.33	5,453.89
	Wages paid to workers	1,689.00	5,787.67
	Total	20,083.33	20,835.56
Interest rate	2.5%	502.08	520.89

It is necessary to emphasize that the low use of financing by small establishments cannot be directly associated with restriction or selective bias. The perception of the need for financing, which precedes the search for this resource, is affected by a number of factors, such as educational level, access to technical assistance and degree of organization, which are generally low among small establishments (SOUZA; NEY; PONCIANO, 2015).

In this case, it is of fundamental importance to analyze production systems economically. For this, it is necessary to have knowledge about the farmer's income, because the permanence in agricultural activity, maintenance of people in rural areas and their quality of life are closely related to it, since it contributes to ensuring social reproduction. The production systems were analyzed based on their income, added value of production, interest rate paid to financial agents for implementing the enterprise, tariffs paid to the State and wages paid to workers.

Table 4 shows the variables necessary for calculating Farmer's Income (FI), obtained by the difference between the added value of production and the costs of interest rate paid to financial agents, tariffs paid as taxes and wages paid to workers for the production systems with or without financing from Pronaf Mais Alimento.

Table 4. Farmer's income (FI) with and without funding for 1.0 ha of monoculture and polyculture. Base year: 2018.

Discrimination	Monoculture		Polyculture	
	With financing	Without financing	With financing	Without financing
AV	R$ 11,788.18	R$ - 4,766.72	R$ 17,023.89	R$ 3,480.79
Interest	R$ 502.08	-	R$ 520.89	-
Wages	R$ 1,689.00	R$ 1,689.00	R$ 5,787.67	R$ 5,787.67
Taxes	R$ 89.60	R$ 89.60	R$ 220.27	R$ 220.27
Annual FI	R$ 9,507.50	R$ - 6,545.32	R$ 10,495.07	R$ - 2,527.14

It is possible to observe in both production systems that the results obtained for the farmer's income follow the same trend when compared to the results obtained for added value, demonstrating that the production system in polyculture maintains its superiority over monoculture, where the farmer's income with the advent of financing was 10.38% higher than in the monoculture. It is also worth mentioning that, even in a scenario where the producer does not have access to the line of credit, still, despite the negative result, the production system in polyculture maintained its superiority over monoculture.

Corroborating this assertion, Silva et al. (2013) evaluated the agronomic performance of organic cotton and oilseeds intercropped with cactus pear and demonstrated that the use of a production system composed of cotton, sesame and cactus pear, as compared to the use of cotton as sole crop, showed better positive results for efficient land use and gross income, parameters that are important in the evaluation of the system's efficiency, thus pointing to this production system in polyculture as an efficient alternative in family farming.

In the Morada Nova Irrigation Project, farmers do not pay ITR (Rural Property Tax), which represents the tax paid to the state on a rural property. Therefore, the taxes recorded in this study refer to the tariff K_2 paid to the Association of Users of the Irrigation District of the Morada Nova Irrigated Perimeter (Audipimn), being represented by a value of R$ 22.40 per hectare in production per month, in 2018.

Souza, Ney and Ponciano (2015), when analyzing the distribution of the use of financing among Brazilian agricultural establishments, concluded that the distribution of financing among agricultural establishments is concentrated, but tends to reflect the differences of these establishments regarding their contribution to the value of production.

The level of social reproduction (LSR) represents the minimum income considered necessary to ensure the social reproduction of farmers, being based on the minimum wage that, by Decree No. 9,255, of December 29, 2017, was set at R$ 954.00. In this case, the LSR value represented in Figure 2 refers to the annual income, having as reference the minimum wage, i.e., R$ 11,448.00.

It is worth pointing out that this level of social reproduction is justified by the fact that the region offers few job opportunities with remuneration above one minimum wage for workers without a specific professional qualification,

a case that comprises the majority of farmers in the municipality.

Figure 2 contains the linear expansion of Farmer's Income (FI) for production systems with and without financing from Pronaf, which allowed the analysis of the level of social reproduction (LSR) of each production unit for a useful agricultural area (UAA) of up to 5.0 ha.

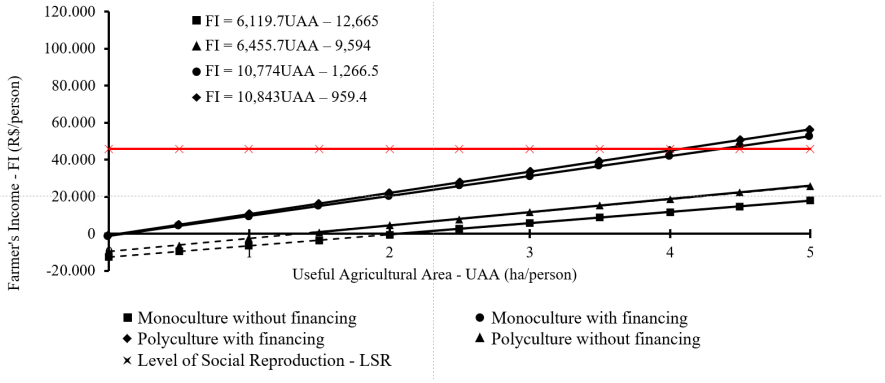

Figure 2. Farmer's income (FI) for production systems with and without financing from the Pronaf system.

Figure 2 shows that the lines representing the two production systems with financing practically overlap, and both systems can definitively surpass the LSR, with approximately 1.5 ha in production. On the other hand, the lines that represent the condition without financing show that the producer will only be able to achieve the acceptable level of social reproduction from 3.0 ha and 4.0 ha in production for polyculture and monoculture, respectively.

In the study, irrigating farmers did not receive any rural advice or technical assistance to the production systems, so the management of both production systems along with the allocation of financial resources are based on the irrigator's experience. The lack of technical assistance and rural extension focused on the economic-social assistance of family -based farmers directly interferes with the producer's ability to access the line of credit, as well as properly allocate the resources obtained and reallocate those already available within the rural property.

For the poorest regions with limited sources of employment and income, the use of more sustainable agricultural practices is a matter of survival and continuity of the family farming segment. In this case, the adoption of more sustainable agricultural practices, without improving agricultural income and social and cultural issues, is not able to maintain the viability of family farming (PASSOS; KHAN, 2019). These results indicate the need for owners to pay attention to the benefit/cost ratio of the technological practices they adopt.

Rocha Junior et al. (2020), using the Propensity Score Matching methodology, proved the effectiveness of technical assistance and rural extension as an instrument for generating income when evaluating the effect of the use of technical assistance on the monthly income of Brazilian family farmers and statistically found the inclusion of R$ 490.54 in the monthly income or R$ 5,886.48 in the annual income of family farmers. The authors also point out that the use of technical assistance by family farmers results in impacts on other dimensions not evaluated in the study.

The level of social reproduction based on the minimum agricultural area and on the current minimum wage is the indicator responsible for ensuring the maintenance and sustainability of the production system. Thus, the higher the fixed capital per person required to implement the production system (coefficient b) and the lower the marginal contribution relative to the area (coefficient a), the greater the useful agricultural area per person so that each family worker can receive a sufficient income for permanence in the agricultural activity (SILVA NETO, 2005).

In the evaluation of the farmer's income, a family nucleus composed of four people who depend directly on the farmer's income was considered. In this specific condition, representative of the local conditions under which the study was conducted, with the advent of financing, the monoculture of rice, in which the farmer's annual income corresponds to R$ 9,507.50 per hectare per year, will allow him/her to pay a minimum wage to each dependent with a rice cultivated area of 4.3 ha.

In an analysis similar to the previous one, still with the advent of financing, but considering the system with the polyculture of rice, maize and beans, in which the farmer's annual income corresponds to R$ 10,495.07 per hectare per year, it would be possible to pay a minimum wage to each dependent with the cultivation of 4.0 ha in production.

For Ventura and Andrade (2011), the polyculture existing in the property means that each plantation will fruit at a certain time of the year without reference to the rainy season. Thus, farmers have the possibility of income even in the dry season. This not only provides food security to the family, but also allows the farmer to continue selling his/her products throughout the year.

It is worth emphasizing the importance of financing, because in a scenario without financing, the production systems under analysis would only allow paying the income of one minimum wage to each dependent for areas greater than 9.6 and 7.8 ha with monoculture and polyculture, respectively.

Agricultural credit, when associated with increased production in physical terms and increased income, is an indicator of success and good results. In this context, credit has a selective role, building a (virtuous) cycle in which the most efficient farmers have better capacity to leverage resources and, therefore, further increase their yield (BELIK, 2014; OLIVEIRA; BUENO, 2019).

For Zimmermann (2009), monoculture with economic objectives is an environmentally unsustainable practice, causes enormous damage to nature and needs to be reviewed urgently, under penalty of making thousands of hectares of land sterile worldwide. According to Ventura and Andrade (2011), Brazil and the world lack new research studies on social technologies on the use of polyculture in semi-arid regions, in order to prove how adapted, replicated and effectively used in different circumstances they can be. In view of the above, the predominant forms of land use in the Brazilian semi-arid region have contributed to the depletion of sources of natural resources and, consequently, to the worsening of socioeconomic conditions, going against innovative perspectives that promote sustainability (SALIN et al., 2012; GODOI; BÚRIGO; CAZELLA, 2016).

CONCLUSIONS

Family-based irrigated production systems in the semi-arid region are severely limited regarding their economic and social sustainability in a scenario without the support of rural credit. The production system in polyculture represents an economically efficient production alternative when associated with the financing scenario, as the use of the line of credit provides a greater marginal contribution per unit of area.

The level of social reproduction for production systems with financing, in view of economic sustainability, can be obtained with cultivation areas that represent less than half of those in systems without financing. It is worth pointing out that each production system has unique peculiarities, so this study cannot be generalized, but the calculation strategy can be applied and adapted in other properties and regions.

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