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Determining rice seed costs in the subregion of La Mojana in Colombia

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Abstract

Seeds are the basic input for any agricultural production system. It determines the yields and economic benefits that the farmer derives from the crop and the subsistence of his family nucleus depends on it. The production of seed has not been a common practice and there is little information about the costs of production. The objective of this study was to estimate the costs of regional rice seed production by small farmers. The geographical framework was La Mojana, region located in the Caribbean of Colombia, in the municipalities of Ahí, Majagual, San Jacinto del Cauca and Ayapel. Data were collected through workshops with producers in the four locations, using the consensus method to arrive at the formulation of cost patterns, emphasizing that the purpose of production is that of regional rice seed. Calculations of unit cost of production, return indicators such as profitability of rice seed production, gross margin and cost-benefit analysis were made. With a benefit/cost ratio of 2.1, a unit cost of $1,379·h^{-1}$, and a sale price of $2,900·t^{-1}$ average yields was 2,085.0 kg·ha^{-1}. It was concluded that the production of rice for seed production generates greater economic benefits than that of rice for human consumption.

Keywords: Break-even point, gross margin, income, inputs, prices, profitability, resources, yields.

Introduction

Seeds are the basis of any agricultural production system, since final yields depend on them and, therefore, the production of food for the sustenance of the family nucleus and monetary income. Therefore, it is important to determine the costs of seed production, particularly that of regional rice produced directly by small farmers in the subregion of La Mojana. In this regard, Chayanov (Bartra, 2015) mentioned that small farmer economy is not typically capitalist, so it is not possible to objectively determine production costs due, to the absence of a market for goods and factors. This argument is reinforced by Sartelli (2018), who indicated that any producer, despite not possessing bourgeois thinking, can generate a surplus that would be part of a mercantile process, generating a surplus from a means of production.

This study was aimed at determining the costs of regional rice seed production by small farmers in the subregion of La Mojana, in the Caribbean region of Colombia. Rice is an essential food for the population of this region and, in general, it is a basic food grain for mankind, being one of the three main cereals that have accompanied the progress of humankind: wheat, maize and rice. According to the Food and Agriculture Organization of the United Nations (FAO, 2019), the world's cereal supply is estimated at 2,600 million tons; 415 million tons of wheat, 1,400 million tons of maize and 500 million tons of rice. Seen as a whole, rice represents 20 % of this basket, surpassed by wheat with 30 % and maize with 50 %. Data available in the National Agricultural Survey and the 2020 rice census reported that, in Colombia, the harvested area of rice was 393,372 ha, with a total production of 2,258,926 tons in green paddy and a participation in the

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production of 16,378 producers (DANE, 2016), making this a staple food in the diet of Colombians.

The geographical framework of the project is the subregion of La Mojana, located in the north of Colombia, characterized by fertile soils with recurrent flooding caused by overflowing rivers, mainly the Cauca (Aguilera, 2004). The main crops and production systems are rice, both mechanized and traditional or regional, some subsistence crops, such as manual rainfed rice, maize, cassava, watermelon and miscellaneous fruit trees developed under the model of productive backyards as established crops (Martínez-Reina, 2013).

The literature on rice seed production costs reports some references worldwide, such as the research cited by Hoque and Haque (2014) who, in Bangladesh, determined through surveys the cost-benefit analysis of 1.44, the highest benefit-cost ratio was found in Jamalpur (1.8) compared to Manikganj (1.48) and Gazipur (1.26). They also found age, plot size and income level as determinants of rice seed adoption.

Ohen and Ajah (2015), using descriptive statistics, analyzed the socioeconomic characteristics of farmers and constraints associated with small-scale rice production in Nigeria, concluding that rice production in the study area was profitable. They also determined that among the economic factors affecting rice production were the cost of seed, farm size, and poor access to credit.

Islam, et al. (2017), by selecting rice farmers by simple stratified sampling technique and through the formulation of a Cobb Douglas type function to determine the factors influencing crop profitability including seed as an input, they determined that rice production costs per hectare in Bangladesh were higher for large farmers, followed by medium and small farmers; they also determined that the cost of seed per hectare was higher in small farms, followed by large and medium farms respectively; meanwhile, the undiscounted cost-benefit ratio was 1. 38, 1.23 and 1.15, for small, medium and large farmers, respectively, based on yields, because small farmers had higher net yields per hectare when compared to those obtained by medium and large farmers. Abera and Assaye (2021), following the line of determining production costs and profitability of rice production under rainfed production system by smallholder farmers in Ethiopia and using random sampling technique, determined the percentage shares of each component of production costs and concluded that the gross margin (12,084 ETB) and cost-benefit ratio (1.44) for this system, was profitable. However, despite the importance of the seed as the basis of the vegetative process and the contribution to high yield production that guarantees the continuity of food security, to date, only the technical process of production of this seed has been documented (Romero, et al., 2020), but there has been no study of the costs of seed production by small farmers in the subregion of La Mojana, so this paper focuses on determining these costs and indicators of return on seed production. This lack of information is manifested in the fact that there is no exact data on the quantities produced and demanded of regional rice seed, desirable characteristics for the farmer, the flow of the seed from production to use in agriculture and its supply, nor is the marketing strategy documented. Therefore, the objective of the study was to calculate the production costs of regional rice seed by small farmers.

Materials and Methods

This study was carried out in 2016, during the implementation of Agrosavia's National Seed Plan, in the subregion of La Mojana in Colombia, in the regional rice producing municipalities of Achí (Bolívar), Majagual (Sucre), San Jacinto del Cauca (Bolívar) and Ayapel (Córdoba), selected for having a representative number of small regional rice farmers who cultivate under the manual rainfed rice system (López et al., 1998; Romero et al., 2020). The target population consisted of small farmers familiar with the regional rice production systems in the above-mentioned municipalities.

A deterministic method proposed by Rodriguez (2005) was used to select the farmers, because they already knew the producers, so it was only necessary to call them to the previous workshop with some requirements, such as full knowledge of seed production and experience in the cultivation of regional rice. The method used to collect information was by consensus (Quijandría and Ruiz, 1991). Three workshops were held in the four municipalities of Achi (Bolívar), Majagual (Sucre), San Jacinto del Cauca (Bolívar) and Ayapel (Córdoba), with the participation of producers who were experts in the management of this system and who had more than five years of experience cultivating the available species of regional rice.

This information was organized in flat files in Excel®, which is done in a logical and sequential manner of occurrence of the activities (Quijandría and Ruiz, 1991). The format consisted of four columns containing information on the concept of the activity or indicator. The second column indicated the units of the decimal metric system. The third column corresponded to the quantities; the fourth to the unit value and the fifth column was the result of the product of the unit value and quantity. The unit value corresponded to the market price (at the farm store), which must be adapted with the cost of transportation to the farm, known as an input at field price.

The calculation of the variables direct and indirect costs, total costs, profitability, unit values, break-even point and others, was determined based on the economic theory of

Krugman, et al. (2013) (Table 1). Based on the information collected, economic returns were calculated by identifying the constituent elements of the total cost of production, such as labor and inputs.

Yield data allowed the calculation of unit costs and economic returns such as net income, profitability, break-even point and efficiency. Labor was valued according to the monetary cost of labor in the region and the price of inputs, according to Perrin, et al. (1988), that is, the price paid by the producer for the product plus the cost of transportation to the farm.

For the analysis of local production technology, we applied the central tendency measure, Moda, considering those activities carried out by producers in the regional rice production system in the subregion of La Mojana, according to Quijandría and Ruiz (1991).

To calculate the price of the seed produced, the regional value paid by the farmers at the time of the workshop in the four municipalities was considered. This value was multiplied with the average yield calculated from the information provided by the farmers at the workshop, which resulted in the gross income indicator, which when subtracted from the production costs generated the net income and profitability (defined as the ratio between net income and total cost). In addition, the minimum amounts of production required by the farmers to match income with costs, known as the break-even point, were estimated.

The efficiency of the production system was calculated as described by Forero et al. (2013), who proposed the indicators of technical profitability of the crop, net profitability, technical efficiency and economic efficiency.

Technical profitability was calculated by establishing the relationship between the difference between gross income and direct costs; in the case of net profitability, the difference between gross income and direct and indirect costs was related to total costs, which corresponds to the same concept of profitability traditionally used. For the calculation of the technical efficiency of the crop, the difference between gross income and direct costs was related to the cultivated area, which is a way of quantifying the contribution per area to profitability.

Table 1. Production cost parameters, economic indicators and marketing margins estimated for the production of creole rice seed by farmers in the region of La Mojana, Colombia, adapted to the year 2022.

Equation	where:
$\sum_{Dc=0}^{n} Dc = Dc1 + Dc2 + Dc3 + \cdots + Dcn$	Dc: direct costs; Dc_1: seeds; Dc_2: agrochemicals; Dc_3: seeds, etc.
$\sum_{Ic=0}^{n} Ic = Ic1 + Ic2 + Ic3 + \cdots + Icn$	Ic: indirect costs; Ic_1: ground rent; Ic_2: financing costs; Ic_3: others, etc.
$PC = Dc + Ic$	Pc: production costs; Dc: direct costs; Ic: indirect costs.
$\sum_{YLD=0}^{n} YLD = \frac{Kilos}{ha}$	YLD: yield; kilos per hectare of rice seed.
$UC = \frac{PC}{YLD}$	UC: unit costs; PC: production costs; YLD: yield.
$GI = YLD * SP$	GI: gross income; YLD: yield; SP: selling price of rice seed production.
$NI = GI - PC$	NI: net income; GI: gross income; PC: production costs.
$TP = \frac{GI - Dc}{Dc} * 100$	TP: technical profitability; GI: gross income; Dc: direct costs.
$NP = \frac{GI - PC}{PC} * 100$	NP: net profitability; GI: gross income; PC: production costs.
$BEP = \frac{PC}{SP}$	BEP: break-even point; PC: production costs; SP: selling price.
$BEPP = \frac{PC}{GI} * 100$	BEPP: break-even point percentage; PC: production costs; GI: gross income.
$Te = \frac{SP}{UC} * 100$	Te: technical efficiency; SP: selling price; UC: unit costs.

Source: Compiled by the authors.

Results and Discussion

Analysis of rice seed production costs

The analysis of regional rice seed production costs was made based on the information gathered by the consensus method in workshops with producers in the municipalities of Achi, Majagual, San Jacinto and Ayapel in 2020, all belonging to the subregion of La Mojana, which are presented in Table 2.

The production of the same product, such as regional rice seed, which is produced using similar techniques, it would be expected to have no significant differences in terms of costs among the localities. In this case, there is great variation in production costs among the different municipalities, with the highest cost in the municipality of Achí. The average costs per hectare were 2,857,789 $\$ \cdot ha^{-1}$ with a variation coefficient of 26% for the four municipalities. Labor, seeds and fertilizer were the most influential elements in this variation. The municipality of San Jacinto del Cauca had the lowest costs per hectare, with a total of 2,193,936 $\$ \cdot ha^{-1}$, which was mainly attributed to packing.

Calculation of return indicators

The information from the workshops was used to calculate the economic returns, which are shown in Table 3.

Return indicators for the production of regional rice seed are high, compared to the production of rice for consumption. According to Martínez-Reina (2013), profitability is 16%, while regional rice seed production has an average profitability of 112% and an average benefit-cost ratio of 2.1. Therefore, it can be inferred that by investing in rice seed production, with yields averaging 2,085 $kg \cdot ha^{-1}$ and average costs of 2,857,789 $\$ \cdot ha^{-1}$, the investment is recovered and a surplus equal to the amount invested is generated, suggesting this is a good production alternative. Also, on average, with 48 % of the production per hectare, the income is balanced with the costs and a surplus of 52 % is generated, which is the producer's profit surplus.

Sensitivity analysis for economic returns

This analysis considered a 20 % decrease in yields and a 10 % decrease in prices, in relation to the information provided by the producers. The objective was to establish how far they can withstand changes in a less advantageous scenario than the actual one, in case of an eventuality. A drop in yields is acceptable and admissible, but a decrease in prices is less drastic than yields, which is shown in Table 4.

Results of the sensitivity analysis (Table 4) showed the same characteristics of Table 3, because production techniques remained constant. Therefore, the quantities of inputs used also remained unchanged. Under these circumstances, a 10% decrease in yields causes a total drop in gross income averaging 1,702,680 $\$ \cdot ha^{-1}$ and profitability decreases by 59 % in relation to the information generated in the cost patterns. However, it should be noted that, with this decrease, net income is positive (1,520,531 $\$ \cdot ha^{-1}$) and profitability averages 53 % for the four locations. This allowed us to infer that, even under adverse conditions, rice seed production by small farmers is viable.

Table 2. Regional rice seed production costs per hectare in the subregion of La Mojana 2022.

Concept	Achí	Majagual	San Jacinto	Ayapel
Direct costs COP.				
Labors	3,326,000	1,272,000	1,281,000	1,702,000
Seeds	80,000	75,250	180,000	75,000
Herbicides	125,000	97,800	174,800	50,000
Fertilizers	150,000	158,000	153,000	300,000
Insecticides	30,000	5,000	22,000	0
Fungicides	0	67,500	25,000	0
Packaging	45,000	80,000	21,000	45,000
Total (direct costs)	3,756,000	1,755,550	1,856,800	2,172,000
Indirect costs				
Rent 1 ha	300,000	300,000	300,000	400,000
Contingencies	75,120	35,111	37,136	43,440
Monitoring	0	400,000	0	0
Total (indirect costs)	375,120	735,111	337,136	443,440
Total costs	4.131,120	2,490,661	2,193,936	2,615,440

Source: Workshops with Agrosavia producers 2016 updated in 2022.
*Values in Colombian pesos COP.

Table 3. Return indicators for rice seed production in one hectare in the La Mojana region 2022.

*Indicador	Achí	Majagual	San Jacinto	Ayapel
Total costs	4,131,120	2,490,661	2,193,936	2,615,440
Yield kg·ha^{-1}	3,000	2,000	1,740	1,600
Gross income	9,000,000	6,000,000	4,524,000	4,800,000
Net income	4,868,880	3,509,339	2,330,064	2,184,560
Profitability	118	141	106	84
Price per unit	1,377	1,245	1,261	1,635
Actual sales price per kilo	3,000	3,000	2,600	3,000
Estimated selling price	1,407	1,273	11289	1,671
Break-even point	1,377	830	844	872
Break-even point percentage	46	42	48	54
Benefit/cost ratio	2.2	2.4	2.1	1.8

Source: calculations based on information from Agrosavia 2022 workshops.
*Values in colombian pesos COP.

Target price to be charged per kilogram of rice seed

An approximation was made to determine the prices to be charged by the regional rice seed producer under the approach of production cost plus normal profit level, which is shown in Table 5.

Since farmers will not sell a kilogram of regional rice seed at the cost of producing it and require a normal profit margin, the price component was considered to be the cost of production plus a profit margin (Varían, 2009) as follows:

Price = Cost + Nomal gain

According to the economic theory, the price is composed of the cost of production and the normal gain level, which is the opposite of the extraordinary gain that occurs due to fortuitous situations. The normal gain is a remainder after deducting costs that allows recovering them and giving a margin to the producer, when the price is very low and does not cover the costs, there is no gain.

The average cost of producing a kilo of regional rice is 1,379 $\$\cdot kg^{-1}$. This cost is increased by 30 %, which is the equivalent of capital costs calculated at 14% effective per year, and the proportion of storage costs and handling losses estimated at 16%, for a total of 30 % of the value of the kilogram produced. Therefore, the final value of each kilogram of regional rice seed produced and sold is equivalent to 1,422 $\$\cdot kg^{-1}$. This difference generates an economic efficiency for the farmer of 3.06 %. In none of the municipalities will this price produce a loss, and it will generate a surplus and a profitability in the order of 3 %, which is a reasonable value and within the reach of the farmer who is going to be the demander of the seed.

This last pricing proposal, despite having lower values than the one submitted by the farmers in the workshop, only varied the calculation with a reasonable profitability percentage of 30%, which is enough to cover the opportunity cost of capital and some transaction costs, which is much closer to reality and would allow for leftovers according to the level of investment. In this case, a low level of investment generates low levels of profit, but always with the presence of profit.

Discussion

In relation to the methods and techniques of analysis for this study, there are some differences, such as the case of Islam et al. (2017), where, in addition to using a cost pattern like the one used in this research, they performed estimation analysis. Furthermore, Islam et al. (2017) estimated a Cobb Douglas-type function to establish the importance of seeds, both in the cost structure and in crop yields. In this study, cost patterns were used to calculate the relative weight of the cost component, with tillage being the most important category in this case. In rice production in La Mojana, the most important element was labor, with 66 % of total costs. Other studies, such as Ohen and Ajah (2015) showed fertilizer as the one with the highest percentage, with 20 % of the total costs. Similarly, although in another species, Caviedes Cepeda (2019), stated that the main costs to produce hard maize correspond to the fertilizer and harvest categories (21.16 and 20.66 %, respectively), with a benefit/cost ratio of 1.20.

The calculated return indicators that result high and show feasibility of deciding to invest in regional rice seed production with a benefit ratio of 2.1, on average for the localities studied, compared to the study by Islam et al. (2017) in benefit-cost ratio of 1.38, 1.23 and 1.15 for small, medium

Table 4. Sensitivity analysis of return indicators in rice seed production in one hectare in the La Mojana Region 2022.

	Achí	Majagual	San Jacinto	Ayapel
Total costs	4,131,120	2,490,661	2,193,936	2,615,440
Yield $kg \cdot ha^{-1}$	2,400	1,600	1,392	1,280
Gross income	6,480,000	4,320,000	3,257,280	3,456,000
Net income	2,348,880	1,829,339	1,063,344	840,560
Rentability	57	73	48	32
Price per unit	1,721	1,557	1,576	2,043
Actual sale price per kilo	2,700	2,700	2,340	2,700
Estimated selling price	1,759	1,591	1,611	2,088
Break-even point	1,530	922	938	969
Break-even point percentage	64	58	67	76
Cost/benefit ratio	1.6	1.7	1.5	1.3

Source: calculations based on information from Agrosavia 2022 workshops.

Table 5. Price to be charged per kilo of regional rice seed in the subregion of La Mojana 2022.

Indicator	Achí	Majagual	San Jacinto	Ayapel
Total costs	4,131,120	2,490,661	2,193,936	2,615,440
Yield $kg \cdot ha^{-1}$.	3,000	2,000	1,740	1,600
Gross income	4,255,054	2,565,381	2,259,754	2,693,903
Net income	123,934	74,720	65,818	78,463
Rentability	3,0	3,0	3,0	3,0
Price per unit	1,377	1,245	1,261	1,635
Estimated selling price	1,418	1,283	1,299	1,684
Break-even point	2,913	1,942	1,689	1,553
Break-even point percentage	97	97	97	97
Benefit-cost ratio	1.03	1.03	1.03	1.03

Fuente: Estimates based on information from Agrosavia workshops (2022).

and large farms, respectively, on average is 1.25 lower than the results given by this exercise for the subregion of La Mojana, which is explained by the high yields with an average of 2,085 $kg \cdot ha^{-1}$. For this reason, a sensitivity analysis was performed, simulating a 20 % decrease in yields and a 10 % decrease in prices, and despite the decrease in return indicators, the investment continues to be attractive. On the other hand, Figueroa Guzmán, et al. (2019), in a study on the economic benefits of using certified seed in rice (*Oryza sativa*) production in Peru, concluded that the use of certified seed would increase the yield per hectare by 26.94 % and increase the profit margin by 94.16 %, which is corroborated by a Marginal Cost Benefit Index of 1.15.

Regarding price setting, given that the value provided by the farmers in the workshop was taken and that its determination is not very clear, the microeconomic theory of price proposed by Varían (2009) was used, which is composed of the cost of production and the normal gain level, using the unit cost and adding a profit remainder (Puentes et al., 2019) resulting in a selling price of 1.422 $\$ \cdot kg^{-1}$, which allows recovering the investment and generating surpluses for the seed producer. In addition, it is considered a reasonable price available to farmers and from that price upwards they can produce and sell rice seed.

Conclusions

The production of regional rice seed by small producers in the subregion of La Mojana is a profitable activity, with indicators above the regional benchmarks for rice production for human consumption. Despite the fact that the regional rice seed production technique in the different municipalities is the same, as well as the price and quantity of inputs used, does not vary notably, the production costs present variations that are explained by the use of labor, volume of fertilizers and quantity of seeds, which is why there are variations between localities, and in San Jacinto del Cauca the costs were the lowest in relation to the other localities. Calculations and estimates of costs and economic returns show that even with drastic decreases in yields, seed production continues to be profitable and attractive for those who want to invest in this activity. However, when the criterion of production cost and normal gain level is applied, the information is closer to the producer's reality, with shades of equity between those who produce rice seed and those who demand it, given a favorable price for farmers who will demand more seed.

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