Characterization of the *milpa* system in four rural communities

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ABSTRACT

Objective: To analyze the social and productive characteristics and the adoption of agroecological practices in family production units (FPUs) of the *milpa* system in four localities of the municipality of Tecoanapa, Guerrero.

Design/Methodology/Approach: Local agricultural producers were interviewed for a descriptive analysis. Social, technological, seed conservation, and marketing aspects of the FPUs were characterized. The research likewise included a bibliographic review.

Results: Most of the producers were men between 40 and 80 years old, with low educational levels. A high rate of youth migration (30%) was recorded. FPUs are mainly owned by families (85.7%). As a consequence of the rugged terrain, these units make a limited use of agricultural machinery. Native corn grains and bean and squash seeds are sown in the FPUs; however, some corn varieties have been lost. The income resulting from commercialization is low. Producers mainly use hand tools. As a result of their health issues and production benefits, 46.7% of producers are willing to adopt agroecological practices.

Study Limitations/Implications: Youth migration and low education levels limit continuity and adoption of technologies. The terrain hinders the use of machinery, consequently impacting productivity.

Findings/Conclusions: Despite the challenges, an interest to strengthen traditional systems through agroecological practices has arisen. These efforts could contribute to seed and grain conservation and local agricultural sustainability.

Keywords: agroecology, rural migration, native seeds, *milpa* system, family production units.

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INTRODUCTION

Milpa is an association between corn, maize, and squash. In addition, polyculture can be associated with a wide variety of domesticated and wild plants. This system provides an average of 40-70% of the food consumed by the rural population which, paradoxically, records an increasingly severe food deficit (Statista, 2021).

The *milpa* is the union of the lore, technology, and agricultural practices required to obtain the food from the land and through human labor, in order to meet the basic needs of peasant families. In addition, milpa plays a major role in the diet and is the basis of food sovereignty in many regions of Mexico (Vizcarra-Bordi, 2019).

The crops of the *milpa* are perfectly intertwined, because plants get sunlight at different heights, bean can fix more nitrogen than other crops, and squash leaves reduce weeds, retaining moisture in the soils (Gouttefanjat, 2020; Harguindeguy, 2021).

The Costa Chica of Guerrero is known by its marginal areas inhabited by indigenous people (Hernández-Soc, 2019). This region has a family-based economy; producers work in rustic production systems, obtain low yields, and frequently use agrochemicals (Hernández-Flores, 2007). Production usually takes place in a *milpa* system, where plants such as corn, squash, bean, and jamaica interact (INEGI, 2019).

The characterization of traditional agricultural systems in rural communities is fundamental to understand the production dynamics that prevail in highly marginalized areas. The municipality of Tecoanapa, Guerrero, has strong cultural roots. It heavily depends on traditional agricultural methods and germplasms. Additionally, this region has been the subject of very few scientific and social research.

Consequently, the objective of this research was to characterize the *milpa* system in four rural communities of the municipality of Tecoanapa. The aim was to identify the main associated crops, agricultural practices, and the role of local lore in this traditional system. The purpose of this characterization was to provide useful information that addresses regional agricultural challenges, related to climate change, soil degradation, and field abandonment.

The resulting information can help to identify key traditional practices that can be used to design locally-adapted and sustainable production strategies. In addition, they can be used to develop rural extension programs and public policies aimed to improve the productivity and sustainability of agroecosystems.

MATERIALS AND METHODS

Study area

The study was conducted in four rural communities of the municipality of Tecoanapa, Guerrero: 1) El Pericón (16° 58’ 45” N and 99° 19’ 18” W, at 640 m.a.s.l.), 2) Los Saucitos (16° 59’ 22” N and 99° 15’ 47” W, at 630 m.a.s.l.), 3) Huamuchapa (16° 56’ 23” N and 99° 31’ 59” W, at 720 m.a.s.l.), and 4) Villa Hermosa (16° 58’ 00” N and 99° 58’ 00” W, at 760 m.a.s.l.) (INEGI, 2020).

The following three criteria were used in the selection of the localities: i) their location within the municipality; ii) their marginalization level; and iii) the persistent use of *milpa* systems as a main agricultural practice. The first criterion allowed the research team to cover different agroecological subregions. The second criterion was based on the data obtained from Consejo Nacional de Evaluación de la Política de Desarrollo Social (CONEVAL, 2020), according to which these localities were classified as areas with a high level of social marginalization. The final criterion included the use of native plant materials and lore. These facts were verified in the preliminary interviews conducted with

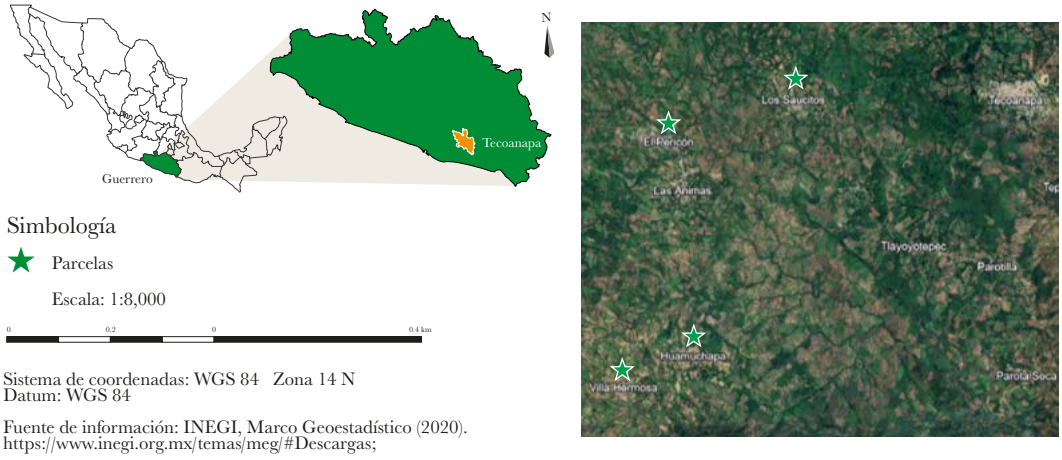

Figure 1. Location of the four localities under study, municipality of Tecoanapa, Guerrero, Mexico.

local producers and rural development technicians. These communities are characterized by subsistence economies, mainly based on rainfed agriculture, a limited productive infrastructure, and a restricted access to technical services. Most of the population belongs to indigenous or farmer groups with strong cultural roots, favoring the preservation of traditional agricultural practices. In addition, agro-climatic conditions slightly change from one locality to another, allowing a comparison of the characteristics of the *milpa* systems, under different ecological contexts but in the same municipality. The basic information of the communities was complemented with data from INEGI (2020), CONEVAL (2020), and direct field observation, in order to guarantee data reliability and scientific precision in the study design.

Sample size and selection

Sixty producers were interviewed. Producers with *milpa* systems (N=240) were chosen from the total population of each community (stratified sampling). The study included 250 (n=14), 300 (n=15), 280 (n=16), and 240 (n=15) agricultural producers from El Pericón, Los Saucitos, Huamuchapa, and Villa Hermosa, respectively. The inclusion criterion of the surveys was to select producers that still work under *milpa* systems. The management practices of the production units were characterized in semi-structured P2P interviews with key informants (*milpa* system producers) using participatory techniques.

Measured variables

The variables measured in this study included: i) social characteristics (household composition, age, education, and land ownership); ii) characteristics of the FPUs (area, crop type, and labor force); iii) agricultural practices (type of tillage, rotation, crop association, and use of fertilizers and inputs); iv) agricultural technology (machinery, equipment, irrigation system, and sowing and harvest tools); v) seed conservation (selection, storage, and exchange); vi) commercialization type (market type and self-consumption); and vii) level of adoption of agroecological practices.

These variables were chosen based on studies about farmer agroecosystems and traditional production systems (such as the milpa system), as well as in similar researches about traditional agriculture systems in Mexico (Enríquez and de Oca, 2022; Leguizamón *et al.*, 2023; Mena-Jiménez *et al.*, 2024). These variables help to understand the milpa system both from a technical and a cultural point of view, as a practice associated with socioeconomic, environmental, and symbolic features. In addition, the variables identify factors that play a role in the sustainability, resilience, and transformation of the milpa system, under a context of a high marginalization in a rural area.

Statistical analysis of the data

The database was codified and input in Microsoft Excel 2016. A descriptive statistic was developed of each interviewed group per locality. The purpose was to obtain a diagnosis of the FPUs. In addition, the SPSS v. 29.0 software was used for the analysis.

RESULTS AND DISCUSSION

Social characterization

Thirty percent of young people (18-25 years old) migrate and, consequently, most of the producers are old men, as well as women and children. These results are similar to the data from INEGI (2020) for the 2015-2020 period: 29.4% women and 70.5% men migrated from Guerrero. These figures account for 4.6% of the total migrant population. Migration is mainly caused by the lack of opportunities and income in the agricultural sector for the young population. International and domestic migration, the role of women in agriculture, and the generational change are the main causes of abandonment of the fields. Consequently, reappraising traditional agricultural systems and their contribution to food security is fundamental (Ramírez, 2021).

Characteristics of the family production units (FPUs)

The results show that 85.7% of the agricultural production units are family-based and that only 13.3% hire external workers (Table 1). Huamuchapa is the community with the highest hiring rate (18.8%). The income in the four localities is generated by the head of the family, followed by his sons, daughters, brothers, and sisters. External workers are hired only for heavy tasks. The workers are mostly men, between 15 and 78 years old. These results are similar to those reported by Conaculta (2020), which highlighted that women participation in the agricultural production has survived from generation to generation. In addition, they play a major communitary role: women are in charge of the selection of the best corncobs and the preparation of food.

The interviewees were 38- to 85-years old. The head of the families had a low education level: they learned to write and read, but they only attended one or two years of primary

Table 1. FPUs in four communities of Tecoanapa, Guerrero, Mexico.

	Saucitos (15)	**Pericón (14)**	**Huamuchapa (16)**	**V. Hermosa (15)**
Familial (%)	86.6	85.7	81.2	86.6
Workers (%)	13.4	14.3	18.8	13.4

school. Eighty-three-point-three percent of the producers of the four localities did not attend school, while 46.7% attended basic education and 15% attended secondary school. The highest rates of uneducated producers were recorded in Huamuchapa (43.8%) and El Pericón (42.9%) (Figure 2). Old uneducated producers are reluctant to adopt new technologies and to delegate responsibilities to young people. In addition, 70.5% of the local population has migrated to the cities in search of employment. INEGI (2020) points out that basic education lays the foundation for a higher or academic education. Education is a great opportunity for Mexicans (and consequently for Mexico) to reach their full potential.

Agriculture

One of the main activities of these localities was rainfed corn production integrated to a *milpa* system (Figure 3). Crops are established in plots with <60° slopes and producers use native grains and seeds. Most corn grains are used for self-consumption. Twenty-five

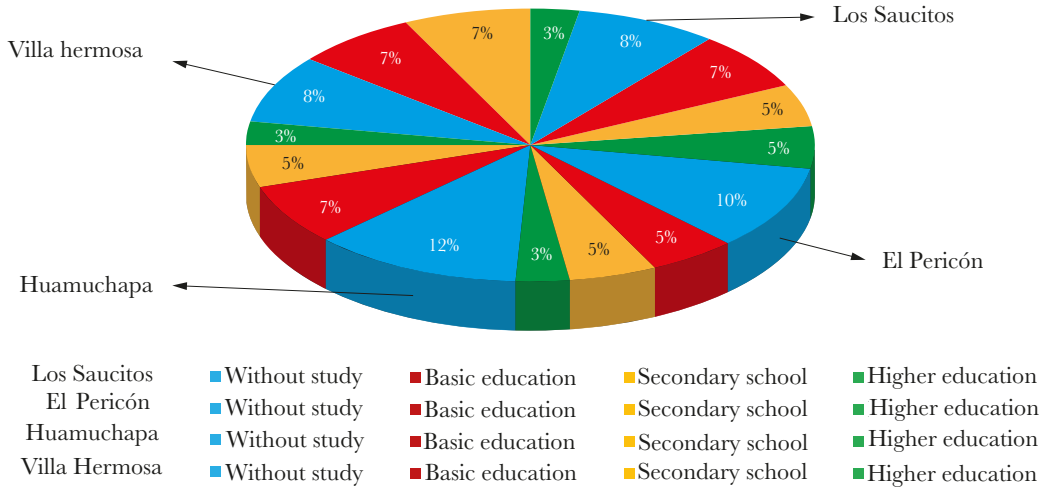

Figure 2. Education level of producers of FPUs in Tecoanapa, Guerrero.

Figure 3. Plot of the *milpa* system located in Los Saucitos, Tecoanapa, Guerrero.

percent of the grains are occasionally sold in local stores or used to feed animals. Beans are also included in rainfed milpa systems. One-hundred percent of the producers use mainly native black bean seeds. The most commercialized product is squash seeds. Not enough income is produced by this production system to support a family.

Magdaleno (2016) mentioned that most of the genetic diversity of corn is native to Mexico and is grown as native varieties in the fields of farmers, who have grown these crops for generations. Farmers prefer using native grains to prepare tortillas for their daily meals and family and communitary feasts (Castillo, 2016).

Agricultural technology

Overall, the FPUs do not employ agricultural machinery; rather they use manual tools for agricultural labors (Figure 4). Very few farmers use rental tractors, because 80% of the plots of these communities is made up of very steep slopes. In addition, these plots are difficult to access. Consequently, most farmers work their plots in the traditional way. One-hundred percent of the interviewees apply fertilizers and herbicides to their crops. Regarding the sowing density per hectare, farmers require 15, 10, and 6 kg/ha for corn grains, bean seeds, and squash seeds, respectively.

Varoto *et al.* (2019) pointed out that producers must grow their crops in these rugged areas, with steep slopes and hills. This situation limits water retention and delays agricultural processes.

Meanwhile, Moreno *et al.* (2020) mentioned that traditional agriculture provides sustainable food and seeks to implement good agricultural practices, using local technology, employing family labor, and occasionally hiring local workers.

Seed conservation for sowing

In Los Saucitos, grains are mainly conserved putting the corncobs into boxes and storing them in a dark room. The corncobs are evenly arranged on top of one another; subsequently, sulphur (S) is applied every five layers to preserve them and protect them from *Sitophilus zeamais* (Motschulsky), also known as maize weevil. This procedure allows

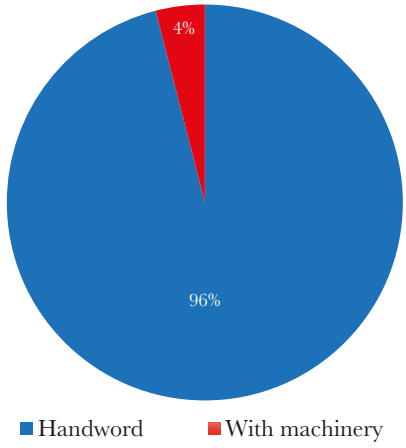

Figure 4. Work types in the four communities of Tecoanapa.

producers to keep grains in good condition (whole corncobs, without holes). Ten percent of producers uses this method. In addition, 8% of producers prefer plastic containers, because they are easier to use, although they require more space. Furthermore, some producers put the corncobs in the hearth of the kitchens, following the believe that log smoke protects them from pests (7%) (Figure 5).

Montenegro De Wit (2019) pointed out that native seeds are inseparable from the localities that have supported them throughout work organization and lore management. Finally, Torres (2016) mentioned that conserving native corn grains and squash and bean seeds is essential to strengthen the food security of local populations.

Commercialization

Figure 6 shows that the commercialization of the agricultural produce of the milpa system generate incomes between MXN$8,000 and MXN$9,000 for the four localities. Ten percent of producers obtained more than MXN$10,000 in profits. The produce was commercialized in local markets; consequently, producers are part of the local

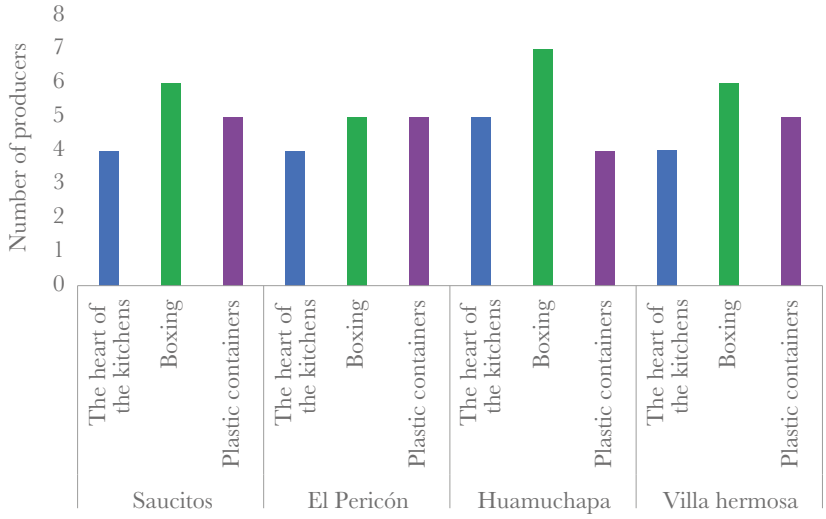

Figure 5. Seed and grain conservation for sowing in the four localities of Tecoanapa.

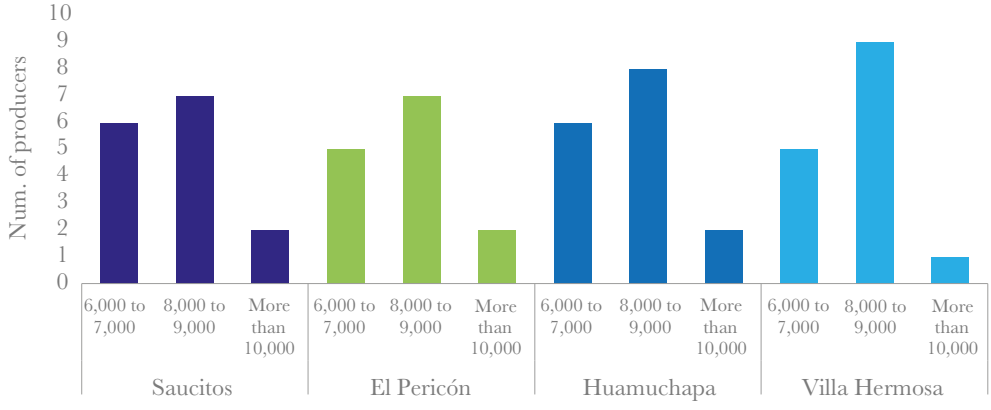

Figure 6. Income of the producers of the communities of Tecoanapa, Guerrero, Mexico.

trade economy. Meanwhile, Otero (2015) highlighted the importance of producers and consumers. On the one hand, producers are a fundamental element and are related to the way in which products are commercialized. On the other hand, consumers are interested in a given product. Finally, Muñoz-Máximo *et al.* (2017) determined that production areas receive income from local, regional, and nearby markets. They pointed out that, up to a certain point, this measure can help producers to refrain from abandoning their *milpas*.

Adoption of agroecological technology

Forty-six-point-seven percent of producers said that using agroecological products largely helps to reach a healthy life. Meanwhile, 33.3% of the producers are willing to reduce the use of agrochemicals in their plots, in order to obtain a healthier produce. Eleven-point-seven percent of the producers are willing to learn more about the use of agroecological products and, finally, 8.3% adopted agroecological products to conserve and improve their grains and seeds (Figure 7). García *et al.* (2021) pointed out that agroecology is interested in lore as an element that can provide a transition of the production systems. Lore is born from environmental experiences and the direct relationship of farmers with the ecosystem in which they live.

Regarding the adoption of agroecology, producers were questioned about their understanding of agroecological practices. Their answers included the application of manure, new farming methods, and knowledge or innovation regarding new equipment and machinery. Most of the answers from producers of Los Saucitos (53.3%) and El Pericón (57.1%) were focused on the conceptualization of agroecological practices such as farming methods, while the producers of Huamachapa (36.5%) believe that agroecological practices only include applying organic manure. One-hundred percent of the producers in Los Saucitos, El Pericón, and Villa Hermosa are willing to adopt agroecological practices, because they benefit agriculture; meanwhile, only 25% of the producers in Huamuchapa are willing to adopt agroecology, because they think that its effects are important for agriculture.

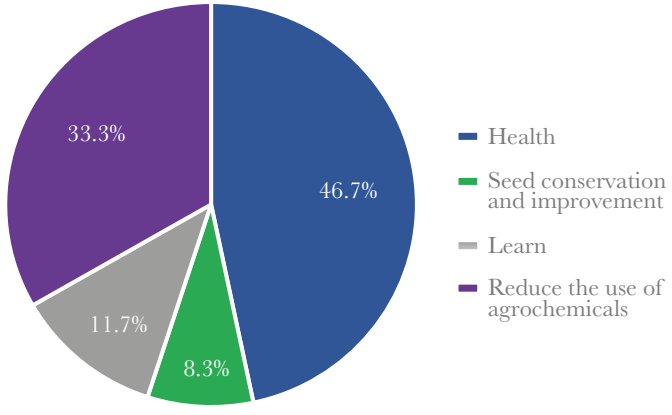

Figure 7. Reasons for the adoption of agroecological practices in the plots of the four communities of the municipality of Tecoanapa.

Questioned about their reasons for adopting these practices, the producers answered: improvement of food and health, reduction of costs, and their desire to learn about them. In Los Saucitos, 53.3% of the producers mentioned good health, while in El Pericón, 57.1% of the producers answered that they were interested in the improvement of food and its association with a higher production. In Huamachapa, 50% of the producers mentioned health as a priority and pointed out that the wide use of agrochemicals has caused health issues. The producers of Villa Hermosa also mentioned health as a main reason to adopt agroecology (Table 2).

Table 2. Adoption of agroecology in the communities of Tecoanapa, Mexico.

Variables	Saucitos		El Pericón		Huamuchapa		V. Hermosa	
	F*	%	F	%	F	%	F	%
Adopting agroecology	8	53.3	8	57.1	6	37.5	7	46.7
Practice of agroecology	15	100	14	100	4	25.0	15	100
Agricultural importance	15	100	4	28.6	6	37.5	3	20.0
Importance of agroecology	6	40.0	8	57.1	8	50.0	10	66.7

*F: Frequency.

García *et al*. (2021) pointed out that agroecology seeks lore as a transition element of the production systems. These systems are born from environmental experiences, a direct relationship with the ecosystems, daily processes, and responsible productive practices. Meanwhile, Pástor (2017) discussed the association of traditional agriculture with rainy seasons (rainfed agriculture) and crop rotation, based on an agroecological reasoning that seeks to balance and preserve ecosystems. Finally, Linck (2018) mentioned that a transition to sustainable agricultural systems must involve the reproduction of local ecological lore, based on a different logic, focused on giving and receiving benefits from ecosystems.

CONCLUSIONS

Most of the producers of the FPUs in the municipality of Tecoanapa are men between 40 and 80 years old. They have little access to education opportunities and approximately 10% of them are illiterate. Migration and field abandonment by the new generations pose a threat to the continuity of traditional agricultural practices and the conservation of seeds and grains. A loss of native corn grains was recorded: none of the interviewees still sow native *Conejo* corn grains and only 40% worked with Olotillo corn grains. Despite these issues, producers are interested and willing to adopt agroecological practices and to take part in activities aimed to strengthen their production systems.

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