AGRO PRODUCTIVIDAD

Colegio de Postgraduados

Analysis of family agroforestry production units in the altiplano Potosino, Mexico

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ABSTRACT

Objective: To understand how small producers perceive their family agroforestry production unit (UPAF) from a social, economic, environmental, and technical standpoint.

Design/methodology/approach: A non-experimental qualitative analysis of several UPAFs was conducted. The information was gathered through semi-structured interviews, direct participatory observation, and a field diary. The said information was subsequently analyzed through codification, categorization, and the development of comparative and descriptive tables for the two municipalities and the farmer families in each one of them.

Results: The UPAFs provide socioeconomic, environmental, and technical-productive benefits to the producers who have adopted and adapted this agroforestry system. Two factors have influenced the adoption of this technology: age and technical monitoring.

Study limitations/implications: The main limitation of our study was the small number of agroforestry production units analyzed, as well as the specificity of the project, which restricts the generalization of results.

Findings/conclusions: Agroforestry production units are consistent with a farmer economy because they match several of its characteristics: they are family production units with a partially mercantile nature, which require undivided family work, foster group belonging, and allow risk-taking. Therefore, these types of agroecological alternatives are viable for farmers.

Key words: Agroforestry systems, Food production, Food security, Farmer economy.

Citation: Barajas-Tejeda, S., Jiménez-Velázquez, M.A., Olivera-Méndez, A., Martínez-Saldaña, T.,& Torres-Aquino, M. (2022). Analysis of family agroforestry production units in the altiplano Potosino, Mexico. *Agro Productividad*. https://doi.org/ 10.32854/agrop.v15i3.2168

Editor in Chief: Dr. Jorge Cadena Iñiguez

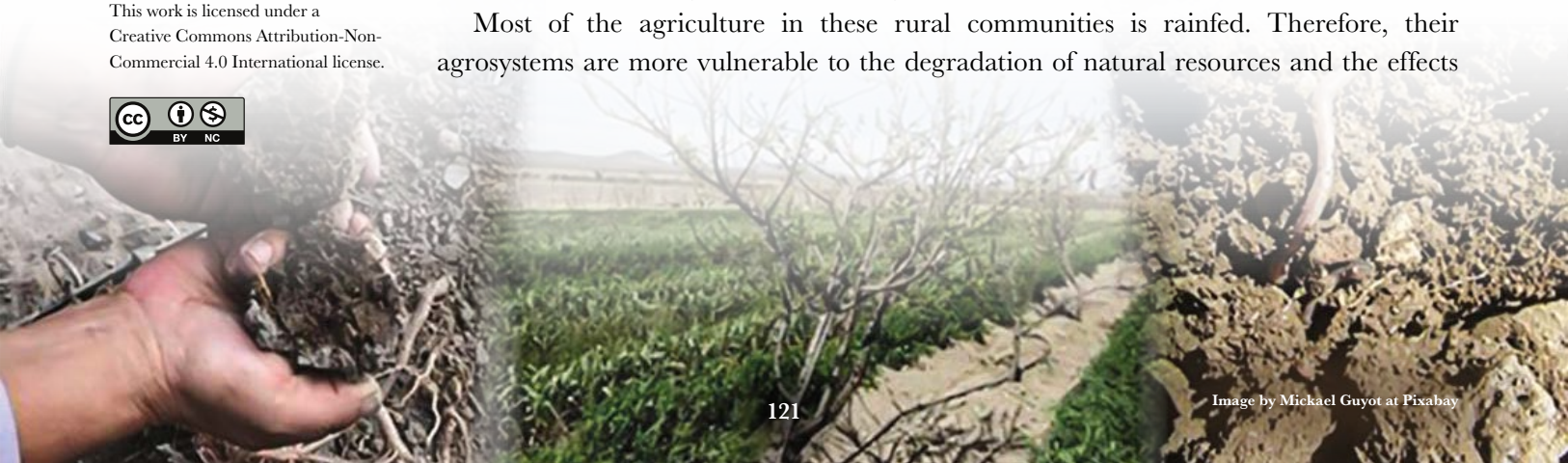
Received: October 13, 2021.
Accepted: February 28, 2022.
Published on-line: April 4, 2022.

Agro Productividad, 15(3). March. 2022. pp: 121-128.

INTRODUCTION

In Mexico, towns with less than 2,500 inhabitants are considered rural. According to INEGI (2020), 21% of Mexicans live in rural towns. There are seven highly marginalized states in the country: Veracruz, Puebla, San Luis Potosí, Yucatán, Michoacán, Hidalgo, and Campeche. Those seven states have 27.4 million inhabitants, which equals roughly one in four Mexicans (CEDRSSA, 2020).

Most of the agriculture in these rural communities is rainfed. Therefore, their agrosystems are more vulnerable to the degradation of natural resources and the effects



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of climate change (FAO and SAGARPA, 2012). Moreover, the scarce production obtained under these circumstances does not guarantee food security for their inhabitants. In this context, agroforestry production systems (SAF) are considered a potentially more sustainable technology to counter low agricultural productivity, reduce poverty, improve food security, reduce soil degradation, and mitigate the effects of climate change (Luedeling *et al.*, 2016; Kalanzi *et al.*, 2021).

The objective of this study is to understand how farmer families perceive their agroforestry production units (UPAF) from a social, economic, environmental, and technical standpoint.

METHODOLOGY

This study was carried out during February and March 2017 in nine family agroforestry production units (UPAF), which represent 52% of the total UPAFs established in 2014 in the municipalities of Charcas and Venado, in the Altiplano Potosino (Figure 1).

An UPAF is characterized by an assortment of functional plant groups growing on a single plot for the purposes of agricultural, horticultural, fruit, and livestock production. The latter focuses on the production of forageforage, which producers use to feed their small livestock with the intention of reducing the pressure that animals exert on rangelands. Additionally, livestock heads receive a high-quality forageforage that boosts their weight gain and leads to better milk production and a lower calf mortality, which in turn benefits the family's diet and economy.

A non-experimental qualitative analysis was carried out to understand how rural actors regard the agroforestry production system, and also to attain a deeper understanding of their experiences. The following social research techniques were used to obtain the data: a semi-structured interview, direct participatory observation, and a field diary (Hernández-Sampieri *et al.*, 2010).

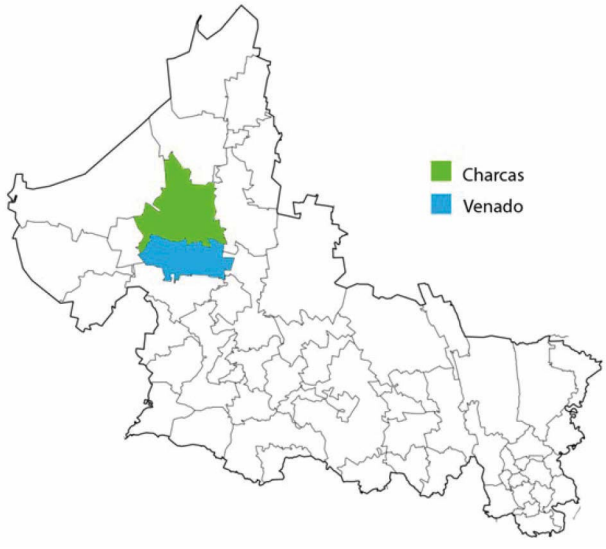

Figure 1. Geographical location of the municipalities of Charcas and Venado, San Luis Potosí, Mexico.

The interview was structured in four sections. The first one collected general information about the family. The second one dealt with the organization within the farmer family and the agroforestry unit. The third section covered the availability of natural resources and agricultural supplies for UPAFs and for rainfed agriculture. Finally, the fourth section considered the adoption and adaptation of the agroforestry technology.

Audio recordings were made during the interviews; photographs of families and UPAFs were taken. Relevant notes were registered in the field diary, both during interviews and in direct participatory observation.

Insofar as the data were qualitative, the analysis was carried out through codification, as well as descriptive and comparative tables for both municipalities and the farmer families living in each of them. Afterwards, the results were described and the corresponding conclusions were drawn, based on the comparison between the existing bibliographic information and the field collected data.

RESULTS AND DISCUSSION

The studied UPAFs have similar characteristics in terms of land tenure, production systems, crops, and production purpose (Table 1). As for the interviewed families, on average, households are made up of four members. In average, parents are 47 years old, which match the findings of other studies that point out that age is one of the determining factors for the adoption and adaptation of new technologies. Some of those articles mention a range between 44 and 49 years of age for producers that adopt such technologies (Meijer *et al.*, 2015; Dhraief *et al.* 2017). Their children's age ranges between 1 and 19 years old, while grandchildren have between 3 and 8 years old. It is worth mentioning that sons and daughters over 20 years of age have emigrated to the municipal seat, to other states of Mexico, or to the United States.

Table 1. Characteristics of families interviewed in the municipalities of Charcas and Venado, San Luis Potosí.

Characteristics of families and family production units (FPU)	**Municipality**	
	Charcas	**Venado**
Parents average age	43.7	49.7
Children's age range	1-14	12 -19
Grandchildren's age range	3	7- 8
Number of family members	4.0	4.0
Land tenure	Ejidal	Ejidal
Average hectares	6.5	5.6
Production system	Rainfed & FPU	Rainfed & FPU
Type of crop	Corn, beans, vegetables, forage, peaches	Corn, beans, vegetables, forage, peaches
Production destination	Self-consumption / commercialization	Self-consumption / commercialization
*Livestock heads	21	47

*Including cattle, goats, sheep, pigs, rabbits, and poultry.

A typology of production units was developed based on this information. It considers four aspects (social, economic, environmental, and technical-productive), which are described below.

Social aspects. The interviewed families resort to various survival strategies, including savings funds (livestock); ceremonial funds (seeds, vegetables, livestock); income funds (tax payment); and replacement funds (making their own agricultural tools, preparing the land, making chorizo and goat cheese, taking care of livestock, repairing irrigation systems, making compost, and other activities). Mora (2008) mentions that understanding the environment and integrating multiple activities guarantee an income and are the fundamental pillars of life strategies in farmer societies.

The interviews made the division of labor in the UPAFs clear. Women (wives) participate in housework, agricultural activities, product manufacturing, herding, harvesting, and marketing the surplus produce. For their part, children —mostly under 18 years of age— learn from their father about the agricultural activities carried out in the production units from an early age. In some cases, they help in the marketing of surplus produce, both inside and outside the community. Orozco and Hernández (2007) consider that farming operations in a farmer economy are based on family work, with their primary activity being the cultivation of land and the raising of livestock with limited levels of specialization. This labor division also contributes to strengthen family ties and enhances the nature of farmer agriculture, since children provide continuity for both the family production unit and the domestic unit (Jiménez-Velázquez, 2010).

Economic aspects. The family consumes less than 50% of the UPAF-grown products and sells the surplus. They use the resulting income to acquire goods that they do not produce, such as clothing, processed food, and inputs for the agroforestry unit. In order to improve the family income, some producers combine their farming activity with paid jobs (such as blacksmith, government employee, or trader). Combining primary with secondary activities is not uncommon in different production systems (Monsalvo-Espinosa *et al.*, 2020; Espinosa-Morales *et al.*, 2021). Martínez and Hernández (2016) point out that farmer domestic groups create commercial and working ties of different nature and depth, based on which they can obtain a monetary compensation for the surplus that the group does not consume and thereby obtain goods or services. According to Palerm (2009), this is a non-capitalist circulation process, a "farmer-capitalism articulation", M-D-M (merchandise-money-merchandise), wherein the farmer unit relates to society by giving shape to its productive environment, based on the production of non-transformed surpluses and unspecialized labor. Farmer units supply and sell them to society below their value.

Environmental aspects. Participant families mentioned three important environmental benefits derived from the agroforestry production system (SAF): (1) formation of soil aggregates; (2) a greater biological diversity (presence of previously-scarce insects and earthworms in the soil); and (3) a greater diversity of vegetable species. These benefits increase the scenic value of these agricultural spaces, since UPAFs are located in semiarid areas. The shrub layer and the short-cycle crops contrast with their surroundings, which is more noticeable during the dry season and in winter (Figure 2). In this regard,

Figure 2. Environmental relevance of agroforestry systems. a) Formation of soil aggregates; b) presence of earthworms; c) view of the agroforestry unit in winter.

Choudhary and Rijhwani (2020) state that the diversification of vegetable species improves microbial activity in the soil and provide habitats for beneficial insects. Similarly, the presence of an earthworm community adds value to the system, since their activities increase the decomposition of dry leaves, the recycling of soil nutrients, and the dispersal of nutrients from tree rows to crop rows (Juárez-Ramón and Fragoso, 2014).

The interviewed families reported that UPAFs achieve a larger production than the rainfed system, since they employ a gravity-fed drip irrigation system and a fertigation technique. UPAFs use 1 m^3 of water per day for production in an area of 1000 m^2. These results match the findings of Mfitumukiza *et al.* (2020), who evaluated the perception of small farmers regarding the use of technologies to adapt to draught conditions. Diversified production and drip irrigation systems were the most valued technologies, because they made higher yields possible.

Technical-productive aspects. The UPAFs located in Charcas and Venado were adapted to the reality of farmers, which involves having food available, generating an income, recovering degraded soil, and making a rational use of water. All this is associated with the production of vegetables, basic crops, and forage, which are used to feed both families and livestock heads. Moreover, these families' diet is more diversified owing to their production of other crops, such as garlic (*Allium sativum*), onion (*Allium cepa*), carrot (*Daucus carota*), coriander (*Coriandrum sativum* Linn.), pea (*Pisum sativum*), lettuce (*Lactuca sativa*), and broad bean (*Vicia faba*). For forage, they produce alfalfa (*Medicago sativa*), oats (*Avena sativa*), and sorghum (*Sorghum* spp.), depending on each crop's season. Mfitumukiza *et al.* (2017) mention that adopting agroforestry brings with it environmental benefits such as the preservation of biodiversity, the provision of goods and services, the improvement of soil fertility, and the socioeconomic well-being of small producers in dry regions. Furthermore, this technology improves the income and diet of rural families (Torres-Aquino *et al.*, 2020). Likewise, producers that worked in the agroforestry unit made the system their own; they made adjustments to the production system, including an increase in the number of crop beds and the introduction of other vegetable species (*i.e.*, agave for forage). Similarly, they showed interest in introducing medium- or long-term changes in order to breed rabbits and plant other fruit trees (like walnut or avocado).

Regarding the techniques that they learned, producers mentioned that the UPAF was innovative, because it has a gravity-fed drip irrigation and fertigation system, which allows them to save water and add fertilizers to the irrigation water. In addition, they use fertilizers adequately, make compost, produce seedlings, and do bottom fertilization, among others. It is also worthwhile mentioning that farmers are the main agents of change in their community and help other farmers to become acquainted with the new technology. Finally, the complex dynamics of the UPAF are summarized in Figure 3.

CONCLUSIONS

UPAFs are relevant for Mexico's arid and semi-arid regions because they help to improve soil quality, make an efficient use of water, and bring benefits to farmers and their families, such as food security, a higher productivity, income generation through produce surplus sales, and a reason to take root in the countryside. The complexity of SAFs fosters learning among producers, who have to show leadership and initiative to transfer technical knowledge about the installation and management of the agroforestry unit to other community members.

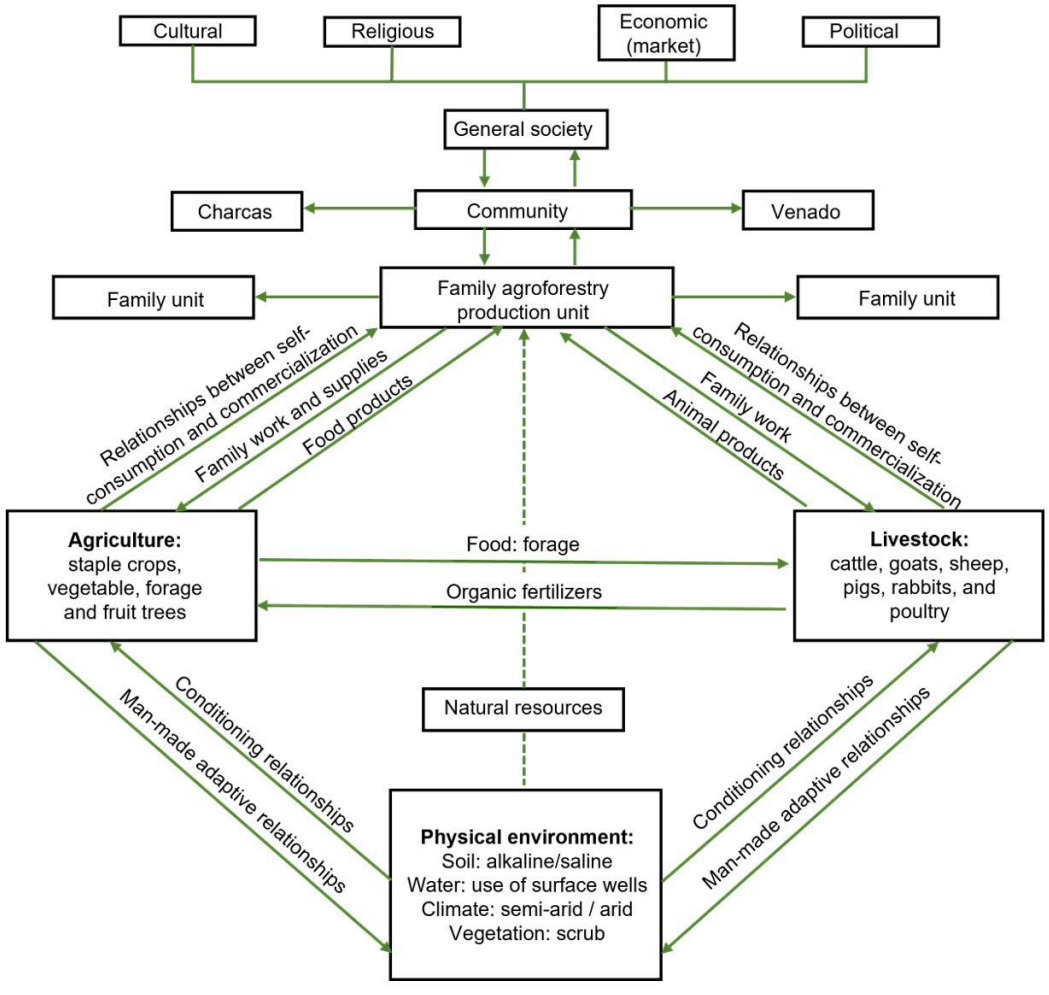

Figure 3. UPAF model (Adapted from Martínez-Saldaña, 1985).

ACKNOWLEDGEMENTS

We are extremely grateful to CONACyT for granting the first author a scholarship to complete her master's degree. We are also indebted to Fundación Coca-Cola and PRONATURA del NOROESTE, A.C. for financing the establishment of UPAFs and to the State of San Luis Potosí - SEDARH for the technical follow-up.

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