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Food security strategies of an indigenous community in Veracruz, Mexico

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ABSTRACT

Amidst most indigenous groups in Mexico, traditional knowledge still prevails which constitutes local strategies that address the issue of food insecurity. This study aims to analyze the body of Traditional Agroecological Knowledge (TAK) of Nahuatl indigenous community of Ocotal Texizapan, Tatahuicapan, Veracruz, to understand the strategies practiced to achieve food security. Participatory observation and semi-structured and in-depth interviews at the household level (n = 20 families) revealed that Traditional Agroecological Knowledge and local life strategies are linked to the "milpa" (traditional agroecosystem), home gardening, gathering, hunting and fishing activities which are key components to achieve food security at the family level. Rain-fed and "tapachole" (residual humidity) milpa, based on sowing maize intercropped with several crops, are closely-related to direct empirical knowledge, the rational use of available natural resources, family labour, and local knowledge. Currently, changes in land use and the use of agrochemicals are increasing in the study community and depleting biodiversity affecting food security at the family level: a situation that endorses the importance of traditional agriculture (milpa), backyard livestock (hens, ducks, pigs) together with gathering, hunting and fishing among the Nahuatl families.

Keywords: Ethnomycology; Ethnobiology; Traditional Mycological Knowledge.

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SIGNIFICANCE STATEMENT

This is an original and unique research carried out in the community of Ocotal Texizapan, Municipality of Tatahuicapan de Juarez, Veracruz, Mexico regarding the Traditional Agroecological Knowledge (TAK) and the milpa and use of available natural resources to cope food security. It highlights the local agricultural strategies settle down by the household to meet their basic needs and ensure survival and social reproduction. It provides relevant information on ethnobiological knowledge, worldview, agricultural practice and traditional knowledge in the use and exploitation of cultivated and wild species in its territory, and the cultural significance of agrobiodiversity for the community. Aspects that together make it possible to achieve food security, social cohesion and strengthen cultural identity.

INTRODUCTION

The Food and Agriculture Organization of the United Nations (FAO 2011) recognizes that traditional knowledge of indigenous communities in Latin America plays a key role in eradicating hunger, food insecurity and malnutrition. These three closely linked issues form an immense challenge to address in many developing countries for multiple reasons. FAO (2013a) holds that food security exists when all people at all levels (individual, home, nation, global) have at all times, physical, social and economic access to sufficient, safe and nutritious food to meet their daily energy needs and food preferences to lead an active and healthy life. This core definition fails to fit neatly, however, when it is transferred to the contexts of indigenous groups, in the following four dimensions: a) physical availability, b) access, c) utilization, and d) stability. Worldwide, food security is one of the Sustainable Development Goals due to the following global concerns: a) 821 million 600 thousand people continue to suffer hunger throughout the world, mainly in developing countries, forming a permanent challenge to the Zero Hunger Objective, which is to be met by 2030; b) More than 2 billion people lack access to safe, nutritious and sufficient food; c) Obesity continues to increase worldwide, especially among the young; d) Accelerated population growth is continuing with an estimated 9.7 billion people by 2050; and e) A change in diet linked to the unhealthy lifestyle associated with a greater consumption of meat, dairy products and refined flours. It is necessary to produce more and better food in efficient and sustainable ways to feed the growing worldwide population, while minimizing health risks, and improving as well as encouraging a more rational use of natural resources such as water, energy (fossil fuel) and soil (Hol-Gimenez et al. 2012). It is also important to (re)value existing, indigenous food systems as these are often predicated upon healthier, more diverse, and local food production and resource utilization contexts (FAO 2013b).

One of the current challenges at the global level is how to achieve acceptable levels of food and nutritional security based on a constant growing population, while at the same time mitigating negative externalities towards the environment (Godfray et al. 2010). In Mexico, the majority of indigenous communities continues to live in conditions of poverty, hunger, and malnutrition (Urquía-Fernández 2014), even though the issue of food security has been on the national agenda since the global financial and food crisis of 2008. The National Constitution was modified in 2011 to recognize food as a fundamental human right (Urquía-Fernández 2014) and eight years ago, the "National Crusade against Hunger" campaign was established, giving rise subsequently to the national "Mexico without Hunger" program, which was included in the National Development Plan 2013-2018 (González-Martell et al. 2019).

Agrobiodiversity is an essential component to achieve food security (Kahanne et al. 2013). Mexico ranks as one of the 12 most biodiverse and multicultural countries (Vidal and Brusca 2020). It is also listed as one of the world origin and domestication centers of commercial and native crops (Damania et al. 1998). In fact, 15.4% of this genetic diversification is constituted by the world´s food system, which enables the persistence of traditional agricultural systems, mainly in indigenous territories and rural communities (Boege 2008). The food system in indigenous communities is based on 1000 to 1500 food species, while the global food system is limited to nearly 120 species that supply 90% of food (Boege 2008; Boege 2009). This signifies a risk in the reduction of worldwide agrodiversity and a threat to traditional agroecological systems, as well as the resilience and long-term survival of indigenous people.

Indigenous communities, in Mexico, are characterized by their contact with their environment, traditional agriculture, and their capacity for cultural adaptation and resilience. In addition, indigenous peoples have contributed to the plant domestication that today feeds almost the entire worldwide population (Boege 2008; Boege 2009). Traditional knowledge and agrobiodiversity, thus, help to address food security through the merging of indigenous knowledge with their agricultural strategies (Toledo 2009; Toledo and Barrera-Bassols 2008). Peasant knowledge is, thus, depicted as being formed by a "corpus", reflecting the set of symbols, concepts, and perceptions (kos-

mos), of a cognitive system with rationalities different from those of science and a praxis, understood by the set of operations through which the appropriation of nature and its processes take place. In fact, traditional ecological knowledge is defined as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes et al. 2000). FAO (2018), pointed out the need of strengthening traditional knowledge to eradicate hunger, food insecurity and malnutrition. But it also depends on rescuing and reassessing this knowledge among the new generations. Therefore, it is important not to lose biodiversity but also the knowledge about this biodiversity. More research is needed to identify the relationships among traditional indigenous knowledge, food security issues and local strategies.

Frequently, regions with a huge presence of indigenous population in Mexico tend to have high levels of poverty. In 2014, there were 55.3 million people living in poverty (Coneval 2014), of which 8.7 million (72%) were indigenous. An estimated 45.5% of these lived in moderate poverty and 26.5% in extreme poverty. Certain strategies have been proposed to fight against food insecurity among vulnerable groups, such as women, the indigenous, the elderly, and children (Coneval 2015). One of these programs began in 1988 under the name "Solidarity", which was later called "Opportunities" (2002-2014), and then "Prosperity" (2012-2018) (González-Martell et al. 2019). However, all these programs that aim to reduce food insecurity have been based on economic subsidies that allow beneficiaries to access a basic food basket lacking in adequate nutritional balance in terms of caloric intake, nutritional quality and food preference. This has led to the abandonment of the agricultural fields, a lowering in agricultural production and malnutrition, as well as causing health and poverty problems.

Many international agencies and development organizations (FAO, IFAD, OECD, Oxfam, WHO and WFP) have incorporated the issue of food security on their agendas mainly in response to the failure of industrial agriculture to achieve food security worldwide, especially in developing countries. These issues have been brought to the international academic arena (Gordillo and Méndez-Jerónimo 2013). However, despite agricultural modernization, traditional agriculture in Mexico still remains an important agricultural subsector that contribute to the stability and food production among rural and indigenous communities (Ocampo and Escobedo 2006; Escalante and Catalán 2008). México devotes 32 million hectares (md ha) to labor land, of which 6.3 million have irrigation and 25.7 million are cultivated under rainfed conditions. A total of 66% of these labor lands are managed in small traditional production units with less than 5 ha each (Robles 2007; Turrent et al. 2017). Ancestral practices of small-scale, agroecological agricultural practices and self-subsistence production methods are gaining recognition worldwide (Toledo 2005; Sen 2005; Boege 2009; González-Jácome and Reyes 2014). Research indicates that indigenous traditional knowledge contains the potential to guarantee food security (FIDA 2016). Research on how indigenous knowledge contributes to and interacts with issues such as food production and security, however, is still only in its early stages.

In general, few studies exist on the Nahuatl community of Ocotal Texizapan in the southern part of Veracruz, Mexico, and focus on the main role that agrobiodiversity plays in their local indigenous strategy to alleviate food insecurity (Leyva-Trinidad et al. 2020). This article aims to address the following two research questions: What local strategies enable the Ocotal Texizapan community to manage and address their local food and nutritional insecurity problems? And how is indigenous agroecological knowledge related to food security among Ocotal Texizapan families?

MATERIAL AND METHODS

This study took place in the community of Ocotal Texizapan, located in the Municipality of Tatahuicapan de Juárez, Veracruz, Mexico from June 2014 to May 2015. The community of Ocotal Texizapan borders to the north with the community of Plan Agrario (Popoluca culture), to the south with the municipal seat (Tatahuicapan de Juárez), to the east with the community of Encino Amarillo, and to the west with the community of Mecayapan. The latter three communities belong to the Nahuatl culture[1] (Figure 1). Geographically, Ocotal Texizapan is located at 18∘ 16' 30" NL and 94∘ 49' 00" WL, in the foothills of the Sierra de Santa Marta (Santa Marta Mountain range) and the San Martin Pajapan volcano at an elevation of 300 to 400 masl (INEGI 2010). The climates in the area are warm and humid with rains almost all year (65%), warm humid with abundant rains in summer (31%) and semi-warm humid with year-round rains (4%) (Gobierno del Estado 2006). The average annual temperature ranges from 23 ∘C to 30 ∘C, with a minimum temperature of 16 ∘C. The average annual rainfall ranges from 2,500 to 4,000 mm (Alatorre 1996). It has a population of 319 inhabitants; all are Nahuatl language speakers. Their degree of marginalization is high due to the lack of access to health

[1]The name "Nahua" is used by scholars to designate people who speak Nahuatl as a language.

services, social exclusion, and poor living conditions (INEGI 2010). The area´s main ecosystem is pine-oak forest (Gobierno del Estado 2006), and the main economic activity is agriculture, especially maize cultivation based on the milpa system (Alatorre 1996). The community of Ocotal has an area of 845 hectares and consists of 34 campesinos (farmers); each of them possesses an average 20 ha.

This community was selected because it met the necessary conditions to be able to learn about the study phenomenon (traditional knowledge, agrobiodiversity and traditional agroecosystems). In addition, families still practice activities related to subsistence agriculture with which they complement their needs for food, health, economic income and social relationships. They also preserve their language, culture and traditions. Another important aspect was that the community was flexible and safe, due to the prevailing violence and ignorance of the language and not having affinity with the Nahuatl culture.

Research methods consisted of an ethnoecological-ethnographic approach (Maffi 2005) that facilitated access to the community´s traditional knowledge, as well as, to its empirical practices and belief system. The social science research techniques utilized were participant observation and semi-structured, and in-depth, interviews of farmer families (study subjects). Also, in-field observations, important dates and events, agricultural activities, rituals, and stories were recorded in a precise and codified manner (Guber 2015) for subsequent comparative analysis. The first author lived one full calendar year with one family of the community, enabling the acquisition of trust, empathy, and rapport with the families of the community.

Sample size

We interviewed men and women over 18 years of age, because at that age, both men and women in Ocotal Texizapan begin to clear their own plots. The research focus was at the household level. A complete data set was collected from 20 households. The non-probabilistic snowball sampling technique was used (Quintana 2006). The sample size was based on the saturation criterion (Serbía 2007). The estimated sample was 30% of the whole population. Each case study was performed with key informants. All the households were visited and adults willing to participate in the study were interviewed. Semi-structured and in-depth interviews were undertaken to understand local traditional knowledge and farmer strategies (Schettini and Cortazzo 2016). For example, some questions were: What are the main issues to be considered to cultivate a milpa? What are the main primary products that came from the milpa used as a food? When and how do you decide to grow milpa in your field? In addition, information was collected by attending community and family meetings; being involved with families in the milpa daily work; interviewing families in the community; and taking part in fishing, gathering (edible plants, mushrooms, and insects), and in daily housework. Plants and mushroom were collected and analyzed at the herbarium of the Tropical Research Center (CITRO) of the University of Veracruz.

Information analysis

Analyzing desk work involved systematizing and codifying the information through the following steps. The study area was characterized by examining the social, economic, environmental and cultural aspects, using descriptive statistics. Grounded theory was utilized to study and systematize the community´s Traditional Agroecological Knowledge (TAK), meaning that the categories for the coding and organization of the information emerged inductively from the data obtained. This research strategy facilitates the progressive development of theoretical ideas that maintain a close correspondence with the data: an ideal situation for research on local traditional knowledge. Likewise, descriptive statistics were carried out using the Excel program to calculate frequencies and rank data to test and evidence the categories of analysis.

RESULTS AND DISCUSSION

Community characteristics

All the communal land holders (commonly named ejidatarios[2]) engage in traditional agriculture to meet their basic needs, to ensure their current and future food supplies, among other activities. Their traditional agriculture is based on the use of tools such as a machete, hoe, wooden lever, local maize seeds and others, and on family labor. It is important to add that basic social and health services, such as clinics and a complete primary school, are lacking and poor sanitation prevails. Table 1 shows, that forty per cent of farmers are illiterate. INEGI (2010) reports that 74% of the inhabitants over 15 years of age only have a middle school-level education. The community has merely one bilingual elementary school that extends only until third grade and shares its classrooms among grades. From the community´s point of view, education has, thus, not met community social expectations. Del Amo et al. (2010) point out that in Mexico education was portrayed to play an important role in social and economic growth and security,

[2]The men and women holders of ejidal rights are ejidatarios.

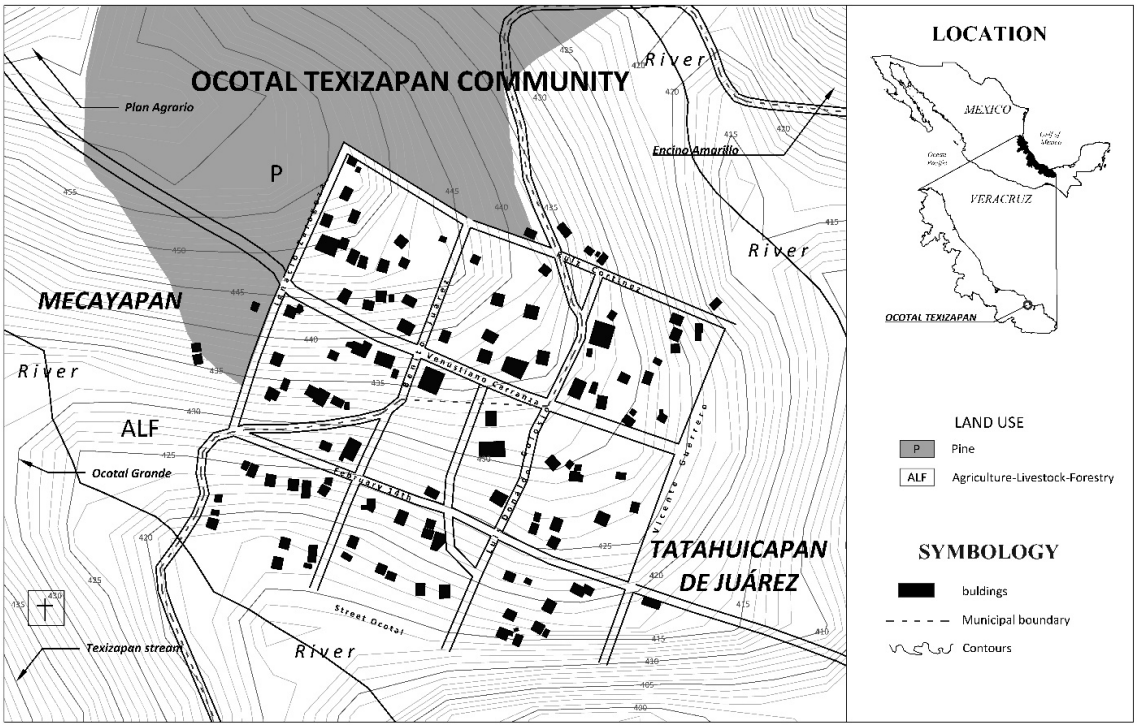

Figure 1. Geographical location of the community of Ocotal Texizapan, municipality of Tatahuicapan de Juárez, Veracruz, Mexico. Source: First author elaboration.

but this has not occurred yet. Moreover, some of the changes that have been made may have a negative impact, such as the loss of community cooperation and the oral and non-oral transmission of knowledge as young people with degrees leave the community in search of new job opportunities. Education must revalue agricultural activity and the need to produce food: something that has not occurred yet. In fact, the access to education and the requirement to attend school has upset community life and memory rather than functioning as a source of strengthening knowledge and communities. This has influenced family composition, community daily life and the intergenerational transmission of knowledge, strongly impacting culture, on the whole. Members of thirty percent of the households have studied only until the level of primary school, and forty percent has not received any formal education.

Del Amo et al. (2010) affirm that it is necessary to look for alternatives in the form of active non-formal education which is carried out through endogenous processes and by the population itself. This will allow for cultural preservation and the social or collective transmission of knowledge.

Family structure

Two types of family structures exist in the community: nuclear (60%) and extended (40%). The nuclear ones are made up of spouses and their children (Magdaleno-Hernández et al. 2014), who live on land separate from their parents, and who have, or are provided, with sufficient resources to establish their own farmer strategies. This can be a disadvantage since the workforce is mainly the head of the household. Extended families formed by several nuclear families, with different generations that inhabit the same property. Include married children without their own piece of land to build their home and sometimes all live in the same household. Thus, if the parents have extensive land for the household, this is split so their children can build their home. The children, thus, become part of the farmer strategies since this allows the expansion of the family workforce. Presents greater availability of labour. Decision-making rests on parents, but mainly on grandparents (sometimes the oldest man). Present a greater diversification of off-farm activities for family support. Each member plays a specific role in carrying out activities. Have a higher economic income, also greater cultural roots and tradition in the Nahuatl culture. In this kind of family, parents have the responsibility and sufficient capacity to feed all family members. Fifty per cent of the families interviewed have two children, 20% three children, 10% four children and 20% account for both one child, and for six children.

With regard to children, within the family unit, there is a certain responsibility depending on age and

Table 1. Demographical characteristics of the entire population of the community of Ocotal Texizapan, Municipality of Tatahuicapan de Juárez, Veracruz.

CHARACTERISTIC	PERCENTAGE
Schooling	
Illiteracy	40%
Elementary school	30%
Middle school	15%
High school	10%
University	5%
Level of Poverty**	
Poor	35%
Very poor	65%
Type of Family	
Nuclear	60%
Extended	40%
Family members (max-min)	8 – 4 members
Extra non-farm family income	
Prospera*	USD 60.15 every two months*
Migration	USD 100.25 ** per month
Average sale of surplus per month (maize, firewood, beans, hens)	USD 7.52 - 37.59
Income spent on food/week	USD 2.51 - 25.06

*Official support program of SEDESOL. **Poverty level was categorized using the indicators of Embriz et al. 2001. It is only for food and depends on the number of children and educational level and can increase to more than $\$5,000.00$ every two months. ** Mexican pesos, equivalent to 19.90 Mexican pesos per American dollar at the time of publication.

gender. If young people are not married, they help in the fieldwork, and when they get married they become farmers to help their family. Extended families have the advantage of more labor, and possibly more local knowledge in food production and the way food is prepared, probably sacrificing nutrition due to being families with more members in contrast to nuclear families.

Traditional Agroecological Knowledge (TAK)

The traditional knowledge in Ocotal Texizapan is based mainly on the beliefs, appreciations and meanings that the Nahuatl families have about natural resources, which allow them to build their own image of nature. For Van Der Plog (2008) the beliefs and perceptions that indigenous cultures have about the use of natural resources are supported by the idea that domestic units participate in a process of cultural construction in the order in which they classify, calculate and decide through their community and eco-geographic experience. In this theoretical-philosophical context, traditional knowledge for indigenous farmers in Ocotal Texizapan is the product of an interaction and appropriation of ecosystems within the territory that express the permanence and the historical-cultural dynamics of the community. This includes tangible and intangible knowledge linked to local ecological, economic and sociocultural conditions and that have played an important role in the survival of families, including aspects of food and nutritional security. The above implies having a deep and concrete knowledge of the climatic

conditions, agroecological conditions, humidity, moon phases, soil, vegetation and ways of using the resources. The families interrelate these to establish a means of obtaining foods. Thus, even in the simplest forms of resource use (fishing, hunting, gathering and extraction), the indigenous people of Ocotal Texizapan employ a repertoire of specific agroecological knowledge that plays an essential role in food security and consists of various activities. These are linked to the development of local strategies, such as habitat, behavior, harvesting time, feeding, life cycle, and shooting mechanics and to materials as well as to the elaboration of specific instruments for hunting, fishing and others; all devised in their own cultural and historical time and space.

The farmers we interviewed possessed ample knowledge about mushrooms. The discussion of this knowledge will illustrate their interrelated system of corpus, kosmos and praxis and detail the nature of their traditional knowledge system.

The collection of mushrooms is carried out during the rainy season (June-October) requiring specific agroecological knowledge including not only knowledge to identify mushrooms but also that of the greater environment and the weather conditions to know when and where to find the mushrooms. For example, the "*cuarrirriquich*" mushroom (*Schizophyllum commune*) is collected mainly in the dry gumbolimbo tree (*Bursera simaruba* (L.) Sarg.) and mango (*Mangifera indica* L.) trunks. The "*cuaxolê*" mushroom (*Pleurotus ostreatus*) is collected on dead tree trunks with a high moisture level, and the yellow or "*cuananaca*" mushroom (*Cantharellus lateritius* (Berk.) Singer) is found under the oak trees´ leaves. These mushrooms are usually cooked by placing them in acuyo (*Piper auritum* Kunth) and banana (*Musa* spp.) leaves, wrapped into a rectangular tamal shape (tamal it's a kind of food made by corn flour), seasoned with a little salt and then placed on the coals. The yellow mushroom (*Cantharellus lateritius* (Berk.) Singer) is consumed after adding lemon and pepper and is roasted.

Another inherent knowledge rooted in their Nahuatl culture are the moon phases: these define many activities around the milpa (Table 3). People believe that if the lunar phases are not taken into account during the sowing and harvesting of maize or beans, there will be little or no production. Mrs. FR commented: "*My husband no longer wanted to respect the moon phases and planted beans in a waxing-crescent moon and almost all the beans were lost; we had little production*". Maize is sown in early June and harvested late September-October; beans are sown in early July-June and harvested as tender vines during August-September and harvested fully matured in September-October.

This knowledge is shared by men, women, and youth. Mrs. JH commented: *"chives are planted at 12:00 on the day of the full moon to make them big, like jicamas (Pachyrhizus erosus). This must be done mainly by a woman."* She also commented: *"the good sower sows in God's name"*. Indeed, the sower makes the sign of the cross in the maize field, and the idea is that God goes forward with the sown field behind him. On sowing day, no toasted tortillas are eaten because otherwise the maize is ruined. "Mrs. FR commented: *"when the maize is folded over, it must be Thursday and Friday. The one who folds over the maize must fast and take the day off. To have a good bean crop, it must be sown in October."*

The foregoing demonstrates a presence of a traditional belief and an ethical choice that stands up from a profound respect for nature originating in the idea of belonging to nature not as an owner, but as a close relationship to everything that has to do with life. Humans are not seen as standing above nature but are considered a part of it. This worldview and ethical choice are essential for the decision-making process at the family level. Traditional knowledge also helps design the strategy for sowing crops, which coincides with the finding of Sánchez-Olarte et al. (2015) in the sense that TAK enables families to generate life strategies. The importance and symbolism of moon phases involved in cultural agricultural practices in the community of Ocotal enables the community to ensure consistently and socio-culturally their agricultural production. Understanding the relationship of moon phases with certain agricultural activities finds its antecedents in the history of humankind in Mexico and, in general, is an acceptable collective way by which to perceive the world (sympathetic magic). It continues to be more or less important in certain cultures in terms of their agricultural calendars (Mariaca 2003). Traditional knowledge is not linear but interconnected with a multitude of components such as historical events, experience, worldview (cosmovision in Spanish, which includes more than the simple worldview does), age and so on (Toledo and Barrera-Bassols 2008).

Another group of knowledge that is important in the minds of farmers in Ocotal Texizapan is undoubtedly the behavior of the physical elements of the environment. The activities, mainly productive as well as hunting, fishing and gathering, are largely designed by the climatic events in the different seasons of the year. An indicator that announces the fall of water in the community are the clouds and on which side the clouds are located. For example: *"- if the clouds are over the San Martin hill they announce heavy rains and if they are over the Santa Marta hill, these are only cloud formations. It will not rain. When clouds are not formed by the hills and the sky is cloudy it*

Table 2. Traditional Agroecological Knowledge and belief based on moon phases.

Agricultural Activity	Local idiom for moon phases	Moon phases	Characteristic
Planting	*Luna Tierna*	Waxing crescente 	Maize should not be sown because the stalk grows more, and the ears are small. If yuca, banana and taro are planted, many roots come out. In beans, the seed are of poor quality.
Planting and harvesting	Luna llena	Full moon 	It is the least favourable type of moon since if maize is sown and harvested in this phase, the grain or "táyôl" will become pockmarked quickly and be more brittle.
Planting and harvesting	*Ida de Luna*	New moon 	This phase provides the best harvests; the ears are larger and more solid.
Planting and harvesting	*Luna sazón*	Last quarter 	Maize and bean are sown so that the plants do not have many roots. In this type of moon, the maize is folded over so that the grains do not become pockmarked.

is the northern wind (el norte). Just like when the ducks bathe, as if they are raising their wings, they see the northern wind and it will certainly rain. The sky announces storms of rain, hurricane or northern winds when it is cloudy - (Mrs ALR and Mr. JCHR). Thus, the presence of rain marks the beginning of planting, mainly of seasonal maize and some crops. In other words, people have learned to read the clouds and interpret their location, color, abundance, and other characteristics such as temperature, time of year, wind speed; they have an ability to predict the weather.

The first rain, which falls in June, is the most eagerly awaited by the farmers. Before the first rain, farmers bury three gumbo-limbo trunks to form a pyramidal structure in the maize field. This structure is set so bats go there during the night and when they eat, they drop in their excrement many seeds (chilpaya (*Capsicum annuum* L.), quelite (*Amaranthus* spp.), chipilin (*Crotalaria longirostrata* Hook & Arn), tomatillo (*Lycopersicon esculentum* P. Mill.) etc.) onto the ground encouraging the growth of a diversity of edible herbaceous species. Prior to the arrival of the rains, the land was already prepared, and the stubble was burnt. In the case of little or no rain, farmers choose not to sow to avoid a low germina-

tion of maize seeds and to have a lower than expected production. Another belief is that if the rain falls, nobody can walk around shouting: *"It's raining"*, because this will scare the rain away and lead to a poor maize harvest. To ensure rain, one magical-religious tradition holds that families pray and ask God for rain so that they do not have food shortages. August is named the *"month of shortage"* since it is the month in which almost nobody has maize. When families harvest maize (tender maize), they do it for boiling or preparing tamales (its a kind of food made by corn flour); these are husked and if the women find a cob in the form of a *"pixcôn*[3] *"*, it is taken to mean that the period of shortage will pass quickly. Before planting the maize, seeds are mixed with bean and squash seeds to have a greater diversity of crops in the milpa and to obtain a variety of foods.

According to Noriero et al. (2012), the milpa continues to be the foundation of families living in rural areas since it provides diverse agricultural food products (maize, beans, squash, quelites (green edible plants), etc.) that complement the family diet. Men usually go to the milpa twice a day, in the morning and in the afternoon. This is because the Mexican birds, known as *pepes, zanate* or *pichos* (*blackbirds in English*) (*Quiscalus mexicanus*), "*eat in the morning and also in the afternoon*", like the rabbit that goes to the milpa in the afternoon-evening or the chachalacas, gray-headed chachalaca in English (*Ortalis* spp.) that eat early in the morning. Sometimes, famers go with their rifle to scare these animals away or hunt them and take them home to cook and eat.

In the past, to avoid the presence of pests, the maize was smoked with copal[4], which was also put in all the house corners. Today, this knowledge is practically in disuse and when pests occur, farmers simply apply synthetic pesticides. When the maize is shelled, the seed is put out to dry in the sun for a day. After that, a pink powder (insecticide, called Graneril) is added to prevent it from being pockmarked, and then the maize is poured into raffia sacks that are stored for consumption until the next planting season. When it is for consumption, it is dried in the sun, shelled, and then placed in sacks that are stacked on wooden pallets, inside the kitchen or the house to prevent it from getting wet and rotting or being eaten by rats. In Mexico, for every thousand hectares 3 thousand 307 tons of pesticides are used, glyphosate one of the most consumed. The World Health Organization classified Glyphosate as toxic and carcinogenic for humans (https://www.senado.gob.mx/64/gaceta_del_senado/documento/65807). However, the impact of pesticides will depend on the toxicity of the substance, as well as the vulnerability of population subgroups, mainly children and women, to these compounds. Health effects include cancer, neurotoxic, endocrine, reproductive, and other effects (COFEPRIS 2015; Silveira-Gramont et al. 2018).

Edible plants and mushrooms are easily identified, even by kids, since their parents take them to the milpa and to fish, and they thus build up knowledge of edible plants, environments and fishing techniques. They learn by observing, participating and asking questions to their parents or grandparents. Likewise, girls learn to cook from childhood. Mothers give them a ball of dough as a kind of game, and they start to learn to shape and make tortillas. An adult person eats between 4 to 10 tortillas (20 cm radius, 3 mm thickness and 100 g weight) per day. Each tortilla has approximately 226 calories (Chávez and Bourges 1974), so normally a person consumes between 904 and 2260 calories per day without counting the calories of other foods.

An old man commented: *"in the past we had good production. As there was no ejido*[5]*, we used to make the milpa everywhere. We planted maize, tomatillo, chayote, beans and banana that we used to grow in abundance. There were a lot of quelites (green edible plants) and we did not apply chemicals, we only did the "monzo*[6]*"*. With the establishment of the ejidos, land was split up. This had an impact on farmer strategies, since in the past they planted with huge freedom in the territory, practicing the slash-and-burn system. The old man adds: *...there were many wild animals such as armadillos, lowland paca, deer, wild boar, spider monkeys, anteaters, which we ate in the monzo. There was a lot of fish, snail, shrimp, crabs and turtles. On July 15, 1940, we suffered a maize crisis caused by the appearance of a grasshopper plague, which wiped out the maize, and to survive we ate food such as yuca, taro, bananas, tomatillo, and some edible herbs. We drank water in a tecomate* (a Cucurbit fruit shell used as a drinking vessel) *and we wore blanket clothes that we made ourselves with cotton, which we embroidered and painted with tincture made of the nanche tree* (*Byrsonima crassifolia* (L.) Kunth)". Therefore, maize represents the backbone of the community diet and if it is lost or absent, it puts food security at risk immediately, and in the whole community. However, in such circumstances, hunting wildlife and gathering is a parallel food supply option, as other studies mention (Caballero and

[3]Pixcôn: Handcrafted wedge-shaped deer bone, used to open the dry cob and remove the leaves.
[4]It is a vegetable aromatic resin, which serves as incense.
[5]Ejido means that farmers are entitled to have rights to the land, by the Agrarian Law.
[6]"Monzo" is a Náhuatl word which refers to the collective mutual cooperation that farmers extend to one another in the form of carrying out heavy activities such as planting and harvesting maize.

Mapes 1985).

In Ocotal Texizapan, maize has a complex symbology: it is a vital, cultural and fundamental element that gives life and identity as it constitutes the principal base of the daily feeding at the family level. It is this daily food provision that endows and gives social meaning to the milpa and that references the evolutionary processes of the Nahuatl-maize culture through time in space. In addition, a variety of knowledge, beliefs, myths and ways of life are associated with maize as an agricultural crop, which have been transmitted from ancestors (grandparents) to the new generations through oral exchange and practical experimentation. Formerly, the farmers of Ocotal Texizapan, recognized the existence of 6 varieties (races) of maize, each named in their language and classified mainly by the color of their grains. Today, there are only four varieties of maize left: white or *"Ista 'sinti"*, pinto or *"Ixcuicuil sinti", yellow* or *"Kosti' sinti"* and black or *"Pisti´sinti.* Two species have disappeared: red or *"chilti' sinti"* and purple or *"axocosinti"*. Likewise, the farmers of Ocotal maintain a meticulous Nahuatl nomenclature to name the different stages of maturity of the maize or *"sinti"*: the whole plant is named *"sincuahui'"*, the tender corn *"xîlô"* ", the new corn as *"cama' sinti"*. When the grains are already formed on the cob it is *"elo'"*, *"tila' elo'"* when the maize is ripe, *"wa sinti'"*, dry corn and shelled maize are called *"táyol"*. The different stages of corn growth also receive a name in Nahuatl. For example: the germ that sprouts from the maize grain is called *"iyix"*, the spike is known as *"miahua"* "and the hair that grows on the maize *"sintitzóncal"* and that of the xilote or jilote, *"xilotzóncal"* (tender corn).

For the indigenous people of Mexico, worldviews and beliefs continue to be part of their daily lives, which is related to the community's own culture. Thus, for the Popolucas of Soteapan and Mecayapan the God of corn is known as *"Homshuk"*, while for the Nahuas of Tatahuicapan de Juárez and Pajapán it is known by the name of: *"Tamakastzin"* who "is born, grows, reproduces but never dies", according to the families of Ocotal Texizapan. For González-Jácome (2007) and Blanco-Rosas (2006), the God Homshuk, was in charge of providing the corn grain to humans and teaching them how to handle it, allowing its successful existence. Similarly, the legend of the God Tamakastzin relates that the God underwent a metamorphosis to become maize grain and thus, become able to feed humans. Some activities in the field are based on this myth and farmers still take this into account, for example: *"- when we plant maize, we do it with deep respect so that our corn is abundant and we do not get short of it. When we harvest maize, we have to collect all the ears and we should not waste a single grain that the earth gives us. If we leave the abandoned maize in the cornfield, "Tamakastzin" is left alone and crying, saying that my owner no longer loves me and then in the next harvests we will no longer have good production because "Tamakastzin got angry"* – Mrs. FRS and Mrs. MRH.

Agricultural activities

Gender makeup and children have a fundamental role in labor, mainly in the social distribution of work, both in the field and at home. One interviewee commented: "A son is the right hand of his father, while the daughter is the one who will help me with the housework, and she is the one who will take care of us when we get old." From the age of 9, girls and boys are "old enough" to help in the field or home activities according to gender. Girls begin to make tortillas by hand, wash clothes or dishes, give food to their dad and brothers and go to the milpa for weeding or gathering mushrooms, quelites (*Amaranthus* spp.), axiquiote (*Smilax domingensis* Wild.) and firewood. Boys help to clear land, graze livestock, plant, set up wire fences and spray pesticides, among others. So, since childhood, there is a social division of labor by gender (Bonfil 2004; Guzmán 2005). Farmer strategies are based on family workforce, which facilitates carrying out various activities related to food security. Since children are incorporated into the field and home duties, parents start transmitting knowledge and daily experience to their children, according to site-context. Mrs. FR commented: *"I learned to do my milpa by watching my dad and my grandfather as they worked. I listened to what they said about when to sow and when to harvest; this was based on the type of moon. They also took me with them and I had to help them ... We left early and we were already back by noon. We used to clear with a machete and a hook." Another young man said: "my parents have passed down and taught us knowledge little by little. Sometimes I ask them. I learned by observing how my dad worked when we went to the milpa, but I also took responsibility to make my own milpa when I started my family at 15 years old. The things that my parents used to work with were a "wuatake" (hoe),"tockalon" (jar to transport seeds) and "wuitzo" (wooden lever). Now, when I do my milpa, I almost never use those tools anymore. Now we spray with a pump and only use a machete, a file, a hook and plastic jars to carry the seeds." And he adds: "My oldest sister took care of my brothers since we were 6 ... She was left in charge of the house, made the tortillas and heated the food for when my dad, my mom, my brother and I re-turned from the milpa to eat."* This implies that the younger learn most of the agricultural activities based on ancestral knowledge, which is now updated as a result of the technological changes, community

exposure and people´s age.

A wide variety of traditional tools used for weeding the milpa are now replaced by agrochemicals (herbicide). This has led to the decline of several edible herbaceous species (quelites) that have been used for food all along in history and whose diversity used to be abundant in the milpa (González-Amaro et al. 2009). One interviewee mentioned: *"if we continued using the tools that our ancestors used, the land would continue giving birth to several plants that have been the food of our families for ages, such as quelite* (*Amaranthus* spp.), *chipilín* (*Crotalaria longirostrata* Hook & Arn), *chives* (*Allium glandulosum* Link & Otto), *tomatillo* (*Lycopersicon esculentum* P. Mill.), *quelite de pájaro* (Salvia spp.), *mushrooms, papalo* (*Porophyllum macrocephalum* DC.) *and pepper* (*Capsicum frutescens* L.). *But now we spray chemicals and kill all these plants. We only leave a small piece of land without spraying to have plants to eat. My wife no longer wants to come with me because she says it feels 'ugly*[7] (disappointed) *that we do not leave herbs (quelites) to eat."* This cultural-technological change represented by the introduction of herbicides is having an impact on green edible plants of the milpa and thus on food security and nutrition. In addition, the lack of vegetation cover results in serious erosion problems. The argument behind this technological change is the lack of local labor, since young people go to school or migrate in search of employment. Another factor is the issue of government programs such as Procampo (Official program of economy support to farmers in Mexico), which sometimes provide aid in the form of spray pumps, fertilizers and agrochemicals. On the other hand, Progan (Official program for the Sustainable Livestock Production that includes beef cattle production and dual purpose livestock system) provides support for planting grass for livestock, encouraging farmers to have a preference towards this activity and, thereby, unfortunately, increasing the deforestation and erosion of the hilly landscapes. This whole context is causing the simplification of the agroecosystems, the loss of agrobiodiversity, erosion and the substitution of traditional crops for others that in many cases are not successful, well-adapted or part of the local food culture.

It was found that in the local indigenous ecological and economic rationality, life strategies were configured based on the body of traditional knowledge of ecosystems and culture that constituted a fundamental element for the continuity of the reproduction of the family unit and production systems. A wide range of local strategies allows farmers such reproduction; life strategies are strengthened, however, through the use of family labour, knowledge and beliefs that revolve around nature and the integration of multiple natural resource gathering activities (the collection of wild plants and edible fungi, hunting, and extensive families) where they combine different biological, ecological and territorial elements (ecosystems and agroecosystems). All this knowledge is part of a cultural heritage that has been passed on from one generation to another. Thus, the elderly are the ones with the greatest traditional knowledge on technologies for the management and use of the agroecosystem's natural resources (Ball et al. 1995).

Families today not only have to cope with the regular adverse social, economic and climatic conditions, but now they are also dealing with the novel processes of accelerated change that result from globalization and which are expressed in terms of vulnerability in access to food, abandonment of the rural sector, absence of local force labour, deterioration of traditional agroecosystems, the searches for a well-paid job outside, and the inclusion of women into agricultural activities, due to the migration of men (Moctezuma-Pérez 2009; Moctezuma Pérez and Murguía-Salas 2014; Sánchez Platas and Vizcarra-Bordi 2012). In spite of the above, families in the community have had the ability to adapt to these complex situations and articulate their culture in relation to the process of modernization, through the pre-existing and time-proven subsistence farming strategies. In this way, in the farmer praxis of Ocotal Texizapan, a wide range of alternative options are practiced, including traditional agriculture, which, together with the milpa form the main productive and food self-sufficiency strategy, operates in addition to home garden production, hunting, fishing, and gathering (insects, mushrooms and native plants): these are all based on local biological diversity. Together with extra non-farm income, including migration and local trade, the families seek to ensure food and agricultural diversity, as well as to adjust to the climatic, social and economic eventualities. The problems faced, such as the lack of rain, pests, are mitigated by adapting local strategies that facilitate food security.

Figure 2 illustrates the model of agricultural strategies exercised -in general- by the farmers of Ocotal Texizapan. Traditional agroecological knowledge includes the worldview, beliefs, facts, experience and other elements that together enable the community to develop and implement productive strategies aimed at satisfying their basic food needs. The income comes from selling home garden surpluses and cattle, extra off-farm work, remittances resulting from migration, and government subsidies. This diversification of income is a rural development strategy, given the agricultural difficulties in the area. Then, tradi-

[7]In the perception of people, ugly refers to the fact that they feel sadness or despair that almost no edible herbs grow in the cornfield, due to the use of agrochemicals.

tional knowledge (biocultural system and cultural and spiritual values) based on agricultural activities and farmer's strategies are interlinked and play a key role in food security and subsistence.

Traditional knowledge, agricultural activities and traditional agroecoystems, together enable the community to obtain and access food, and to supply families with other basic needs (clothing, education, transportation, etc.). Traditional agroecological knowledge about the different ways of producing and obtaining food and family labor have enabled the families to develop and implement different agricultural strategies for the use of natural resources and to carry out the productive activities with which they secure their food supply. Also traditional knowledge helps to address food insecurity by understanding the agroclimatic conditions through the year, by their in-depth knowledge about main edible plants and animals that occur in their environment, and even by mutual help or family work involved. In addition, they incorporate a *praxis* based on the assembly of traditional and conventional technology (use of agrochemicals), which allows them to strengthen their productive force and face current limitations. In fact, the FAO (1996) points out that food security is based on traditional knowledge and farmer strategies at the family level that allow for production and social reproduction. It seems that most official programs (Procampo, Prosperity, Progan) look at improving people´s well-being conditions but in fact, they are not.

In general, the local strategies of farmers and the management of natural resources are mediated by the incorporation of Traditional Agroecological Knowledge (TAK), which expresses the permanence and historical and culinary dynamics of the community under study, where the relationship with the entire the ecosystem allows the food and nutritional security of families in a sustainable way and according to their culture. These strategies include the utilization of resources through hunting, fishing, gathering, traditional agriculture (milpa and home garden), livestock production and agroforestry systems incorporating traditional and modern technology. This responds to a farmer's ecological rationality and circumstances (Toledo 1993). Finally, the logic behind indigenous knowledge is the lack of separation among the spiritual from the material, their Gods, religion and culture and the interaction with nature and the environment. Such worldview is shared by indigenous culture whose philosophy is characterized by a holistic cosmovision (Langill and Landon 1998).

CONCLUSION

It is concluded that the food security at the family level in Ocotal is managed through collective work that contributes daily food to the family, either with what is grown, tolerated in their agroecosystems (cornfield, orchard, others), or collected as primary food stuffs (insects, fungi, herbs, edible fruits), or by hunting and fishing. Much is based on their traditional knowledge and social exchange (*trueque*) surpluses. The products obtained are based on food preferences and food culture through a comprehensive use of territory. It should be noted that official programs increase dependency on agrochemicals and sometimes food provided is not related to local food and cultural preference or is counterproductive in terms of human health.

Traditional knowledge enable the nahuatl community of Ocotal to manage and address their local food and nutritional security by their traditional knowledge about moon phases and the activities to be carried out to be successful, the family and communal organization that allows them to produce and have diverse foods, the family structure that supports the production and preparation of food and a deep knowledge of their environment and biodiversity and its uses.

The Ocotal community´s local agricultural strategies rely on traditional knowledge related to agricultural activities, the management of agrobiodiversity and traditional agroecosystems, which in conjunction allow families to obtain and access food partially and satisfy other basic needs (clothing, education, transportation, etc.) and family preferences. In addition, traditional agroecological knowledge about the different ways of producing and obtaining food and family work has allowed families to develop and implement different agricultural strategies for the use of natural resources and to carry out productive activities with which they ensure their food supply. However, guaranteeing food security and agrodiversity in indigenous communities requires the establishment of public policies aimed at strengthening their agrobiodiversity, their preferences and the production of a large part of their food. Official programs of food and nutrition security are important. They must include the production of foods, though, that are culturally utilised and preferred by families.

In general, at the rural level, food security exists when families ensure food for the extended or nuclear family and manage to satisfy the production of maize in two growing cycles allowing the acquisition of basic food crops (beans, chili peppers, tomatoes, squash), and quelites for the preparation of daily food. Together with fishing, hunting, gathering, livestock production and social food interchanges their food needs are secured enabling the community to continue, albeit frugally.

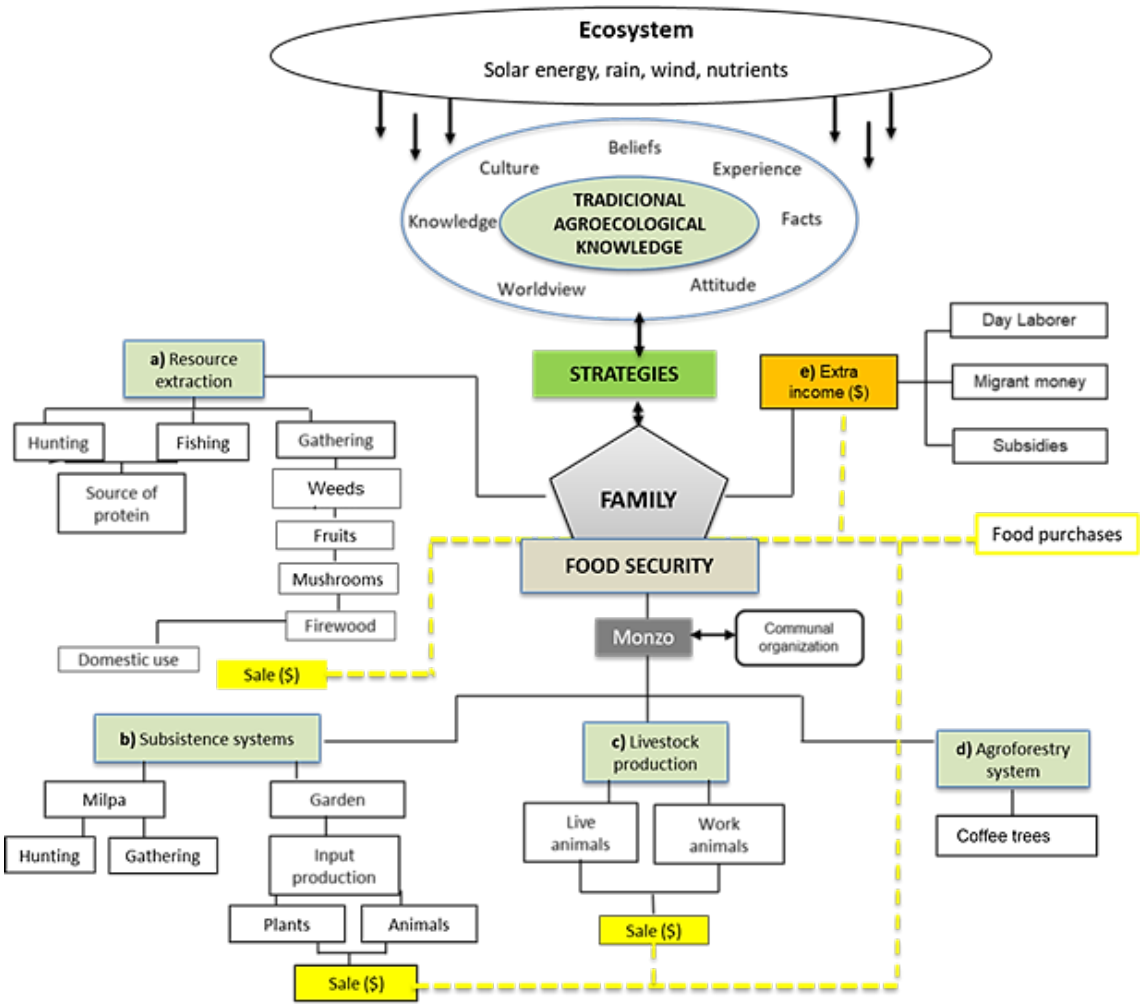

Figure 2. Indigenous model of agricultural strategies that contribute to food security of the Nahuatl community from Ocotal Texizapan. Source: own elaboration.

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DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors whose names are listed above certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as income; educational grants) or non-financial interest (such as personal or professional relationships or affiliations) in the subject matter or information discussed in this manuscript.

CONTRIBUTION STATEMENT

DALT: Did the field work, wrote early drafts of the research design and the manuscript.
APV, collaborate in research work and research design, and data analysis.
JCGA and AGJ: reviewed and improved the proposal and the manuscript.
GEN: revised and improved the translation of final draft.
All authors read and approved the final manuscript.

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