Article

Financial evaluation of agave and mezcal production: case study Caltepec, Puebla

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Abstract

In recent years the production of agave distillates in Mexico, including mezcal, has become increasingly important. In the period 2013-2019, its value has increased to an average annual rate of 19.76%. Such behaviour has been driven by product prices and increasing domestic and international demand, compared to the latter concept from 2017 to 2018 mezcal exports grew at a rate of 34.40%. This has led to more and more productive units linking to the agave value chain, as has been the case of the municipality of Caltepec, Puebla, whose population is in poverty and lives on agriculture. In this sense, it is necessary to analyze the opportunities that agave and mezcal production could generate, to provide productive opportunities that seek to improve the municipal economy. Based on the above, a financial assessment was developed from 2020 with a planning period of eight and 15 years from the start-up of the project. Research findings suggest that both types of business opportunities are financially feasible, because have a net present value of $34 074.09 and $1 911 792.96, respectively. They can therefore serve as potential alternatives to improving the wellness of different productive units in the region, thereby helping to alleviate local poverty.

Keywords: *Agave potatorum*, agribusiness, financial analysis, profitability.

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Introduction

Agave is the raw material for the production of different distilled beverages, including mezcal, whose appellation of origin is Mexican and is considered a high-quality spirit drink (Carcamo and Noriega, 2009). Exports of this product reached 2 013 thousand liters in 2016, which amounted to an income of 26 million of dollars to the country (SAGARPA, 2017); in addition, sales to the rest of the world increased in 2018 by 34.4% compared to the previous immediate year (INEGI, 2020).

According to Pérez *et al*. (2016), in 2014, Mexico had about 330 000 ha of agave in operation, owned by 9 000 producers, generating 29 000 direct and indirect jobs. For mezcal, in 2006 there were 625 factories, 80 packaging plants and 130 brands of mezcal. For 2014, the number of trademarks was 362 and mezcal production increased by 48% compared to 2011.

According to figures from the Agri-food Information Consultation System (SIACON, 2020) production and planted area of mezcalero agave has grown in the last ten years from 2008 to 2018 production increased from 301 790 to 303 382 t, while the area sown did so from 4 700 to 5 360 ha. Although there are advances in the cultivation of agave and improvement in the conditions of bidders and plaintiffs, the agribusiness of mezcal faces challenges and limitations in the different links of the chain (AGARED, 2017). However, the dynamics observed on the supply indicate that more and more productive units have been linked to the agave value chain and its distillates.

This has been the case of Puebla, Mexico, the state is considered to have a potential of more than 250 thousand hectares for the cultivation of agave in the south-central part of its territory (Jiménez-Merino, 2017; Ulloa and Medrano, 2019).

The area planted with agave in Puebla increased 67.33% between 2008 and 2018. However, this production of mezcalero agave is concentrated in few municipalities, including San Diego La Mesa Tochimiltzingo, Huehuetlán El Grande and Tecali de Herrera with 50, 40 and 30 ha, respectively. This is despite the fact that in other municipalities of the state there are suitable conditions for its production.

As part of the suitable or endemic mezcal agaves of Puebla is *Agave potatorum*, which is distributed in semi-arid lands of the upper parts of the state, at altitudes ranging between 1 240 to 2 300 meters above sea level, on slopes with dense herbaceous vegetation and remnants of pine and oak vegetation. On the slopes that extend along the Puebla-Oaxaca road, near Yanhuitlán, the *Agave potatorum* specimens of small rosettes and cluster inflorescences are usually visible (García, 2010).

Within the poblana regions with suitability for the production of *agave potatorum* is the municipality of Caltepec, an area considered marginalized, where more than 70% of its population lives in poverty and has as its main means of generating income to agriculture (CONEVAL, 2010). Table 1 provides some relevant indicators.

Table 1. Caltepec Puebla Human Development Index.

	People	(%)
Total population	3 704	100
Population poverty	2 792	75.37
Extreme poverty	990	26.73
Extreme poverty without food	434	11.37
Moderate poverty	1 802	48.64
Vulnerable by social deprivation	853	23.04
Vulnerable by income	33	0.9
Not poor and not vulnerable	26	0.7

CONEVAL (2010).

On this framework arises the need and interest to analyze the opportunities and benefits that could bring with it the start-up of agave and mezcal producing farms in the region, whose practice has emerged as an alternative source of income in marginalized places (Rincón *et al*., 2015). This sought to identify business opportunities that seek to improve the municipal economy and open a menu of options for farmers to decide, in consideration of federal and state support, to diversify their sources of income, which are currently limited to grass production.

Therefore, the objective of the research was to calculate the profitability of agave and mezcal production in Caltepec, Puebla. To this end, it was considered a planning period of eight and 15 years, respectively and the returns of the projects were contrasted with those currently obtained from maize production, which allowed to conclude on their feasibility.

Materials and methods

The study was carried out for the municipality of Caltepec, Puebla (Figure 1), which is located between the parallels 18° 02’ and 18° 16’ north latitude; meridians 97° 21’ and 97° 39’ in west length. It adjoins to the northeast with San José Miahuatlán and from west to north with Zapotitlán, to the southeast with the municipalities of Tepelmeme Villa de Morelos, to the west with Santiago de Chazumba, to the south Santa Catarina Zapoquila and Concepción Buenavista, to the southwest San Pedro and San Pablo Tequixtepec (INFADED, 2019).

The predominantly semi-warm climate of the region is suitable for *Agave potatorum*, which grows wild in the upper parts of the municipality. According to Cruz (2019) the usual technical and cultural practices for agave production in Caltepec are: 1) fallow; 2) scrape; 3) cross; 4) bed lifting; 5) seed preparation; 6) planting; 7) transplantation; 8) weeding; (9) hilling; 10) fertilization; 11) phytosanitary control; and 12) harvest (often made at the hands of the buyer). The above cost structure information was obtained in the field, Table 2 provides for the information obtained per hectare.

Figure 1. Study area, Caltepec, Puebla, Mexico. Elaboration with google earth data.

Table 2. Cost structure of agave production (thousands of pesos).

Activities carried out in the cycle	Year								Total cost
	1	2	3	4	5	6	7	8	
Land rent per hectare									0.30
Technical advice	*	*	*	*	*	*	*	*	3.00
Frame stroke with level curve	*								0.50
Cajeteo	*	*	*	*	*	*	*		16.80
Buying seedling	*								4.80
Flet from the nursery to the planting site	*								0.30
Transplant	*								0.80
Buying agave seedling		*							0.48
Flet from the nursery to the planting site		*							0.30
Replant		*							0.08
Total									27.36

Elaboration with data based on Cruz (2019).

From investment to agave harvest there is at least an eight-year period; for this the project's financial assessment took that same time. That is, research only considered a productive cycle of agave. The cost structure in Table 2 is independent of the weight of agave pineapples after the production cycle is over, poor agronomic management that implies a low weight in the final product will have high unit costs. The results of the research delve into the latest.

With regard to income, these were obtained per hectare and assumed the following: a) a weight of 30 kg per pineapple in the harvest; b) a loss of 10% of agave seedlings over the eight years; that is, a loss of 80 plants; and c) a sale price of $6.00 kg^{-1} of pineapple. So it was expected to earn an income of $144 000.00 to the eighth year of the project's start-up in 2028.

The mezcal production project was considered independent of agave production, the reason for this was to identify separate business opportunities, so that farmers can assess which option is most cost-effective and feasible depending on their context. However, in case of evaluating the profitability of the project as a whole, this would be higher than that obtained for the production of mezcal separately (since the costs would be lower when self-supplying agave, the main input in the cost structure).

The project was proposed under a 15-year planning period and it was considered an annual production of 3 000 liters over the first three years and twice as many from year four to the end of the project in 2035. The reason for the 15-year planning period was because, in general, the agave-producing region does not have a market for asset resale; that is, once the economic life of the asset is over it is thrown away. Therefore, to avoid unnecessary losses, it is exactly in a period of 15 years where the useful life ends up equating with the economic life of most of the company's assets. With regard to the investment structure and costs of the artisanal mezcal project, the information provided in Tables 3 to 5 was obtained, respectively.

Table 3 highlights the fact that the main investment concept of the project was the acquisition of fixed assets with 61.01% of the total of this percentage, most go to auxiliary and complementary equipment (stone wheel, copper vat and alembic) 63.26%, followed by the pack animals to move the stone mill with 19.17% and finally, civil works (oven construction, era and records) with 17.57%.

Table 3. Investment required for mezcal production (thousands of pesos).

	Concepts	Total
	Fixed assets	156.50
1	Civil works	27.50
2	Pack animals	30.00
3	Auxiliary and complementary equipment	99.00
	Subtotal	156.50
	Deferred assets	100.00
1	Company constitution	10.00
2	Land rental contracts	90.00
	Total fixed and deferred assets	256.50

Table 4 exhibit the components of fixed and variable costs, and Table 5 added according to the planning period. Fixed costs meant, for all years, just over 15% of the total (most of the budget was allocated for the purchase of firewood and the maintenance of the pack animal) while the variable costs were the most important with just under 75% of the total (the main concepts of spending were agave pineapples and glass bottles for packaging).

Table 4. Components of fixed and variable costs of mezcal production.

Cost description	Concept	Cost per concept	Temporality
	Variable costs		
Raw materials: Pineapples	6 750 kg	6	Monthly
Glass bottles	250 bottles	20	Monthly
Staff for stone and firewood hauling	3 wages	150	Monthly
Bake	2 wages	450	Monthly
Staff for chopping and slice pineapple	2 wages	150	Monthly
Staff in fermentation	2 wages	150	Monthly
Distillation staff	2 wages	200	Monthly
Staff in refinement	2 wages	200	Monthly
	Fixed costs		
Mule food	Food	2145	Monthly
Firewood	25	250	Monthly
Freight	1 freight	300	Monthly
Polyduct maintenance	1maintenance	1500	Annual

Table 5. Cost structure of mezcal production (thousands of pesos).

Costs	Initial capacity			Full capacity		
	100%	100%	100%	200%	200%	200%
	1	2	3	4	14	15
Variable costs	579.00	579.00	579.00	1 158. 00	1 158. 00	1 158. 00
Fixed costs	105.84	105.84	105.84	184.44	184.44	184.44
Operating costs	684.84	684.84	684.84	1 342. 44	1 342. 44	1 342. 44

For the size of the table the information from years five to thirteen of the project is omitted, the respective data are identical to those exposed for years four, 14 and 15.

Finally, Table 6 establishes the income from mezcal production. As in the previous table, the presentation of the data for the years five to thirteen was omitted.

Table 6. Assumed income from mezcal production.

Concept	Unit	Initial capacity			Full capacity		
		100%	100%	100%	200%	200%	200%
		1	2	3	4	14	15
1L mezcal bottles	Thousands of bottles	3.00	3.00	3.00	6.00	6.00	6.00
Total Revenue*	Thousands of pesos	900.00	900.00	900.00	1 800.00	1 800.00	1 800.00

*= A sale price of $300.00 per bottle is assumed. Note: the size of the table omits information from years five to thirteen of the project; the respective data are identical to those presented for years four, 14 and 15.

By contrasting the total costs and revenues in Tables 5 and 6, respectively, there is a positive differential; that is, year after year the project generates a profit of more than $200 000.00 in the first three years and even more than double in the successive ones, this being a good project regarding its profitability. While the above provided an ambiguous notion that both the mezcal project and the agave production project could be profitable, their precise measurement consisted of the calculation of the most common financial indicators, which are (De la Torre and Zamarrón, 2002; Muñante, 2002; Baca, 2013):

Net Present Value (VAN), $VAN=\sum_{t=1}^{T}\frac{B_t-C_t}{(1+r)^t}-I$; Benefit-Cost Ratio (RBC); $RBC=\left(\sum_{t=1}^{T}\frac{B_t}{(1+r)^t}\right)\Big/\left(\sum_{t=1}^{T}\frac{C_t}{(1+r)^t}\right)$; Internal Return Rate (TIR)TIR= r such that VAN= 0.

Where: B_t and C_t are, respectively, the benefits and costs of the project for year t, I is the initial investment and r is the discount rate of the project. While for this last parameter there is no consensus on its value, rather it is a discretionary decision of the evaluator, in this research it was proposed r= 0.14, which was considered sufficient in incorporating inflation, project risk and a minimum profit margin.

The evaluation of the project took a purely financial route or cost-benefit (CEPAL, 2004); that is, only the benefits and costs of the project were considered at market prices (Duarte *et al*., 2007). However, the impact on development was not discarded, because projects, due to their demand for inputs and coverage within the region, were considered to be able to intervene in specific areas or dimensions of reality to improve it and thus contribute to community development (Rodríguez and Zeballos, 2007). The following section of the manuscript sets out the main results of the research where the above-listed indicators are incorporated.

Results and discussion

Table 7 sets out the results of the financial analysis per hectare for agave production based on the cost structure of Table 2 and the earning of an income of $144 000.00 to the eighth year of project start-up; a final agave pineapple weight of 30 kg and a price of $6 kg^{-1} was considered.

Table 7. Financial analysis of agave production (thousands of pesos).

Concepts	Year							
	1	2	3	4	5	6	7	8
Total revenue	0	0	0	0	0	0	0	144.00
Total costs	12.10	3.56	2.70	2.70	2.70	2.70	2.70	0.30
Cash flow	-12.10	-3.56	-2.70	-2.70	-2.70	-2.70	-2.70	143.70
Updated total revenue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.55
Updated total costs	12.10	3.12	2.08	1.82	1.60	1.40	1.23	0.12

Concepts	Year							
	1	2	3	4	5	6	7	8
Updated cash flow	-12.10	-3.12	-2.08	-1.82	-1.60	-1.40	-1.23	57.43
VAN	34.07							
RBC	2.54							
TIR	33%							

According to Table 7, agave production would allow farmers who decided to invest in the project a net profit of $34 074.09 per hectare, in addition to its cost structure and RBC, it was inferred that for each weight spent on the project it would be recovered and there would also be a return of $1.54. The TIR of the project indicated that its maximum return is around 33%, higher than the discount rate considered 14%.

Table 8 show project sensitivity analysis, the result of considering different weights and sales prices in agave pineapples. For example, under a final pineapple weight of 30 kg and a fluctuation in the sale price from $6.00 (Table 7) to $4.00 per kg (line 10 Table 8) the project VAN would fall by 56.30%. For its part, if the sale price is set to $6.00 kg and the weight of the pineapples will go from 30 to 15 kg; the VAN would fall by 84.45%.

Table 8. Financial indicators of agave production at different weights and purchase prices.

Weight (kg)	Price ($)	VAN ($)	TIR (%)	RBC
30	7.00	43 665.39	37	2.86
25	7.00	32 475.55	32	2.38
15	7.00	10 095.86	21	1.43
25	6.00	24 482.80	29	2.04
20	6.00	14 891.50	24	1.63
15	6.00	5 300.21	18	1.23
25	5.00	16 490.05	25	1.7
20	5.00	8 497.31	20	1.36
15	5.00	504.56	14	1.02
30	4.00	14 891.50	24	1.63
25	4.00	8 497.31	20	1.36
15	4.00	-4 291.09	10	0.82

Red figures are indicative of weight-price combinations in which agave production is not profitable.

Based on the findings, while agave production is profitable, its success is mostly related to agronomic management than to market conditions, because variations in the final weights of agave pineapples were associated with larger contractions in financial indicators.

Table 9 provides updated benefits and costs, and financial indicators of a mezcal-producing farm with an annual production capacity of 3 000 litres during the first three years of the project and double until year 15.

Table 9. Financial analysis of mezcal production at updated values (thousands of pesos).

Concepts	Operation							
Year	0	1	2	3	4	5	6	7
Costs	256.50	600.74	526.96	529.07	909.93	805.98	700.16	614.18
Benefits	0.00	789.47	692.52	607.47	1,065.74	934.86	820.06	719.35
Cash flow	-256.50	188.74	165.56	78.4	155.81	128.89	119.89	105.17
Year	8	9	10	11	12	13	14	15
Costs	538.75	477.2	414.55	366.96	318.99	285.09	245.45	215.31
Benefits	631.01	553.51	485.54	425.91	373.61	327.72	287.48	257.68
Cash flow	92.25	76.31	70.99	58.96	54.62	42.63	42.03	42.38
VAN	$1 911.79							
RBC	1.27							
TIR	91.98%							

Except for year zero of the project, positive cash flows were achieved in the 15 years. Thus, the investment in the project meant a net profit of $1 911 792.96 regarding its RBC, for each weight spent on the cost structure the project allows to recover it and obtain an additional $0.27. Finally, the TIR measure indicated that the maximum profitability of the project is 91.98%.

The sensitivity analysis of mezcal production profitability was implemented. To this end, the cost of agave pineapples and packaging bottles were adjusted upwards, due to their importance in cost structure (Table 4). The results are shown in Table 10.

Table 10. Financial analysis of sensitivity of mezcal production.

Concepts	20% increase in pineapple price	20% increase in bottle price
VAN (thousands of pesos)	$943.42	$1 792.24
RBC	1.12	1.25
TIR	54.92%	87.46%

While fluctuations of 20% in the price of agave pineapples and glass bottles negatively impacted the project's profitability (compared to Table 9, the VAN was reduced by 50.65 and 6.25%, respectively), the project is still financially feasible, as in both cases the indicator proved to be greater than zero. Therefore, even when considering various adverse scenarios in sensitivity analysis, the final decision, for both the agave and mezcal projects, was that they are financially profitable projects; since VAN> 0, RBC> 1 and TIR> r= 14% values were obtained.

Conclusions

The financial analysis of the implementation of agave and mezcal projects in Caltepec, Puebla, had positive results. In particular, investment in agave production would result in a profit of $34 074.09 per ha, higher than farmers get from planting and selling grasses. In Caltepec farmers could get maximum of $5 610.00 t^{-1}, which would generate an average earning per ha of $1 430.55 $year^{-1}$, which at eight years would mean a profit of less than $11 444.40, a value that represents about 1/3 of what would be earned from the agave production project.

However, it should be noted that the profitability of the project is conditioned on the final weight of agave pineapples, so it is necessary to invest in technologies and human capital, which allow optimal agronomic management and get good-sized agave pineapples after eight years of production implementing. However, as far as the mezcal project is concerned, it is profitable by obtaining a VAN= $1 911 792.96. Contrasting this value with what the farmer could get from the sale of maize for 15 years, the return of mezcal would represent more than 54 times that value.

It highlights the fact that this agribusiness would be financially profitable in scenarios where the price of its main raw materials: agave pineapples and packaging bottles, increase its cost by 20%. However, their indicators could be reduced to 50%. In short, it is possible to say that, under its correct implementation, the production of agave and mezcal are important alternatives to improve the income of individuals and are considered as a great opportunity for economic development in poor and marginalized communities, such as Caltepec, Puebla. With regard to the production and marketing of mezcal, industrial production generates more economic benefits than agricultural (Plascence and Peralta, 2018).

In addition, the relevance of good agronomic management and strategic alliances to reduce costs in the production of raw materials is highlighted; without these, agave and mezcal farms, respectively, would see their future profits compromised. So the implementation of the projects in Caltepec, Puebla, should be oriented towards the incorporation of such factors.

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