

Cost of production and profitability of potato cultivation in Zacapoaxtla, Puebla

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Abstract

The present investigation was carried out in the year of 2017, with the objective of determining the costs of production of the potato crop in the municipality of Zacapoaxtla, Puebla. Within the economic occupations of the Sierra Norte de Puebla there are few productive activities of economic importance. The commercial crops that have traditionally been planted are coffee and potatoes. In the case of potatoes, it is a crop with greater added value; however, it is highly dependent on agrochemicals and other inputs, which local producers cannot afford at times, so the agroclimatic advantages of the area have been exploited by business producers. The cost structure of the producers was determined by algebraic expressions based on economic theory. According to the results, the difference in production costs and yields obtained between small producers and large producers causes the former to be displaced by the latter. For large producers, the activity is profitable because what they are competitive in the market, but the small producers the activity leaves them little margin of profit so they have been abandoning potato production.

Keywords: inputs, price, yields.

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Introduction

In Mexico, potato production becomes important because it is a crop with high added value and because of the jobs it generates directly or indirectly, especially at harvest time. However, the domestic fresh potato consumption market is low, despite the nutritional benefits it provides. According to García (1992), each 100 g of cooked potato contributes: 1.5 g of protein, 0.1 g of fat, 20 g of carbohydrates, 0.5 g of fiber, 4 mg of calcium, 30 mg of phosphorus, 0.5 mg of sodium, 350 mg of potassium, vitamins A, B, C.

Consumption in Mexico is 17 kg per capita per year (Vázquez *et al.*, 2012), which causes the national production to be discouraged, and to have slow growth. Sabbagh (2012) in an analysis on the trend of potato consumption found that by 2025 the consumption will increase to 21 kg so there are few expectations of growth of consumption, other countries such as Perú consume 74 kg per person at year. Another factor that affects the national production are the high costs of tuber production, since it is a crop with high requirements of agrochemicals, in addition to the requirement of having an irrigation system.

In 2006, the national production reflected in the hectares sown was 61 244.55 ha and in 2016 we have a planted area of 64 465.55 ha, that is, only 4%. (SIAP, 2017). That is to say, in 10 years the production shows a slow growth.

The potato is consumed in Mexico as follows: 56% fresh, 29% goes to the industry, and 15% is reused for next year sowing. For the most part, production is directed to the domestic market, 29 833 t are exported and 286 652 t are imported (CONPAPA, 2014).

Apart from the high added value of the crop, it becomes more important because in the country there are 8 700 producers scattered in 22 of the states that are dedicated to this activity. Due to the various tasks that demand in the sowing, harvesting, commercialization, this crop has a strong economic impact in the rural areas where it is cultivated, of which 77 800 families depend and there are 17 500 direct jobs and 51 600 indirect jobs and 6.9 million of wages per year (CONPAPA, 2017).

The state of Puebla is among the five main producers of potatoes nationwide, since 8 413 ha are planted, a figure that has doubled since ten years ago.

The first potato producer in the state is the municipality of Tlatlauquitepec with a planted area is 2 202.24 ha and with a production of 50 591.50 t and yields of 17. 179 t ha⁻¹ in the last ten years. The production of this municipality represents 27.85% of the total state production. For this investigation because of its border with the municipality of Zacapoaxtla, it is cited as a reference.

In the case of the municipality of Zacapoaxtla, this occupies the second place in the state production. The planted area is 1 380. 21 ha, with a production of 16 685 t, and with a yield in the last ten years of 15 402 t ha⁻¹.

The production of potatoes is one of the few commercial crops in the Sierra Norte of Puebla. However, due to the high production costs even when it is a high value-added crop, small producers cannot sustain themselves in the activity and it is the agricultural entrepreneurs who take advantage of the economic advantages of sowing this crop (Fernández, 2011).

Therefore, production costs are presented according to the field work according to the technology used by small producers and business producers, as well as the profit margin of both actors in the municipality.

Materials and methods

The present investigation was carried out in the municipality of Zacapoaxtla, with the most representative producers of the different forms of production detected in the area. To this end, a typology of producers was carried out, with which the production costs were determined for the traditional producers of the area *versus* the business producers who have monopolized the production. A directed survey was conducted to carry out exploratory studies. Within the survey, socio-economic aspects of the producer were considered, as well as aspects of potato costs, production and commercialization.

To determine the profitability of the crop, an estimate was made with the data collected in this year's production cycle. Which was estimating the total cost of production and the total income of the crop. The costs for its understanding are divided according to the culture's cultural tasks.

Regarding the prices of inputs and activities of production, seed, agrochemicals, land rent, wages, fertilizers and machinery, the commercial prices paid in 2017 in the production zones were used. For the determination of the income, despite having the reference of the rural average price of the SIAP, the sale price manifested by the producers in the interview was used, as well as the reported yields.

To determine profitability, algebraic expressions based on economic theory were used (Krugman and Wells, 2006; Samuelson and Nordhaus, 2009).

$$CT = P_x X$$

Where: CT= total production cost; P_x = price of the input or activity X; X= activity or input.

The total income per hectare is obtained by multiplying the yield of the crop by its market price. The algebraic expression is.

$$IT = P_y Y$$

Where: IT= total income (\$ ha); P_y = market price of crop Y (\$ t); Y= crop yield (t ha⁻¹).

So finally, the profitability is equal to.

$$\text{Profitability} = IT - CT$$

Results and discussion

The context of the Sierra Norte of Puebla

The Sierra Norte of Puebla is made up of 65 municipalities including the north-east, its population forms one of the largest indigenous regions of the state of more than one million inhabitants, living together Nahuas, Totonacs and Otomies. The communities are rural according to the definition of rural community which are those less than 2 500 inhabitants. The average of inhabitants by municipality is less than 20 thousand inhabitants, having contrasts of municipalities as small as Coatepec of 756 inhabitants to more urbanized municipalities like Huachinango of 103 thousand inhabitants. Marginalization is high and very high (Coneval, 2010).

The population is highly dependent on the activities of the primary sector. The agricultural systems of most of the Sierra are of a traditional subsistence agriculture, with practices of slash and burn and totally dependent on the storm. Agriculture is for self-consumption basically with crops of corn, beans and chiltepin usually associated with polycultures, more wild plants such as quelites that are not considered as weeds by the peasant. These crops are rooted in the mores and the working tradition of the serranos, with this the reproduction of the family has been allowed and, as Todaro (1998) points out, the peasant families hardly risk changing crops because although they are not economically profitable, there is rationality on the part of individuals, to continue sowing them, because with these crops the survival of the family is guaranteed.

In relation to cash crops in some regions, especially in Xicotepec, there are large coffee business producers; however, in most of the Sierra the coffee is sown by small producers with low yields, since it is a perennial crop the use of labor is given for activities mainly of harvesting and harvesting. Therefore, the crop is labor-intensive, but due to the size of the productive units, the activity does not require a large number of workers, so even during the harvest season it does not absorb all the labor (Mejía, 2016).

Potato is a crop that is planted in the area of Zacapoaxtla and Tlatlauquitepec, adjoining municipalities, being the most labor-absorbing crop with the greatest economic impact in the region.

Due to the rugged terrain of the Sierra Norte, few commercial crops can adapt to these conditions, although the area covers the agroclimatic requirements of the crop.

The agroclimatic requirements of the crop

The area of potato production studied ranges from 1 000 to 2 400 m of altitude, within the morphological region of the Sierra Norte in the Sierra Madre Oriental. The relief of the municipality is quite uneven, it presents numerous and long mountain ranges with numerous slopes and hills that form small intermontane plains. The height of the region of the municipality where the potato is planted is 1 620 meters above sea level, which goes from the Xalacapan mountain range to that of Totoltepec, which is close to 2 000 meters above sea level. To the northeast side of the municipality bordering with Nauzontla and Tlatlauquitepec, municipalities with activity potato production.

It covers two large soil units: Andosols humid or differentiated from the southern slopes of the volcano, silty or sandy-silty texana and characterized by an important useful reserve, the semi-arid brown soils of the west slope, sandy-clayey texture.

This area is characterized by a temperate humid climate. The rainy season starts in May-June and lasts until September-October. Potato production begins in the region of Xalacapa almost two months apart from the Totoltepec zone, covering the dry season. In the case of Xalacapan, planting begins in October and in Totoltepec at the end of February beginning of March. So, this avoids the risk of frost of the cold season and decreases the effect of moisture on the proliferation of diseases and fungi.

The average annual temperature is 16.1 °C with average precipitation of 1 467 mm.

The cultivation takes place within or close to the housing area

In field work we find that most of the potato crop in Zacapaoxtla is planted in the community of Xalacapan and only a very marginal part of the community of Totoltepec. 30% of the Xalacapan plots are in the inhabited area, so this facilitates the care of the producer, although it also generates conflicts between neighbors and contamination in the community due to the use of agrochemicals (Figure 1).



Figure 1. Harvest of white potatoes in the inhabited area of Xalalacapan.

Although traditionally the potato has been planted for more than 50 years, the variety that local producers have planted is the red potato, because of its hardiness it is more resistant to phytosanitary problems and climate; however, this variety achieves lower prices and lower yields than white potatoes.



Figure 2. Local traditional production of red potatoes in Xalacapan.

The potato is a crop that requires a lot of inputs to obtain the adequate yields that allow its profitability, the local producers have been abandoning the activity in the first place because they cannot face the high costs of the crop and secondly because foreign producers of Oyameles from the neighboring municipality of Tlatlauquitepec have monopolized local production.

Typology of producers in the area

According to the size of the production and the income obtained, the producers have been classified as follows.

Small producers with low incomes that sow red potatoes

They are producers who have traditionally produced potatoes in the municipality generationally for 50 years. Only about thirty producers of this type remain. They belong to the community and their plots are within the population zone. The size of its productive units on average is three hectares. Their plots have good fertility in the soil. In their productive activities, they use organic fertilizers and, to a lesser extent, chemical fertilizers. The sowing season is in the month of October. They use the variety of red potatoes for being more rustic and require less agrochemicals. The productive cycle of the potato is of 5 or 6 months. Once the harvest is up, he uses his plot to sow another crop, which is usually corn, thereby improving his income.

Small producers with low income sowing half with Oyameles producers

These producers have some control over production, although they depend on the Oyameles producer for the most expensive inputs. Thus, the purchase of seed corresponds to the foreigner, costs are generally divided in half. They sow the most commercial potato. Sometimes they try a new variety, which does not always give good results, it causes losses. But they get better income than if they only rented the land.

Owners who rent their land

They are usually producers who have abandoned the activity, or owners who have marginal lands on the slopes. The price of rent will depend mainly on the accessibility to water for irrigation. Thus, the land ranges from \$10 000.00 pesos to \$20 000.00. The high rents are a cost that the Oyameles producers can absorb because their activity is totally commercial. The land rent is for a harvest, which in the case of the white potato, its productive cycle is 3 months, plus a month for the potato to ripen.

Foreign producers

Medium-sized, they rent land in the Xalacapan or work halfway with local producers. They are producers that generally produce for the local market. It sells its production at the foot of the farm to intermediaries of the Supply of Puebla power plant or of the Supply of Central of Huixcolotla.

Large, are business producers that monopolize more than 50% of local production. They have their own assets, which allows them to obtain a higher profit margin. They have their own irrigation system, and transport flotilla. They have plant workers and give little employment to local labor. They market their product directly in the national market. Having a transport system and warehouses can position your production at better prices. They take their production to Aguascalientes or Monterrey. A single producer can have up to 250 ha in the municipality, plus others in the Puebla-Veracruz potato production zone.

Impact on local employment

According to the information gathered in the structure of production costs, the hand potato production of local producers is 71 wages per hectare that according to Mora (2013) indicates that potato production occupies 70 wages per hectare in the national context. The activity carried out by foreign producers is reduced in labor basically by the substitution of machinery and by the specialization of work, so they use 36% less labor, using an average of 52 wages per hectare.

The potato requires some specialization on the part of the worker especially in the harvest. This should be done with experience especially in the use of the tlachacha not to damage the tuber, for that reason the producers do not hire people from the neighboring municipalities of the northeastern highlands, so the labor community already has experience in this work is used alone.

In the traditional production of red potato cultivation, it is a more intensive activity in the use of local labor, sometimes women participate in some of the cultural tasks. The price of the wage is \$130.00 pesos, in cultural activities except for the harvest, where workers earn per full grid. The price is \$10.00 pesos per grid and the average of bars per worker is 50 per day, in this work help to fill the grid women or family. The harvest is the activity where the day laborer can improve his income because according to his abilities he can earn more than \$500.00 pesos in a work day.

Local labor is used 100% by the small traditional producer. In cases where production is half the labor force is used 50% locally and equal percentage of foreign workers from the Oyameles region.

In the case of business producers, the labor force used is 100% foreign, the price of wages ranges from \$150 to \$180 pesos, regularly from the Oyameles region, so the impact on the local economy is not significant. In addition, only men participate in cultural activities.

If we consider that there is an approximate of 30 local producers and that the SIAP (2015) reports 1 380 hectares harvested. Local production represents less than 10%, making it a foreign activity with little impact on local employment.

Table 1. Comparison of the wages used in the production of potatoes of the red variety (traditional) and the white variety (business).

Traditional	Workers	Business	Workers
Clean the ground	10		
Subscriber	2	Subscriber	4
Fumigators	20	Fumigators	20
Harvest	16	Harvest	22
Desecrate the potato	8		
Total	71	Total	52

Source: elaboration based on field data.

Production costs and profitability

According to the information obtained from the surveys applied, we consider the differences in the production costs of the small producers that sow the red potato, against the commercial producers that sow the white potato.

In relation to the information of the statistical and agricultural yearbook 2014, it indicates that of 1 350 ha planted in Zacapoxtla in 2013, 100 ha correspond to an irrigation system and 1 250 ha to temporary, which means according to these data that only 7.4 % sowing under an irrigation system, however in field work, it was found that although small producers depend on the temporary regime, they still use at least twice the irrigation system offered by some people in the community as a service associated with production, whose costs are contemplated.

Production costs in the Zacapaotla region are similar to those obtained by Fernández (2011) in the Perote region Veracruz. He says that the technological package for temporary is \$50.00 pesos and for production under an irrigation system \$108 000.00 pesos. That is similar to the data collected in the field among small producers, the production costs are close to \$50 000.00 and the expenses of the medium producers are around \$100 000.00 pesos; however, in the case of the commercial producer, which has its own irrigation system and other assets, the production cost is \$86 000.00, which makes it more competitive in the use of agrochemicals and in the price of the tuber in the market.

Table 2. Comparison of the cost structure of a commercial producer versus a small producer.

Activity	Unit	Commercial producer			Traditional producer		
		Quantity	Pu	Total	Quantity	Pu	Total
Land rent	(ha)	1	15000	15000			
Potato seed	(t)	4	6 000	24 000	120	60	7 200
Preparing the terrain	Tractor	1	2 000	2 000	10	130	1 300
Fallow	Yoke	4	450	1 800	6	450	2 700
Sowing	Workers	6	200	1 200	15	130	1 950
Fertilizer	Application	2	4 000	8 000	122	84083	9 400
Fertilized	Workers	4	200	800	2	130	260
Irrigation	Application	4	2 000	8 000	2	4 000	8 000
Fumigation	Application	10	1 000	10 000	10	700	7 000
Fumigators	Workers	20	200	4 000	20	130	2 600
Desecrate the potato	Workers				8	130	1 040
Harvest	Bars	1 112	10	11 120	600	10	6 000
Other costs	Soda				1	200	200
Total costs				\$85 920.00			\$7 650.00
Total income	(t)	30	5 000	\$150 000.00	600	80	\$48 000.00
Earnings				\$64 080.00			\$35 000.00

Source: elaboration with results of the surveys.

The yields that the producers obtain are high if we consider that the average is of the state of 19 t ha⁻¹. Small producers obtain up to 15 t ha⁻¹ and commercial producers obtain a ratio of 30 t ha⁻¹.

According to the channel of marketing of the tuber, the income will be determined. Since the small producer when he does not sell it in the local market, he has to do it with an intermediary that takes him to the Supply Central of the City of Puebla or Huixcolotla, they buy the potato at the farm. In the case of the red potato, the producers have little profitability of the activity because of the low tuber prices in the market, as shown in Table 2, the profit margin is not significant because they only manage to recover the production costs.

In contrast, the commercial producer obtains better prices in the white potato market, and can sell it either to an intermediary, or as in the case of the large producers who monopolize the production in the area, directly market their product, that leads to a higher profit margin. In Table 2, it is shown that while a commercial producer achieves at least \$64 000.00 pesos in profits, the small producer is very vulnerable to the price of the tuber.

Conclusions

The production of potatoes in the Zacapoaxtla region, at the state level, represents the second place, it is not a local production, but foreign from the neighboring zone of Tlaltlauquitepec that has specialized in the production of the tuber.

The production of white potatoes is profitable for commercial producers, who obtain more than 64 thousand pesos per hectare. It is considering that the acreage leased by a commercial producer are 250. This allows it to make the use of its assets and agrochemicals more efficient.

The economic income from the production of potatoes in the municipality is not significant, because most of the production and labor used is foreign, so the municipality only benefits from the land lease.

Negative externalities due to the excessive use of agrochemicals lead to environmental contamination and soil impoverishment, whose consequences have not yet been evaluated.

Cited literature

- Biarnés A. 1995. La agroeconomía de la papa en México. Edit. Orstom-Colpos. México. 193 p.
- Calderón, C. M.; García, M. R.; López, D. S.; Mora, F. J. S. y García, S. J. A. 2004. Efecto del precio internacional sobre el mercado de la papa en México, 1990-2000. *Rev. Fitotec. Mex.* 27(4):377-384.
- CONEVAL. 2016. Consejo Nacional de evaluación de la Política de Desarrollo Social (datos de marginalidad de los municipios).
- CONPAP. 2017. Consejo Nacional de la Papa. Monografía del cultivo de la papa de los años 2013-2017. Sistema producto de la papa. México.
- Fernández, E. 2011. Costos de producción del cultivo de la papa (*Solanum tuberosum* L.), en el valle y Cofre de Perote. Tesis. Universidad Veracruzana. México. 30-35 p.
- García, M. y García, D. 2000. Mercados y comercialización de productos agrícolas. Colegio de Posgraduados, Montecillo. Estado de México.
- Krugman, P. y Wells, R. 2006. Introducción a la economía, microeconomía. Reverte (Ed.). Barcelona España. 537 p.
- Mejía, M. 2016. Precariedad del empleo rural en la Sierra Norte de Puebla. *In: Congreso IV Internacional y XV Congreso Nacional de Investigación y Servicio, Territorio, Sociedad y Ambiente.* Chapingo, México.
- Mora, A. 2014. Consumo y mercadeo de la papa en México. *In: XXV Congreso bienal de la Asociación Latinoamericana de la Papa (ALAP).* Bogotá.

- Morales, H. J. L.; Hernández, M. J.; Rebollar, R. S. y Guzmán, S. E. 2011. Costos de producción y competitividad del cultivo de papa en el estado de México. *Agron. Mesoam.* 22(2):339-349.
- Sabbagh, S. A.; García, S. J. A.; Matus, G. J. A.; Jiménez, S. L. y Hernández, J. M. 2011. Comportamiento del consumo de papa (*Solanumt uberosum L.*) fresca en México. *Rev. Mex. Cienc. Agríc.* 2(4):559-572.
- Samuelson, P. A. y Nordhaus, W. D. 2009. *Economía.* 19ª (Ed.). McGraw-Hill, Madrid, España. 744 p.
- SIAP. 2014-2017. Sistema de Información Agropecuaria. Estadística agrícola del cultivo de la papa. A nivel municipal, estatal y nacional. México.
- Todaro, M. 1998. *Economía para un mundo en desarrollo.* Fondo de Cultura Económica (FCE).103-125.
- Vázquez, C. M. G.; Rubio, C. O. A.; Salinas, M. Y. y Santiago, R. D. 2012. Usos alternativos de la papa en el Estado de México. INIFAP. CIRSE. CEVAMEX. México. Libro técnico núm. 15. 114 p.