Colegio de Postgraduados

Traditional knowledge in an agroforestry system and perspectives about agroecological practices in Nahua communities

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ABSTRACT

Objective: To identify traditional knowledge associated to the traditional agroforestry system (TAFS) integrated by corn-coffee-allspice and to recognize perceptions and interests of Nahua communities towards the incorporation of agroecological practices.

Design/methodology/approach: Work was done in two Nahua communities of Cuetzalan, Puebla, Mexico, devoted to the production of corn (*Zea mays* L.), coffee (*Coffea arabica* L.) and allspice (*Pimenta dioica* Mill), in TAFS. A qualitative research approach was used, in which semi-structured interviews were conducted.

Results: A representative population sample was interviewed; 74% of the population were women, 38% was older than 65, 100% self-described as Nahua and recounted that maintenance of the TAFS is a family activity. Performing soil and organic matter conservation was manifested by 29%; 26% described promoting the diversity of species (cultivated and tolerated); 9% described establishing *Scaptotrigona mexicana* (endemic pollinator) in the plot; 65% knows an agroecological practice, and of this portion, 42% would like to use organic fertilizers, 41% considers that management of fertility and soil conservation are key to maintain the TAFS.

Limitations on study/implications: The findings reported are applicable to the context of Nahua communities in the Sierra Norte region of Puebla.

Findings/conclusions: There are traditional understandings associated to the TAFS. These have an approach of adaptation and emulation of local environmental characteristics to satisfy self-consumption. The approach of integral management of the agroecosystem tends to sustainability. The perception of the incorporation of agroecological practices is positive, and there is special interest in the management of soil fertility and conservation.

Keywords: traditional agroforestry system, sustainability, agricultural practices, perceptions.

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INTRODUCTION

Traditional knowledge is called popular wisdom, peasant knowledge, local understandings, among other; these understandings seek the recognition of unique cultures and identities to contribute solutions from a specific cultural approach (Argueta, 2016). Traditional knowledge is part of the immaterial cultural heritage and contributes to socioecological resistance, especially in small-scale agricultural systems. The participation of rural women especially contributes to the medicinal and nutritional sphere through daily practice (Ramírez-Santos *et al.*, 2019).

These understandings are related to the ways of thinking and to the territory of native peoples, which are constructed collectively. However, processes of acculturation and capitalist development threaten this knowledge, since the population adopts new cultural patterns, relegating their conservation and transmission (Argueta, 2016; Cervantes-Herrera *et al.*, 2016). Despite of this, the rural population shows interest in revaluing, recovering and disseminating agricultural traditional knowledge. In Latin America, in

the 1990s, programs of agricultural extension work influenced by the Green Revolution could not adapt to the demands that emerged from globalization and the sustainability approach. Likewise, the interaction between agriculture and ecology decreased as a result of omitting and/or surpassing ecological principles (Arcilla-Moreno, 2020; Carnero-Avilés *et al.*, 2021). This disconnect between agriculture and ecology evidenced the importance of the transmission of these understandings, so channeling these efforts is required for the dissemination of traditional knowledge about agroforestry systems (Castillo-Arriaga and Jiménez-Osornio, 2020).

An expression of traditional agricultural technology corresponds to the traditional agroforestry system (TAFS), where biocultural diversity has developed; the practices associated to TAFS transcend history, even Pre-Hispanic, with multiple strategies for the use and management of diversity, associated to diverse social groups and ecosystems. In Mexico, various types of TAFS can be identified: low-intensity plot, medium-high intensity plot and garden, forest, medium-highly intensive plot, high-intensity plot and garden, intensive garden (Moreno-Calles *et al.*, 2013). Although agroforestry systems are identified as resilient and potentially appropriate systems for sustainable production, there remains a worry about their simplification and about technologies that are inadequately transferred to the environment and culture (Illescas *et al.*, 2020). In the Sierra Norte region of Puebla, Nahua peasants call the diversified TAFS that has followed the forest and native rainforest, "Kuojtakiloyan", which means "productive forest" in the Nahuat language. The species that make up the Kuojtakiloyan are not a product of the natural succession process (acahual), but the union of ideas and the work of the peasant in consonance with regional biological and ecological processes (Toledo, 2016). The promotion of technological and educational packages in native communities has failed because it does not consider integral development, from an environment of equality, dignity and respect for free determination (Hirose-López, 2018). Therefore, it is crucial to perform studies and proposals that involve traditional understandings, to improve them, to contribute to their rescue, and to fortify existing knowledge about them (Illescas *et al.*, 2020). The objective of this study was to identify traditional knowledge that contributes to the production of corn-coffee-allspice, as well as the perceptions, limitations and interests of Nahua communities towards the application of agroecological practices.

MATERIALS AND METHODS

The study was conducted in the Nahua communities of Yohualichan and Capola, Cuetzalan del Progreso, devoted to the production of corn (*Zea mays*), coffee (*Coffea arabiga*) and allspice (*Pimenta dioica*), through agroforestry systems (Figure 1). The community of Yohualichan has a total population of 602 inhabitants and in Capola there are 328 inhabitants (INEGI, 2020).

The quandary was addressed from a qualitative research approach, seeking to delve into information collection through interview as an instrument to approach the conceptions and meanings of people. The information was obtained through the application of semi-structured interviews, technique that allows responding with more flexibility and capturing

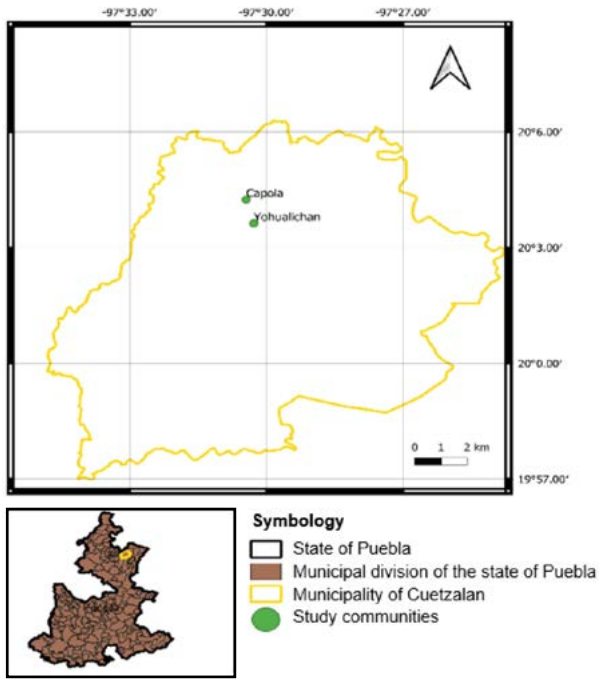

Figure 1. Study zone (Yohualichan and Capola, Cuetzalan del Progreso, Puebla). Prepared by the authors with vector information from INEGI (2020).

the detailed perception of the interview respondents (Velasco-Hernández *et al.*, 2016; Troncoso-Pantoja and Amaya-Placencia, 2017).

The semi-structured interview included the following sections: population profile, characteristics of the agroforestry system, traditional knowledge about the agroforestry system, perception about agroecological practices, and problems for the implementation of agroecological practices.

The target population was made up by men and women farmers with experience in corn, coffee and allspice farming for at least 10 years. The size of the population was 70 people, devoted to corn, coffee and allspice production in agroforestry systems in the communities of Yohualichan and Capola, Cuetzalan (Personal communication). A population sample of 34 people was estimated, with an accuracy of 10% and the normal distribution value of 1.65 and reliability of 90%, through the following formula (Castañeda-Guerrero *et al.*, 2020):

$$n = \frac{NZ^2 Z^2_{a/2} P_n q_n}{Nd^2 + Z^2_{a/2} P_n q_n}$$

N=total population of peasants involved in the corn-coffee-allspice agroecosystem; n=size of the sample population selected randomly; d=accuracy (10%); $Z^2_{a/2}$=reliability (90%)=1.65; P_n=0.5; q_n=0.5

The information collected was systematized in a database and analyzed through descriptive statistics.

RESULTS AND DISCUSSION

Profile of the population and characteristics of the agroforestry system

Of the people interviewed, 74% were women and 26% were men (Figure 2A). Within the age groups, the one that concentrated the greatest number of people is older than 65, followed by the group of 31 to 50 years of age (Figure 2B). The population interviewed has occupations in addition to farming, which are mostly domestic work and the elaboration of crafts (59% and 15%, respectively) (Figure 2C).

Of the population, 91% manifested they do not receive government backing to maintain the TAFS (Figure 2D); 94% responded that they had land of their own, although most have plots with a surface of <0.5 ha (Figure 2E and F).

All the population interviewed (100%) mentioned identifying themselves as Nahua and speaking Nahuat as native language, in addition to mentioning that two or more members of the family are involved in the maintenance tasks of the agroforestry system.

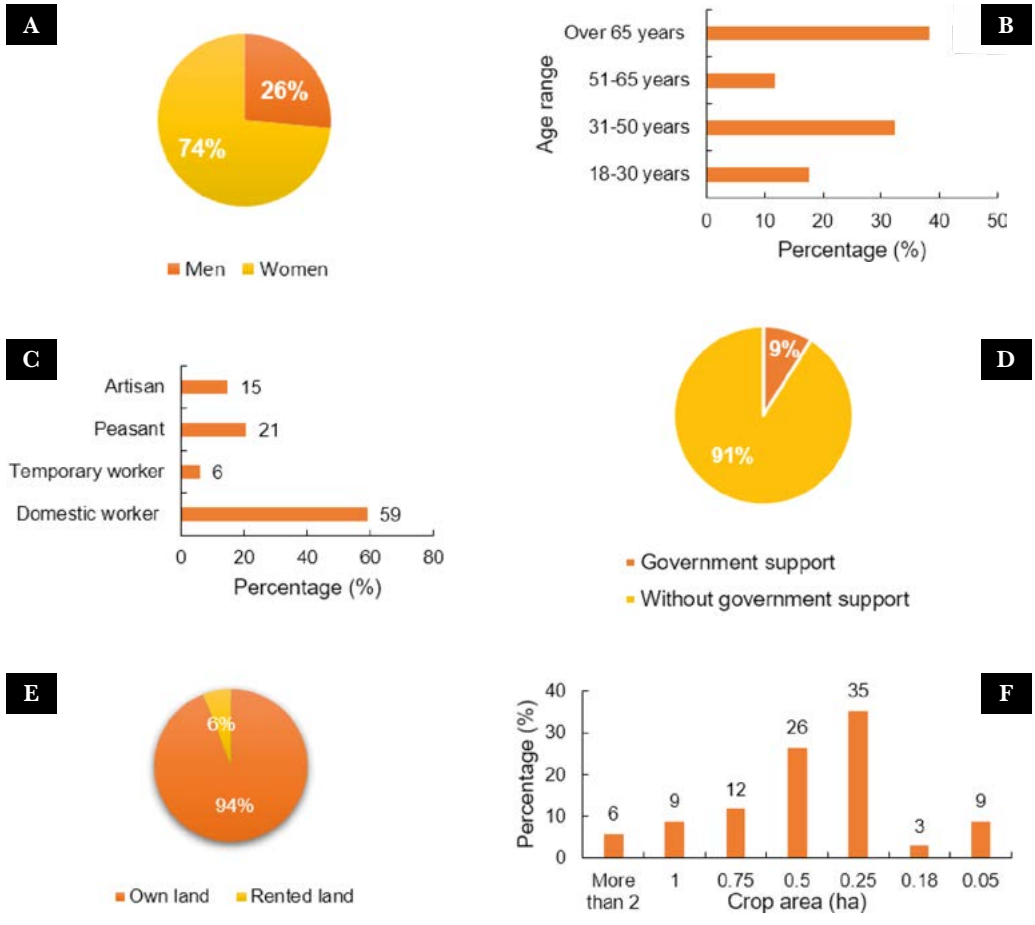

Figure 2. Profile of peasants that cultivated the corn-coffee-allspice agroforestry system in Nahua communities of Cuetzalan, Puebla. Field work 2022. A) Sex; B) Age; C) Additional occupation; D) Reception of government backing; E) Land ownership; F) Farming surface.

Practices associated to the management of the TAFS

As part of the ecological knowledge, the people interviewed described that they identify the Melipona bee (*Scaptotrigona mexicana*) or psilnekmej (in Nahuat), as a beneficial insect associated to the TAFS, because of its role as pollinator insect and honey producer. This confirms that the population interviewed identifies the beneficial action of pollinator insects on the productivity of agroecosystems and turns this knowledge into an agricultural practice associated to the conservation and sustainability of the agroecosystem (García-García *et al*., 2016; Collantes *et al*., 2023).

Stingless beekeeping in Mexico has pre-Hispanic origins as described in the Tro Cortesiano codex from Madrid where it is mentioned that Maya deities would conduct beekeeping practices of the stingless bee, *Melipona beecheii*. For their part, in the Sierra Norte region of Puebla, las Huastecas and Totonacapan, native populations designed pots to breed the *Scaptotrigona mexicana* bee. Nahua people classify insects between predators and reciprocal. In the predation group, parasites are identified which affect human beings and corn, among others. In the other extreme, there are beneficial insects, including bees, the only insect with a mystical relationship with people, demanding good behavior from inhabitants of the household, since they consider that their permanence depends on it (González-Acereto, 2012; Beaucage and Taller de Tradición Oral Totamachilis, 2017).

Considering that traditional understandings lead to agricultural practices associated to TAFS management, the people interviewed mentioned establishing the Melipona bee at the beginning of each production cycle in the plot or near it, as a way to improve production to favor pollination of the plants (Figure 3A and B).

There is evidence of the domestication of the Melipona bee by the Nahua people, who manage hives in two pots, one inverted over the other, with a small orifice (Beaucage and Taller de Tradición Oral Totamachilis, 2017). The communities that manage stingless bees identify their life form and their habitat, the time of day when they go out to feed, the places where they are found, and the plants that they prefer to collect nectar and pollen from: jonote (*Heliocarpus appendiculatus*), mahogany (*Swietenia macrophylla*), carboncillo (*Ocotea puberula*), black cherry (*Conostegia xalapensis*), orange (*Citrus* sp.),

Figure 3. Practices associated to management of the TAFS in Cuetzalan, Puebla. A) Melipona bee (*Scaptotrigona mexicana*), B) Establishment of the Melipona bee within the TAFS to favor pollination.

coffee (*Coffea* sp.), allspice (*Pimenta dioica*), chalahuite (*Inga* sp.), and guava (*Psidium* sp.) (Castillo-Hernández, 2022).

Similarly, it has been recognized that the development of stingless beekeeping helps to take care and propagate biodiversity of specific environments (Contreras-Cortés *et al.*, 2020); in this study, the interview respondents recognize that the species described before are part of the TAFS, which means that the communities have identified the relationship of mutualism between Melipona bees and some agricultural species and have strengthened this relationship through their integration in the composition of the Kuojtakiloyan (Toledo, 2016).

Likewise, the population interviewed described those seeds from perennial plants such as cinnamon, coffee and allspice, which germinate in the plot as part of the natural regeneration of the Kuojtakiloyan, are taken to the family nursery and then used to renovate plants or to occupy available spaces within the TAFS. This practice is constituted as a way to build self-sufficiency of the TAFS by decreasing the dependency on external inputs and where it is recognized that each plant is important, so the conditions for their development are generated (Figure 4 A-B). In addition, the people interviewed indicated that the ash that is produced by cooking with firewood, the manure produced by backyard animals (pigs and birds), the organic residues generated while cooking, in addition to the pulp of cherry coffee when it is processed, are taken to the plot, especially when the perennial plants are renovated (coffee, allspice, cinnamon) in the TAFS, incorporating these organic residues into the stumps. Through anthropological studies, it has been identified that in the states of Tlaxcala and Puebla, inhabitants contemplated the periodic incorporation of organic matter into agricultural systems, such as green fertilizers that are byproducts of the plot and manure obtained from domestic or wild animals (bats) and human feces, since 1000 BC (González-Jacome, 2016) (Figure 4C).

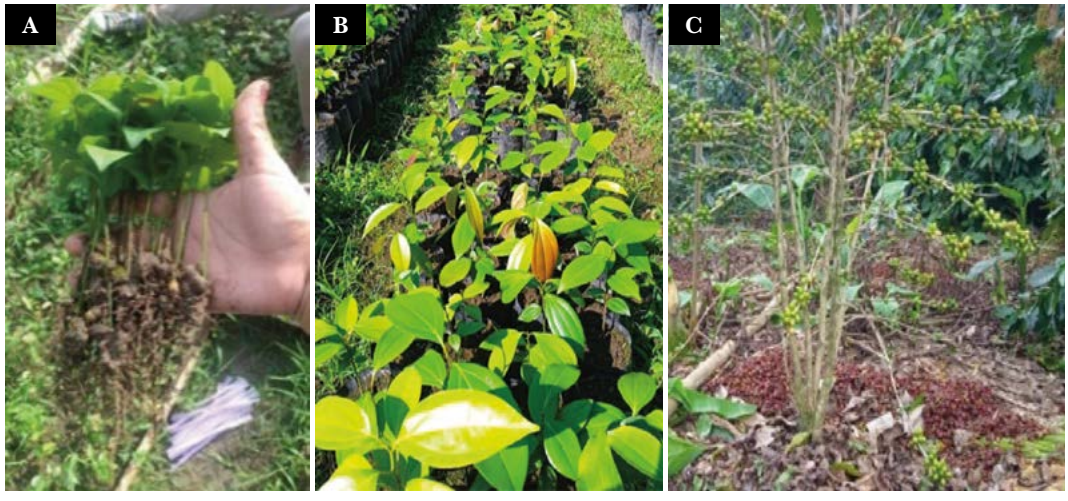

Figure 4. Practices associated to the management of the TAFS in Cuetzalan, Puebla. A) Natural regeneration of the Kuojtakiloyan, B) Family nursery used for the renovation of plants obtained through natural regeneration of the Kuojtakiloyan, C) Addition of organic residues as management practice of the TAFS in Cuetzalan, Puebla.

Farmers explained that they conduct activities for soil conservation through drains in the plot, and earthenware pots or individual terraces for perennial plants (*Coffea arabica*, *Pimienta dioica*, *Cinnamomum zeylanicum*, *Citrus* sp.), which are covered with fallen leaves or branches when the trees are pruned (Figure 5A). Terraces are an ancient system that was used since approximately 1700 BC, until 1200 years BC. In the year 1000 BC, the population of Tlaxcala increased the number of terraces, most of these managed only to farm and they were grouped with drains, dams, and reservoirs to decrease the speed of water and erosion (González-Jacome, 2016). Simultaneously, another practice identified is the conservation of organic matter that is produced in every productive cycle, that is, burning of the harvest residues is avoided, promoting their incorporation into the plot.

On the other hand, the people interviewed described that they promoted the high diversity of associated species (between those cultivated and tolerated) in the TAFS, with the following being the most common: coffee (*Coffea arabica*), allspice (*Pimienta dioica*), corn (*Zea mays*), bean (*Phaseolus vulgaris*), cinnamon (*Cinnamomum zeylanicum*), vanilla (*Vanilla planifolia*), plantain (*Musa balbisiana*), wild banana (*Musa rubra*), roatan banana (*Musa paradisiaca* var. cavendish), mamey sapote (*Pouteria zapota*) chicozapote (*Manilkara zapota*), white cedar (*Cupressus lusitanica*), tomato (*Solanum lycopersicum* L.), chiltepín (*Capsicum annuum* var. *glabriusculum*), chamaki (*Heliconia rostrata*), white pine nut (*Jatropha curcas*), valletilla or huitziquitenqui (*Hamelia patens*), chalahuite (*Inga* sp.), Persian lime (*Citrus latifolia*), orange (*Citrus sinensis*), mandarin (*Citrus reticulata*), lemon (*Citrus limon*), ataulfo mango (*Mangifera indica*) (Figura 5 B).

Finally, they mentioned that they avoid the application of agrochemicals, especially the use of herbicides, since according to their experiences, their use affects the emergence of medicinal plants and wild edible plants; the soil humidity is kept for less time because the plant coverage decreases, in addition to rainfall causing loss of soil when there is no plant cover. The traditional knowledge identified in the Nahua communities of Cuetzalan

Figure 5. Practices of soil conservation in Traditional Agroforestry Systems (TAFS) in Cuetzalan, Puebla. A) Terrace covered with fallen leaves and branches, B) Diversity of associated species.

is related to the ecological understanding and the management of the agroecosystem. According to Vázquez-Pérez *et al.* (2020), the systematization of knowledge and the compilation about traditional management favors the maintenance of biodiversity in the communities and their livelihoods.

Perception and problems of the implementation of agroecological practices

With the intention of identifying the assessment of the population of agroecological practices, there were questions about whether there is interest for the implementation of these practices, if there is prior knowledge about them, and the possible difficulties in the case of their implementation. According to the perceptions recorded, 65% has previous knowledge about the agroecological practices and has used at least one, 12% mentioned that although they know agroecological practices, they have not put them into practice, 24% said they ignore this type of practices or they do not think they are viable and therefore have not performed them (Figure 6A). Of the people interviewed that understand agroecological practices, 42% mentioned that they would be interested in promoting soil conservation practices to avoid soil erosion and keep its fertility, such as fertilizers (biofertilizers, composts, among others), level curves, construction of terraces, etc., 23% mentioned that they would like to know about alternatives to the use of agrochemicals, 19%

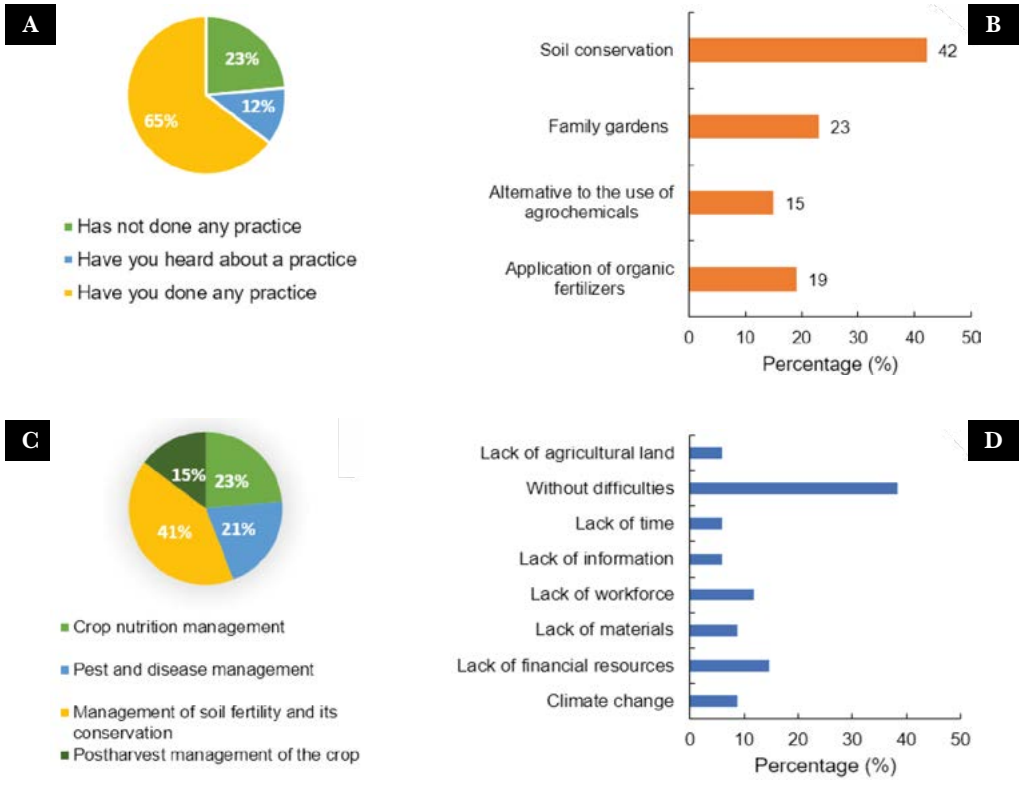

Figure 6. Perception about agroecological practices in Nahua communities of Cuetzalan, Puebla. A) Prior approach to an agroecological practice; B) Agroecological practice that they would like to know; C) Practices that are considered of more importance to maintain the productivity of the TAFS; D) Possible difficulties to face for the application of agroecological practices.

to know practices to improve plant nutrition, 15% want to know practices that strengthen the production of nursery plants since currently the demand for plants that are required in the TAFS are not reached through natural regeneration and they must resort to purchasing plants in local nurseries (Figure 6B).

These appraisals agree with what was reported in other communities of Puebla, where a good assessment about the effects of organic fertilizers on agricultural production is identified and, primarily, on the soil (Huerta-Muñoz *et al.*, 2018). Of the interview respondents, 41% consider that in order to increase and maintain the productivity of the TAFS, it is necessary to devote more time and resources for the management of soil fertility and conservation (Figure 6C). Lastly, some of the difficulties foreseen for the application of agroecological practices are the lack of resources, scarce workforce, and the effects of climate change (droughts, extreme temperatures, hurricanes, torrential rains) (Figure 6D); these aspects have been reported by other researchers as well (Reyes-Reyes *et al.*, 2020).

CONCLUSIONS

There is traditional knowledge associated to the practices that are conducted in the TAFS in Cuetzalan, Puebla, which have been transmitted in a general way, primarily between families and within each community. Some of the traditional practices that stand out are those associated to soil conservation, plant nutrition, and strengthening of symbiotic relationships. The interest in agroecological practices by inhabitants was focused primarily on the management of soil fertility and plant nutrition. There is a vision of Nahua peasants associated to maintaining the agroecosystem and its integral functioning and not only to the increase of productivity, so it could be considered as a vision linked to agricultural sustainability. It is important to continue focusing studies on the perspective of interests and the cultural and environmental pertinence for Nahua communities of Cuetzalan. The practices identified in the TAFS contribute to the construction of sustainable agricultural production, although more studies are required from a holistic view to strengthen their productivity and to maintain the stability of the agroecosystems.

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