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Contributions of Agroforestry Systems to Food Provisioning of Peasant Households: Conflicts and Synergies in Chiapas, Mexico

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Traditional agroforestry systems are widely recognized for their contributions to provisioning, support, regulation, and cultural services. However, because of the advancement of industrial agriculture and a corporative food system, peasants' food systems are rapidly undergoing transformation. We identify the contributions of four types of agroforestry systems (AFS)—shade cocoa agroforest, shade coffee agroforest, *milpas* and homegardens—to food provisioning in peasant families and discuss conflicts between traditional food systems and the contemporary industrial model of production and consumption confronted by peasants and semi-proletarian migrants. We carried out research in 17 peasant communities in Chiapas, Mexico, and conducted 97 semi-structured interviews and agroecological inventories with peasant families, and 15 interviews with semi-proletarian families laboring in shade-grown coffee plantations. Thirty-nine weekly food diaries were applied in two communities. We recorded 108 plant species belonging to 49 botanic families. These species play an important role as sources of carbohydrates, protein, vitamins, minerals, and fatty acids. Despite the extraordinary agrobiodiversity of peasant agroecosystems, peasant families (PF) are changing their AFS' structure, composition and functions due to the influence of agribusiness, global markets, and public policies that orient changes in production and marketing, which in turn devalue local food, agrobiodiversity, and knowledge. Changing perceptions regarding the value of "good food" vs. "food of the poor" and competition over land use between traditional and *modern* systems are driving changes in diet, food sources, and health of PF who are including industrialized foods in their diets, driving changes in consumption patterns and affecting human health. For semi-proletarian migrants laboring in coffee plantations, land access in and outside of the plantation and strengthening social networks could mean access to healthier and culturally appropriate foods. While peasants have historically responded to market and household needs, articulating both activities to satisfy family needs and provide income is limited. This work highlights the urgent need to acknowledge the non-monetary value of local foods, agrobiodiversity, local knowledge, community building, and the need to work towards securing land access for landless workers in Latin America.

Keywords: coffee, cocoa, homegardens, *milpa*, Mayan agriculture, social and environmental services

INTRODUCTION

Agroforestry systems (AFS) are complex and multifunctional units. They offer social, economic, environmental, and recreational benefits (Barbieri and Valdivia, 2010; Tscharntke et al., 2011). Coffee and cocoa agroforests, *milpas* (diversified crop fields, typically of maize, beans, squash, and other annual crops) and homegardens include crops and trees; and are subject to various types of management depending on economic and organizational levels, access to land and paid work, family structure, and market prices (Merlín et al., 2018). These systems sustain hundreds of thousands of *campesinos*[1] and migrant workers in southern Mexico (Vásquez González et al., 2018; Jiménez-Soto, 2020) by supporting resource bases for communities: natural resources (e.g., local seeds), physical environment (e.g., shade for coffee), human (e.g., local knowledge), financial (e.g., cattle as savings), and social (e.g., organizations for production and commercialization). In Chiapas, as in the rest of the world, different political and socio-economic factors compromise the capacity to sustain agroecosystems and food provisioning.[2] Among these factors are the increasing influence of global markets that impose prices on peasant farmers, the advancement of the export economy, the absence of supporting public policies, and media influences on consumption patterns, displacing local products (van der Ploeg, 2010; Rosset and Martínez-Torres, 2016; Henderson, 2017). These factors are defining features of the advancement of "modernity" in Latin America, that includes the expansion of neoliberal policies and globalization (Larraín, 2014).

These changes impact people's relationships among each other and with their environment, as well as value chains and human and environmental health (Hermann et al., 2009; Benítez et al., 2020). While such changes occur gradually, over time they have led to deforestation as well as loss of biodiversity, food sovereignty, food security, and ecosystem services (Soto-Pinto, 2019; López Cruz et al., 2021; Pantera et al., 2021). Furthermore, they are associated with increased social, economic, and political dependence on other external sectors (Giraldo, 2018).

In Mesoamerica, traditional agroforestry systems have historically sustained peasant communities (many of which are Indigenous Maya), where local agrobiodiversity, Indigenous practices, and knowledge play a significant role. At the same time, these systems support the livelihoods of laborers who live and work within AFS as permanent and temporary wage laborers (semi-proletarians[3]), migrating temporarily to work on AFS to reproduce their peasant livelihoods back home. For example, Guatemalan semi-proletarian migrants who own home gardens at home are employed temporarily in agroforestry systems in Chiapas, which allows them to purchase seeds and fertilizers for their own family plots in Guatemala (Jiménez-Soto, 2020). Here we argue that although AFS have historically sustained peasant and semi-proletarian families, external socio-economic factors threaten livelihoods and impose an important contradiction and conflict between the remarkable value of AFS to human livelihoods and the advancement of "modernity" (Vásquez González et al., 2018; Soto-Pinto, 2019; Cerda et al., 2020; Kerr et al., 2021). The present study analyzes the plant structure and diversity of four types of traditional agroforestry systems and their relationship to food provisioning of peasant and semi-proletarian families, and discusses the conflicts and contradictions between the AFS agrobiodiversity and food provisioning in the face of globalization.

METHODS

This study was carried out in nine municipalities of Chiapas, the southernmost state of Mexico, with peasant families and semi-proletarian seasonal migrant workers. We studied four agroforestry systems: shade cocoa, shade coffee, *milpa*, and homegardens. Shade cocoa systems were studied in the municipality of Acacoyagua; shade coffee systems in Bellavista and Tapachula; agroforestry *milpas* in Salto de Agua, Tumbalá, and Chilon; and homegardens in Tuzantan, Motozintla, and Huixtla.

We conducted a total of 97 semi-structured interviews and agroecological inventories in farmer's plots in 17 rural communities (Rinconada in the municipality Bella Vista, Nueva Europa, Primero de Diciembre, Quince de Enero, and Estrella Roja in the municipality of Huixtla, Belisario Domínguez, El Relicario, Rio Bravo and Nueva Maravillas in the municipality of Motozintla, Manacal in the municipality of Tuzantán, Los Cacaos, María Esther, Nueva Libertad, and Acacoyagua in the

[1]Peasants are mainly organized in families and practice agriculture predominantly for self-sufficiency and local or regional markets. They complement their income with intra- or extra-communitarian jobs, remittances from migrant family members, and governmental subsidies.

[2]Here, we refer to *provisioning* as the contribution of agroecosystems to foods and other goods, which are accessed by families through hunting, fishing, gathering, and harvesting of crops (Wilson 2008). Under a multifunctionality framework– which suggests "a 'deepening' of diversification activities" –, strong multifunctional systems are characterized by the provisioning of high food quality and diversity, associated with differentiated food demands and strong valuation of household knowledge and processes that go beyond productivist agricultural activities (Wilson 2008).

[3]The Marxist term semi-proletarian refers to rural families who depend on both farm income and labor migration. Many migrant families travel from Central America to harvest coffee in large coffee plantation systems; many of them maintain a *campesino* livelihood at home, but use temporary migration to complement their family economy.

municipality of Acacoyagua, Arroyo Palenque in the municipality of Salto de Agua, Tronconada in the Municipality of Tumbalá, and Bachajon in the municipality of Chilón) (**Figure 1**).

Additionally, in every AFS we carried out areal sampling methods to account for discrete variables in cocoa AFS, coffee AFS, *milpa* AFS, and AF home gardens through inventories (modified from Williams, 2001). Inventories were carried out in 20 × 20 m-quadrat plots for coffee, cocoa and *milpa*, and 5 × 5 m-quadrat plots in homegardens (Mueller-Dombois and Ellenberg, 1974). In all plot, a ≥ 10 cm-diameter trees and shrubs, and ≥3 m-height herbs were recorded, in addition to herbs in the 5 × 5 m-plots. Plant specimens were collected and identified in the El Colegio de la Frontera Sur herbarium. Plant species richness and edible species richness (number of plant species in the quadrats) were recorded in all plots as an indicator of the botanical composition, food availability and food diversity.

Photographs were taken in each plot to ascertain the number of strata; the crop and woody plant densities were estimated from the number of individuals per area, as indicators of the system's structure. The species uses, common names, parts of plants used, agroecological management, the number of products, and product destination were recorded with the participation of local farmers.

In addition, in two communities we conducted 36 weekly food diaries (Bellisle et al., 1999) that were applied to individual families, recording the food consumed during one week during the dry season, when food shortages have previously been reported in coffee zones in Mexico and Central America (Morris et al., 2013; Fernandez and Méndez, 2019). We carried out a botanical collection and with the help of family members, identified and documented local names, uses, and parts of species used.

We also conducted 15 interviews and participant observation with semi-proletarian families working on large shade coffee plantations in the Soconusco region of Tapachula (both temporary and permanent workers). The aim of this ethnographic research was, in part, to record food-related experiences of migrant workers in shade-grown coffee plantations during the harvest season (September-December) (Jiménez-Soto, 2020). Interviews and diaries were analyzed using qualitative and quantitative analyses in R Studio, and MAXQDA 2020 (VERBI Software, 2019). Structural, compositional and food variables were correlated with Pearson analysis.

RESULTS

Campesino Peasant Families (PF) and Semi-Proletarian Migrants

The majority (90%) of the peasant families consist of nuclear or extended groups with ejido[4] land tenure. In the municipalities of Motozintla and Huixtla in the Sierra Madre mountains and Acacoyagua on the coastal plain of Chiapas, PF are predominantly mestizo of Mam and Spanish origin. PF of the *ejido* Bachajon in the municipality of Chilon are of the Tzeltal Mayan ethnic group. Those families from the community of Arroyo Palenque and Tronconada belong to the Ch'ol Mayan ethnic group. Families are bilingual, speaking both the native language and Spanish.

PF consist of 5.00 ± 2.6 members. Most heads of families are males over age 60. Of all men, 44% are engaged in agricultural activities, 25.6% are students, and the rest are non-agricultural laborers (construction, commerce, etc.). Of all women, 54.4% are housewives, 33.8% are students, 7.2% practice agriculture, and the rest work as teachers, government employees, or other. Women take charge of preparing food for their family and temporary wage laborers, as well as raising domestic animals such as chickens, turkeys, ducks, and pigs. Other domestic activities include preparing bread or chocolate, roasting and grinding coffee, selling or exchanging agricultural products, propagating, and selling ornamental plants, and saving seeds. Furthermore, women collectively prepare food for religious and other festivities as well as funerals and take care for the elderly or the ill.

PF have an average of 4.9 ± 2.4 ha of land.[5] They allocate small plots of their land for different uses, such as *milpa*, small areas of fallow land, cattle grazing, and homegardens that provide products for family subsistence; cocoa and coffee crops are cultivated principally for selling. Cattle in Salto de Agua and Tronconada are destined to markets.

These traditional low-input agroecosystems rely on local knowledge and germplasm, manual tools, family labor and oral transmission of agroecological knowledge which allows for the reproduction of agroecosystems and PF's livelihoods.

Semi-proletarian families carry out wage labor on large shade coffee plantations. This group includes migrants who are originally from Guatemala and work as temporary wage laborers in shade coffee plantations during the harvest season. Most of these seasonal laborers grow their own food in home gardens, *milpas* and raise small numbers of cattle back at home in Guatemala. This group overlaps with a permanent labor force that live within agroforestry systems. These laborers do not own land, although some have acquired land in neighboring *ejidos* where they grow coffee. A small number of these permanent laborers have small homegardens in the area where they work consisting of potted plants, and also forage and hunt in and around the coffee agroforest. These two types of plantation laborers overlap in time and space in the coffee AFS.

Cocoa Agroforestry Systems

Cocoa (*Theobroma cacao* L.) is cultivated traditionally using family labor and manual tools on plots with a mean area of 2.5 ± 2.04 ha, under the shade of an agro-silvicultural or *multistrata* system consisting of native and introduced multipurpose trees, shrubs, palms, herbaceous and other type of plants. The majority of families (74.1%) combine coffee and cocoa trees under shade trees with the intention of reducing their vulnerability if

[4]Ejido is a form of land tenure -a communal resource-holding institution where a community was granted land by the federal government-. The ejido land is regulated by an assembly and individually managed by each farmer (often through family decision making (López Cruz et al., 2021).

[5]Some community members, known as *avecindados* (a variant of the Spanish word for neighbors), lack formal ownership of land.

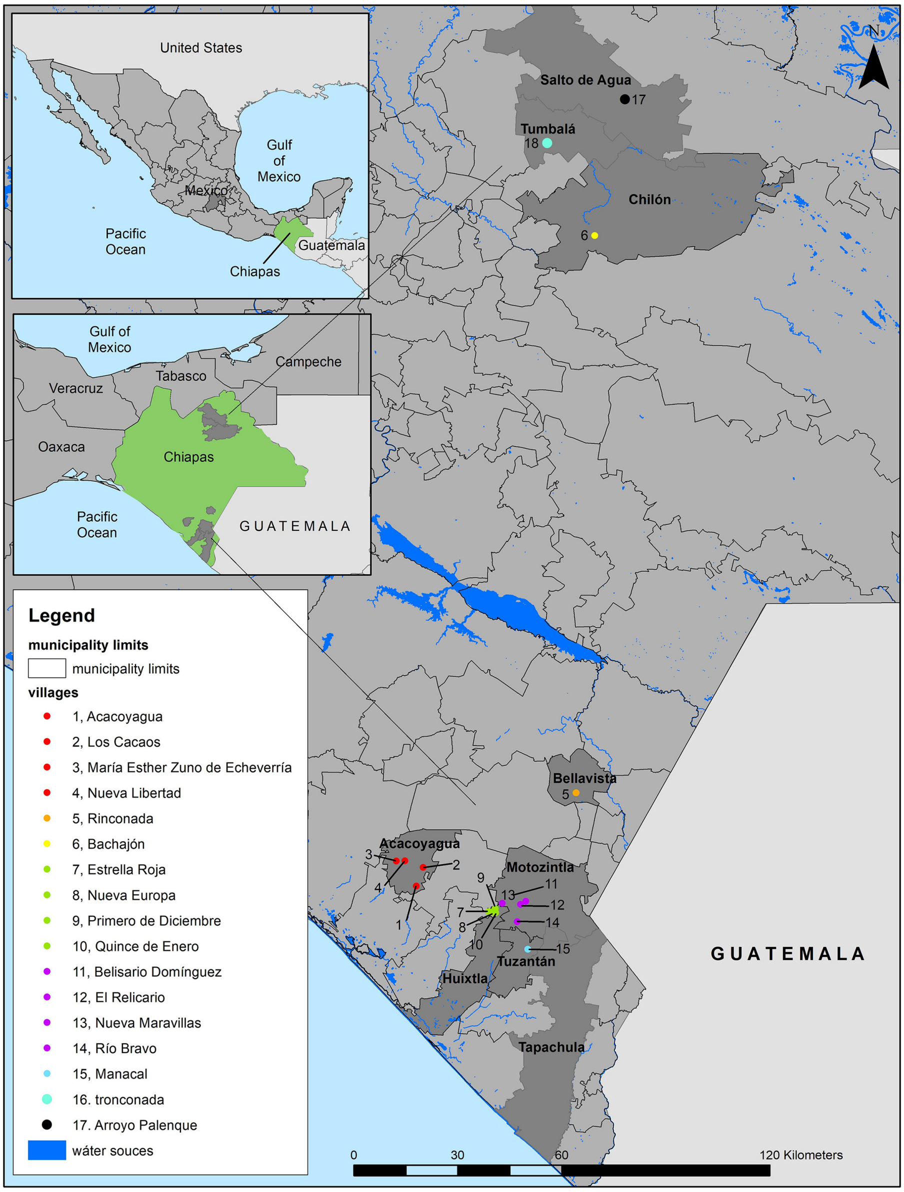

FIGURE 1 | Study area in Chiapas, Mexico.

faced with low prices, pests and diseases, as indicated by the following testimony:

> "*We grow coffee and cocoa together. If cocoa fails because of low prices or pests, we have coffee. If coffee fails, we have cocoa. That way, one helps herself*" (Ada, age 45, Acacoyagua)

Cocoa trees (*Theobroma cacao* L.) raised by PF of the region belong to the varieties *forastero* (from Trinidad) and *trinitario* (*criollo—forastero* hybrid). Most cocoa trees are older than 20 years with yields between 200 and 400 kg^{-1}. Cocoa is used for family consumption and sold to intermediaries. Most PF that grow cocoa have formed cooperatives to sell organic cocoa and thereby obtain better prices as well as funds for parallel projects. Cocoa *multistrata* agroforestry systems host native and introduced multipurpose species which provide food, timber, and fruit.

Agricultural practices throughout the year include removal of shoots, weeding, pruning and harvesting of cocoa trees, pest and disease control through cultural practices and the application of lime and ash to control *monilia* (*Moniliophtora roreri* (Cif.) H.C. Evans, Stalpers, Samson & Benny) and frosty pod rot (*Phytophthora capsici* Leo.). Farmers interviewed do not use chemical fertilizers and follow organic methods. Commonly used tools include the machete and *cuchilla* (knife attached to a long stick to harvest fruit and prune apical shoots). Cocoa is harvested throughout the year, although yields are greatest during February and September.

Forty-eight useful species were recorded in cocoa AFS (**Table 1**). Over half are multipurpose species (52.3%), which belong to six categories of use: food (35.2%), timber (28.4%), shade (18.2%), fuelwood (10.2%), manure (3.4%), and other (4.4%), which includes medicinal plants, plants with aesthetic value such as *Licania platypus,* rat repellent such as *Ricinus communis*, and as an implement for mixing beverages *(Quararibea funebris).* The most common species were avocados, citric fruits, bananas, *pataste* (*Theobroma bicolor*), pineapple, palm inflorescence, chili peppers, and soursop, *Annona muricata*, most of which are used for family consumption (**Table 1**). Fruits are also commonly sold by women within the community or in regional markets, thus contributing to community value chains. Gender division of labor was observed in cocoa cultivation; women and younger family members harvest, select, wash, and dry cocoa beans while men carry the pods home weed around the cocoa trees and prune both the cocoa and shade trees. Women are also in charge of preparing chocolate using cocoa beans from their AFS.

Often, trees are tended for timber to obtain income for festivities or medical expenses and other family emergencies. Cocoa beans are commercialized through regional intermediaries who distribute them to the national market. Only one third of families process cocoa beans into chocolate, which is used for family consumption, sold, or given as a gift.

Of the 48 useful species recorded in cocoa systems, 23 were used as food, 15 of which were native. Those fruit tree species which were most frequent and found at the greatest densities were *mamey*, *cuil*, *chalum*, mango, soursop and avocado (**Table 1**). Typically, the mean tree density was 160 trees ha^{-1} varying from 2 to 3 tree/shrub strata.

Shade Coffee AFS

The coffee systems evaluated were managed by PF as organic systems. Cultivation practices consisted of nursery management to raise coffee seedlings, weeding, coffee pruning (twigs and shoots), shade-tree pruning, production and application of compost and other organic inputs, pest and disease control, and fruit harvest. Men typically weed, prune cocoa and shade trees in the coffee plots, while women mainly harvest, wash, and dry the beans as well as playing an important role in collecting plants and hunting wild animals for food, medicine, and aesthetic purposes. Women teach children about food preparation and other plant uses, including how to identify edible and poisonous plants.

Coffee AFS yield ~480 kg ha^{-1} of clean coffee, which is sold in the international market through the Emiliano Zapata *campesino* cooperative. These AFS are complex, managed with shade consisting of varied proportions of native trees and shrubs. A total of 112 plant species were recorded in coffee plots, including 57 shade plants, 37 trees, 16 shrubs, four tall herbaceous plants (>4 m), and 52 small herbaceous plants. An average of 221 trees ha^{-1}, 66.6 shrubs ha^{-1}, and 79.1 banana plants ha^{-1} (*Musa acuminata* Colla) were recorded.

Categories of use were food, medicine, fuelwood, construction material, living fence, green manure, tamale wrapping, nesting material for hens, brooms, fodder, decoration, and food for wildlife. Food resources inventoried included 33 native or introduced trees, 21 of which provide edible fruit, such as *Saurauia oreophila*, *Saurauia scabrida*, *Annona muricata, Persea americana, Musa × paradisiaca, Psidium guajava, Passiflora ligularis, Parathesis chiapensis, Prunus persica,* and several citrus fruits. Roots, stems, leaves, fruits, inflorescences, flowers, infructescences, and other parts of trees found in the coffee plots resulted in a total of 146 products used for different purposes.

Some species indirectly provide food; for example, the stem of the *salvio* tree (*Lippia chiapasensis*) hosts a lepidopteran larva of the Hepialidae family known in Rinconada and Estrella Roja as *chiquirines*, which is highly appreciated for its flavor and has a high protein content (Gómez et al., 2016). This is also observed with other plant species in other regions; for example, tree species of the genus *Heliocarpus* host a Lepidopteran larva of the Saturniidae family known as *sats*.

The greater the shade tree and shrub species richness in the coffee groves of the study area, the greater the number of food species ($p < 0.05$; **Table 2**), which demonstrates the importance of maintaining shade species agrobiodiversity in coffee agroforests. In recent decades, many communities have eliminated shade trees and shrubs to plant higher densities of coffee shrubs, thereby diminishing potential local benefits. In some areas of the Sierra Madre region, coffee densities reached 6,000 plants per hectare, compared to traditional densities of from 2,500 to 3,000 plants per hectare.

By contrast, interviews with semi-proletarian migrants and domestic workers of large-scale, shade-grown coffee plantations, or *fincas,* of the Soconusco region of Chiapas (~300 has) revealed very different food-related experiences from those recorded for small-scale peasant farmers. Large coffee plantations rely on hired labor throughout the year, though primarily during the harvest season (September to January). These workers consist of families that have lived on the plantations for generations as well as temporary workers, principally from Guatemala, who travel to work during the coffee harvest (Jiménez-Soto, 2020).

Semi-proletarian families receive a weekly food ration consisting of beans, rice, tortillas, and animal products such as chicken or beef soup. Regardless of the number of household members, a set ration is provided to the head of the family or household (usually male) in the form of food vouchers to be redeemed at the same farm.

Plantation laborers' experience concerning food depends largely on their social position and access to land. For example, semi-proletarians who continue to cultivate in Guatemala and travel seasonally to work on a plantation have a greater level of food provisioning as they harvest products at home and take them to the plantation. These products include tubers, such as *camote* (yellow and sweet potatoes) and radishes, as well as animal products, for example pigs and chickens. Additionally, workers often travel with their dogs which they use to hunt armadillos on the plantation (Jiménez-Soto, 2020). Strong ties to family members and friends within these plantations as well as back home are critical during the harvest season as it allows workers to exchange food and other goods. For example, families that travel may leave their home gardens in charge

TABLE 1 | Species recorded in four AFS: milpa, homegardens, coffee and cocoa in Chiapas.

Botanic family	Species name	Common name	BF	OR	Uses	UP	AE
Actinidiaceae	*Actinidia deliciosa* (Chev.) Liang & Ferguson	Kiwi	3	2	1	5	H
Actinidiaceae	*Saurauia oreophila* Hemsl.	Moquillo o xcabitze	1	1	1	5	CF
Actinidiaceae	*Saurauia scabrida* Hemsl.	Moquillo	1	1	1	5	CF
Amaranthaceae	*Amaranthus retroflexus* L	Bledo	3	1	1	3	H
Amaranthaceae	*Iresine celosia* Humb et Bonpl. ex Willd	Pata de paloma	3	1	1	4	H
Anacardiaceae	*Anacardium occidentale* L.	Marañón	1	2	4	5	H
Anacardiaceae	*Mangifera indica* L.	Mango	1	2	1	5	CC, CF, H, M
Anacardiaceae	*Spondias mombin* L.	Jobo	2	1	1	5	H
Annonaceae	*Annona macroprophyllata* Donn Sm.	Papausa	2	1	1	5	H
Annonaceae	*Annona muricata* L	Guanábana	1	1	1, 3	5, 7	M, CC, CF, H
Apiaceae	*Coriandrum sativum* L	Cilantro	3	2	1	3	H, M
Araceae	*Colocasia esculenta* (L.) Schott	Camote	3	1	1	5	M
Araceae	*Spathiphyllum sp.*	Guishnay	3	1	1	5	H
Araceae	*Xanthosoma robustum* Schott	Quequeshte	3	1	1	3	CF
Araceae	*Xanthosoma spp.*	Macús	3	1	1	1, 3	H
Arecaceae	*Chamaedorea tepejilote* Liebm.	Pacaya	3	1	1, 3	5, 7	CC, CF, H
Arecaceae	*Cocos nucifera* L.	Coco	1	2	1	5, 7	H
Arecaeae	*Astrocaryum mexicanum* Liebm. ex Mart.	Chapay	3	1	1	5	M
Asparagaceae	*Yucca* sp.	Winte, Izote	2	2	1	4	CF
Asteraceae	*Sonchus oleraceus* L.	Diente de león	3	2	1	2, 3	CF
Begoniaceae	*Begonia graciis* Kunth.	Ala de ángel	3	1	1	4	H
Bignoniaceae	*Stemmadenia mollis* Benth.	Coyol de cochi	1	1	1	2, 5	H
Bixaceae	*Bixa orellana* L.	Achiote	2	1	1	6	H
Bombaceae	*Pachira aquatica* Aubl.	Zapote de agua	1	1	1	5	M
Brassicaceae	*Brassica oleracea var. gongylodes* L.	Colinabo	3	2	1	3	H
Brassicaceae	*Rhapanus sativus* L.	Rábano	3	2	1	1	H
Bromeliaceae	*Ananas comusus* (L.) Merril	Piña	3	1	1	5	H, M
Cannabaceae	*Trema micrantha* (L.) Blume	Capulín cimarrón	1	1	2, 3,	5, 7	CC
Caricaceae	*Carioca papaya* (L.) Gaertn.	Papaya	2	1	1	5	H
Chrysobalanaceae	*Licania platypus* (Hemsl). Fritsch	Sinzapote	1	1	1	5	H
Clusiaceae	*Garcinia mangostana* L.	Mangostán	1	2	1	5	H
Convolvulaceae	*Ipomea batatas* (L.) Lam.	Camote	3	1	1	1	H
Cucurbitaceae	*Citrullus lanatus* (Thunb.) Matsum.& Nakai	Sandía	3	2	1	5	H
Cucurbitaceae	*Cucumis sativus* L.	Pepino	3	2	1	5	H
Cucurbitaceae	*Cucurbita ficifolia* Bouché	Chilacayote	3	1	1	5, 6,	H
Cucurbitaceae	*Non identified*	Pepinillo	3	2	1	5	H
Cucurbitaceae	*Sechium edule* (Jacq.) Sw.	Chayote	3	1	1	1, 2, 3, 5	CF, H, M
Elaeocarpaceae	*Muntigia calabura* L.	Capulín	2	1	1	5	H
Euphorbiaceae	*Cnidoscolus aconitifolius* (Mill.) I.M.Johnst.	Chaya	2	1	1	3	H
Euphorbiaceae	*Maninhot esculenta* Crantz	Yuca	2	1	1	1	H, M
Euphorbiaceae	*Croton sp. (possibly trinitatis)*	Pata de paloma	1	1	1, 4	7	CF
Fabaceae	*Cajanus cajan* (L.) Millsp.	Chícharo de árbol	2	2	1, 4	6	M
Fabaceae	*Crotalaria longirostrata* Hook. & Arn.	Chipilín	3	1	1	3	H
Fabaceae	*Erythrina americana* Mill.	Colorín	1	1	1, 2, 4	4	M
Fabaceae	*Inga edulis* Mart.	Paterna	1	1	1	2, 5, 7	H
Fabaceae	*Inga laurina* (Sw.) Willd	Caspirol	1	1	3, 1	2.5.7	CC
Fabaceae	*Inga nobilis* Willd.	Guagua	1	1	1, 2, 3	2, 5, 7	CC
Fabaceae	*Inga oerstediana* Benth. Ex Seem.	Chalum	1	1	1, 2, 3	2, 5, 7	CC, CF
Fabaceae	*Inga pavoniana* G. Donn.	Coquil 'te	1	1	1, 2, 3	2, 5, 7	M
Fabaceae	*Inga punctata* Willd.	Caspirol, tzelel	1	1	1, 3	1, 5, 8	CF, M
Fabaceae	*Inga vera* subsp. *spuria* (Humb. & Bonpl. ex Willd.) J. León	Cuil de agua	1	1	1, 2, 3	2, 5, 7	CC

(Continued)

TABLE 1 | Continued

Botanic family	Species name	Common name	BF	OR	Uses	UP	AE
Fabaceae	*Inga vera* Willd.	Cuil	1	1	1, 2, 3	2, 5, 7	CC
Fabaceae	*Phaseolus vulgaris* L.	Frijol	3	1	1	5, 6	H, M
Icacinaceae	*Oecopetalum mexicanum*	Caca 'te	3	1	1	5	M
Lamiaceae	*Mentha piperita* L.	Hierbabuena	3	2	1	3	H
Lamiaceae	*Ocimum basilicum* L.	Albahaca	3	2	1	3	H
Lamiaceae	*Origanum vulgare* L.	Orégano	3	2	1	3	H
Lauraceae	*Persea americana* Mill.	Aguacate	1	1	1, 3	2, 7	CC, CF, H, M
Liliaceae	*Allium schoenoprasum* L.	Cebollín	3	2	1	7	H
Malpighiaceae	*Byrsonima crassifolia* (L.) Kunth	Nance	1	1	1, 3	2.5.7	CC, H
Malvaceae	*Theobroma bicolor* Bonpl.	Pataste	1	1	1	5	CC, H
Malvaceae	*Theobroma cacao* L.	Cacao	2	1	4	6	CC, H
Marantaceae	*Calathea lutea* (Aubl.) E.Mey. ex Schult.	Hoja blanca	3	1	4	3	CC, H
Moraceae	*Artocarpus heterophyllus Lam*	Yaka	1	2	1	5	H
Moringaceae	*Moringa oleifera* Lamark	Moringa	1	2	1	3	H
Musaceae	*Musa acuminata* Colla	Guineo	4	2	1	3, 5	CC, M
Musaceae	*Musa sapientum* L.	Plátano de seda	3	2	1, 4	3, 5	CF
Musaceae	*Musa* × *paradisiaca* L.	Plátano macho	4	2	1	3, 5	CC, CF, H, M
Myrtaceae	*Psidium guajava* L.	Guayaba	1	1	1, 4	5	CF, H, M
Non identified	Non identified	Bejuco de contuve	3	1	1	5	CF
Oxalidaceae	*Averrhoa carambola* L	Carambola	3	2	1	5	M
Passifloraceae	*Passiflora edulis* Sims.	Maracuyá	3	2	1	5	H
Passifloraceae	*Passiflora ligularis* Juss.	Granadilla	3	2	1	5	CF
Phyllanthaceae	*Ribes rubrum* (L.) Skeels	Grosella	2	2	1	5	H
Piperaceae	*Piper auritum* Kunt	Hierba santa, momon	3	1	1	3	CF, H, M
Poaceae	*Saccharum officinarum* L.	Caña	3	2	1	2	CF, H, M
Poaceae	*Zea mays* L.	Maíz	3	1	1, 4	2, 3, 5, 6	M
Primulaceae	*Parathesis chiapensis* Fernald	Uva	2	1	1	5	CF
Rosaceae	*Eriobotrya japonica* (Thunb.) Lindl	Níspero	2	2	1	5	H
Rosaceae	*Prunus persica* (L.) Batsch	Durazno	1	2	1	5	CF
Rubiaceae	*Coffea arabica* L.	Café árabe	2	2	4	6	CC, CF, H
Rubiaceae	*Coffea canephora* Pierre ex A. Froehner	Café robusta	3	2	1	6	CC
Rubiaceae	*Randia* sp.	Zapuche de árbol	1	1	1	5	H
Rutaceae	*Citrus* × *latifolia* Tanaka ex Q. Jiménez	Limón persa	1	2	1	5	CC, CF
Rutaceae	*Citrus* × *limon* (L.) Osbeck	Limón criollo	1	2	1	5	CF, H, M
Rutaceae	*Citrus* × *limonia* (L.) Osbeck	Limón mandarina	1	2	1	5	CF, H
Rutaceae	*Citrus aurantiifolia* (Christm.) Swingle	Lima	1	2	1	5	CC, CF, H
Rutaceae	*Citrus reticulata* Blanco	Mandarina	2	2	1	5	CC, H
Rutaceae	*Citrus sinensis* (L.) Osbeck	Naranja	1	2	1	5	CC, CF, H, M
Rutaceae	*Citrus* × *limetta* Risso	Lima	2	2	1	5	H
Sapindaceae	*Nephelium lappaceum L*	Rambután	1	2	4	5	H
Sapindaceae	*Talisia olivaeformis* (H.B.K.) Radlk	Guaya	1	1	1	5	H
Sapotaceae	*Manilkara zapota* (L.) P.Royen	Chicle	3	1	1, 4	2, 8	M
Sapotaceae	*Pouteria campechiana* Baehni	Zapote amarillo	1	1	4	5	H
Sapotaceae	*Pouteria sapota* (Jacq.) H.E. Moore & Stearn	Mamey	1	1	1	2, 5,	CC, H
Solanaceae	*Capsicum annuum* L.	Chiltepe	2	1	1	5	CF, H, M
Solanaceae	*Capsicum annuum L.* var. *Glabriusculum*	Chile	3	1	1	5	H
Solanaceae	*Capsicum pubescens* Ruiz y Pav.	Chile jalapeño	2	1	1	5	CF
Solanaceae	*Cucurbita pepo* L.	Calabaza	3	1	1	5	H, M
Solanaceae	*Cyphomandra betacea* (Cav.) Sendtn.	tomate de árbol	2	2	1	5	CF
Solanaceae	*Physalis philadelphica* Lam.	Miltomate	3	1	1	5	H

(Continued)

TABLE 1 | Continued

Botanic family	Species name	Common name	BF	OR	Uses	UP	AE
Solanaceae	*Solanum americanum* Mill.	Quilete o macux	3	1	1	5	H
Solanaceae	*Solanum appendiculatum* Dunal	Correlón	3	1	1	3	CF
Solanaceae	*Solanum licopersicum* L.	Jitomate	3	1	1	5	H
Solanaceae	*Solanum nigrum* L.	Hierbamora	3	1	1	3	H
Solanaceae	*Solanum wendlandii* Hook. f.	Quishtán	3	1	1	2, 3	CF, H
Vitaceae	*Vitis* sp.	Bejuco de agua	3	1	1	8	CF
Zingiberaceae	*Zingiber* sp.	Maraca	3	2	1	3	H

BF, Biological form: (1) tree, (2) shrub, (3) arborescent, (4) herbaceous; OR, Origin: (1) native, (2) introduced; Uses, (1) food, (2) fuelwood, (3) shade, (4) other uses (including medicinal); UP, useful parts: (1) roots, tubers, or rhizome, (2) stems, branches, timber, or cortex, (3) leaves, (4) flowers or inflorescence, (5) fruits or infructescence, (6) seeds, (7) the hole plant; (8) sap; AE, Agroecosystems: M- milpa, H-homegarden or sitio, CF-coffee, CC-cocoa.
Source of data: Milpa: Modified from Soto-Pinto et al. (2013), Soto-Pinto and Armijo-Florentino (2014) Homegardens: Marina Benitez Kanter fieldwork (MSc Thesis, 2018); Coffee AFS: Sandra Escobar Colmenares fieldwork (MSc Thesis, 2017); Cocoa AFS: Angelita López Cruz fieldwork (MSc Thesis, 2019).

TABLE 2 | Correlation between species richness and food species richness (a proxy of natural food availability).

Variables	Food species richness r^2/p	Shade species richness r^2/p
Shade species richness	0.5954 0.0021	0.6624 0.0004
Tree species richness	0.5948 0.0022	0.5776 0.003
Shrub species richness	0.4742 0.0192	0.5799 0.0030
Shrub density	0.4118 0.0455	0.5496 0.0054

Pearson correlation coefficients and p value.

of elders or neighbors who harvest their crops while they are working temporarily in the plantations and frequently they will return home for a short period of time to bring such goods with them. Similarly, friends and family in the plantation may facilitate access to "good" hunting dogs or hunt together at night.

On the other hand, permanent laborers do not own land elsewhere, except for a few who have been able to purchase land in nearby *ejidos*. Although they live in a highly biodiverse coffee agroecosystem, they face constant food scarcity and depend on food rations received on the plantation and food purchased at high prices in the plantation store.

Both seasonal and permanent workers hunt and gather to complement their diets, and some cultivate their own food in plant pots or small plots in remote areas on the plantation. Some commonly foraged plants are also promoted and maintained without agrochemical use by workers; these include chili, *pacaya* palm (*Chamaedora tepejilote*) and *izote* palm (*Yucca* sp.) used for their inflorescences, *chayote* (*Sechium edule*), and herbaceous plants such as *pata de paloma* (possibly *Croton trinitatis*), *hierba mora* (*Solanum nigrum*), different varieties of amaranth (*Amaranthus* spp.) used for their leaves, *chipilin* (*Crotalaria longirostrata*), and *hierba santa* (*Piper auritum*), used to wrap tamales.

The Rotational Agroforestry Milpa

The *milpa* is a polyculture cultivated according to a rotational system consisting of a crop period and a fallow period. In the study areas of Chilón, Salto de Agua, and Tumbalá, a plot is commonly cultivated one year before being left to fallow seven to 10 years, according to land availability. If land is scarce, the milpa is planted continuously without a fallow period, requiring the application of fertilizers and/or pesticides as well as additional labor investment. PF typically cultivate *milpas* with an area of ∼1 ha in which maize is associated with beans, squash, chili peppers, cassava and other tubers, leafy greens, and palms, interspersed among ∼200 trees, shrubs, and palms per hectare. There are two maize and bean harvests each year and a variety of other products are collected at different times of the year. *Milpas* interspersed with timber trees may be planted continuously for four to seven years before they are left to fallow for ∼11 years. In one 1 ha *milpa,* a total of 75 wild, cultivated, tolerated, and domesticated plants species were recorded, most of which are used for food (**Table 1**).

Common fruit species are: *Anona* (*Annona muricata),* avocado, varieties of banana, guava (*Psidium guajava),* lemon, *oranges* (*Citrus × sinensis*)*, zapote* (*Pouteria sapota*)*, guash* (*Leucaena brachicarpa*), and *chícharo de árbol* (*Cajanus cajan*). Species with edible tubers or roots include *camote* (*Colocasia esculenta*)*, Quequeste and Macus* (*Xanthosoma sp.*), and casava (*Manihot esculenta*). Farmers also harvest inflorescences of the palms *chapaya* (*Astrocaryum mexicanum*) and *pacaya* (*Chamaedorea tepejilote*), and flowers of *colorin* (*Erythrina* spp).

Peasant families of some communities with commercial products such as coffee, cocoa, cattle, and/or oil palms have reduced their *milpas* to a minimum. For example, in coffee producing communities of the Sierra Madre, *milpa* covered an average of only 24% of PF's total cultivated area, while coffee was planted on 50–100%. Similarly, in the Ch'ol municipalities, commercial products predominate at the expense of *milpas* and other production for family consumption. In these cases, maize is purchased from other PF of the same community or in nearby markets.

Homegardens

The family homegarden, referred to as *sitio* in the study area, or patio or *solar* in other parts of Mexico and Central America is an area where a variety of productive and social reproductive activities are carried out. The *sitio* is cultivated near the house within a landscape mosaic of home gardens, *milpa*, coffee or cocoa agroforests, fallows, and other types of land use. The house, *sitio*, and other agricultural plots are typically shared among extended family members.

Homegardens range in size from 25 to 1,000 m^2 and vary in form. Land inheritance is generally patrilineal. However, in some cases women have inherited land. PF cultivate plants and raise free-range poultry, ducks, and turkeys—or *guajolotes* in the *sitio*. Fruits from the *sitio* are used for family subsistence as well as sold in community and regional markets. Poultry is prepared for festivities and sold in local and regional markets, often to provide emergency funds. In addition, nurseries for coffee and other seedlings, compost, and crop processing equipment are included in the *sitio*, and part of it is used to dry coffee and/or cocoa beans during the coffee harvest. Childcare, maintaining the oral tradition and aesthetics, resting, washing clothes, family collective cooking for festivities, and funerals and *convivencia* (leisure time among family and friends) also takes place in the *sitio*.

Fruit and vegetable species frequently found in homegardens include varieties of banana and avocado (*Persea americana*), papaya (*Carica papaya*), *jobo* (*Spondias purpurea*), *hierba mora* (*Solanum* spp), *nance* (*Byrsonima nance*), and soursop (*A. muricata*). allspice (*Pimienta dioica*) and cashew (*Anacardium occidentale*). Ninety percent of *sitios* in the coffee area included a compost area. The home gardens are characterized by a high density of woodyspecies, with a mean of 11, 476 individuals ha^{-1}, including trees, shrubs, herbs, vines, and epiphytes, distributed over four strata.

Women exchange flowers, fruits, and seeds between each other, with relatives, and with other community members. They also work within the community in grocery stores, as teachers, and as domestic farmworkers while some work outside the community.

Food Practices in Relation to Agrobiodiversity

Weekly food diaries showed that families consumed products from different local agroecosystems throughout the year. We recorded a list of 123 food items shown in the word cloud (**Figure 2**). The most common were from local and external sources, with 32 products or 65.6% of the total number; the remaining 91 products were consumed more sporadically. People in these communities are consuming a significant amount of carbohydrates from maize, bananas, rice, wheat flour (pasta, bread, cookies), and oats flakes. Common sources of protein were beans, eggs, chicken, cheese, milk, and yogurt. Common sources of fats were avocados, cocoa *pozol (a traditional beverage made with maize and cocoa)*, cheese, sour cream, and cooking oil. Processed products from external food industries were also consumed.

Weekly food diaries showed a mean individual daily consumption of 217.9 gr of tortillas and other maize products, 60 gr of beans, 111.7 gr of plantains and bananas, and 38.9 gr of sugar. Consumption of chicken, beef, pork, and fish was minimal. However, members of communities near streams catch fish and snails or occasionally hunt aquatic wildlife. Traveling salespeople bring fish raised in nearby fisheries to the communities and some families also purchase canned sardines and tuna. Other frequently consumed products, in order of average daily consumption, are tomatoes (47.3 gr), potatoes (45.5 gr/day/person), rice (44.2 gr), oats (36.4 gr), onions (34.3 gr), eggs (17.4 gr = 0.3 egg), store-bought cookies (16.2 gr), home-made or locally made cheese (14.3 gr), pasta (13 gr), coffee (10.7 gr = 3.9 kg), and chili peppers (6.5 gr).

Workshops with 11 to 15 year old secondary school students and technicians aged 18 to 55 indicated that food preferences vary according to age. Younger workshop members tended to prefer sweets such as cookies, wheat flour or potato chips, and soda. Many of them were not familiar with their grandmother's recipes. By contrast, those over age 50 recall and appreciate local foods and recipes based on wild and semi-domesticated leafy greens, fruits, roots, tubers, and other plants and animals with sour and bitter—as well as sweet—flavors. These results indicated a trend toward changing food preferences and a loss of traditional autochthonous knowledge related to local agrobiodiversity.

Staple foods include maize, squash, plantains, bananas, sweet potatoes, cassava, species of the Araceae family with edible inflorescence and tubers, and edible inflorescences from palms (**Table 1**). Other commonly consumed foods were beans and pigeon peas, as well as herbaceous plants, generically known as *quelites* in central Mexico, and referred to as weeds in Chiapas. These include amaranth greens, *quishtan* (*Solanum wendlandii*), hierba mora, dandelion greens (*Sonchus oleraceus*), *quilete* (*Solanum americanum*), *chaya* (*Cnidoscolus aconitifolius*), and *correlon* (*Solanum appendiculatum*; **Table 1**). Other foods with high contents of essential oils were vital in the local food systems: avocado, coconut, cocoa, *pataste* (*Theobroma bicolor*), and squash seeds. Furthermore, a wide diversity of fruits with distinct flavors and colors and a high vitamin and mineral content are present in the agroforestry systems described above.

Nonetheless, PF perceived that food coming from their agroecosystems had better quality than processed foods but that still the quantity and quality is not as they would expect (**Table 3**). More than a half of those interviewed (62.5%) remarked that during an average of 4.2 months a year, there is insufficient money to purchase food in the Sierra Madre, particularly maize. Furthermore, 43.8% confirmed that there was a need for more food variety (**Table 3**).

DISCUSSION

Multiple Functions of Agroforestry Systems

Agroforestry systems such as the traditional *milpa*, home gardens, cocoa and coffee AFS play a significant role in Mesoamerican livelihoods (Falkowski et al., 2019). AFS act

FIGURE 2 | Word cloud of food consumed by families, based on weekly food diaries in two coffee communities of the Sierra Madre region of Chiapas, Mexico. The size of the words corresponds to the frequency of citation—the most cited, the largest, the less cited, the smallest.

TABLE 3 | Perception of peasant families (%).

Perception of household members about food, depending on food origin (*n* = 25)	Yes	Not	No answer
Is the food coming from local agroecosystems nutritive?	92	4	4
Is the food coming from external sources and frequently bought in grocery stores nutritive?	76	20	4
Are household members satisfied with the food coming from the coffee and cocoa AFS?	84	12	4
Is the harvest coming from the household land enough?	31.3	68.8	–
Is the bought food enough?	43.8	56.3	–
Would the household members like to eat something different?	43.8	56.3	–

On the quality and quantity of food from agroecosystems and food from external sources in Bellavista, Sierra Madre of Chiapas, Mexico n = 22.

as a source of food, income, self-employment, remedies, ornaments, plants for rituals, thus conserving agrobiodiversity and the cultural practices that support it (Barbieri and Valdivia, 2010; Tscharntke et al., 2011; Soto-Pinto, 2019; Purba et al., 2020).

Our results show that agroforestry systems are essential for a variety of ecological, social, and economic functions, including food and income provisioning. Aside from their contributions to the family economy, these systems play important roles in health and social reproduction. AFS provide a variety of high-quality foods that meet with protein, carbohydrate, vitamin, and mineral requirements. They also provide medicine, fodder, fuel, construction materials, manual tools, fibers, and dyes. These multifunctional spaces also contain products that can act as family savings, such as animals or trees that may be sold during times of crisis or emergency or to meet expenses for social events. Gifting and exchanging products from agroecosystems among families are social acts of great importance. These spaces also provide products to be sold in shorter commercial chains, promoting closer producer-consumer relationships, advantageous for value appropriation, reducing energy costs, climate change mitigation, local agrobiodiversity conservation, and provide ecosystem regulation, cultural, and support functions (Barbieri and Valdivia, 2010; Tscharntke et al., 2011; Cerda et al., 2020; Kerr et al., 2021). The complex structure and diversity of agroecosystems are sustained by cultural and agroecological knowledge, and vice versa. Therefore, maintenance of these complex socioecological systems is essential for conserving life.

As described above, homegardens and other agroecosystems provide a space for multiple productive and social-reproductive activities, including germplasm domestication and preservation, taking care of the plants, plant acclimation, as well as leisure activities, aesthetic appreciation, and spiritual inspiration (Trevilla Espinal et al., 2020), as indicated by the following testimony:

> "*We like to walk in the coffee agroforest because of its freshness and greenness.*" (Ana María, age 35)

Agroecosystems provide spaces for adults to share knowledge with their children, for example regarding edible vs. poisonous plants. Stories, legends, recipes, and beliefs are transmitted in homegardens from generation to generation, particularly from mothers to children. Furthermore, in agroecosystems, grandparents transmit knowledge of plant properties, phenology, agricultural calendars, seed conservation, agricultural practices and other biological, technological, and cultural knowledge and beliefs (Cervantes Trejo and Bello Baltazar, 2017).

Collectively, these agroecosystems make up a complex agricultural matrix that supports habitat for biodiversity and human life, while supporting a myriad of environmental services, including soil health (Dollinger and Jose, 2018), pest and disease control (Wemheuer et al., 2020), microclimate regulation (Lin, 2010; Carvalho et al., 2021), carbon sequestration (Soto-Pinto and Armijo-Florentino, 2014; Cerda et al., 2020), hurricane and landslide protection (Lin, 2007), aesthetic values (Purba et al., 2020), nutrition (Falkowski et al., 2019), and other social and economic values (Bello et al., 2019).

However, PF are gradually changing their production and consumption patterns, substituting local foods with less nutritious products, resulting in a reduction in agrobiodiversity and its potential to provide food to families. While 60% of PF interviewed still cultivate maize and most of their caloric intake still comes from maize, relatively expensive purchased products with low nutritional quality such as rice, pasta, cooking oil, and food and beverages with refined sugar increasingly make up a large part of the diet, as is common in other rural areas of Latin America (OECD./WHO., 2020).

However, the agroecosystems in this study continue to exploit local ecological inputs, manual tools, family labor, local knowledge and germplasm, and plant care (Toledo and Barrera-Bassols, 2008).

Contradictions Between Agrobiodiversity and Food Consumption by Peasant Families

Our results highlight the remarkable agrobiodiversity hosted in AFS, with the potential to sustain livelihoods and human health. However, changes induced by the advancement of agribusiness, global markets, and public policies that orient production and marketing (Rosset and Martínez-Torres, 2016; Henderson, 2017), are contributing to the devaluation of local foods, agrobiodiversity, and local knowledge (Benítez et al., 2020). This globalizing and modernizing trend in the food system conflicts with the existence of a high level of agrobiodiversity and the availability of high-quality foods in AFS. The corporatized agri-food system, which favors profit over social reproduction, is driving significant changes in consumption patterns, resulting in negative health impacts and increasingly simplified agroecosystems (Martínez Espinosa, 2017).

The study also highlights that food-related experiences of peasant and semi-proletarian families may vary depending on their agrarian social positions—for example, whether they live in and off AFS, or if they own land back at home, as in the case of migrants (Isakson, 2009). On large-scale shade-grown coffee plantations that depend on wage labor, semi-proletarian families who still own land in their place of origin consume products from their own *milpas* and homegardens during their time as migrants. At the same time, plantation labor allows them to purchase seeds and other inputs to reproduce their peasant livelihood in their place of origin (Isakson, 2009). In contrast, land-less laborers may be more vulnerable to food insecurity and inequalities in the workplace, particularly migrant laborers who are already in a disadvantaged and marginalized position in the workplace. Therefore, although large shade-grown coffee plantations contribute greatly to ecosystem services and biodiversity conservation, the socio-economic, agrarian, and political identities of families within those systems determine their relationship to their food and their environment. Further understanding of these relationships is needed to truly appreciate the importance of land access for migrant laborers in coffee producing regions, one of the most marginalized actors in the coffee production chain (Jha et al., 2014; Jiménez-Soto, 2020).

AFS have undergone simplification of structure and agrobiodiversity, as shown by the dominance of some plant genera, shade species, and uses as well as a reduction in the number of strata, tree densities and coffee plant densities, as previously reported for coffee and cocoa agroforests, homegardens, and *milpas* (Moguel and Toledo, 1999; Belchier et al., 2005; Soto-Pinto et al., 2013; Soto-Pinto et al., 2014, Soto-Pinto et al., 2019; Benítez et al., 2020; Escobar-Colmenares et al., 2021; López Cruz et al., 2021), which demonstrates similarities between food forests and anthropized forests (Moguel and Toledo, 1999; Belchier et al., 2005; Ford and Nigh, 2009; Van Dooren et al., 2018). All these AFS are within forest environments and have often been established as part of these ecosystems. Over time, due to the prioritization of economic activities and land reduction, primary agroecosystems (staple foods) are suffering a substitution of structure and functions for more profitable activities. Additionally, homegardens, which formerly provided a space for food security and social reproduction, are currently being transformed for urban uses or more ornamental, less functionally diverse, purposes (Rico-Gray et al., 1990; Vogl et al., 2002; González-Jácome, 2012; Soto-Pinto, 2019; Benítez et al., 2020).

The mean land area of homegardens has been reduced in size (from an average of >2,000 to 200 m^2), as well as in number of strata and agrobiodiversity (Rico-Gray et al., 1990; Vogl et al., 2002; Mariaca-Méndez, 2012; Soto-Pinto, 2019), leading to a decrease in their productive and reproductive potential.

Coffee polycultures contain a considerable number of multipurpose species, as demonstrated by the present study as well as others. However, due to a reduction in coffee prices, fungal diseases (*Monilia* sp. in cocoa agroecosystems and coffee leaf rust (*Hemileia vastatrix)* in coffee systems), *campesinos* are eliminating associated vegetation under the misguided idea that shade is causing fungal diseases, although traditional agricultural practices and scientific results suggest the possibility of reconciling shade vegetation with cocoa and coffee production (Vaast and Somarriba, 2014; Schroth et al., 2016; Armengot et al., 2020; Haggar et al., 2021; López Cruz et al., 2021).

As more profitable specialty crops are being favored, *milpas* are experiencing a reduction in both land area and the duration of the fallow period with negative impacts on soil bearing capacity, diversity, tree and shrub abundance, and environmental services.

The local food system is increasingly incorporating processed foods high in carbohydrates, refined sugar, saturated fats, and salt, while low in protein, fiber, vitamins, and minerals, leading to a reduction in agroecosystem diversity s and negatively impacting health (Martínez Espinosa, 2017).

Women develop agroecological and food strategies for household survival, including food production, transformation, preparation, and consumption, meeting a permanent contradiction between consuming local healthy food that is readily available but increasingly less accepted by family members, especially younger members who favor expensive processed foods which occupy the market and colonize territories (Trevilla Espinal et al., 2021). Young people are adapting their palate to sweet and salty flavors and the greasy texture of processed foods such as cookies and potato chips, disparaging the tastes of local fruits, vegetables, tubers, roots, and insects that may have sour, spicy, bitter, or tacky tastes. Pasta, rice, oats flakes are taking important place in family food consumption, substituting maize, while home-raised eggs and meat are replaced by those raised in large-scale farms.

There is a perception of scarcity, which coincides with other works (Méndez et al., 2013; Bacon et al., 2014). However, it seems that there is not an absolute scarcity of food, but maize scarcity and a shortage of money for buying extra-communitarian food during some seasons, this added to a change in the value of what is "good" and what is "food of the poor" threatens more traditional diets and the health of peasant farmers. There appears to be a kind of status given by the acquisition of industrialized products. Therefore, it is essential that the non-monetary value of these AFS is revalued; that the role of local agrobiodiversity and particularly maize cultivation (*milpa*), in terms of nutrition, food dependence, availability, and resilience is taken into consideration.

There is also a need to re-value the importance of producing and maintaining healthy native crops in agroecosystems, as well as promoting community engagement with local agroecological food systems and cultures.

CONCLUSIONS

Agroforestry systems provide food and income for peasant families. These complex, agrobiodiverse multifunctional systems consist of a wide diversity of cultivated and wild trees, shrubs, herbaceous plants, palms, and vines which contribute to fulfilling a broad range of social, economic, and environmental benefits.

These agroecosystems are founded within the framework of people's livelihoods (local knowledge, physical, and biological resources such as germplasm, agroecological management, human values, and belief systems). However, modernization drives changes in food production and consumption in peasant households, which in turn leads to simplification of their agroecosystems and consequent loss of their social and environmental attributes. This is exemplified by the reduction in size and function of *milpas* and homegardens, which provide mainly staple food—resulting in a shortage of maize and other protein sources during certain seasons, driving further dependency on external sources.

Peasant families are finding it increasingly difficult to respond and adapt, through agricultural activities, to meet both market, and family provisioning needs in order to provide cash income and satisfy basic requirements. Peasant families are increasingly substituting local foods, purchasing maize, maize flour, and wheat, as well as canned goods, refined sugar, sugary beverages, cooking oil, and other processed foods, thus potentially affecting people's health and transforming local food systems. Despite the great diversity in AFS, semi-proletarian families who complement their livelihoods laboring on AFS are vulnerable to food insecurity, particularly landless families who are highly dependent on food vouchers to fulfill their food needs. In contrast, migrant families that maintain a peasant livelihood in their original communities may be better positioned to overcome insecurities during the harvest season when they are away from home. This highlights the importance to secure land access for migrants and laborers in Latin America, particularly as the advancement of industrial modernization threatens land accessibility and agrobiodiversity.

Finally, there is a need for transdisciplinary collaboration among public policies makers, academics, civil society, NGOs, and businesses in order to promote agroecological food production, equitable relationships, and other local benefits in accordance to human values, respect to local people and cultures, and maintenance of environmental functions and life on the planet.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by El Colegio de la Frontera Sur Ethics Committee. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

LS-P directed the research work, did fieldwork on the Milpa system, analyzed, synthesized information, discussed results with the co-authors, and wrote the manuscript. SE carried out fieldwork in the coffee system, making analysis and synthesis of information. MB carried out fieldwork in the home garden system, synthesis of information. AL carried out fieldwork in the cocoa system, made information synthesis. EE advised the fieldwork in coffee and home gardens, analyzed and synthesized data. BH secured funding for fieldwork carried out in the coffee systems, home gardens, and cocoa systems. They all discussed results with each other and returned the results to participants. All authors contributed to the article and approved the submitted version. EJ-S gave significant intellectual input to the manuscript, conducted part of the data collection, and wrote a large portion of the manuscript itself.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2021.756611/full#supplementary-material

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