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Food beyond the farm: significance of non-crop plants and mushrooms for food security of highland farming communities in Veracruz, Mexico

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Abstract

Forest and riverbeds are known to have positive effects on neighboring agricultural plots. Although ethnoscience studies have shown that these environments can contribute to food self-sufficiency, little agroecological research has been conducted on the role of forests and riverbeds as sources of non-crop food for farming communities. In this chapter, we present the findings of a case study in which we analyzed the contribution of edible non-crop plants and mushrooms to the food security of five farming communities in the highlands of Cofre de Perote in central Veracruz, Mexico. The locations of these five communities differed regarding their respective distances to urban areas. We evaluated: 1) variations in the richness of consumed non-crop plants and mushrooms across habitats and farming communities; 2) the effect of urban centers' proximity on the consumption of these species, and c) the willingness of participants to engage in advocacy actions to promote sustainable consumption of edible non-crop species. Within each farming community, we conducted five focus groups, and field surveys of agricultural fields (milpas), riverbeds, and forest patches. We also surveyed fifty households to explore how edible non-crop species contribute to the food security of farming families. Participants in the workshops and field surveys reported consuming more than sixty edible non-crop plants and 25 edible mushroom species/morphotypes. Forest and milpa were equally important sources of edible plants, while forest patches were the only source of mushrooms. Distance between communities and urban centers was not correlated with the richness of edible non-crop species/morphotypes. Participants expressed interest in 1) advocating for the protection and consumption of these species through community recipes, 2) producing edible herbs in domestic greenhouses, and 3) restoring local ecosystems. Our research demonstrates that the use of edible non-crop plants can play a significant role in enhancing food security in these and similar farming communities and is rooted in the communities' traditional ecological knowledge, desires, and practices. Further, this study highlights the need to assess non-crop food sources from an agroecological perspective.

Keywords: Food security, milpa, urban centers' proximity, dietary diversity, advocacy

1. Introduction

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Agroecological research, like most disciplines that study the nexus between productive systems and human nutrition, has assumed a linear model of societal development, according to which societies that transition to agriculture cease to be hunter-gatherers, thus becoming sedentary and more socially complex (Ellis et al., 2021; Schunko et al., 2022). This assumption is only partially true: although agriculture continues to be the main source of food in rural areas worldwide, gathering and hunting still play a fundamental food-provisioning role (Bharucha & Pretty, 2010; Chappell et al., 2013; Fernandez & Méndez, 2019; Guzmán Luna et al., 2022). Hunting and gathering are especially important during the "lean months" when families deplete the annual food reserves of staple crops (Morris et al., 2013; Rivera-Núñez et al., 2022). The agroecological approach to restructuring the food system "from the farm to the table" (Gliessman, 2016) has shown limited consideration for the crucial role of foods sourced from non-agricultural ecosystems, riverbeds, or farm borders. The common focus on farms and crops still recognizes that the ecosystems adjacent to farms contribute to food security by providing important ecosystem services benefitting agriculture, such as providing habitats for pollinators and natural enemies (Perfecto & Vandermeer, 2010; Vandermeer & Perfecto, 2007). However, this focus understates the extent to which those ecosystems contribute directly to food security, by being sources of non-crop foods.

In Mexico, farmers gather edible non-crop species[1] in diverse habitats including farm fields, home gardens, agroforestry systems, forests, and riverbeds (Fernandez & Méndez, 2019; Perfecto et al., 2019; Solis Becerra & Estrada-Lugo, 2014). These habitats host a wide variety of fruits, flowers, roots, aromatic herbs, wild mushrooms, and animals that are regularly consumed by local families (Casas et al., 2007; Martínez-Pérez et al., 2012). Edible semi-domesticated herbaceous plants, known as *quelites* in Mexico, also occur in milpas: fields devoted to a traditional polyculture system of domesticated species, including corn (*Zea mays ssp. mexicana* L.), squash (*Cucurbita spp.*), and beans (*Phaseolus vulgaris* L.) (see Chapter 4.2 and 4.5). Up to 500 *quelites* species are consumed in Mexico (Linares Mazari & Bye Boettler, 2015). Adjacent forests and riverbeds add to the agrobiodiversity of the milpa and its surroundings.

The diversity, richness, and distribution of edible non-crop species are determined by ecological processes occurring at different spatial scales. On the landscape scale, the management system determines how the ecosystems surrounding farmlands are utilized, the extent to which they are fragmented, and the dispersion of propagules across these ecosystems (Kremen & Merenlender, 2018; Perfecto & Vandermeer, 2010). On the individual-field scale,

[1]In this chapter we considered edible non-crop species as weeds growing in agricultural fields as well as edible wild plants.

farmers can promote non-crop species by choosing agricultural management systems that promote agrobiodiversity (CIDSE, 2018). The milpa is a good example of such a system as it provides habitat for diverse non-crop species and it fosters connections and ecological processes that enable those species' presence (Chappell et al., 2013) and conserve the surrounding ecosystems.

Traditional farming families in Mexico commonly collect edible non-crop species while walking to production fields (Chappell et al., 2013; Linares Mazari & Bye Boettler, 2015). The use of these food sources shows the farming families' deep knowledge of the non-crop species' biology, seasonality, and ecology (Soto-Pinto et al., 2022; Turner et al., 2011). Specifically, families gather plant parts including leaves, flowers, inflorescences, fruits, infructescences, stems, roots, meristems, and petioles (Casas et al., 2022; Soto-Pinto et al., 2022). Farmers align the availability of these food resources with their agricultural calendars to enhance and complement their dietary needs (Bakar & Franco, 2022). Thanks to their traditional ecological knowledge, these farmers are also capable of recognizing that specific mushrooms are associated with the presence of certain tree species. Similarly, farmers locate particular plant species that are associated with riverbeds, as well as herbaceous ruderal and sporadic species that grow in crop fields, on the edges of fields, and along rural roads (Cruz-Garcia & Price, 2011).

The important role that such edible non-crop plants and mushrooms play in farmers' food security has been reported in studies by Turner et al. (2011) and (Toledo & Barrera-Bassols, 2020). To our knowledge, studies published to date have not evaluated the extent to which the location of farming communities determines the species richness of gathered non-crop plants. However, research conducted in rural contexts around the world indicates that the diversity of edible non-crop species consumed by a household is inversely correlated with the proximity of the household to food sales in urban centers. Access to marketed food makes households less dependent on edible non-crop species, and, consequently, less inclined to care for the systems that produce them (Jones, 2017; Khoury et al., 2014, 2022).

In this chapter, we examine the impact of distance to urban markets where food is available for purchase on the role of edible non-crop plants and mushrooms in enhancing food security[2], particularly focusing on the dimension of access (FAO, 2006). We conducted this

[2] The FAO (2006) defines food security and entitlements as "access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet. Entitlements are defined as the set of all commodity bundles over which a person can establish command given the legal, political, economic and social arrangements of the farming community in which they live (including traditional rights such as access to common resources)."

study in different landscape units within five farming communities in the highlands region of Cofre de Perote in central Veracruz, Mexico (Figure 1). Communities within those units were situated along a gradient of transportation times, which we use as a proxy for market accessibility, considering an equivalent state of roads. We offer an overview of how this accessibility affects the consumption of edible non-crop plants and mushrooms.

The results we present are part of an effort by the Mano Vuelta Project[3] to evaluate the richness of edible non-crop species. This project aims to develop and implement an inclusive strategy, fostering food security in a socially and environmentally sustainable manner for the communities in the highlands region of Cofre de Perote. This initiative relies on a transdisciplinary collaboration involving milpa farming families, technicians, scientists, and artists. While the project is more extensive, the three specific research questions that we address in this chapter are: 1) Which edible non-crop species are available to the five observed farming communities, and how does this availability differ spatially and temporally?, 2) Is there a relationship between the distance of a community to urban centers and the amount of consumed edible non-crop plants and mushrooms?, and 3) Which advocacy actions with a focus on enhancing the availability of edible non-crop species, are most appealing to farmers in the studied region?

2. Methodology

2.1 Study Site

We studied five farming communities (Buena Vista, Saucal, Zapotal, Xico Viejo, and Ocotepec) in the municipalities of Ayahualulco, Xico, and Acajete, located in the high mountain region of Cofre de Perote in central Veracruz, Mexico (Figure 1). All five communities have a temperate humid climate, and their altitudes range from 1739 to 2566 masl. Remnants of montane cloud forests can be found in the lower-altitude communities (Williams-Linera et al., 1996). The natural vegetation of the higher communities is primarily coniferous forest (INEGI, 2020). According to the National Council for the Evaluation of Social Policy (CONEVAL, 2015), between 62% and 91.5%, varying by municipality, of the population in these communities are below the Mexican poverty threshold. Transportation times to commute from each of the observed communities to nearby urban markets (e.g., the cities of Coatepec, Xalapa, or Xico) range from 25 to 150 min (Lugo-Castilla et al., 2023). The communities with longer travel times to markets tend to be less populated (Table 1). Although subsistence family milpa farming forms the primary livelihood

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[3] Mano Vuelta Project (2022-2024). Biodiversity in the milpa and its soil: the base for food security for rural women, adolescents, and children (PRONAII SSyS 319067) Funded by the National Council of Science and Technology of Mexico (CONAHCYT, México)

foundation, its yields often fall short of meeting the families' food needs. Consequently, farmers regularly find themselves compelled to buy food from local markets, and to cover these expenses, they typically engage in off-farm activities and rely on government subsidies (Negrete-Yankelevich et al., 2018). The observed farming communities differ in the type of land tenure. While Buena Vista, Saucal, and Zapotal represent *ejidos*—collectively owned lands (INEGI, 1991; Morett-Sánchez & Cosío-Ruiz, 2017), in Xico Viejo and Ocotepec, all agricultural lands are private property. The studied households had an average of five members (range = 2 to 10; SD = 2). The main productive activities of the heads of households were farming for men (93%, SD=16) and housework for women (97%, SD=7).

Table 1. Geographic and demographic characteristics of the five farming communities in Cofre de Perote, Mexico, where we assessed the consumption of edible non-crop plants and mushrooms.

Farming community	Altitude (MASL)[1]	Number of households[1]	Travel time to the nearest urban center (min)[2]
Xico Viejo	1740	138	25
Ocotepec	2272	112	45
Zapotal	2441	77	60
Saucal	2566	20	90
Buena Vista	2160	14	150

[1]INEGI, 2020
[2]Travel times were self-reported.

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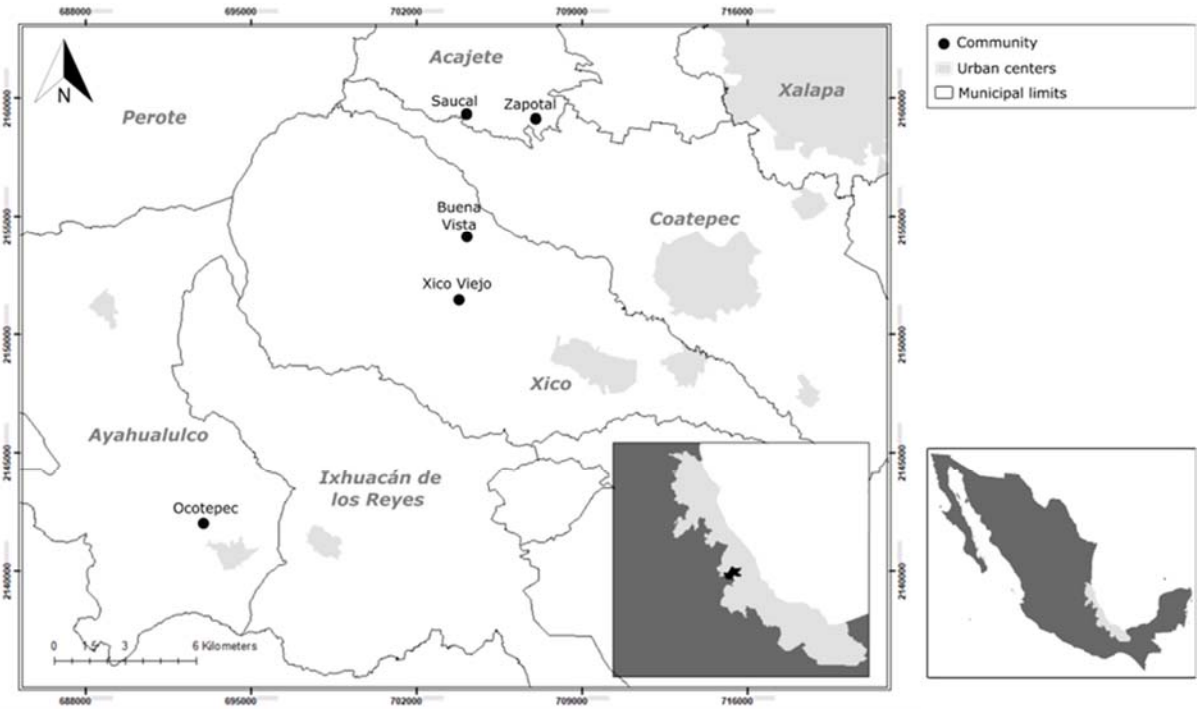

Fig 1. Study site. Location of the five farming communities in Cofre de Perote, Mexico, where we assessed the consumption of edible non-crop plants and mushrooms. Created by Sofía Lugo Castilla.

2.2. Data Collection and Analysis

2.2.1. Focus group and species inventory

We conducted field surveys, focus groups, and households' surveys to assess the uses and species richness of edible non-crop species. All participants were contacted through the Mano Vuelta Project and its facilitators who worked with the five communities. During August and September 2022, we conducted a focus group (Morgan, 1996) in each farming community. A total of 47 individuals, all from different households, participated across communities, including 80% of the respective female heads of household. All of the surveyed individuals had participated in a previous social seed exchange network analysis for native corn (Lugo-Castilla et al., 2023). The focus group consisted of two steps. First, we showed a documentary[4] about *quelites* to introduce the participating families to the topic. Then, along with the participants, we developed inventories of the popular names of consumed edible non-crop species and registered the months of availability of each species as a food source. The inventories included the ecosystem where each species was collected, i.e., milpa, forest, or riverbed. After focus

[4] "*Quelites: Historias de saberes y sabores*" ("*Quelites: histories of knowledge and flavors*"), which had been produced by the Institute of Biology at the National Autonomous University of Mexico (UNAM, 2018). https://www.youtube.com/watch?v=e62KVDSo5hI

groups, we conducted field surveys (Ayyanar & Ignacimuthu, 2011) around the different landscape units. The purpose of the field surveys was to clarify which taxonomic species corresponded to the popular names, to verify the accuracy of the inventories, and to create a photographic archive of all captured species. Contrasting the photos with the list of popular names in the inventory, together with the participants, we were able to relate 71 out of 85 listed species to their respective scientific names (CONABIO, 2023; Piedra-Malagón et al., 2022). We included those specimens as morphotypes that we could not identify (n=14), but which appeared to belong to unique species.

2.2.2. Survey

Following Krosnick & Presser (2010), we used a mixed survey with a total of 46 open-ended, close-ended, and hierarchical ranking questions to explore how edible non-crop species contribute to the food security of surveyed farming families. The survey consisted of four sections: 1) use and ecological management of edible non-crop species, 2) edible species commercialization and gastronomy, 3) socio-economic factors and food consumption, and 4) preferences for advocacy actions suggested by the Mano Vuelta Project necessary to improve food provision and agroecological management of edible non-crop species. The survey was conducted between February and March 2023, through KoboToolbox (https://www.kobotoolbox.org/), an open-access software. A total of 42 women and eight men heads of households (n=50) completed the survey.

2.2.3. Data analysis

To address our first research question, the spatial and temporal availability of edible non-crop species, we evaluated differences in species richness across landscape units (milpa, forest, and riverbeds) by fitting a generalized linear mixed model with a Poisson distribution and maximum likelihoods calculated via the Laplace fitting method. The type of landscape unity was modeled as a fixed explanatory variable, and the farming community to which households belonged was modeled as a random variable. We did not run a model for mushrooms because they tend to grow in forests. Thus, their presence in milpas and riverbeds is almost zero (Montoya et al., 2003).

To answer our second question, the relationship between access to urban centers and the richness of edible non-crop plants and mushroom species, we used a generalized linear model with a Poisson error distribution. Again, the maximum likelihood was calculated via the Laplace method. Travel time to urban centers, used as a proxy of accessibility, was used as the explanatory variable, and the number of edible non-crop plants and mushrooms utilized in the farming community was the response variable. Statistical model simplification was performed using Akaike's Information Criteria (AIC) (Burnham & Anderson, 2002).

Finally, we explored whether the uses of edible non-crop species varied according to the municipality of residence. For this purpose, we conducted a Nonmetric Multidimensional Scaling (NMDS) analysis using a Bray Curtis index, followed by a permutational multivariate analysis (PERMANOVA). The survey data, which covered household demographic characteristics, productive activities, use of non-cultivable edible species, and preferences for advocacy actions, were analyzed meticulously. The methodology used for the analysis was visualized using RStudio version 2023.03.0.

2.3 Characteristics of Households in the Five Farming Communities

Only five of the 44 female household heads reported farming as their main activity, in addition to housework (four in Ocotepec and one in Xico Viejo). Government subsidies were the most significant source of household income (33%, SD=7), followed by wages earned within the farming community or in nearby cities (21%, SD=15), and farming (14%, SD=14). Households belonging to two communities (Xico Viejo and Ocotepec) reported receiving migrant remittances (12%, SD=24). Income diversification was low: 61% of the households reported two sources, and 39% only one.

Forty percent of the surveyed families farmed one crop field, 28% farmed two, and 32% three or more. The most common use of the crop fields was for milpa agriculture (64%), followed by grazing (14%), and forest (7%). The remaining 15% was allocated for various land uses, such as home gardens. Ocotepec was the only community that reported exclusively milpa fields. Fifty percent of the milpas were polycultures of corn, beans, and squash, but the percentage ranged from 33% of the crop fields in El Zapotal to 83% in Xico Viejo. The rest of the milpas (28%) contained a simplified system of corn with beans and were reported in all five communities. The additional 22% reported as 'milpa agriculture' comprised corn monoculture. In El Saucal, 46% of the milpas were used for corn monoculture, *versus* 25% in El Zapotal and 39% in Ocotepec. Many of these crop fields were smaller than a hectare (43%). Five families owned crop fields of three to five hectares. Two families had crop fields larger than five hectares, and all of them were forest plantations or natural forests.

3. Results and Discussion

3.1 Diversity and Supply of Edible Non-crop Plants and Mushrooms

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As a noteworthy example of agroecological principles in action, milpa enhances the cultivation of edible non-crop species (Linares Mazari & Bye Boettler, 2015). Nevertheless, our findings revealed no distinctions with forests, which served as the most abundant source of edible non-crop plants and the predominant habitat for mushrooms. Despite forests being the primary habitat for mushrooms, we observed that both forests and milpas displayed comparable richness in edible non-crop plants. In contrast, riverbeds exhibited lower richness in both plants and mushrooms.

During the focus groups, the five communities reported a total of 71 species and 14 morphotypes of edible non-crop plants and mushrooms (Table 2). The number of edible non-crop plant species gathered in milpas was the same as in forests, and was greater than in riverbeds (GLM: $X^2_{(4, 2)}$=65.968, p<0.001). The majority (91.7%) of the edible mushrooms were gathered in forests, but 8.3% were gathered in milpas. No mushrooms were reported to be collected in the riverbeds.

In general, the survey results suggest that the forest was a rich source of edible non-crop plants and mushrooms with 48.4% of all the plants gathered there, as well as 91.6% of the mushrooms (Table 1). We found that 46.6% of edible plants were reported in the focus groups and 91.6% of mushrooms grew exclusively in the forest. Most edible non-crop plants were reported to be found "around the corner" from the family's homes, or "an hour away" (Table 2). In contrast, the travel time for gathering edible non-crop mushrooms reached two hours (Table 2).

Table 2. Richness, management unit, and distance (travel time) from households for gathering the edible non-crop plants and mushrooms utilized by 50 households in Cofre de Perote, Mexico.

	Plants	**Mushrooms**
Species/morphotypes reported (n)	60	25
Species reported by each farming community (n)		
Xico Viejo	35	9
Ocotepec	33	13

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Zapotal	29	10
Saucal	21	13
Buena Vista	31	8
Habitat (%)		
Forest	48.4	91.6
Milpa	45.3	8.3
River	6.2	0
Distance from housing (%)		
Around the corner	64.6	12.0
An hour away	26.2	40.7
Between one and two hours	9.2	15.7
Over two hours	0	31.5
Most frequently reported species consumed in the surveys (%)	1) Quintonil/cantonil (*Amaranthus hybridus*); 58 2) Hierbamora (*Solanum nigrum)*; 36 3) Berro (*Nasturtium officinale*); 22 4) Chiquelite/chichiquelite (*Cleome magnifica*); 22	1) Alarcho/alarchi (*Armillaria tabescens*); 46 2) Chinanacas (*Hypomyces lactiflorum/ Hypomyces macrosporus*); 34 3) Tecomates (*Amanita basii)*; 30

As documented in Anderzén et al. (2020), the peak period for the utilization of edible non-crop plants in Mexico, particularly mushrooms, occurred during the rainy season from June

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to August (Figure 3). At this time of the year, many farming families have used up the part of their yearly harvest saved for autoconsumption. Practices aligned with agroecological principles in milpa, coupled with sustainable management in forests and riverbeds, contribute to the growth and subsequent harvest of these resources.

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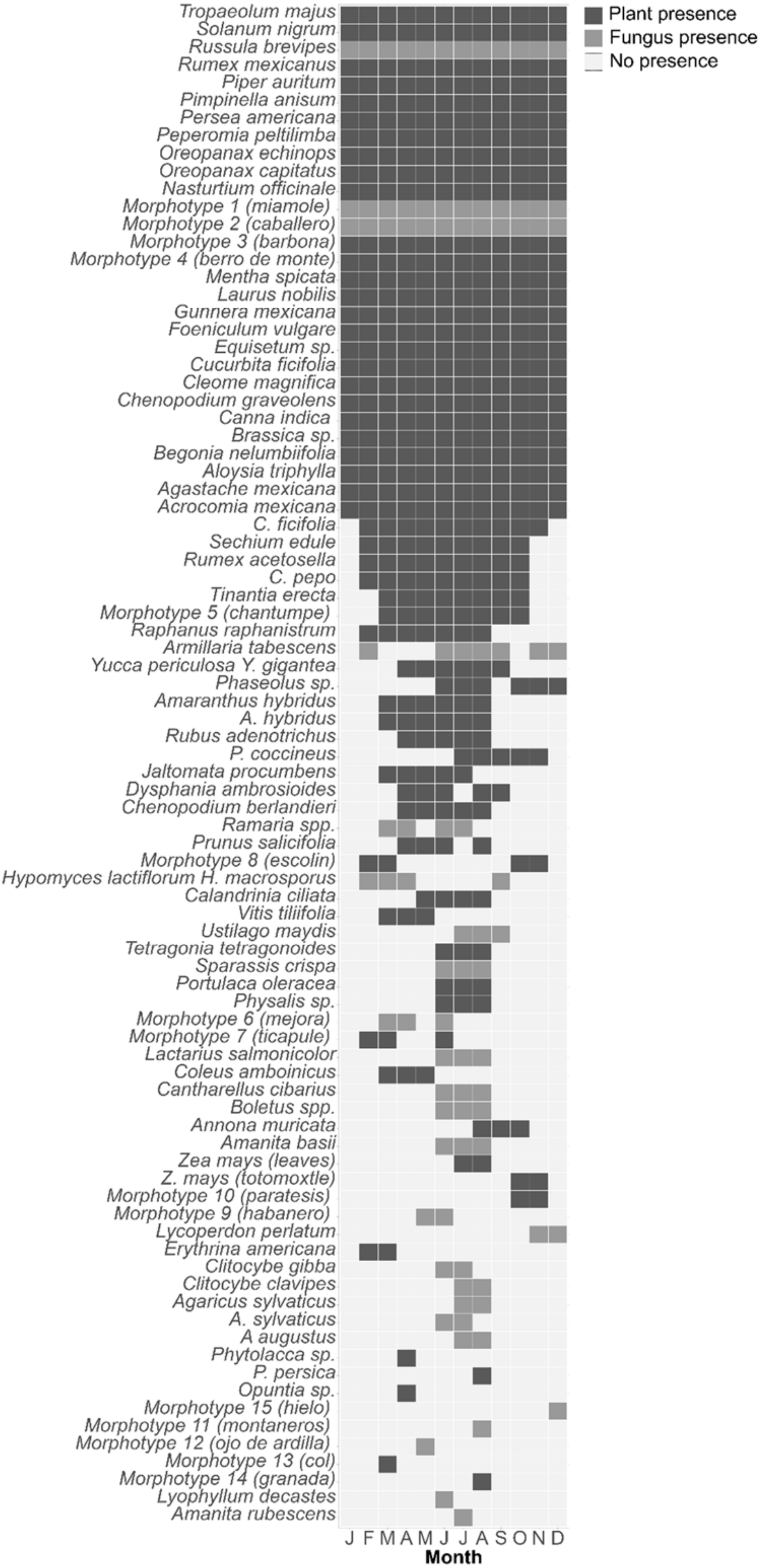

Figure 3. Seasonal consumption of the 85 species and morphotypes of edible non-crop plants (black) and mushrooms (grey) reported to be regularly consumed in five focus groups conducted across farming communities in Cofre de Perote, Mexico.

The abundance and species/morphotypes of edible non-crop plants and mushrooms varied across the communities (Table 2). In addition, the makeups of those inventories were highly location-specific: 34.1% of the species/morphotypes were unique to, or at least listed by, a single community. Another 29.4% of the species/morphotypes were listed by only two communities. Only ten out of 85 species/morphotypes listed in the inventories are consumed across all five communities. Nevertheless, the species/morphologies consumed by the five communities were similar, as confirmed by NMDS and PERMANOVA analyses (F=1.12, df=2, p=0.46).

Our results are consistent with those from earlier studies conducted in farming communities of mountain ecosystems across Mexico (Linares Mazari & Bye Boettler, 2015; Vieyra-Odilon & Vibrans, 2001). For example, in the Sierra de Chincua in the Nevado de Toluca in central Mexico, sixteen species of edible non-crop plants were found in milpas, but 119 species of edible plants were reported in other landscape units. Similarly, studies in the Tehuacán Valley reported that 20 of the region’s 81 edible species were found in milpas (Linares Mazari & Bye Boettler, 2015; Vieyra-Odilon & Vibrans, 2001). As for mushrooms, we recorded more species than in previous studies that were conducted in similar mountainous ecosystems. For example, in the Sierra Madre of Chiapas, Rivera-Núñez et al. (2022) reported only two edible mushroom species, and Guzmán Luna et al. (2022) reported 16.

For farmers, access to land is a requisite for reducing their dependence on the global food system, which makes land tenure a fundamental right (La Vía Campesina, 1996; Patel, 2009). However, the land considered essential for farmers is commonly perceived solely in relation to productive fields, often overlooking surrounding landscapes such as forests. We found that for farming families that have access to gathering food in a forest, regardless of tenure, these ecosystems become an essential source of edible non-crop plants and mushrooms. This finding is in agreement with numerous ethnoscience studies that have acknowledged the importance of forests as a source of edible non-crop plants and mushrooms (Balemie & Kebebew, 2006; Burrola-Aguilar et al., 2012; Cruz-Garcia & Price, 2011; Ladio & Lozada, 2004). Thus, studies on food security ought to expand their scope beyond the farm and encompass other landscape units that may play a crucial role in supplying food for farming families.

3.2 Relationship Between Access to Urban Centers and Richness of Edible Non-Crop Species

We found no correlation between access to urban centers and the number of edible non-crop plants and mushroom species/morphotypes harvested by households. Nevertheless, 58% of the surveyed people reported that they consumed edible non-crop plants and mushrooms more frequently when they had less money to buy food in urban centers. The effect of accessibility to urban centers on agrobiodiversity has been shown to follow non-linear across gradients (Zimmerer & Vanek, 2016). For example, Khoury et al. (2014) and Khoury et al. (2022) found that as the access of farmers to urban centers increases, and the economies of farming communities become more dependent upon these centers, a commodification process takes place within the agricultural communities which leads to agrobiodiversity loss. This pattern has been documented specifically for the milpa (Fonteyne et al., 2023; McLean-Rodríguez et al., 2019). Additionally, Jones (2017) found that households that have easier access to food markets often depend less on the families' own production, and more on purchased goods.

However, our results coincide with previous reports that accessibility of urban centers did not correlate with edible crop species richness (Perales, 2003; Poot–Pool et al., 2015; Zimmerer et al., 2019). This could be explained by the cultural attachment of farmers in the Cofre de Perote region to edible non-crops consumption. Furthermore, in the study area, edible non-crop species contribute to food security because farm families, independently of their communities' ease of access to urban centers, can procure these species at no monetary cost, just by investing in labor. In this sense, farming families consume edible non-crop species as a way to diversify their diets, which helps to get access to different types of nutrients than those obtained from crops. These findings suggest that in regions where accessibility for farming households and richness of consumed edible non-crop species are not correlated, two factors determine the continued use of edible non-crop plants. The first is that families do not have access to food in regional urban markets, regardless of travel time due to financial limitations. In our study, this factor is reflected in the fact that almost two-thirds of the families reported consuming a greater amount of edible non-crop plant and mushroom species when the families did not have sufficient financial resources. The increased consumption of non-crops due to the limited affordability of commercially grown food corresponds to patterns observed in farming communities of the Sierra Madre of Chiapas, where families utilize non-crop foods when they are affected by seasonal food scarcity (Guzmán Luna et al., 2022; Rivera-Núñez et al., 2022). The second factor is related to the non-linearity of the transition from rural livelihood strategies to urban ones. Even as access to market cities becomes easier, farming families depending on urban-related incomes often sustain themselves through a hybrid livelihood strategy, engaging in activities that generate cash income, showcasing their interdependence (Lerner et al., 2013). Therefore, those two activities are not necessarily mutually exclusive (Lerner & Appendini, 2011). As a result, the increasing accessibility of urban centers may have an impact on some

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of the social processes that affect agroecosystems, but not on the use of edible non-crop species (Lugo-Castilla et al., 2023).

There is a need to explore the mechanisms by which accessibility to urban centers impacts the consumption of edible non-crop species. For example, we observed that global food markets penetrate community grocery stores even in the most remote rural communities. However, research on the transition of farmer families' diets suggests that the consumption of traditional foods may still prevail within the context of an industrial-food diet (Guzmán Luna et al., 2022; Jenatton & Morales, 2020). Furthermore, farming families enter urban markets, commonly selling edible non-crop species in both street markets and alternative market. These types of markets could have a positive impact on the persistent use of edible non-crop species.

3.3 Advocacy Actions

Among the diverse advocacy actions to improve the management and feeding associated with non-crop edible plants and mushrooms proposed by Palomo-Campesino et al. (2018, see Section 3.2.), the four actions that sparked the greatest interest among participants were 1) the construction of seedbeds and greenhouses for production geared towards self-consumption and/or commercialization, 2) workshops on cooking to broaden local gastronomic culture, 3) recipe books based on the communities' practices to systematize the regional culinary tradition and acknowledge the contributions of each community, and 4) workshops to learn about species' ecology and to implement management strategies that favor their conservation. Actions such as educational programs, specialized workshops for children and young people, and marketing strategies aroused less interest (Table 3). We found differences in advocacy preferences between farming communities (p=0.05) and genders (p=0.05). Specifically, women preferred advocacy for seedbeds and greenhouses for production, management actions (i.e., habitat improvement), and culinary workshops. The five surveyed individuals who expressed no interest in any advocacy activity were men.

Table 3. Percentage of people who indicated interest in different advocacy actions for sustainable consumption of edible non-crop species, as reported by participants from the five farming communities in Cofre de Perote, Mexico. n=50, 42 women and 8 men.

Advocacy actions	**Men (%)**	**Women (%)**
Seedbeds and greenhouses for production	10	44
Culinary workshops	4	36
Community recipe books	6	16

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Management workshops	2	20
Workshop for youth and children	4	16
Marketing strategies	4	10
Recovery of overexploited species	2	10
Food education programs	2	10
Mushroom growing	0	2
None	10	0

Among farming families, greenhouse propagation of edible underutilized species was the most popular advocacy action. Similarly, Linares Mazari & Bye Boettler (2015) reported that greenhouse propagation is popular because it increases the availability of these plants both for self-supply and sale in markets. In addition, families were in favor of the construction of greenhouses because they are typically funded by non-governmental/governmental organizations that promote better agricultural and food conditions for farming communities (Guzmán Luna et al., 2019), and because the use of herbicides has reduced the abundance and diversity of edible non-crop plants in the seed banks, making it difficult to promote them at the plot level (Mascorro de Loera et al., 2019). Nevertheless, the greenhouse propagation of many of these species is intricate due to the complex co-evolution with the soil microbiome of milpas. As non-crops, the availability of highly fertile and relatively homogenous seed lots for edible weeds is limited (Castro-Lara, 2014). Further horticultural experimentation is needed to explore this issue.

Workshops on nutrition and community recipe books were other advocacy actions that interested the surveyed communities. These workshops help to destigmatize the consumption of edible non-crop plants as “food of the poor” (Rivera Núñez & Lazos Chavero, 2022), and to inform residents about the plants’ nutritional and nutraceutical properties (Mera-Ovando, 2003). Community recipe books are excellent repositories for documenting, systematizing, and revitalizing the local culinary tradition of consuming *quelites* and mushrooms. In this way, these books help to revert the erosion that those traditions have suffered due to the dietary transition in rural areas (Popkin, 2014). Recipe books could also have regional reach and national contextualization, thereby favoring the exchange of information between farming communities while giving the communities greater visibility and enhancing the farmers’ food culture.

Finally, the promotion of sustainable practices both at the crop field level and the surrounding landscapes can increase the impact of advocacy actions and encourage farm families to learn sustainable management practices for edible non-crop species. For example, non-crop plants can be used as green manure, cover the soil, help control nematodes, and reduce the need for agrochemicals (Altieri et al., 2017). At the landscape level, milpa farmers need to implement educational, conservation, and restoration programs to enhance the acknowledgment of the significance of the surrounding areas, such as forests, remnants, and riverbeds as they can serve as habitats for edible plant and mushroom species, apart from important ecosystem services (Perfecto et al., 2019). Farmers and advocacy groups may engage in agroecological initiatives that broaden their perspective beyond the farm. This approach aims to develop a more nuanced understanding of farmers as both cultivators and gatherers, challenging the common limited perception of farming communities solely as food producers, overlooking their role as collectors.

4. Conclusions

We analyzed the contribution of edible non-crop plants and mushrooms to the food security of farming families in the rural highlands of Mexico. Our findings indicate that the frequency of edible non-crop species consumption is not associated with the gathering location, despite a higher diversity of edible species in forests compared to a lower variety in milpas. Additionally, the utilization of these species is not influenced by distances from farming communities to regional urban centers, which we used as a proxy for accessibility to purchasable food. However, families reported an increase in the consumption of edible non-crop species when financial constraints prevented them from buying food at the market. This observation implies that non-crop species play a crucial role in enhancing the food security of these communities, particularly during periods of economic hardship.

This chapter makes a valuable contribution to the emerging agroecological literature by presenting a case study that explores avenues for enhancing food security in subsistent farming communities beyond agricultural production and through the use of gathered plants and mushrooms. We found those means include farming families relying on multiple forms of utilizing their own diverse landscapes to obtain this complementary food. Agroecological approaches to the gathering of edible non-crop species have the potential to advance the understanding of agriculture-harvesting management within multifunctional landscapes as a livelihood strategy for farming families.

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