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Profitability and comparative advantage: Analysis of strawberry production in Michoacán, Mexico

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ABSTRACT

The production of berries is an issue that has become relevant over time due to the increase in the popularity of these fruits; its use extends every day to more markets, and the fact that its production requires specific geographical conditions and specific care restricts the amount of supply in the international market. Therefore, it is noteworthy that the state of Michoacán presents the appropriate characteristics for planting and harvesting berries. Because of this, the objective of this study is to determine the profitability and comparative advantage of Mexican strawberry production in Michoacán for the year 2021, through the Policy Analysis Matrix (PAM). A limitation to the study is the period of time selected in this case, which corresponds to the year 2021. Among the main conclusions, it stands out that with a value of 0.14 and a value of 0.37, it can be deduced that strawberry production is a competitive activity with an advantage for Michoacán producers.

Keywords: strawberry, berries, profitability, production in Michoacán.

INTRODUCTION

Strawberry is a fruit from a plant of the Rosaceae family. Most people know or can relate to the shape and color of strawberry due to its peculiar red tone, and because its sweet flavor has many uses in gastronomy. The attributes of this fruit in the nutritional aspect are also diverse and varied, which make it a natural selection in diets and in nutritional plans, and its use is one of the most widespread, reason why it is one of the fruits with extended consumption.

Strawberry is a fruit that requires large land extensions, as well as a careful harvest because of how delicate and sensitive it can be; for example, it requires a controlled temperature usually below 15 °C from the moment of cutting, storage, transport, and final sale; these details impact the product's general cost.

In particular for 2019, according to the Food and Agriculture Organization of the UN, there are three countries at the global level that show supremacy concerning strawberry exports, particularly Spain, Mexico and the United States, which exceed by at least double the amount to the Netherlands, which in the particular case of Mexico allows to see that strawberry production is intensive and large-scale.

Image by Jérémie Perron at Pixabay

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Therefore, Mexico has the capacity to produce and export large volumes of product if required.

Likewise, the countries that imported strawberry in 2019 were 134 which allow to see that strawberry has a generalized and much extended acceptance among diverse nations, where sometimes it is known as an exotic fruit and its price per kilogram can exceed the $150 MX pesos.

These data allow asserting that strawberry, despite being an expensive fruit in its production and transport, is a desired product and with an interesting volume of commercialization in different countries (FAO, 2019).

Regarding Mexico, there are 14 states in the country related to strawberry production which sow and harvest this fruit, in part because of the climate conditions of the country, as well as the geographical conditions that offer advantages for the production of this fruit, which is reflected in the total production volume of the country.

According to the agrifood and fishing information service of Mexico's government, by 2019, the state with highest production was Michoacán with 66 percent of the national production, where there are six municipalities that generate all of the strawberry in the state and they are the universe of the study. From the data presented, the objective of the study is to determine the profitability and comparative advantage of Mexican strawberry production in Michoacán for the year 2021, through the Policy Analysis Matrix (PAM). For this purpose, the study is divided into four sections, the first being the introduction which shows the production and demand of strawberry at the international, national and state level; the second section explains the methodological treatment used to fulfill the objective set out; in the third section, the main results derived from the methodological study are presented, divided into two parts: the private analysis that accounts for the profitability, and the social analysis that accounts for the comparative advantage in the meta market selected; and finally, the conclusions derived from the study are presented.

MATERIALS AND METHODS

The Policy Analysis Matrix for agricultural development (PAM) published and developed by Eric A. Monke and Scott R. Pearson in 1989 is made up by two countable identities: countable profitability or rather the difference between production costs and profits; and the divergence effects or policy effects, which measures the effects caused by the existence or absence of policies for producers.

The private profitability is made up of private prices and social prices. Therefore, PAM is composed of two accountability identities, the first defines the profitability and the second measures the effects of policy and the market distortions. PAM accounts for the results and separates them to determine the profitability that is obtained from the producer's point of view (private profitability) and the profitability that the country obtains through the efficient use of their resources (social profitability), so that the private profitability indicates the level of competitiveness of producers and the social profitability indicates the level of comparative advantages of the country in the production of a specific good.

$$Profits = \sum P_i X_i - \left[\sum P_j X_j + \sum P_k Z_k \right]$$

Where: P_i=Price of the product in the national market; X_i=Amount of tons produced per hectare; P_j=Price of marketable inputs in the national market; X_j=Amount of marketable inputs and indirectly marketable inputs applied per hectare; P_k=Price of the internal factors in the national market; Z_k=Amount of internal factors applied per hectare.

The first accounting identity is defined by $\sum P_i X_i$ (price of the product in the national market multiplied by the amount of tons produced per hectare); this identity is the amount of income received by the producer from the harvest of the product.

The second identity is identified by $\sum P_j X_j + \sum P_k Z_k$ (the sum of the prices of the marketable inputs in the national market, as well as the direct and indirect marketable inputs applied per hectare multiplied by the sum of prices of the internal factors in the national market by the amount of internal factors applied per hectare), which are the costs for the producer of producing the harvest.

Likewise, other ratios are derived from PAM where the following stand out:

Private Cost Ratio

$$PCR = \frac{C}{A - B}$$

Where: PCR=Private cost ratio; A=Gross income valued at private prices; B=Production cost of the marketable inputs valued at private prices; C=Cost of the internal factors valued at private prices.

This ratio shows the difference between the production value and the costs of marketable inputs; it shows how the system allows paying the domestic factors and continuing to be competitive.

PCR<1 then the producer is competitive.

PCR>1 then the producer has profits higher than the average.

PCR=1 then the producer generates the resources that he spends.

Domestic resource cost ratio

$$DRC = \frac{G}{E - F}$$

This ratio serves to measure indirectly the social benefits and as this ratio is smaller, the relationship between the social benefits that are being obtained will be larger; it is an indicator of efficiency.

DRC (+) 0-1 then there is comparative advantage in the production of the good.

DRC (+) >1 then there is no comparative advantage in the production of the good.

DRC (−) then there is a waste of resources that impact the efficiency that would allow aspects to be improved.

RESULTS AND DISCUSSION

As has been mentioned before in the previous sections, strawberry production in Michoacán represents 66% of the national production, which is why for this study it is considered the most important agricultural production from the region, taking data from eight regions that cultivate these fruits: Zamora, Pátzcuaro, Zitácuaro, Sahuayo, Uruapan, La Piedad, Morelia and Apatzingán. It should be highlighted that each region presented a considerably different level of infrastructure and investment in the harvest of these berries, although it largely represents an important income for families of these regions.

The first part of PAM requires obtaining the profits at private prices for the industry (private prices refer to the costs incurred and the profits obtained at the price that it costs for the companies or industries to produce their products).

When contrasting the income that is obtained per hectare harvested by crop versus the cost that implies sowing a hectare to determine the profitability that each crop offers in the presence of average scenarios of price and yield. Strawberry offers a slightly higher profitability at the cost volume that is required, as observed in Figure 1.

Because for these berries the sale prices depend on factors such as quality, amount harvested, season, among others, the different scenarios that can be used to identify which factors are more sensitive and which combination of factors can severely damage the utilities of the producers in case of the appearance of internal distortions are shown graphically. In order to measure these imperfections of the market, four sensitivity analyses were conducted per crop: 1. Minimum price expected by yield per hectare minimum expected; 2. Minimum price expected by yield per hectare maximum expected; 3. Minimum price expected by yield per hectare average expected; and 4. Maximum price expected by yield per hectare average expected.

Figure 2 shows four different scenarios; it is worth pointing out that the minimum prices were established based on historical data obtaining the price expected in each scenario, which is why the minimum price of $20 pesos per kilogram (kg) was established, and maximum price of $33 pesos per kg. Then the average yield per hectare harvested was obtained, which the producers can get based on historical data and experience gathered by some producers, establishing the amount of 35 tons per hectare in normal conditions

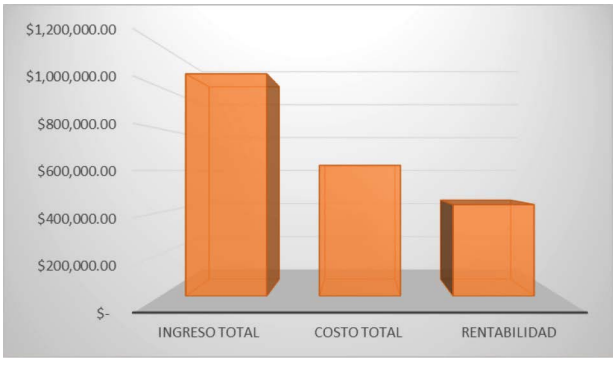

Figure 1. Income-cost ratio of strawberry.
Source: Prepared by the authors with data obtained from PAM.

Figure 2. Sensitivity analysis for strawberry.
Source: Prepared by the authors with data obtained from PAM.

for production, that is, not from a pest or loss from any natural disaster. For the case of a reduced harvest, the amount of 55 tons per hectare was established, in perfect conditions. Performing the operations in Figure 3, it is seen that the income obtained by producers responds strongly to the price that each kilogram is sold at, showing that it is necessary to maintain a price in balance through time so as to not destabilize the income of producers from Michoacán.

Considering the assumption where a producer obtains income different from the average, in a scenario in which the producer is forced to decrease his sale price at the time of harvest, the profitability would be impacted as a response to the one who maintained his production costs during the year, which is a habitual practice for strawberry producers from Michoacán who must finance its production for months with the hope of selling the fruit at the time of harvest and thus obtain a profit; to understand which would be the results expected from these assumptions, operations were conducted where the profitability was obtained in the presence of stressed scenarios.

Facing a stressed scenario, then, in which the income results obtained in the prior study were used but subtracting the production costs of the fruit, where a similar result is obtained in which the utility is strongly linked to the price and a decrease in it generates

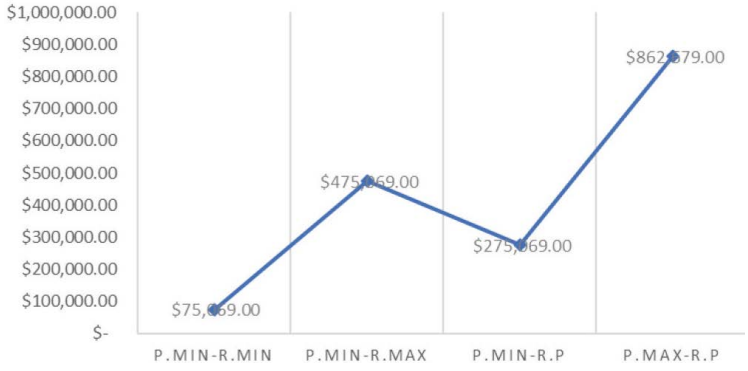

Figure 3. Sensitivity analysis in profitability for strawberry.
Source: Prepared by the authors with data obtained from PAM.

minimum profits for the producers. Although there are still profits, they would not be as expected because in the case of the producer this profit must be enough to cover a year of production to begin leveraging the following year and to be able to harvest again. With this in mind, we could say that there may be an incentive or a barrier to keep the producer from sowing in his fields again. Because of this, then, it is recommended to agree on a price before starting the harvest and that this price is respected through agreements and solid contracts; support could also be given to the producers, finding an adequate way of leveraging or financing their harvests, with this allowing to maintain a stable utility even when facing pessimist scenarios.

PAM analysis at private prices

Once the different analyses presented before were conducted per crop, the table of results is presented in terms of PAM, which as was specified in the methodological section, has a base structure in which the revenues are established and the costs in separate columns at private and social prices.

The first column shows the revenues obtained, if the result obtained in the line of social prices is subtracted from the line of private prices, we obtain an amount which in case of being negative (as is the case in our study in which the amount of −873,075 is obtained), it means that there are market distortions that impact the income that producers can obtain.

The second and third column group the production costs that strawberry producers face in Michoacán, using the same sequence of operations, subtracting from the production costs at private prices the production costs at social prices, where a negative result is obtained (−624.25 and −611) which implies the existence of policy effects. However, we can highlight that the differences obtained are not a considerable amount, so it can be established that the costs present effects in favor of producers in terms of level of protection for the inputs required.

The last column shows the profits or profitability obtained; we apply the sequence of operations and we observe that both at social prices and at private prices, the strawberry producers from Michoacán obtain profit. The fact that a negative result is obtained applying the sequence of operations means that the presence of market distortions have a negative effect on the level of profitability obtained from the producers. This then indicates that a greater volume of utilities could be generated without the existence of these distortions that can be taxes, duties or custom barriers.

Table 1. Policy analysis matrix (PAM) for strawberry.

PAM				
Strawberry				
Concept	Income	Production costs		Profit
		Commercial inputs	Internal factors	
Private prices	$1,062,360.00	$371,449.00	$223,482.00	$467,429.00
Social prices	$1,935,435.18	$372,073.25	$224,093.00	$1,339,268.92
Effect or divergence	−$873,075.18	−$624.25	−$611.00	−$871,839.92

Source: Prepared by the authors based on PAM results.

When there is an efficient use of products, there are prices in balance in revenues, costs and profits at the international level. If, on the contrary, they are in imbalance they could be a signal of distortions whether in public policies of the country or of the market, for which PAM allows comparing between social and private prices to obtain a result between them.

Table 3 shows the PAM indicators, and each of the indicators refers to information of great use for knowledge of strawberry production in Michoacán. If the indicator PCR is <1 it means that the producer is competitive in the market, which is fulfilled for the case of strawberry.

The higher that the RRP indicator is, it means a higher profitability level for the producers; in the case of strawberry it is not very high so there must be work done at the level of profitability obtained by producers.

The VAP and PVAP indicators show the same information, except one is reflected in the monetary amount and the other in the percentage; the information that these indicators show is the added value to the work factor, both of labor and of the producer.

The first contrast was conducted between the indicator of cost ratio of internal resources DRC and the private cost ratio PCR through quadrants. It must be mentioned that the first quadrant shows an efficient and profitable crop (with comparative advantage[2] and

Table 2. Ratios at private prices of PAM for strawberry.

Relationships at private prices		**Crop**
Indicators	**Formulas**	**Strawberry**
PCR	PCR=C/(A−B)	0.37
RRP	RRP=D/(B+C)	0.70
VAP	VAP=(A−B)	$690,911.00
PVAP	PVAP=(A−B)/A	0.65

Source: Prepared by the authors with data obtained from PAM.

Table 3. Contrast of RCP-PCR ratio for strawberry.

Contrasts of PAM ratios for strawberries			
Result obtained 0.14/0.32		**Ratio of internal resources DRC**	
		DRC <1 o > 0	**DRC <0 o >1**
		With advantage	**Without advantage**
Private cost ratio	PCR <1 o >0	I	II
	Competitive		
	PCR >1 o 0	III	IV
	Not competitive		

Source: Prepared by the authors based on results from PAM.

[2] Competitive: a competitive product is such that can be sold in an appropriate volume within a specific market, because the buyers consider that its price and quality are acceptable, taking into account the services of support, credit, shipment conditions, guaranteed reparations, and publicity (Smith, An inquiry into the nature and causes of the wealth of nations, 1776).

competitive); the second quadrant encompasses an inefficient although profitable crop (without comparative advantage but competitive); the third quadrant signals an efficient and non-profitable crop (with comparative advantage and non-competitive); and the fourth quadrant shows an inefficient and non-profitable crop (without comparative advantage and non-competitive).

The last analysis that is done is the Subsidy Ratio to Producers. This indicator shows whether there were subsidies from the government or if, on the contrary, the taxes established deplete the utility of the producer.

If it is positive, there are subsidies and sufficient backing from the sectors of the economy towards the producers. On the contrary, if it is negative, there are distortions of policy, duties and taxes that deplete the utility of the producers, the producers could increase their utility received in a market without the appearance of those distortions.

For the case of strawberry a value of 0.37 was obtained, which according to the previous parameters is located in the cell for PCR of <1 or >0 which is why strawberry production in Michoacán is a competitive activity in commerce, since strawberry producers in Michoacán obtain profits from their products and the final price at which they can sell their products without the need to affect the utility has a considerable margin of difference compared to the prices at which the product is found in international markets. For the DRC indicator, the same value of 0.37 is respected and according to the parameters, the value is located in the cell <1 or >0 which indicates that the strawberry production in Michoacán is an activity that has advantage compared to other production zones. In a more exhaustive analysis, this corresponds to the fact that the necessary inputs are purchased at adequate prices, the level of taxes is low, and it is an activity that is protected within Mexico. In addition to this, the climate conditions, as well as the cost of water and the price of the land, allow planting normally over average and of good quality, without requiring a costly chemical treatment.

CONCLUSIONS

An important aspect in this study is to identify whether there is a comparative advantage or not. For this purpose, the PAM methodology has an indicator that identifies the existence of comparative advantage within its analysis. For PAM, this is the indicator of cost of internal resources where, if the value obtained is higher than 0 and lower than 1, then there is comparative advantage in the production of that good. Once the calculations were carried out, the following results were obtained: strawberry 0.14, found in the range of 0 to 1, so there is comparative advantage, which is why it can be inferred that there is comparative advantage.

Likewise, a deeper analysis was conducted through a contrast between the indicators of cost of internal resources and of private cost, to ratify whether the value is consistent with a comparative advantage, giving as a result a value of 0.37 which indicates that strawberry production is a competitive activity and with advantage for producers from Michoacán.

It can be concluded that the PAM methodology also allows analyzing the comparative advantage to determine if it is a profitable product. Therefore, according to the PAM analysis, strawberry is one of the most harvested berries in Michoacán; it offers a

profitability of 41% corresponding to the investment, offering a profitability of $437,429 pesos per hectare sown and harvested, on average, according to the analysis.

Once the study was conducted, it can be concluded that strawberry production is a profitable activity. However, it should be pointed out that for the cultivation of this berry, the number of hectares that are required is considerable, because their production is not scalable in the vertical plane.

Within the problem observed, the lack of financial resources is identified, which is why it will be necessary to work in favor of a financial structure that allows generating resources, as well as for the required reinvestment in the new harvests, and maintaining a savings plan that allows reducing leveraging progressively as the years advance.

Investment in specialized machinery is recommended, for cutting and selecting the fruits, as well as packaging and labeling, which considerably influences the costs generated by exports. Therefore, purchasing the appropriate containers for storage and transport, cost that can be reduced by having a system of their own, which could also be acquired through groups or societies of farmers.

Likewise, it is recommended to establish anticipated sales, with firm contracts that stipulate the final prices, as well as using insurance for harvest and production, with the objective of ensuring a higher investment return and guaranteeing continuity in the market for the producer. Likewise, it is recommendable to study deeply the sanitary norms that countries of high demand have, and to work in fulfilling each of them; at some point in time it can be investment without utility, although in the long term it would be a differentiation of the competitors. It is recommended to work on a financial structure that does not affect the investment returns, but which protects the producer in case of reductions in their harvest.

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