https://doi.org/10.32854/agrop.v14i4.1840

Strategy to strengthen the traditional milpa family production systems

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ABSTRACT

Objective: To characterize family production units (FPUs) to identify critical points for their activities and propose intervention strategies for them.

Design/methodology/approach: The research took place at Yaxcabá municipality, state of Yucatán, Mexico. It is descriptive and its information obtained through 1) a questionnaire in a mobile application compatible with the Android operating system, structured by modules: producer data, FPU characteristics, crops, infrastructure, machinery, equipment, and marketing. The sample size was randomized with replacement, under the maximum variance condition, 2) assessment visits to the farmer's plots and 3) participatory community diagnosis workshops.

Results: The traditional milpa system was oriented to the cultivation of corn, beans and squash of creole origin, for consumption by the FPUs with minimum technologies usage. Through apiculture, producers obtain an economic resource to finance other activities, including those of the milpa. It is, therefore, necessary to strengthen their productive capacities of this activity with a chain approach, for the diversification of their products and derivatives of their hives that allow their income to increase.

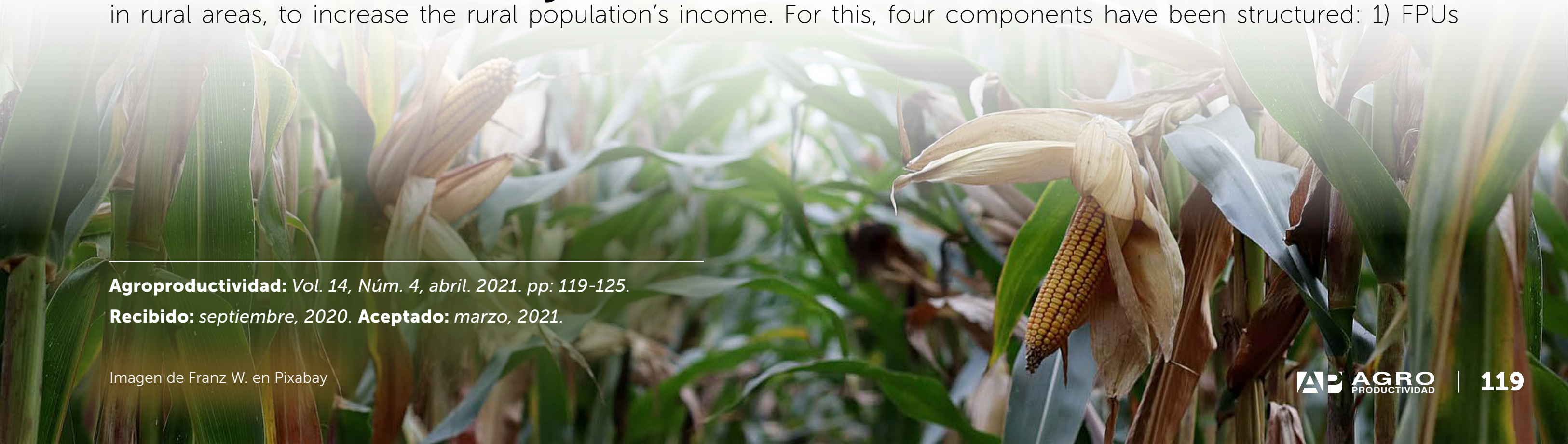
Limitations on study/implications: The proposals and intervention strategies may only be applied to the production system in the evaluated area.

Findings/conclusions: The strategies for the traditional milpa production should be oriented to food security, biodiversity preservation and the nutritional health of their related population. Apuculture strategies should aim to include producers in the value chain.

Keywords: PRODETER, UPF, milpa, rural development, apiculture.

INTRODUCTION

The main objective of the current rural development program in Mexico is to increase the productivity of family production units (FPUs) in rural areas, to increase the rural population's income. For this, four components have been structured: 1) FPUs



Agroproductividad: *Vol. 14, Núm. 4, abril. 2021. pp: 119-125.*
Recibido: *septiembre, 2020.* **Aceptado:** *marzo, 2021.*

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strengthening, 2) Economic integration of the productive chains, 3) Capacity development, extension and rural advice, and 4) Research and technology transfer. The latter, where this research is framed, aims to articulate research with extensionism to promote the application of technological components, as well as address structural problems in rural environments or productive chains (SADER, 2019).

To achieve this, the Territorial Development Projects (PRODETER) were created. These, through investment, both in assets and knowledge, serve small producers in high and very high marginalization areas, applying gender equity and social inclusion criteria in the FPU (SADER, 2019).

The PRODETER projects are made up of three elements: 1) productive technical diagnosis for the FPU, 2) technology transfers, and 3) Technical support strategies. Taking the characteristics of FPUs as a reference, a PRODETER was established in the municipality of Yaxcabá, Yucatán, Mexico.

This municipality has high rates of marginalization, which limits the population's social opportunities and the ability to acquire or generate them. Likewise, they have deprivations and inaccessibility of fundamental goods and services for their well-being, the majority of this population (95.1%) are indigenous (SEDESOL, 2015).

Although the municipal poverty indicator decreased from 2010 to 2015 by 2.2%, 70.7% of the population are in poverty conditions; 50.4% report moderate poverty and 20.3% extreme poverty. The most frequent social deficiencies among the population were social security and basic housing services (CONEVAL, 2015).

Regard their agricultural production, corn cultivation continues to be of greater importance, due to the planted area and the value of the production. Even though in a smaller area, vegetables of high commercial value such as watermelons and habanero peppers also stand out (SIAP, 2018).

For these reasons, the objective of this research was to characterize the technological degree of the FPUs of a PRODETER in Yaxcabá, to generate knowledge that allows identifying critical points to propose intervention strategies in that area.

MATERIALS AND METHODS

A descriptive investigation was carried out in family production units of a "milpera" community, at Yaxcabá municipality, state of Yucatán, Mexico, located in the central region of the state, between parallels 20 ° 19' and 20° 49' north latitude and meridians 80° 36' and 88° 56' west longitude, 7 masl altitude and 1475 km^2 total area (INAFED, 2010).

The information was obtained through a questionnaire in a mobile application compatible with Android operating systems, structured by modules (producer data, characteristics of the production unit, characterization of crops, infrastructure, machinery and equipment, and marketing) and evaluation visit to the plots of producer for information validation.

The sample size was obtained by random drawing with replacement, under the maximum variance condition p=50% (p=0.5) and q=50% (q=0.5) following the formula suggested by Snedecor and Cochran (1967):

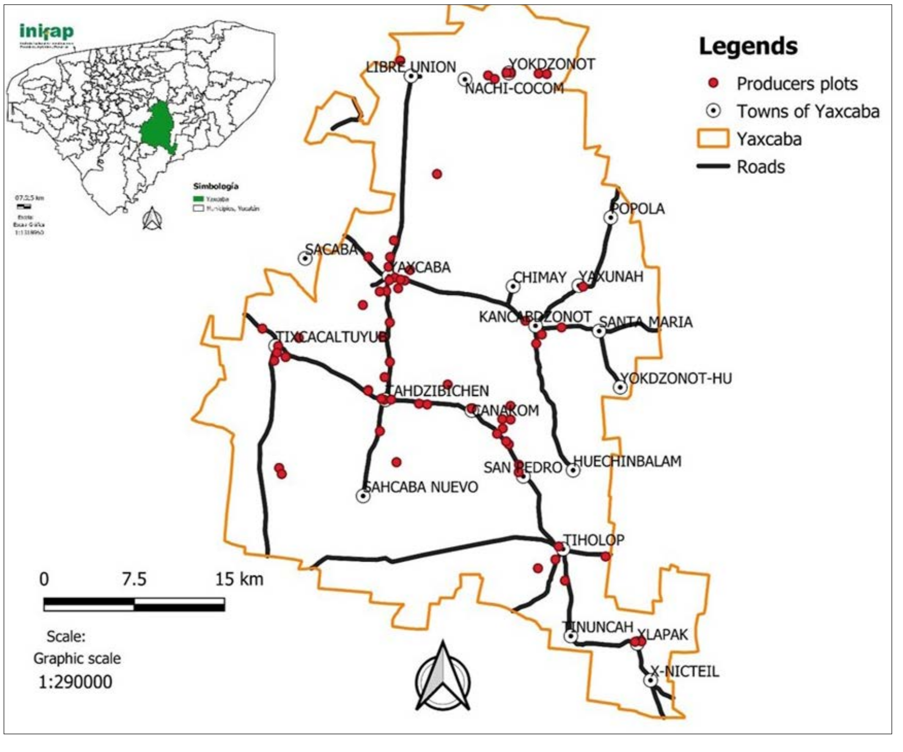

Figure 1. Municipality geographic location and assessed agricultural plots in Yaxcabá municipality, Yucatán, Mexico.

$$n = \frac{\frac{Z^2 p_n q}{d^2}}{1 + \frac{Z^2 p_n q}{N d^2}}$$

Where: Z=Confidence level at 95% (1.96), d=Level of precision 10% (0.10), p_n=Proportion of the population from the group of interest, q=(1−p_n), N=Population size (390 registered PRODETER producers) and n=Sample size.

Likewise, workshops were held, and two community participatory diagnosis techniques were used: 1) Brainstorming, to obtain information on factors that limit production and 2) problems prioritization with a double-entry matrix (Geilfus, 1998). The data were analyzed with the Predictive Analytical Software and Solutions (PASS) statistical package version 21, for the description of the variables.

RESULTS AND DISCUSSION

Among the most outstanding characteristics of the interviewed producers 87.5% of the corn producers are also beekeepers, hence the importance of this activity as secondary to this PRODETER. Furthermore, the combination of slash-and-burn agriculture with beekeeping is indicated by Güemes-Ricalde *et al*. (2003) and Pat-Fernández *et al*. (2020) as a complementary activity, not only in milpa systems but in other subsistence activities such as forestry, livestock and backyard animals.

The average age of the producers was 50 years and five years of school. This data coincides with that from Uzcaga *et al*. (2015) for corn producers and that from Pat-Fernández *et al*. (2020) for beekeepers. 97% of the family production units (FPUs) were communal land and 3% privately owned.

In the assessed plots, in addition to corn, a hectare of beans (62.5% black and 6.3% white) and squash were established associated. In this system, there are different variants of slashing-grave-burning-long fallow until the clearing of short fallow (Dzib-Aguilar *et al*., 2016). The sowings were established in dryland farming from April 15 to August 30, however, most producers (64.1%) sowed from June 1 to July 30, the recommended sowing period (Medina and Rosado, 2015). All the producers used creole seeds of which 64% were white, 33% yellow and 3% purple.

These seeds come from variants like "Tuxpeño", "Dzit-Bacal", "Nal-Tel" and combinations of these. It is documented that the use of hybrid seeds and even free pollination improved varieties, have not been successful in the "milpa" production in the region (Dzib-Aguilar *et al*., 2016; Uzcaga *et al*., 2017) since, most of the producers continues to sow their creole seeds due to their taste preferences being the main ingredients in their diet (De los Santos-Ramos *et al*., 2017). Also, selling these seeds represents an important income for small-scale producers (Hellín and Keleman, 2013) (Table 1).

Through the participatory workshops, it was identified that producers perceive their production system to be vulnerable to extreme weather conditions, either due to lack of rain or floods. This is because erratic weather in

Table 1. Characteristics of traditional "milpa" corn production in Yaxcabá municipality, Yucatán, Mexico.

Technological and management		Socioeconomic and cultural	
Types of species	Corn (*Zea Mays*) alternately with: Beans (*Phaseolus* spp.), Pumpkin (*Cucurbita* spp.).	Production objective	100 % subsistence
Varieties used	73% Creoles and 27% Improved Creoles		
Cultivation system	Polyculture	Plot Type	Family
Applied technology	Milpa-roza		
Intensity of space use	It is grown for two to five years.	Production scale (ha)	2.6
Tools	Espeque, coa to weeding, machete		
Fertilization (kg/ha)	78% applied fertilizer. The majority applied a single dose of 16 kg (Nitrogen) + 35 kg (Penta phosphate) 30 days after sowing.	Marketing / Storage	Self-consumption 51% troje, 40% sacks, 7% dairy and, 2% in wooden boxes
Labors	Sowing was carried out with a single row spar. They do weed and use low doses of herbicide.	Yields (t/ha)	0.5

Note: Espeque (XÚUL), a planting stick used to make holes and deposit the seed. The Creole seeds are from the Tuxpeño Breed (X NUUK NAL) with a long cycle, white color, an intermediate cycle Dzit-Bacal breed and early varieties such as Nal-Tel (X MEJEN NAL).

the Yucatan Peninsula, as well as damages caused by hurricanes and deforestation, negatively impacting not only the milpa systems but also the apiculture (Güemes-Ricalde *et al*., 2003; Martínez-Puc *et al*., 2018; Dzib-Aguilar *et al*., 2016). The main identified problems for corn production in the traditional milpa are listed in order of importance in Table 2.

According to Rodríguez-Canto *et al*. (2016) a family consumes 5 kg of corn per day, equivalent to 1825 kg per year. The interviewed producers barely cover their consumption requirements since the estimated production for the spring-summer cycle was 1300 kg. Therefore, they buy corn to cover their needs for the rest of the year.

One factor that impacts performance is the resting period. In the past, the land was cultivated for two to five years, and then the plot was left to rest from ten to one hundred years, so that the natural vegetation could regenerate (Aguilar *et al*., 2003).

Today the dominant lands in the Yucatan Peninsula are five to seven years old, also the ones with the lowest yield (400-500 kg/ha), even with fertilizers addition and adequate weather (Rodríguez-Canto *et al*., 2016).

For 20% of the producers, the value of their production was insufficient to cover their food requirements if corn production was their only activity. Since the estimated value was $1000 at the end of the agricultural cycle, which is lower than the $1149.2 per month of the minimum welfare line for the rural population (CONEVAL, 2020).

In this regard, Rodríguez-Canto *et al*. (2016) mention that 50% of the households dedicated to the milpa system in the Yucatan Peninsula were in income poverty, meaning they did not have sufficient economic resources to achieve minimum well-being.

This situation has fostered a vicious circle among small-scale producers and, since they do not have the necessary means to survive, producers end up depending on low-skilled low-paying jobs, which do little to improve their food security (Pat *et al*., 2010; Rosales y Rubio, 2008).

In this scenario, apiculture plays a priority role within the family economy, since it is a commercial product that

Table 2. Prioritization of the problems for corn cultivation in the traditional milpa system at Yaxcabá municipality, Yucatán, Mexico.

Problem	Description	Classification	Strategy
1. Rain Shortage	Producers are susceptible to adverse weather conditions such as drought, due to insufficient accumulated precipitation per month during the June-August period.	A	Vegetable mulch Sowing dates
2. Lack of irrigation infrastructure	Only 15.6% of the producers have an irrigation system with an average surface area of 2 ha, where watermelon, hot peppers and tomato are grown.	T	Rainwater harvesting. Realif irrigation
3. Low yields	The average yield was 0.5 t/ha and this production does not satisfy the family demand.	A	Improved Native Corn Seeds. Topological arrangement for density increase.
4. Seed availability	The producers used Creole seeds. Most are "own" seeds that they reserve from the previous cycle, which is selected for the size of the ear but without adequate control of the agronomic characteristics.	S	Mass selection to obtain seeds.
5. High cost of agricultural inputs (seed, agrochemicals)	95.3% applied low doses of fertilizer (80 kg/ha from 18-46-00) due to the lack of economic resources for the purchase of inputs.	E	Use of biofertilizers such as: mycorrhiza y *Azospirillum* spp. Composting and use of biosustainable bedding.
6. Delay in payment or delivery of subsidies	During the participatory workshops, information was collected on the timeliness of the resources from the different supports, which frequently arrive late and, therefore, cannot be used efficiently in cultivation.	S	Strengthen the association between producers.
7. Lack of pest control	75% of the plots with corn had the presence of the fall armyworm plague.	T	Uso de *Bacillus thuringiensis* (Bt) for fall armyworm control. Monitoring with pheromones and bioinsecticides.

E=Economic; S=Social; A=Environmental; y T=Technical.

has allows obtaining the monetary income that the milpa systems no longer provides (Rosales and Rubio, 2008). Besides, these resources also finance other productive activities, since on average apiculturists invest 2.25 days for this activity (Martínez-Puc *et al*., 2018).

However, apiculture is also an activity where the honey is traditionally extracted to obtain both, honey and wax. Most of the 87% of apiculturists carried out their work manually, with a production scale of three apiaries, which coincides with the national average (Magaña *et al*., 2016) and 30 hives per beekeeper. However, the number of hives can vary over time. For example, Magaña and Leyva (2011) estimated 17.9 hives and Magaña *et al*. (2016) estimated 35.6 hives per beekeeper in Yucatán. Likewise, the other two apiculture-producing entities in the Yucatan Peninsula had reduced their hives over time. Magaña *et al*. (2016) estimated 30.4 beehives for Campeche and 30.6 for Quintana Roo, Mexico, and, recently, Martínez-Puc *et al*. (2018) estimated 20.26 beehives for Campeche, Mexico, and 20.6 beehives for Quintana Roo.

On other hand, a production of 362 kg of honey was estimated per beekeeper, out of which, 50 kg were for self-consumption and 312 kg marketed in different sales points a $19 per kg price, below that registered for the municipality by the SIAP (2018) of $37.1 per kg. The average wax production was 25 kg, for self-consumption. This panorama has not changed and coincides with the primary vocation where productive diversification is limited to honey and wax.

Like the production in milpa systems, apiculture has been undercapitalized by the unfavorable economic conditions in the country (Magaña and Leyva, 2011). This decapitalization has limited the adoption of new technological practices, which means lower returns (Table 3).

The main problem identified by apiculture was the high cost of its inputs and, in sixth place, the labor shortage. In this regard, Magaña *et al*. (2016) showed that in the costs of the structure for honey production in Mexico 67.1% corresponds to variable costs, of these 31.2% corresponds to the wages value and 12.2% to food inputs acquisition such as sugar.

Another identified problem was the commercialization of the honey due to the different factors (Table 4). Studies carried out in the Yucatan Peninsula highlight that apiculturists have no bargaining power in most markets (Magaña and Leyva, 2011). Also, there are two marketing channels: 1) conventional honey for export marketed by apiculturist, local collectors, cooperatives and private trading companies and exporters and 2) conventional honey for the local market, marketed otherwise through apiculturist, local retailers and to the consumer (Pat-Fernández *et al*., 2020).

Regard pests and diseases, 94.6% of the apiculturist reported experienced a disease transmitted by the Varroa destructor mite. In another study carried out in Yucatán, Martínez-Puc et al. (2018) found that 93.1% of the interviewed apiculturist reported the presence of that disease in their apiaries. However, unlike that study where all the beekeepers knew about the mite, only 35% of the Yaxcabá beekeepers could identify the Varroa destructor mite.

Table 3. Characteristics of honey production in Yaxcabá municipality, state of Yucatán, Mexico.

Technological and management		Socioeconomic and cultural	
Species	Honeybee (*Apis mellifera* L.)	Production objective	13.8% subsistence, 86.2% sale
Applied technology	87.7 % manual, 12.3% mechanical	Type of plot	Family
Tools	Smoked, veil, alzaprima, gloves, boots, extractor, overalls.	Production scale	Number of apiaries: 3, number of hives: 30
Feeding	June-November; with granulated sugar, sugar syrup, or honey	Commercialization	34% contract with the industry, 32% direct to the consumer, 18% collection center, 12% producer organization and 4% foot of plot.
Method used	36% with feeder, 31% with plastic bottles and 33% others.	Yields (kg/hive)	4
Labors	Obtaining queens, changing panels, dividing colonies, changing queens, dealing with colonies, swarming, joining hives and capturing swarms.	Sales volume/year (kg)	312

Table 4. Prioritization of the problem for apiculture in Yaxcabá municipality, state of Yucatán, Mexico.

Problematic	Description	Classification	Strategy
1. High cost of inputs	It affects the sustenance feeding of bees during the period of scarce flowering since it is based on granulated sugar or syrup.	E	Design of competitiveness strategy with a chain approach. Differentiation of honey according to origin and handling.
2. Lack of marketing channels	It was identified that there are two marketing channels: direct sales to the consumer or contract with the industry. However, beekeepers expressed the need to improve 1) sale price, 2) quality, 3) presentation, and 4) added value.	E	
3. Low price of honey	66% of beekeepers considered that the selling price of honey $ 19 per kg was bad.	E	
4. Lack of a collection center	89.3% of beekeepers expressed the need for a collection center to improve the competitiveness of the activity.	S	
5. Lack of wax machine for beeswax in the municipality	25% of beekeepers obtain wax in an artisanal way for consumption. However, they lack the necessary equipment to obtain it more efficiently to allow them to market it.	S	
6. High cost of labor	Due to the demands of the work, labor is scarce and the available one is paid PMX $ 250/day.	E	
7. Lack of knowledge to make other products	Other products and derivatives are not obtained mainly by: 39.3% ignorance, 23.2% technical, 23.2% economic, 12.5% climatic and, 1.8% lack of market.	T	Training to obtain other products from the hive of commercial value (pollen, propolis, creams, soaps, sweets)
8. Lack of pest and disease control	89.5% of the beekeepers reported having illnesses in the colony offspring. Likewise, 35.7% reported incidence of Varroa destructor mite. Varroa destructor.	T	Training in strategies for pest control and sanitary management, strengthening hives

E=Economic; S=Social; A=Environmental; y T=Technical.

In this regard, extensionist work such as those carried out by Martínez and Medina (2011) has been carried out to promote alternative control methods such as organic acids and essential oils, which have shown good control of the mite populations and generate no resistance.

CONCLUSIONS

The milpa system is a cultural activity, its products are destined to satisfy the nutritional needs of the FPU and, therefore, the strategies to strengthen this production system should be oriented towards food security, biodiversity preservation and nutritional health of their population. However, the sociodemographic characteristics of the producers limit them to adopt new practices. Apiculture is one of the components of the milpa system and provides financial resources to FPU to finance other activities. Therefore, strategies should be aimed to further include producers in the apiculture value chain.

ACKNOWLEDGMENTS

The authors would like to thank the Mexican Federal Government through the Secretaria de Agricultura y Desarrollo Rural (SADER), for the financing granted to undergo the Diagnosis, Technology Transfer and Technical Support to meet the needs of the PRODETER traditional milpa-apiculture project number: 134224082.

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