Article

Coffee cultivation in Ojo de Agua de Cuauhtémoc, Malinaltepec, Guerrero

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Abstract

In the region of the Mountain of Guerrero, coffee cultivation is mainly cared for by the indigenous population, and its production is affected by pests, diseases, poor management of the orchard, scarce institutional support, low price of coffee and intermediarism. The objective of this research was to systematize the coffee production process in the indigenous community of Ojo de Agua de Cuauhtémoc municipality of Malinaltepec, Guerrero and detect the crucial points to improve production. By census, 35 coffee producers were interviewed through a questionnaire to gather information on the production process. The average age of the producers was 52 years with a low level of schooling, with a cultivated area of coffee of less than one hectare. Ninety-four percent grow the variety Typica or creole. The harvest involves the family, the yield is low and the production is sold to the intermediary. Sixty percent of producers obtain income from coffee farming, despite little economic support from the State and limited producer organization. These problems are common in coffee regions, so developing skills and technical knowledge with producers will allow seed selection, orchard management, organic fertilizer production, biological control, effective producer organization, solidarity economy and self-management.

Keywords: commercialization, management, organization, production.

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Introduction

Mexico, in the agricultural cycle 2016-2017, ranked eleventh as a coffee producer worldwide, contributing 1.6% of production and ranked twelfth as an exporter internationally, contributing 1.5%, after Brazil (32.2%) and Colombia (8.9%) in the Americas, Vietnam (19.1%) and Indonesia (7.7%) in Asia, and Ethiopia (4.2%) in Africa (FIRA, 2016).

Ninety-one point five percent of the national coffee production in 2019 was contributed by the states of Chiapas (35%), Veracruz (20.8%), Oaxaca (18.9%), Puebla (10.2%) and Guerrero (6.5%) (SIAP, 2019). The crop is cared for by indigenous smallholder producers living in regions with high marginalization and poverty (Robles, 2011; Aguirre-Cadena *et al*., 2012).

In Mexico, coffee cultivation represents a viable alternative to improve the living conditions of small coffee producers. Coffee farming is an activity of great relevance for the indigenous and peasant population that lives in the mountainous areas of central and southeastern Mexico, because the production and sale of this grain has historically allowed obtaining economic income for the subsistence of this segment of society (Anta, 2006). On the other hand, the coffee agroecosystem, in addition to providing environmental services, represents a space to reproduce the mechanism of generation and transmission of local knowledge through generations, which is lived in a differentiated way according to gender and age.

This collective knowledge must be understood as a local epistemology about a changing reality, from this perspective, local knowledge is dynamic and innovative (Toledo and Barrera, 2008). Under the different climatic conditions in which coffee is grown, production and commercialization are affected by factors such as: pests and diseases, low profitability, lack of stimuli for production (Morales *et al*., 2019), low prices that put it at risk, poor management and economic insolvency (Figueroa-Hernández *et al*., 2015a). In addition, the properties are in areas of difficult access, which makes it difficult to properly care for the orchard, because those responsible for the cultivation are mostly elderly people.

Despite this problem (FIRA, 2016; Medina-Meléndez *et al*., 2016; Cardeña *et al*., 2019), producers, mainly indigenous, continue to care for coffee plantations. This is due to the sociocultural and economic roots as a survival strategy for indigenous peasant families and the lack of production alternatives, as well as the lack of sources of employment.

Specifically for the state of Guerrero, in 2019, coffee, based on the established area (45 603 ha), ranked twelfth at the state level, with a production of 38 465 t and a value of $230 018.00 pesos, and an average yield of 0.94 t ha^{-1} (SIAP, 2019). The municipalities that contribute most to the production of this crop are Atoyac de Álvarez, San Luis Acatlán, Malinaltepec, Coyuca de Benítez and Iliatenco, with 82% of the state production (Landeta *et al*., 2011; SIAP, 2019).

These municipalities are located in the Mountain region, characterized by high marginalization, poverty, subsistence producers, scarce basic services, lack of sources of employment and a predominance of indigenous population (Tlapaneco and Mixteco). The aforementioned situation on coffee cultivation is present in the community of Ojo de Agua de Cuauhtémoc, municipality of Malinaltepec.

In this community, coffee is a crop considered of great social and economic importance because the population, by tradition, depends economically on it, it involves the family in the activities of cultivation, generates social relations at the time of selling the product, and due to the income of sale to the family bosom. However, it is perceived that producers have left the orchards to carry out other activities that complement family expenses. Under this logic, it is important to document the current state of the coffee production system in the community of Ojo de Agua de Cuauhtémoc so that the ancestral knowledge that the community has about the crop is not lost, since there is no evidence on the case.

Based on the above, the present research aimed to systematize the coffee production process of the indigenous community of Ojo de Agua de Cuauhtémoc, to detect critical points and have a reference that can be used in decision-making on initiatives aimed at improving the production of this crop.

Research methodology

The work was carried out in the community of Ojo de Agua de Cuauhtémoc, municipality of Malinaltepec, Guerrero, in the region of the High Mountain, located at 17° 12' 6.0" north latitude, 98° 39' 23.0" west longitude, at an altitude of 2 105 m. The total population is 505 people, of which 304 over 5 years of age speak Tlapaneco (Me' phaa) (SEDESOL, 2013). Ten point seven percent of the population is illiterate and 27.1% of the population is economically active. The main activity is agriculture, with corn and coffee being the main crops.

The research was descriptive (Padua, 2004; Tamayo, 2004). As the community is small, the 35 producers who grow coffee were interviewed, no selection criteria were applied, it was by census. The information was collected through a questionnaire with structured questions, which collected personal information, information on the properties, coffee varieties, seedbed, management of the orchard, production and its destination; as well as problems that affect the crop.

The information collected was coded and captured in an Excel database, which was analyzed using descriptive statistics with the Statical Package for the Social Sciences (SPSS) version 19 program in Spanish.

Results and discussion

Information on coffee producers

Fifty-seven percent and 43% of the interviewees were men and women respectively, with an average age of 52 years and a range between 19 to 82 years, therefore, the interviewees are of working age. Seventy-four percent of them are married, 20% single, 3% in free union and 3% widowed. The average number of members per family was 4.8, 34% of the interviewees had 3 members. Young producers have young children, older ones live alone, children have migrated to other places such as Tlapa de Comonfort, Acapulco, Mexico City and the United States of America.

Sixty percent of interviewees are responsible for household income, while 25.7% are supported by the eldest son or wife. The main sources that generate income for the family are: coffee farming (62.9%) and government programs (37.1%), such as Procampo, older adults and promotion of production. Under this assumption, 80% of the interviewees consider that they have a monthly income of $500.00 to $1 000.00 pesos, 8.6%, from $1 100.00 to $2 000.00 pesos per month.

Thirty-four percent finished primary school, 31% had no education, 14% finished high school, 12% finished junior high school, 6% and 3% primary and incomplete high school respectively; with a tendency that young people have a higher degree of schooling. On the other hand, 83% of producers carry out agricultural activities, 14% are housewives and 3% are bricklayers.

As for the women who attend the field activities, this is because husbands migrate in search of work, because in the region there are no sources of employment. Sixty-three percent of producers have more than 20 years as coffee growers, 22% from 6 to 15 years, 9% from 1 to 5 years and 6% from 16 to 20. Given this, it can be pointed out that they are producers with experience in the cultivation of coffee, despite a scarce institutional support for production and a low price of the product, as stated by 100% of them.

Characteristics of the properties

One hundred percent of producers have communal land, on average, 0.93 ha per producer. Eighty-five point seven percent have a property, 14.3% have 2 or 3 properties, from one quarter to 1 ha. Ninety-seven percent of the land was inherited and 4% bought. Figueroa-Hernández *et al*. (2015b) mention that coffee farms in Mexico have atomized, on average there is 1.38 ha per producer, due to the division of land that has been inherited to the children and the expectation of receiving subsidies from government programs. This situation coincides with what has been found in the present research, since inheriting the land to the descendants is a sociocultural phenomenon but having the hope that with it a right to government programs is obtained, this is a topic to be confirmed to understand the causes that originate that way of thinking.

Coffee varieties

The variety that predominates in the orchards is the Typica or creole (*Coffea arabica*), 94% of the producers have it, 77% as a monoculture and 23% associated and interspersed with the varieties Caturra Amarillo (11%), Caturra and Mundo Novo (12%). In Mexico, the main variety grown is Typica (Figueroa-Hernández *et al*., 2015b; López-García *et al*., 2016), which, according to the experience of producers, is the one that best adapts to the climatic conditions of the community. This allows obtaining better yield and grain quality, other varieties are more susceptible to pests and diseases, wind, rain and drought. According to Fischersworring and RoBkamp (2001), Typica can be grown from 400 to 2 000 m in height, adapting to different climatic conditions and soils.

Renovation of coffee plantations

Forty-six percent of producers have coffee plants between one and ten years old, 40% between 11 and 35 years old and the rest (14%) more than 36 years old. Seventy-seven percent of them renew plants between 8 and 10 years, 14% between 10 and 15 years and 9% every year replenish plants that dry, this depends on the characteristics that the orchard presents. The reasons for the renovation are: aged plants (53%), low productivity (38%) caused by pests and diseases and physical characteristics of the plant (size) that affect the fruit (9%).

Renovation is important to counteract physical deterioration and ensure long-term sustainable production (Fischersworring and RoBkamp, 2001). According to Rendón (2016), the renovation of coffee plantations should be carried out considering plant height, age, variety, number of plants, lost plants and the phytosanitary status of the coffee plantation. To carry out the renovation, the producers coincide with Fischersworring and RoBkamp (2001), they are practical, they visualize the physical state of the plant and production.

The renovation is carried out with plants that grow in the orchard; those of best appearance with large leaves, green and greater stem thickness are selected. This activity is carried out in a traditional way in the community; therefore, it is necessary to develop technical knowledge with the producers to produce plants with better quality for renovation, and with it, improve grain production.

Nursery and shade

Ninety-four percent of producers do not make seed selection to establish a seedbed or nursery. Seventy-four percent do not establish a nursery for the following reasons: 31% do not consider it important, 26% get the plant from the orchard, 23% mentioned being very laborious and 9% do not know how to do it and do not have institutional support to do it. Those who carry out nursery (26%), only 6% select seed from the best plants in the orchard. In accordance with the above, a program that develops the capacities of producers in the selection of seed and plant must be implemented, and consider some characteristics such as vigor, health, sustained production, age and establishment of the nursery.

This can be done with the participation of producers, which would gradually contribute in the medium and long term to generate a participatory improvement program in the community. Ninety-four percent of producers perform shade management, with this they have certain control of pests and diseases of the coffee plantation, which agrees with Rojo (2014), when explaining that environmental and humidity conditions in crop management are important for the incidence or not of diseases. The producers mentioned that these factors are controlled by thinning trees, and with it they obtain wood that they use for construction and as fuel.

The coffee production system that is practiced in the community is the 'rustic', since the management of the shade is given by natural vegetation. This system is common in indigenous regions, characterized by low yield (Aguirre-Cadena *et al*., 2012). In the system there is a minimal impact on the forest ecosystem when the lower stratum of the jungles or the forest (understory) is removed. In this regard, Moguel and Toledo (2000) indicate that the simple replacement of plants (shrubs and herbaceous) of the floor of the jungles or forests by coffee bushes is what is known as rustic or mountain system.

On the other hand, 97% of producers have planted shade species such as cuajinicuil (*Inga jinicuil* Schltdl & Cham Ex G.) (66%) and elite (*Alnus acuminata* Kunth) (26%); they are plants that retain soil moisture and serve as barriers to soil retention. For their part, Vargas and Pire (2017) found that by using *Inga jinicuil* plants as shade in coffee, the grain yield was better compared to species of another genus. In the community, despite having *Inga*, the grain yield is low. This is because production depends on several factors such as technological level (Benítez-García *et al*., 2015), management, variety, age of the plant, health, fertilization and climate.

Pruning, weed control and fertilization

Authors such as Fischersworring and RoBkamp (2001) mention that pruning increases and regulates the harvest, thereby avoiding premature depletion of the coffee tree, improving the quality of the grain and facilitating harvesting. Under this assumption, 80% of the interviewees perform rejuvenation pruning (plants of 8 to 10 years producing) and 20% of formation in coffee trees 6 to 7 months after being planted and consists of bending or tilting a part of the plant (branch) to the opposite side of where the sun rises, as recommended by the Conider (2013). No formation pruning is carried out, so it is important to know the causes or reasons, information that was not collected in the present investigation. Formation pruning causes sprouts in the branches and helps to maintain productivity over time (Rendón, 2016), not doing them, affects the yield of coffee, perhaps, this is a reason for the low yield that was found in the community.

Fifty-four percent of producers carry out two weed cleanings a year, before and after the harvest and only 46% perform one. This activity is done manually (100%) using machetes so as not to eliminate edible and medicinal weeds, and not to expose the soil to erosion. This coincides with Aguirre-Cadena *et al*. (2012), mentioning that 90% of coffee producers control weeds with machete and that 65% perform two weeds per cycle. For their part, the FHIA and the European Union (2004) indicate that indiscriminate weed control can cause soil erosion. Weed control is carried out in the shade area of the coffee tree, if there is no adequate control, there may be losses in grain yield of up to 65% (Arcila *et al*., 2007).

Producers are aware that fertilizing coffee crop favors production, but due to the high costs involved in the purchase of chemical fertilizers and the distance for their acquisition, as well as the limited availability of manure to fertilize, 43% do not fertilize. The 57% that fertilize, do so once a year (before or after the harvest), which depends on the time of the producer and rainy season. To fertilize, organic fertilizer (bovine and goat manure) and with soil obtained from the anthills of leaf-cutting ant (*Atta mexicana*) is used.

According to Fortanelli and Servín (2002), the use of ant waste is a potential resource for fertilizing in dry regions of Mexico. Fertilization is important because in addition to increasing production, there is greater plant health (Bedoya and Salazar, 2014).

To carry out optimal fertilization, it must be carried out based on the results of a soil analysis (González *et al*., 2014), a difficult technique for Ojo de Agua producers to perform. For this reason, producers continue to fertilize coffee tree in a traditional way, because of this, technicians and producers must design a chemical and organic fertilization plan that considers the selection of sources and optimal quantities for the coffee requirements in the region. This plan could be achieved through participatory training of producers on an ongoing basis. The production of organic fertilizers with local products can be an alternative to improve production, due to the high nutrient contents, in addition, the balance between the social, the environmental and the economic is achieved (Restrepo, 2006) and thus reduce production costs.

Diseases and pests

Diseases occur at different stages of plant development, in the seedbed, nursery and established planting. The most important are leak or rooster's eye (*Mycena citrocolor*) (66%) and rust (*Hemileia vastatrix*) (8%). In Mexico, coffee rust and rooster's eye are present in the main coffee producing areas, which is why they are of economic importance (SENASICA, 2014 and 2016). In the study community, the incidence of rust is less frequent, as producers keep the shade of the coffee crop under control and remove and burn diseased plants. On the other hand, the ambient humidity is low, which affects the reproduction of the fungus. The producers do not control the diseases, they mentioned that the damages are minimal and that the cost of the products for the control is high, something that they cannot afford because of their economic situation.

One of the pests is the leaf-cutting ant (*Atta mexicana*) that attacks small plants (seedbed or nursery); for control, the producers use Furadán, scattered in the soil and around the plant. This product works and the producers buy it because it is affordable. Another pest is the coffee berry borer (*Hypothenemus hampei*), which causes damage to the fruit, at an early age (drop) or ripe (fruits of low weight and poor quality). The producers who control it (71%) do it with traps and attractants (63%) and organic repellents (8%).

The health of the coffee plant affects the yield and quality of the bean, due to this situation, it is important to raise awareness among producers about phytosanitary problems and develop a program on biological control. One way is by supporting the organization and training community monitors (Rosas *et al*., 2015) or by forming health committees, taking advantage of the community's organizational structure based on practices and customs.

Harvest and destination of production

For the harvest, family labor is used, this because the producers do not have the economic resources to hire labor, as mentioned by 100% of the producers. This is carried out from December to February, usually 2 to 3 cuts must be made due to the irregularity of maturity of the fruit. However, producers (100%) make one cut per cycle (collecting green, ripe or dried fruits), which reduces the quality of the grain. The reasons why they do so is due to the low yield per area (84%) and the wages required for harvesting and moving grain from the orchard to the producer's home, which increases production costs. In this regard, Puerta-Quintero (2000) indicates that the presence of immature cherries is one of the factors that affects the quality of Mexican coffee (bitter taste).

The yield of coffee beans fluctuated from 200 to 1 350 kg, depending on the area per producer, which ranged from one quarter to three hectares. The average in two production cycles was 0.598 and 0.694 t ha^{-1} for 2011 and 2012 respectively, lower than the state average (0.902 t ha^{-1}) and national average (1.26 t ha^{-1}) (SIAP, 2018).

Producers consider several reasons why they obtain low yields as mentioned in Table 1. The existence of aged plants (low yield), damage from diseases (rooster's eye and rust), pests, rain (landslides) and wind (broken branches) stand out. These factors coincide with what was mentioned by FIRA (2016), referring to the fact that coffee production decreases due to aging plants, rust

incidence, climatic conditions and reduction of the coffee area. Obtaining higher yields has to do with greater attention to the orchard and investment (Table 1), which is related to Benítez-García *et al*. (2015), who argue that the application of technology in coffee favors bean yield.

Table 1. Reasons why there was variation in coffee yield in the harvest of the cycles 2010-2011 and 2011-2012 of the community of Ojo de Agua de Cuauhtémoc.

Low yield	(%)	High yield	(%)
Old plantations	29	More economic resources for the management of the orchard have been invested	67
Now there are more pests and diseases	26	Pests and diseases on the plantation have been controlled	17
Land no longer produces as before	23	Plantations have been renewed and now there is more production	16
There is no market, and the price is low, therefore, the orchard is not cared for	22		

Eighty percent of the producers mentioned that coffee farming is an important activity in the community, and although no information was collected regarding other sources of income, 60% consider that it is their main source of income during the year, the rest (40%) identify that the prices obtained have been very low, and therefore, have neglected the orchard.

Eighty-seven point five percent of the producers sell all the grain production in capulín presentation to the organization 'La Luz de la Montaña', others sell part of it. When the harvest is near, representatives of this organization go to the community to ensure the purchase, but at the time of selling each producer does so individually. In 2012, the kilo of dry ball or capulín was paid at $20.00 pesos, only 17% sold parchment coffee at $40.00 pesos per kilo. The amount of coffee that each producer sells is based on the presentation of the bean, the price and the needs they have to survive with the family.

The lack of incentives on the part of the State for the production of coffee has caused the demotivation of producers to care for the crop. Given this panorama, one way to revalue the crop is through the management of economic resources by producers, that through advice and training they develop capacities to improve the management of the orchard and with this, they increase production and improve the quality of the grain.

Problems and solution alternatives

Poor advice and market uncertainty are the main issues that negatively affect coffee yield and quality (Figure 1). One hundred percent of producers highlighted the importance of forming and consolidating an organization, 71% mentioned that if they organized, they could add value to the coffee bean (roasted and ground) by managing machinery and equipment for the transformation of the grain, and 29% that market options could be sought.

The organization allows agreeing on personal ideologies and visualize a union project of life, which in addition to being productive, must be self-managed (Sánchez, 2015). Therefore, it is important to seek advice and support to the organization of coffee producers in the short and medium term,

and with it, improve the production and commercialization process. This could be achieved, with the interaction of the different actors, using the internal forms of organization of the community and taking advantage of the bonds of trust that coffee producers have towards the authority that represents them.

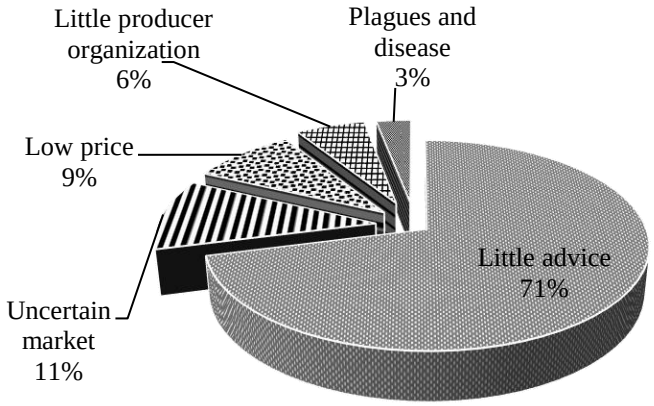

Figure 1. Problems affecting coffee production in the community of Ojo de Agua de Cuauhtémoc.

To improve attention to the coffee orchard, producers demand more training and financing (73%). Under this situation, it is perceived that producers are still rooted in the paternalism of the Government, leaving aside the possibility of self-management. Eighty-five point seven percent of them have never applied for a loan, they only invest the minimum to carry out the activities in the orchard, which negatively affects the grain yield. According to Robles (2011), the lack of incentives for coffee production affects the management, yield and income of producers.

In the community, due to the degree of poverty and marginalization of the population, a stimulus for coffee production by some institution would reactivate the importance of the crop on the part of the producers. In the absence of institutional support, alternatives for self-management and resource generation must be generated. One way is the implementation of the popular and solidarity economy, which has the common good, where the human being is the subject to address common problems (Saltos *et al*., 2016), that through accompaniment in management, they become self-managers of their own development.

Conclusions

Despite poor institutional support, poor management of the orchard, low production, little advice and technical training for producers. They maintain that coffee cultivation is an important activity that generates income during the year, so it is necessary to conserve and preserve as a way of life that contributes to the social development of the community and the territory. The main problems that affect the production and commercialization of coffee are phytosanitary, technical, uncertain market and scarce organization of producers, which could be improved if producers are self-managing to solve their own problems, strengthening the organization.

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