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Investigation note

Typification of coffee growing in Temascaltepec, State of Mexico

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Abstract

In Mexico, coffee (*Coffea arabica* L.) is grown on 644 801 ha by 500 000 producers in 15 states. The State of Mexico with 539 ha ranks eleventh in volume of production, however, it meets conditions that place it among the first three places of the 'The Cup of Excellence' competition. With the aim of typifying coffee growing in the municipality of Temascaltepec, State of Mexico, during April and May 2021, 20 producers were interviewed, 19 questions related to sociodemographic, economic, agronomic and cultural aspects were considered. The age of the producer was (56.05 years), level of schooling (8.25 years), average yield per hectare (977.5 kg), planting density (869.5 plants ha^{-1}), number of years growing coffee in the area (21.85 years), international selling price ($525.00), as ground coffee, income from the sale of cherry coffee ($9 713.35). The principal component analysis grouped the highest percentage of variability in the first two components (46.5%) and allowed the identification of three groups of growers: high, medium and low profitability.

Keywords:

Coffea arabica L, coffee grower, productivity, sociodemographic.

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For 2022, Mexico reported a harvested area of coffee of 644 801 ha, distributed in 15 states and 480 municipalities, which include more than 500 000 coffee growers, it contributes 2.41% of world production, which places it in the tenth place (SIAP, 2022) and eleventh as an exporter (ICO, 2022). Ten states stand out in production: Chiapas (40.7%), Veracruz (24.6%), Puebla (15.9%), Oaxaca (8.27%), Guerrero (4.56%) and Hidalgo (3.26%), they contribute 97.29% of the national volume (García and Lemus, 2018; SIAP, 2022).

The State of Mexico, with 539 ha planted, is considered a microproducer of coffee, although the current harvest is marginal, Morales-Ramos *et al*. (2021) mention that the conditions of climate, soil and altitude in the coffee-growing regions create an ideal environment to produce coffee of excellent quality, the municipalities of Amatepec (338 ha), Sultepec (60 ha) and Temascaltepec (55 ha) occupy 84% of the state area (CENACAFÉ, 2019).

Temascaltepec is part of the coffee-growing region of Tejupilco, although it has the potential to develop this activity thanks to the experience in the management of the crop generated by a production of more than 60 years, high geographical areas, diversity of microclimates, ideal temperatures for production, in some cases the availability of water resources and proximity to some of the main cities that demand this aromatic finished product, its development has not increased enough to go from a microproducer state to a recognized state in terms of area, yield and quality. Higuera and Rivera (2018) point out that there are problems associated with production, among which the following stand out: climate change, excessive rainfall or droughts, phytosanitary problems such as coffee rust, age of coffee plantations, among others.

Despite the minimum production, a potential in the quality of the grain as a specialty coffee is speculated, in 2018, Mr. Federico Barrueta Barrueta, owner of Finca La Ilusión, located in Temascaltepec, participated in the 'The Cup of Excellence' competition and with a score of 90.47, he reached the second place nationally and in 2021 with the participation of a washed coffee (Caturra 70%, Bourbon 20% and Typica 10%), he obtained a score of 90.13, which placed him fourth of said competition. Values that exceed those established by Morales-Ramos *et al*. (2021), who point out that the cup quality score is 81.5 ±2.8 points, for the coffee-growing region of Tejupilco.

It is relevant to study and analyze the situation presented by the production and commercialization of coffee crops, in order to detect the main problem that currently exists in the different stages of the production chain, to subsequently issue opinion judgments and alternative solutions aimed at potentiating this agroindustry (González *et al*., 2019), therefore, the objective set was to typify coffee producers in the municipality of Temascaltepec, State of Mexico.

Temascaltepec is located between parallels 18° 59' and 19° 14' north latitude and meridians 99° 49' and 100° 14' west longitude, at an altitude between 1 100 and 3 800 m. The temperature between 12 and 16 °C, an average of 700 to 900 mm of annual rainfall. It presents diversity of climates, temperate subhumid (23.98%), semi-warm subhumid and warm subhumid stand out. The dominant soil is Regosol (56.03) (Prontuario de Temascaltepec, 2009).

The field data were collected from April to May 2021 under a probabilistic sampling, which considered a population of 21 producers and each of the participants was taken as a sample unit. Twenty-one coffee growers were contacted, who were distributed in the following four localities: San Andrés de los Gama, Mina del Rincón, Rincón de San Andrés and Real de Arriba, and only 20 participants (95.23%) were interviewed. The formula by Murray and Larry (2009) was considered to determine the sample size, a questionnaire structured with variables proposed by FAO (1985) and Medina *et al*. (2016) was integrated. The questions were grouped into the following sections:

Sociodemographic aspects

Age of producer (AP), level of schooling (LS), number of years growing coffee in the area (NYGCA), number of years growing coffee (NYGC), number of permanent workers involved in the production of coffee (NPWIPC) and number of temporary workers involved in the harvest of

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coffee (NTWIHC). Economic aspects: international selling price (ISP), average yield per hectare (AYH) considered in kilograms and income from the sale of cherry coffee (ISCC) recorded in pesos.

Agronomic aspects

Area allocated to coffee cultivation (AACC), number of plantations (NP), planting density (PD), pruning in coffee crops (PCC) and type of fertilization carried out (TFC) and Cultural aspects: behavior of the inhabitants of the area (BIA), percentage of women involved in the production of coffee (PWIPC), participation in courses, workshops or diploma courses (PCWD), interested in participating in technological tours at the national level (IPTTNL) and training-instruction (TI). The information obtained was analyzed using descriptive and multivariate statistics with principal component analysis (PCA), using the SPPS statistical program.

Sociodemographic aspects

An average of 56.05 years was found in AP, similar to that obtained in Cuetzalan del Progreso, Puebla by Benítez-García *et al*. (2015), where they report an age of coffee growers of 56 years. In the LS of the interviewees, the basic predominated; with an average of 8.25 years (basic level: incomplete junior high school). Fifty percent have junior high school education, 25% elementary education, 15% high school level, 5% hold a technical bachelor's degree and the remaining 5% have no studies.

This differs from Benítez-García *et al*. (2015), who report an average of 5.6 years (basic level: incomplete elementary school) in Puebla and García-Domínguez *et al*. (2021) in the Mixe region of Oaxaca, who report 80% of illiterate (incomplete elementary school and no formal education). The NYGCA is 55.5 and the NYGC personally was 21.85 years. Thirty-five percent of the interviewees have been coffee growers for more than 20 years, 20% (6 to 10 years), 10%(1 to 5 years) and 35% (11 to 20 years), figures similar to those by Tablas *et al*. (2021) in a study conducted in Malinaltepec, Guerrero, where 63% have been coffee growers for more than 20 years, 22% from 6 to 15 years, 9% from 1 to 5 years and 6% from 16 to 20 years.

The average age of the actors corresponds to a little less than half the time they have been growing coffee in the locality under study, which suggests that they are coffee producers of the first and second generation, relatively young, but with experience. For the NPWIPC, an average of 3.6 daily workers carry out cultural work such as: replanting, land clearing, management of plant tissue (pruning), application of agrochemicals, harvest of the fruit in cherry and grain processing, among others.

For the harvest of cherry coffee, producers temporarily hire workers to speed up activities and avoid losses in the ripening of the cherries harvested. Therefore, the NTWIHC is 6.7 on average, this depends on the cultivated area, yield and the harvest period of the fruit (Benítez-García *et al*., 2015).

Economic aspects

The ISCC are around $ 9 713.75 pesos per year on average, which differs from what was reported by García-Domínguez *et al*. (2021) for a producing area of Oaxaca, which is $ 2 432.00 pesos per month from coffee growing (sale in parchment coffee). For ISP (kg), 10% export indirectly and sell it at a price between $551.00 and $650.00 pesos, mainly to the markets of the United States of America (5%) and to the Asian market (5%) at a price of $525.00 pesos as ground coffee.

A strong problem faced by coffee producers is the AYH (t ha^{-1}). Fifty percent obtain between (0.751 and 1 t ha^{-1}), 15% are between (0.501 and 0.75 t ha^{-1}), 10% less than (0.5 t ha^{-1}), 10% oscillate between (1.701 and 2 t ha^{-1}), another 10% are between (1.001 and 1.5 t ha^{-1}) and only 5% (1.501 and 1.7 t ha^{-1}) of coffee per year. The average yield is 0.977 t ha^{-1}. According to data

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from SIAP (2022), for the State of Mexico it is 1.18 t ha^{-1} and the national average is 1.5 t ha^{-1} in cherry coffee, values that indicate that they are below the state and national average.

Agronomic aspects

For the AACC, the size of the plot is 1 ha, (40%) of the growers, followed by those who have 0.5 ha (20%), the (15%) with 2 ha, the (10%) with 3 ha, followed by those who own 1.5 ha (10%) and finally with less than 2 500 m^2 (5%). Overall, 65% of respondents own less than 1 ha. Figueroa-Hernández *et al*. (2015) mention that coffee farms in Mexico are on average 1.38 ha, due to the division of the lands that have been inherited to the children and due to the expectations of receiving subsidies from government programs. For this area under study, an average area of 0.89 hectares was found.

Regarding the NP, 60% own one plot, 25% two to three plots and 15% own three to four coffee plots on different areas. Tablas *et al*. (2021) reported similar data, they mention that 87.7%have one farm, 14.3% have two or three farms, from a quarter to 1 ha. As for PD, there are on average 750 plants ha^{-1}, 50% have from 500 to 1 000 plants ha^{-1}, 20% between 351 and 500 plants ha^{-1}, 15% between 300 and 350 plants ha^{-1}, 10% range from 1 001 to 1 500 plants ha^{-1} and 5% between 1 501 and 2 000 plants ha^{-1}.

The recommended densities are 1 500 plants ha^{-1} for the varieties Typica, Bourbon and Tabi and up to 5 000 plants ha^{-1} for Caturra, densities for systems under shade, in full sun they can be increased up to twice as many plants per unit area (Arcila *et al*., 2007). For the last four years, producers have carried out PCC. Sixty percent perform this agronomic practice due to factors such as: old coffee plantations, phytosanitary problems, low productivity, rejuvenation of plant tissue and structuring of the plant.

Tablas *et al*. (2021) mention that 80% of the interviewees perform rejuvenation pruning (plants 8 to 10 years of production) and 20% formation pruning of coffee trees 6 to 7 months after planting. Fifty percent use organic fertilization, 40% do not apply any type (organic or chemical), 5% use chemical fertilization and the other 5% practice both.

Tablas *et al*. (2021) point out that producers are aware that fertilizing coffee crops favors production, but due to the high costs involved in the purchase of chemical fertilizers, the distance for their acquisition or the scarce availability of manure to fertilize, it is difficult for them, hence 43% do not do it and 57% fertilize once a year (before or after harvest), which depends on the economic availability of the producer and the rainy season.

Cultural aspects

In relation to the BIA, 60% are represented by working inhabitants, 25% without incentives to improve, 10% without any activity and 5% as cooperatives. Regarding the PWIPC, 70% of the interviewees answered that less than 20% collaborate in coffee-related activities. While 30% mentioned that the female sex participates in a higher percentage (21 to 50%), because their husbands have migrated to other regions in search of better living conditions for the well-being of their families.

As for the PCWD, 70% of the interviewees have participated in topics related to coffee and the rest do not participate (30%). They have mainly been trained by the State Committee for Plant Health of the State of Mexico (CESAVEM, for its acronym in Spanish). Rosales-Martínez *et al*. (2018) report that 60% of producers are in favor of receiving training for the management of their farms.

Training for coffee producers in Mexico is provided in 78.8% by technicians, 17.7% by producers, 2.8% by academic or research institutions and 1.5% provided by private firms (Cuevas *et al*., 2012). However, producers are interested in IPTTNL, 95% mentioned that holding some kind of event would be important for them, since they would have the opportunity to exchange ideas and experiences with producers with greater progress in the management of the crop in general.

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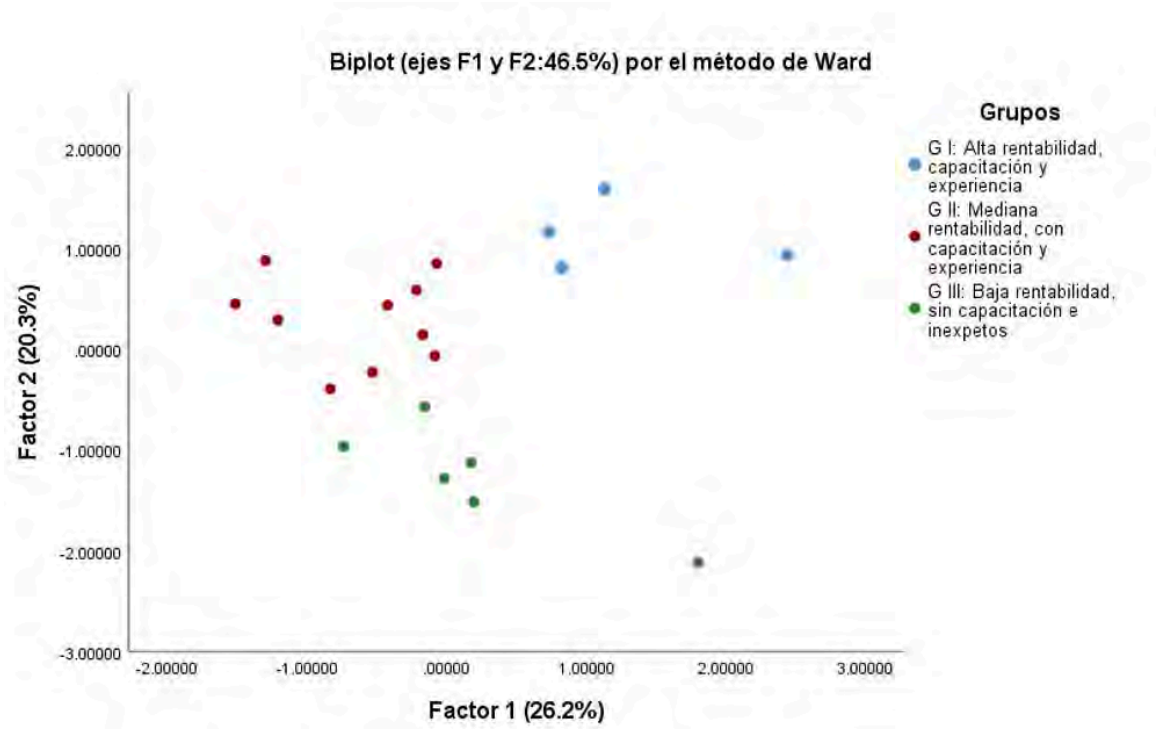
For TI, 33.7% of the interviewees require training in agronomic crop management, 33.3% in commercialization, 13.3% in product transformation (production of liquors and confectionery), 10.4% in pest and disease management, 7.9% in management of commercial varieties and only 1.25% in nutrition.

Principal component analysis (PCA)

It shows the variables that present greater variability, a total inertia of 46.50% is explained, grouped by two components that present an eigenvalue greater than 1 and by the variance of the original matrix of the 19 variables evaluated of the 20 interviewees. The first component contributes 26.2%, a construct related to profitability, consisting of the variables: NPWIPC (0.733), ISCC (0.733), ISP (0.721), AYH (0.675) and NYGCA (0.573).

The second component, composed of 20.3%, linked to the experience and training of the coffee grower with the variables associated with PCWD (0.708), IPTTNL (0.652), PWIPC (0.611), PD (0.518) and LS (0.513) both components correlated positively. Once the variables have been analyzed using the Pearson correlation technique, it can be seen in the biplot graph (Figure 1), which projects the analyzed variables and producers through a cloud of observations (coffee growers) and observations in groups.

Figure 1. Biplot that shows three groups resulting from the interaction of the studied variables of coffee producers.



Analyzed in a factorial plane of axes 1 and 2. Group I (high profitability, training and experience): Juan Barrueta, Fedérico Barrueta, Victor Barrueta and Enrrique Barrueta. Group II (medium profitability, with training and experience): Gabriel Barrueta, Cenobio Barrueta, Marcelino Barrueta, Jiosé Baltazar, Ismael Barrueta, Florina Cruz, Eustasio Denova, Marcelino Martínez, María Domínguez and María Estrada. Finally, group III (low profitability, untrained and inexperienced): Gerardo Baltazar, Lortd Macedo, Marcos Baltazar, Gustavo Vences, Leonardo González and Diana González.

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For PC2, represented by 20.3% of the variability, producers Gerardo Baltazar and Juan Barrueta are the oldest and have the most experience in managing coffee crops or NYGCA, while Mr. Marcelino Martínez has the lowest LS. In a PCA conducted by García-Domínguez *et al*. (2021), two components explain 87.1% of the groups formed.

Component 1 integrated the variables of cost of renewal of the coffee plantation, production area, sale of dry parchment coffee, 2019-2020 cycle and perception about coffee growing and for component 2, characterized by the age of the producers, years of experience as a coffee grower and level of education. Constructs that are related to the present study, in the components found of profitability (component 1) and experience and training of the coffee grower (component 2). When analyzing the interaction between variables studied with the producers, three groups were formed, which are shown in Figure 1.

Group I

It grouped four producers with high profitability, training and experience, they have invested more in production, commercialization and distribution of the product, have a trademark, export in nano batches temporarily and indirectly to the markets of the United States (California), Europe (Germany and Spain) and Asia (Korea and Mongolia), at a price of $525. They have an area greater than 2 ha, high density (greater than 800 plants per ha), better yields (one tonne of cherry coffee per ha), perform agricultural practices such as fertilization, phytosanitary control and management of plant tissue (pruning), among other cultural tasks according to the needs of the crop and the phenological calendar of the established varieties.

They grow the Typica variety in greater proportion, while Bourbon, Catimor, Caturra and Oro Azteca in minimal quantities. The educational level of the interviewees is high school education, they obtain training on their own and a member has twice won one of the first places in the quality award of the Cup of Excellence competition at the national level. They affirm that this agricultural activity is a good business option, as long as enough time and attention are devoted to each of the activities and processes comprised by coffee growing.

Group II

Composed of 10 growers of medium profitability, with training and experience, they carry out certain agricultural practices (fertilization and phytosanitary control). Some sell cherry coffee and others ground coffee locally and regionally at different prices, which range from $ 200 to 280 pesos, they grow varieties such as Catimor, Costa Rica and Typica mainly. They have areas between 1 and 1.9 ha, little plant renewal in their plots, low planting densities and yields compared to the previous group. They are under 55 years of age, have a basic level of schooling (junior high school) and consider this activity to some extent profitable and a source of income for the locality.

Group III

Formed by six coffee growers of low profitability, without training and inexperienced, they sell their cherry coffee to the first and second group, they are of advanced age (over 65 years), have a basic level of schooling (incomplete elementary school), scarce resources, they perform minimal agricultural practices in the coffee plantations, have old varieties such as Typica, have smaller area per production unit (<0.75 ha), low yields and planting densities. They obtain minimal income from the sale of their coffee and have no desire to continue as producers in this activity and have explored other options within agriculture, they consider coffee growing as an unprofitable option.

A behavior similar to that reported by García-Domínguez *et al*. (2021), who identified three groups of producers from the analysis of social, economic, productive characteristics and social perception of coffee growing in the Mixe region of Oaxaca, Mexico. This allows us to establish

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that the development of this crop follows a similar pattern of behavior in different areas of the country.

Conclusions

The integrated characterization of producers is a source of useful information for making decisions that allow defining the activities to potentiate the development of this activity as it identified three groups, the most nourished considers those of a medium technology, who, with a combination of support from the official sector and their own initiative, can migrate and increase the small group of producers of high profitability, training and experience, which, added to the combination of favorable edaphoclimatic characteristics, turns the municipality of Temascaltepec into a development pole for coffee cultivation.

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