



PROFITABILITY OF POTATO (*Solanum tuberosum* L.) CROP IN THE SOUTHWEST OF THE STATE OF MEXICO

[RENTABILIDAD PRIVADA DEL CULTIVO DE LA PAPA (*Solanum tuberosum* L.) EN EL SUROESTE DEL ESTADO DE MÉXICO]

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SUMMARY

With the objective of analyzing the profitability and competitiveness of the potato (*Solanum tuberosum* L.) in the southwest region of the State of Mexico, a Policy Analysis Matrix (PAM) was calculated for this crop during 2009. Results indicated a positive private profitability (0.88), the private cost ratio (PCR) was found at 0.27 and the added value within the total income was 0.67. Potato production in the year of study allowed payment of the market value of the internal factors, once the productive activity was profitable in terms of prices received and prices paid. Contrary to other years, one factor that influenced private profitability was the mean rural price, which increased by 52%, rising from 3.4 to 6.5 \$ kg⁻¹. Potato production is a profitable alternative for producers of the region in terms of generated income, as long as the conditions of favorable mean rural price per kilogram of potato are maintained.

Key words: potato; competitiveness; private profitability; the southwest of the State of Mexico.

INTRODUCTION

The potato (*Solanum tuberosum* L.) is one of the most important crops in Mexico, surpassed only by corn (*Zea mays* L.), bean (*Phaseolus vulgaris* L.), wheat (*Triticum aestivum* L.) and rice (*Oryza sativa*). Among vegetables, only the crops of tomato (*Lycopersicon esculentum* L.) and of green pepper (*Capsicum frutescens*) occupy greater surface, while in volume produced it is only surpassed by tomato. The potato is cultivated in different regions under different ecological and technical conditions, which determines differences in the yields obtained per hectare (SIAP, 2010). Although potato is one of the most cultivated vegetables in the country, it is not the most productive,

RESUMEN

Con el objetivo de analizar la rentabilidad y competitividad de la papa (*Solanum tuberosum* L.) en el suroeste del Estado de México, se calculó una Matriz de Análisis de Política (MAP) para este cultivo durante 2009. Bajo las condiciones planteadas, los resultados indicaron una rentabilidad privada positiva (0.88), la relación de costo privado (RCP) se ubicó en 0.27 y el valor agregado dentro del ingreso total de 0.67. La producción de papa, en el año de estudio, permitió pagar el valor de mercado de los factores internos, una vez que la actividad productiva fue rentable en términos de precios recibidos y precios pagados. Un factor, a diferencia de años anteriores, que influyó en la rentabilidad privada fue el precio medio rural, que se incrementó en 52.0% al pasar de 3.4 a 6.5 \$ kg⁻¹. La producción de papa es una alternativa rentable para productores de la región en términos del ingreso generado, siempre y cuando se mantengan las condiciones de precio medio rural favorable por kilogramo de papa.

Palabras clave: papa; competitividad; rentabilidad privada; suroeste del Estado de México.

as there is evidence that the species *Oxalis tuberosa* Mol., known in Mexico as red potato, among other characteristics, has more productive potential than *Solanum tuberosum* L. (Mejía *et al.*, 2006:231).

In Mexico, during 2000-2009, an average of 65 thousand 700 ha were sown, obtaining a mean production of approximately 1 million 480 thousand t, which made it possible to satisfy internal consumption (SIAP, 2010:1). In 2009, the principal producers of potato were Sinaloa (23.0%), Sonora (19.1%), Chihuahua (8.6%), State of Mexico (7.5%) and Veracruz (6.5%), which together supplied 64.7% of the national total. The surface sown with certified high quality seed is centered in little over 13.1% of the total

area, whereas the potato of self-sufficiency (subsistence agriculture of medium level technology) occupies the rest of the surface (Santiago and García, 2001:24). In the same year, the Apparent National Consumption (ANC) of potato was 1.7 million t, of this volume 95.9% was national production, 4.1% imports and the rest was exported. The annual per capita consumption of potato was 15.9 kg, compared with that of the U.S. (58.4 kg) and Holland (85.8 kg) (SIAP, 2010:1; FAO, 2010:1).

Approximately 35.0% of the potato crop is with native varieties, cultivated principally in the high sierras and valleys of the central plateau of Mexico, where the greatest number of potato producers are located. This crop is produced in the Fall-Winter (FW) and Spring-Summer (SS) cycles; 51.0% is grown under rainfall conditions and 49.0% under irrigation (SIAP, 2010:1). The average national yield was close to 25.2 t ha⁻¹, lower than that of the United States (36 t ha⁻¹) and similar to that of Canada (27 t ha⁻¹) for all of the varieties (Alpha, Rosita, Marciana, San José, Mexiquense, Ileri, Nortena, Atlantic, Gigant, Herta, Tollocan, Montsama and Granola) SIAP, 2010:1; INIFAP-PRODUCE, 1997:58).

With the signing of the North American Free Trade Agreement (NAFTA), the organized producers of Mexico obtained a tariff of 272.0% which would be reduced to 0.0% in 2003; situation which obligated the national producers to increase productivity to compete with the member countries of NAFTA. Various factors explain a heterogeneous competitive situation: the division between white and pink potato, production quality, the structure of production costs, the commercial infrastructure and the knowledge and ease of access to the markets (Santiago and Ruvalcaba, 199:82).

In 2009 the potato crop was cultivated with high production costs, between 55 and 70 thousand pesos per ha as a function of the technological package. It occupied four million wages a year and nearly 15.0% of the national production was destined for the industry of fried potatoes. In the State of Mexico 4 500 ha of potato were cultivated and production was 129.4 thousand t (SIAP, 2010:1); one of the producing regions with relative importance and for its climatic advantages is precisely Temascaltepec, municipality to the west of the State of Mexico, with 547.7 km² (2.4% of the surface of the State), its climate is temperate sub-humid (most of the territory) and tropical semi-warm rainy (the south of the municipality); the annual temperature fluctuates between 8 and 22 °C and the annual rainfall is between 1 100 and 1 300 mm. The predominant soils are andosols (haplic), cambisols, regosols and vertisols; the latter are the most adequate for the agricultural activities.

Official data indicate that in 2008 88.0 ha were cultivated in Temascaltepec with a production of 1 526.0 t and a yield of 17.3 t ha⁻¹, 62% lower than the national average (27.7 t ha⁻¹). The varieties of seed that are cultivated the most in the municipality (and in this region of the state) are Gigant or Gigante (white potato), Alpha, Tollocan, Lady and Mundial. These varieties are obtained by the producer from the states of Sinaloa and Chihuahua; the production technology includes improved seed, gravity irrigation, use of fertilizers and partially mechanized (use of machinery only for the activities of preparation of the soil); an average of 70 wages are used, with a total production cost (including rent of the land) of close to \$ 70 000.0 ha⁻¹ equivalent to 5 405.0 U.S. dollars (until December of 2008¹). The principal markets of the product are the supply centers of the city of Toluca and the Federal District; with an important proportion to Guerrero, Morelos and the north of the country.

Since 1999 the low prices received by the national producer have discouraged domestic production and the deficit between consumption and production has been covered with imports (López *et al.*, 1999:112). The average rural price of 1999 to 2008 was place at \$3 007.0 t⁻¹. The importance of the potato is that it still represents an important source of income (López, 1994) for the producers and its consumption depends on the cost of production, profitability and competitiveness, and above all on prices (Calderón *et al.*, 2004:379); this constitutes the principal justification for analyzing the profitability and competitiveness at the private level in the abovementioned region. The technology used in the crop and the proximity of the producing region to the principal consumer center of the country, lead to the assumption of the existence of positive private profitability.

METHODOLOGY

The Policy Analysis Map (PAM) (Monke and Pearson, 1989:15) was used, whose principal objective was to measure the impact of governmental policies and distortions of markets on private profitability and efficiency in the use of resources. Furthermore, it helps to calculate the divergence between tabulated budgets to private and economic prices (of efficiency); which makes it possible to estimate the distortions of the market and the probable measure in which the resources are poorly allotted. The structure of the PAM is comprised of a double entrance accounting system composed of two identities (Table 1).

¹ Type of exchange used to convert the balances in foreign currency of the Bank

Table 1. Structure of a Policy Analysis Matrix (PAM), income and costs per hectare.

Concept	Income	Costs		Gains
		Marketable inputs	Internal factors	
Private prices	A	B	C	D
Social prices	E	F	G	H
Divergences	I	J	K	L

Monke y Pearson, 1989.

From the PAM structure indicators can be obtained that allow us to conclude whether or not a determined agricultural system is competitive and has comparative advantages. For this investigation only the first row of the matrix was used (private budget), that is, the analysis at private prices. Therefore, from this row the information that can be obtained is as follows: production costs at private prices ($CP=B+C$); gains at private prices ($D=A-B-C$); ratio of private profitability ($RRP=D/(B+C)$); ratio or efficiency of the private cost ($RCP=C/(A-B)$), value added to private prices ($VAP=A-B/A$).

For the region of study, the elaboration of the PAM required the classification of the costs of marketable and non-marketable inputs. The private prices (financial prices or effective prices) served to calculate the gain and private income. For the internal factors or primary production factors, the valuation was made based on the internal opportunity costs. In the study, the marketable goods were the products and inputs that were acquired both in the national and international market, or that could be marketed under conditions of commercial aperture, for which there is an international price. The internal factors are those that intervene in the production, but are not commercialized or quoted in the international market, such as labor, electric energy, credit, land, water, insurance premiums and administrative services (Monke and Pearson, 1989:16). The technical coefficients were verified with data of the SAGARPA and of the regional agricultural organizations.

Private profitability (PP). In private profitability, the gain (D) was obtained as the difference between the income (A) and costs of commercial inputs and internal factors (B+C). The information for potato production was estimated at observed prices or effective market prices. Thus, the cost, defined as income before taxes that the owners require to maintain their investments in the system, was included in the costs of the internal factors (C). If the private gains (D) are negative ($D<0$), the producers receive a yield rate that is lower than normal, thus they might abandon this activity, unless some change increases the private gains to a normal level ($D=0$). A positive private gain ($D>0$) indicates profitability above normal and could precipitate an expansion of the system,

excepting other more profitable activities that prevent it.

Private cost ratio (RCP). This ratio makes it possible to compare the private efficiency between two different production systems, and is obtained from the quotient of the cost of the internal factors (C) and of the added value (A-B) at private prices. The added value is equal to total income minus the cost of the inputs.

$$RCP = \frac{\text{Cost of internal factors}}{\text{Added value}}$$

The RCP indicates the limit where the production system, in terms of efficiency, can sustain the payment of the internal factors (including the normal capital return), still remaining competitive. If the $RCP<1$, the producer is competitive and receives extraordinary gains, as once the production factors are remunerated, both own and contracted, a residual remains in the added value which is the retribution of the efforts of the producer. If $RCP = 1$, there are no extraordinary gains, thus the producer pays only the production factors, which include labor and capital (Sosa *et al.*, 2000:109).

Added value (VAP). This is understood as the contribution of the activity to the income of the agricultural sector, or the amount of the total income of the system used to pay for resources such as labor, credit, water, electricity and administration. In other words, the VAP indicates the payment or remuneration to the internal production factors toward the interior of the productive sector.

Intermediate consumption. (CIP). This is the payment of the sector to the rest of the regional economy (comprised of current expenditures of the crop, except salaries and payment of equipment and installations). For this effect, the information was obtained from the same production system, validating some costs with supply houses of agricultural inputs of the region. To carry out the analysis, information from 30 potato producers was used from the abovementioned municipality, selected by intention (Cochran, 1984:31), who cultivated potato under

irrigation during the fall-winter cycle of the period in question.

RESULTS AND DISCUSSION

Private production costs

Under the conditions stated in 2009, in percent terms, the structure of production costs per cultivated hectare was represented principally by the value of the marketable inputs, followed by internal factors, and finally by indirectly marketable factors. The principal component of the marketable inputs was the cost of seed (69.3%) and within the total cost, including the rent of the land, with 42.3%. In second place was the acquisition of fertilizers and pesticides with 30.7%. In the other hand, in the concept of internal factors, the category of manual labor and diverse materials used in the production of potato participated with 81.2%. The total cost of production in the period of study was \$ 41 072 ha⁻¹, of which 68.8% was considered as variable costs and the difference as fixed costs (Table 2).

Table 2. Structure of costs of production of potato in Temascaltepec, Mexico. 2009.

Concept	Value	%
Marketable inputs	41 072.0	60.7
Internal factors	22 600.0	33.4
Indirectly marketable inputs	4 000.0	5.9
Total (including land)	67 672.0	100.0

Made by the author.

The total cost per ton produced was 3 722.7 pesos, where the variable costs occupied the highest relative participation (73.0%) with respect to fixed costs, which only contributed with 27.0%. The income that was received from the sale of potato was \$6 500.0 t⁻¹, which represented, from the difference of the income minus the total production cost, a net gain per ton produced of 2 777.3 pesos (Table 3).

Table 3. Summary of costs, income and gain of potato in Temascaltepec, State of Mexico, 2009. Figures in pesos per ton.

Concept	\$ t ⁻¹
Total cost	3 722.7
Variable costs	2 719.6
Fixed costs	136.3
Total income	6 500.0
Net gain	2 777.3

Author's calculations based on the Policy Analysis Matrix (PAM).

Net gain

To obtain the indicators of profitability, efficiency and competitiveness, it was necessary to determine the relationships of each one of the variables referred to in the Policy Analysis Matrix (PAM), through an analysis with values determined in pesos per cultivated hectare. The gain (once the costs of commercial inputs had been discounted and of internal factors to the net income per surface unit) estimated at private prices was positive and was placed at \$55 769.0 ha⁻¹. The latter, with respect to the total income, represented 45.2%, the percent difference was 54.8% determined by the cost of the marketable inputs and internal factors (Table 4).

Coefficient of private profitability (CRP)

Private profitability, understood as the quotient that results from dividing the net gain of the process by the sum of the costs of marketable inputs and internal factors of the PAM, indicated a margin of gain in the income of the producer, equivalent to 88.0 % for each peso invested (Table 5).

Relationship of private cost

The relationship of private cost was positive but less than the unit, as it presented a value higher than zero and lower than one; coefficient that indicated, just for the year of analysis, that the production system was profitable and therefore competitive. In this sense, the private cost ratio (RCP) for potato in the region of study was 0.27. This value represented efficiency and competitiveness in the use of the resources. In other words, the RCP indicates that the cost of production of the internal resources was notably lower than the added value generated by the activity; and implied that the costs of opportunity of using domestic resources measured in world prices or in currency would be lower than the added value generated by the activity, measured in world prices or currency. This means that although the market conditions are or have been unfavorable for the product, the crop was efficient in the use of the resources, that is, it could present a comparative advantage. With this indicator, the crop represented profitable alternatives of production in terms of the contribution to the income of the producer; despite the above, if the situation of a policy with low prices continues, the production would run the risk of becoming stagnant (Table 5).

Table 4. Structure of the Policy Analysis Matrix at private prices (\$ ha⁻¹).

Concept	Income		Costs		Gains
			Marketable inputs	Internal factors	
Private prices	123 500.0		41 072.0	22 600.0	55 769.0

Made by the author.

Table 5. Summary of the budget at private prices of potato in Temascaltepec, State of Mexico, 2009.

Concept	Value
Private Profitability (%) $PP = D/(B+C)$	88.0
Relationship of Private Cost $RPC = C/(A-B)$	0.27
Value Added to Private Prices (\$) $VAP = (A-B)$	82.429
Intermediate Consumption in the Total Income (%) $ICTI = B/A$	33.0
Added Value in the Total Income (%) $AVTI = (A-B)/A$	67.0

Author's calculations.

Contribution to the sectorial and regional economy

The participation of the added value of the process within the total income of the activity was placed at 0.67 or 67.0%. This value signified an acceptable contribution in the generation of employment product of this activity, which includes the gain of the producer and the payment of the internal factors, principally labor; however, the difference indicates that another part of this contribution represented the incorporation of family labor, which under the logic of the labor market, receives no remuneration. Its counterpart is intermediate consumption (PCIP), which is placed, in relative terms, at 0.33 or 33.0%, and indicated a lower percentage of the income generated by this activity, which does not remain in the region, but goes toward another sector of the economy, by concept mainly of the acquisition of marketable inputs (Table 5).

DISCUSSION

The variation of the mean rural price of 2008 to 2009 (3.4 to 5.5 \$ kg⁻¹) had an influence in the value of the private gain or profitability giving a positive rate to the producer, allowing him to maintain himself in the production system and with possibilities of expansion. These results confirm what was obtained by Jimenez (1999:488), which indicated positive values in private profitability for two localities of Costa Rica. In the period of analysis, the results of the production costs in the region of study indicated a high percentage of marketable inputs with respect to the total cost, which for the most part included seed, fertilizer and pesticides (60.7%). Similar results were obtained by Jimenez (1999:488), placed at 66.0% for these same concepts. Similarly, Colin (1990:49) obtained 56.7%

for marketable inputs in the states of Puebla and Veracruz.

The unitary production costs evaluated showed a similar panorama in the products evaluated, indicating that the technology used is followed by the producers in a similar manner. This factor can be modified by the use of new technologies that reduce these costs and increase the gain of the producer (Gallardo, 2007:5).

The private cost ratio for the region of study showed solvency and competitiveness; that is, the system generated an added value superior to the cost of the internal factors that it utilizes. Similar conditions in this ratio were reported by Jimenez (1999:488) (0.12), which made it possible to generate sufficient income for the producers, pay costs for internal factors and obtain a gain.

A low percentage is presented in Intermediate Consumption within the Total Income (PVIP, 0.33), which signifies the contribution that this activity has in the payment of inputs and services that come from another sector of the economy. For the cultivation of potato, its counterpart Added Value in the Total Income (PVAP, 0.67) signifies the participation this productive activity has in the generation of direct employment, quantifying a high participation of the activity toward the interior of the system.

CONCLUSIONS

The production of the potato crop in the region of study and for the period of analysis was profitable and competitive, given that it presented positive private gains. The existing market conditions and the agricultural policy of prices during 2009 for the crop constituted an incentive for the production system,

given that the mean rural price increased by 52.0%; which favored the total income and the net gain of the crop during this cycle. The above indicates that potato production is and can continue to be a profitable alternative for the producers, and that production technology should be improved to reduce costs and increase production. Improving the quality of the product and avoiding temporal excesses of supply could increase the prices received by the producer.

The coefficient of private profitability was positive and indicated that of each peso invested, the potato producer obtained an additional gain. Similarly, the value of the private cost ratio showed a value lower than the unit and indicated that the production system paid for the internal production factors, showing the existence of a higher added value in the crop.

The value of the intermediate consumption in the total income (PCIP) pointed out the participation of the sector toward other sectors of the economy considering this participation to be adequate. On the other hand, the complement of this indicator, the Added Value in the Total Income (PVAP), resulted with a high value, indicating that the crop had a high participation in the generation of labor in the region and its consequential effect toward the interior of the system.

The values of the input, despite the high prices, did not affect the profit margins of the potato crop in the region, thus it is suggested that policy of price control be maintained to sustain profitability and competitiveness.

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