

# Elements to improve the management and commercialization of dragon fruit (*Hylocereus undatus* (Haworth) D.R. Hunt)

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## ABSTRACT

The objective of this study is to identify production and commercialization problems and potential of dragon fruit (*Hylocereus undatus*) in the socioeconomic context of San Luis Atlotitlan, Caltepec, Puebla, Mexico. A questionnaire was applied between March and May 2020 to n=20 producers-marketers of the Asociación de Producción Rural de San Luis Atlotitlan, Caltepec. The cultivation of dragon fruit is part of a crop diversification system within a social context characterized by migration, low education, and extensive dependence on local buyers. In addition, its maintenance practices, use of organic fertilizers, and average yields are minimal. However, if management is improved and transformation and marketing channels are identified and diversified, the system will be able to boost the economy of the region. Young producers, with a higher educational level and with an innovative attitude, could improve those measures.

**Keywords:** Marketing, production costs, production technology.

**Citation:** Ayala-Garay, A. V., Del Ángel-Pérez, A. L., Rivera-Gutiérrez, R. G., Preciado-Rangel, P. (2023). Elements to improve the management and commercialization of dragon fruit (*Hylocereus undatus* (Haworth) D.R. Hunt). *Agro Productividad*. <https://doi.org/10.32854/agrop.v16i2.2381>

**Academic Editors:** Jorge Cadena Iñiguez and Libia Iris Trejo Téllez

**Received:** September 12, 2022.

**Accepted:** January 19, 2023.

**Published on-line:** April 12, 2023.

*Agro Productividad*, 16(2). February, 2023. pp: 129-135.

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## INTRODUCTION

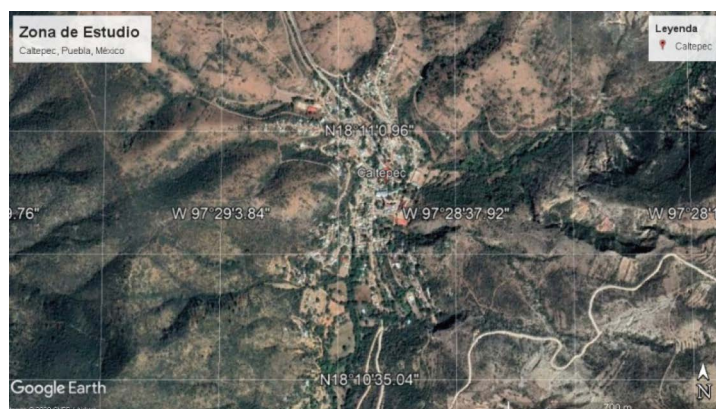
Dragon fruit (*Hylocereus undatus*) is native to southeastern Mexico and Central America (Zee *et al.*, 2004; Legaria *et al.*, 2005), although currently its commercial cultivation has been expanded to Southeast Asia, Europe, and the United States, where it is consumed more than in Mexico. From 2009 to 2019, the production of dragon fruit (*Hylocereus undatus*) in Mexico was carried out in the states of Yucatán, Quintana Roo, Puebla, Nayarit,

Tabasco, Guerrero, Sinaloa, and Nuevo León (SIAP, 2020). As a whole, Quintana Roo and Yucatán accounted for 95% of that production. Dragon fruit production has increased from 1,493 t to 9,029 t: an average annual growth rate (AAGR) of 22.14%. Quintana Roo and Yucatan had an average harvested area of 356 and 272 ha, respectively —94% of the total area destined for cultivation. From 2009 to 2019, the state of Puebla accounted for 4.76% of the average domestic production (*i.e.*, 174 t and average yields of  $4.1 \text{ t ha}^{-1}$ ). The cultivation has been carried out in the Distritos de Riego (Irrigation Districts) of Izúcar de Matamoros, Tecamachalco, and Tehuacán, with an average participation of 28.2%, 21% and 26.2%, respectively (SIAP, 2020). The objective of this research was to describe the production of dragon fruit (*Hylocereus undatus*) in San Luis Atolotitlan, Caltepec, Puebla and to identify its technological needs and existing commercialization channels.

## MATERIALS AND METHODS

The study was carried out in the municipality of Caltepec (Figure 1) in southwestern Puebla. It limits to the northwest with the municipality of Zapotitlán and to the northeast with the municipality of San José Miahuatlán, both in the state of Puebla. To the south it limits with the state of Oaxaca.

It is part of economic region VII, whose municipal seat is located in Tehuacán. It has an area of 391.74 square kilometers that makes it the 11th biggest municipality in Puebla. It has five auxiliary governing boards: Acatepec, Acotlototlan, Coatepec, Acatitlan, and Tlalocuitepec (INEGI, 2017). For this research, the information was obtained through the application of a survey. This technique can be used when there is not enough information about certain topics or when the information cannot be obtained through other techniques (Rojas, 2002). The survey was applied to 20 dragon fruit producers-marketers who belong to the Asociación de Producción Rural de la comunidad de San Luis Atolotitlan, Caltepec, from March to May 2020. To calculate profitability, the average production costs and productivity of the surveyed producers were obtained. The following algebraic expressions based on economic theory were used for that purpose (Krugman and Wells, 2006; Samuelson and Nordhaus, 2010):



**Figure 1.** Dragon fruit (*Hylocereus undatus*) study area. Caltepec, Puebla, Mexico.

$$CT = PxX$$

Where:  $CT$  = Total cost;  $Px$  = Price of input or activity  $X$ ;  $X$  = Activity or input.

$$IT = PyY$$

Where:  $IT$  = Total income ( $\$ \text{ ha}^{-1}$ );  $Py$  = Market price of crop  $Y$  ( $\$ \text{ t}^{-1}$ );  $Y$  = Crop yield ( $\text{t ha}^{-1}$ ).

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

## RESULTS AND DISCUSSION

### Producers' characteristics

Dragon fruit producers from San Luis Atlotitlan are in average 62-years old and their age range goes from 39 to 69 years. Seventy-eight percent of the producers are over 50; therefore, the population of the rural primary sector faces an aging problem. According to SAGARPA-FAO (2014), the aging of the population has been more pronounced in rural areas, mainly as a consequence of the national and international migration of the working age young population. The age of the producer is decisive for the adoption of new practices and technologies. In this study, only 22% of the producers were 50-years old or younger, have attended secondary school and are interested in knowledge, innovation, and the adoption of the new technologies. The rest of the producers showed no interest in this regard. None of the producers have studied beyond the secondary level: 78% had completed primary school and 22% secondary school. According to INEGI (2020), the 15+ population in the state of Puebla has attended a 9.2 average schooling level (little more than the third year of secondary school). This figure is lower than the national level (9.7 levels, a little more than completed secondary school). According to SAGARPA-FAO (2014), analyzing the schooling level of agricultural producers has a major implication in their capacity to implement productive technologies and to manage the production units.

Seventy-eight percent of the interviewees had relatives or they themselves had had to leave their homes looking for other places of work where they could improve their income. The USA was the destination of 43% of them. According to INEGI (2020), Puebla ranks 19th among Mexican states, regarding the migration of its population. Meanwhile, producers mention that remittances are an important source of income. Another major characteristic is that the producers fail to take advantage of their membership in the Asociación de Producción Rural de la comunidad de San Luis Atlotitlan, Caltepec. They neither make massive purchases, nor sell their production as a group. According to Ayala *et al.* (2013), the lack of productive organization prevents them from generating economies of scale; consequently, they must deal with intermediaries, who establish the price of the product.

### **Production characteristics**

The producers are smallholders with an average of 4 ha, who raise backyard cattle species. The crops they grow along with dragon fruit are papaya, corn, and avocado. On average, producers use one hectare for dragon fruit, which is considered a rainfed crop; however, in some cases it has support irrigation. Producers are unaware about technological packages endorsed by agricultural or academic research institutions. The technology developed by INIFAP allows producers to handle up to 2,500 plants ha<sup>-1</sup>. Applying the recommended technological components, as well as high-yield cultivars, returns of  $\geq 18$  t ha<sup>-1</sup> can be achieved (Del Ángel *et al.*, 2012).

### **Dragon fruit propagation and cultivation**

The crops are planted in May, transplanting cuttings into the ground with the help of posts (mostly made of concrete). Previously, the propagation of the cuttings is carried out during the new moon of April, according to the beliefs of the producers. The cuttings are planted in plastic bottles where they are allowed to grow until the end of April and, after rooting, they are planted directly in the ground. Before the dragon fruit trees are planted, the land is weeded and fertilized with a combination of donkey manure and organic matter.

### **Plant maintenance**

A fertilizer is applied in May, while Malathión<sup>®</sup> (a pesticide used to combat the fruit fly and other dragon fruit pests) is applied in May, July, and August. The amount varies according to the condition of the crop: when a persistent pest is identified, producers tend to apply a higher dose. Dragon fruit plants are mainly attacked by parasitic pests, particularly the worm known as capichi or owlet moth (*Noctuidae* sp.) and the fruit fly (*Dasiops* sp.). Producers use support irrigation, although the crop is practically rainfed. Plant pruning is also carried out in May, before flowering begins. Together with the pruning, the bushes are subjected to a *rameada*, an activity that consists clearing the plant to guarantee that the buds about to bloom receive enough sunlight to grow without problems. This activity should be a sanitation pruning.

### **Harvest**

Plants bear fruit until the second year. To satisfy the demand, producers plant around 150 cuttings per year. They record an average mortality of 15% —*i.e.*, for every 10 cuttings planted, at least two are lost in the process. This situation takes place when the roots of the plants have been fully developed before they are planted. Dragon fruit plants bloom three to five times a year. For each cut, 800 to 1,000 fruits ha<sup>-1</sup> are obtained, as a result of the low planting density. The harvest is carried out in three cuts; however, five floral emissions are common and they normally overlap.

### **Production costs**

At the beginning of the dragon fruit plantation, concrete posts are set up to serve as tutors for the plants' development. This investment was calculated based on 2020 prices,

estimating a cost of \$9,700 Mexican pesos. The posts receive an annual maintenance and are replaced after five years. Table 1 shows the total production costs for dragon fruit.

The fruit is harvested in three cutting periods, which take place at the end of July, August, and October, with an average production of 10 fruits per plant and an average of 100 plants per hectare. Table 2 shows the profitability calculations for the producer, breaking down cuts and average price paid per fruit.

The crop is profitable, as long as it finds a buyer (Table 2). The collectors usually visit the dragon fruit plantations located in the municipality; however, if collectors fail to visit the plantation, the harvest of that cut would likely be lost. The fruit is sold per piece and not per weight (kg), because some producers consider that they can obtain a higher profit margin that way. The dragon fruit is a promising crop for the producer, because it is profitable and does not require a great deal of investment, once the plant has started to

**Table 1.** Costs per hectare (2020 prices) of dragon fruit maintenance and production in San Luis Atolotitlan, Caltepec, Puebla.

Actividad	Unidad	Cantidad	Costo unitario (\$)	Subtotal (\$)
Tratamiento del tallo				
Obtención del esqueje	Pieza	150	5	750
Cortador de esqueje	jornal	2	120	240
Abono	kg	730	1.4	1,022
Aplicación de abono	jornal	1	120	120
Labores para el transplante				
Transplante	jornal	3	120	360
Aplicación de abono	kg	1,180	1.4	1,647
Labores culturales de mantenimiento				
Composta	kg	1,650	1.0	1,650
Aplicación de composta	jornal	1	120	120
Abono	kg	1,680	1.4	2,352
Aplicación de abono	jornal	1	120	120
Plaguicida	l	1	415	415
Aplicación de plaguicida	jornal	1	120	120
Insecticida	l	1	251	251
Aplicación de insecticida	jornal	1	120	120
Riego	l	2,000		1,200
Poda de formación (rameado)	jornal	2	120	240
Poda de limpieza	jornal	2	120	240
Deshierbe	jornal	2	120	240
Cosecha				
Corte 1	jornal	2	120	240
Corte 2	jornal	2	120	240
Corte 3	jornal	2	120	240
Total				11,927

Source: developed by the authors based on the information collected in the field.



**Table 2.** Fruit production, production costs, and profit per hectare (2020 prices) for the dragon fruit producer in San Luis Atolotitlan Caltepec, Puebla.

Concepto	Primer corte	Segundo corte	Tercer corte	Subtotal
Frutos por planta	10	10	10	30
Plantas por ha <sup>-1</sup>	100	100	100	300
Producción de fruta por ha <sup>-1</sup>	1000	1000	1000	3000
Precio pagado por fruta	7	7	7	
Ingreso por corte	7000	7000	7000	21,000
Costo de producción				11,927
Utilidad por ha <sup>-1</sup>				9,073

Source: developed by the authors.

bear fruits; nevertheless, the main issue is having a market that constantly demands the product. The fruit is sold right outside the plantation. The price is established by the buyer, depending on its size and appearance. Producers mention that market saturation hinders the sale of fresh dragon fruit in times of maximum production. Ideally, producers should start transformation processes to add value to the fruit. This measure could generate local employment and improve the profitability and quality of life of the producers. According to Castillo (2006), this exotic fruit is accepted and reaches good prices in domestic and foreign markets. Although some of its characteristics still constitute a problem, the plants are ideally suited for their exploitation. Dragon fruit is a product with scarce diffusion in the domestic market; therefore, the promotion of non-traditional products with development potential becomes a fundamental task for the sustainable development of the agricultural sector (García and Quirós, 2010). The production and commercialization of this product is limited to the local market, since there are no land plots used exclusively for this crop and most of the production is collected from backyards. As a result of its nutritional value, the dragon fruit may have various opportunities in the market. The properties of the fruit are auxiliary in the treatment of some diseases (Lezama *et al.*, 2007).

## CONCLUSIONS

The production is carried out without a technological package endorsed by a public institution and the producers use their empirical knowledge for the maintenance of the crop. The management of cultural practices carried out by the producer only takes into consideration weeding and pesticides. The producers lack any connection with experts in the field. Regarding the commercialization, it is necessary to establish a transformation process for the use of pulp or by-products. As an alternative to commercialization, we propose working under a rural cooperative arrangement that allows regional producers to collect and transform the fruit, in order to position the dragon fruit in competitive markets and boost demand. Positioning the dragon fruit in the domestic market requires campaigns that raise awareness about its benefits and promote its consumption. The dragon fruit is a promising crop for the smallholding producers, if they establish an adequate agricultural management and if there is a growing demand.

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