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Plant diversity and uses in family gardens, a case study

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ABSTRACT

Objective: To characterize the current condition of home gardens in the Ejido Nueva Esperanza 1st Section, Palenque, Chiapas.

Methodology: A semi-structured interview was conducted with 43 families to determine socioeconomic conditions, garden characteristics, floristic composition, and their uses (satisfaction). Gardens were categorized by size (small, medium, and large) and location (center, intermediate, and periphery of the community). Data were analyzed descriptively to obtain frequencies, percentages, and averages. Additionally, Shannon-Wiener (H') and Simpson (S) diversity indices were calculated according to size and location.

Results: Families were found to be below the poverty line, with agriculture as their primary activity. A total of 3549 individuals were recorded, grouped into 46 botanical families, 82 genera, and 89 species. Native species were the most dominant at 52%. There were 33 tree species, 33 herbaceous species, 15 shrubs, 5 rosettes, and 3 arborescent species. Families reported using plants for fruit, medicinal purposes, ornamentation, horticulture, timber, condiments, fuel (firewood), and medicinal-horticultural purposes, primarily for self-consumption. The highest number of individuals recorded were fruit trees, with 28 species. Small ($H'=2.8$), intermediate ($H'=2.6$), and peripheral ($H'=2.6$) gardens showed higher diversity similar to Fisher's alpha.

Implications: This study highlights the importance of floristic composition and plant species diversity in home gardens concerning the uses attributed by families.

Conclusion: The diversity and composition of plant species in home gardens are determined by their location and size, as well as the value of use that the family attaches to them.

Keywords: Family agriculture; wealth; floristic composition; plant use; family economy.

INTRODUCTION

The biodiversity present in home gardens is determined by traditional knowledge and the value of use that families attribute to plant and animal species over time (Watson and Eyzaguirre, 2002; Mariaca, 2012; Reyes-Betanzos and Álvarez-Ávila, 2017).

Home gardens are ancestral production systems highly adaptive, located around the house where the family has recreated from generation to generation (Mariaca, 2012), assembled within a logic reflecting the structure and social dynamics not only of the household but also of the community (Lope-Alzina *et al.*, 2018). Ecological, agronomic, cultural, and social processes occur within these gardens, considering cultural parameters related to their floristic composition (García de Miguel, 2000), biodiversity conservation, food production for family consumption, and generating monetary income from their products or by-products (Mariaca, 2012).

Home garden production is one of the oldest land-use activities. Globally, it has been highlighted as a strategy for achieving the Millennium Development Goals and subsequent Sustainable Development Goals (Montemayor *et al.*, 2007; Krishnamurthy *et al.*, 2017).

The home garden as a traditional agroecosystem provides various fulfillments with use value and potential benefits (Dussel, 2014), especially those related to food, health, economic income, rituals, fuel, and ornaments to provide an aesthetic vision in family gathering spaces and social relationships that contribute to maintaining their quality and enjoyment (González, 2008; Cahuich-Campos, 2012; Olvera-Hernández, 2017). They also contribute to generating direct and indirect economic income (Pulido *et al.*, 2008) with minimal investment (Toledo *et al.*, 2008). Additionally, they are considered *in situ* biodiversity reservoirs as they contribute to the care, conservation, distribution, and domestication of useful species (Pulido *et al.*, 2008; Escobar and Estrada, 2015; Salazar-Barrientos *et al.*, 2015; Bautista-García *et al.*, 2016; Castañeda-Navarrete, 2021).

Despite global recognition and high ratings in productive and service functions, home gardens have not been given concrete importance as an inclusive development strategy (Krishnamurthy *et al.*, 2017). Many initiatives, programs, and promoted projects have failed by not taking into account local culture and realities (Cano Contreras, 2015), leading to the possible extinction of gardens as sustainable and highly productive systems in their various dimensions (González, 2007). Consequently, in many places, their productive condition and benefits do not contribute to reducing living costs or meeting family needs.

Due to the increasing urbanization in the study community from family growth, commercial activities, and the establishment of oil palm (*Elaeis guineensis* Jacq) and rubber (*Hevea brasiliensis* Muell Arg) crops, which are the primary income source for most families (Castellanos, 2018; Méndez y Mier y Terán, 2020), the role of gardens as productive units is being relegated and undervalued. Therefore, understanding floristic richness allows us to document diversity, plant uses, and benefits, as well as changes in management priorities (Pulido-Salas, 2017). Consequently, it is necessary to "untangle" the implicit complexity of home gardens and understand their intimate relationship with the biological, cultural and social environments (Mariaca, 2012; Lope-Alzina *et al.*, 2018).

Therefore, this research aimed to characterize the current condition of home gardens in the Ejido Nueva Esperanza 1st Section to understand the diversity, floristic composition, and use value as satisfiers of plant species in family gardens in the Ejido Nueva Esperanza 1st Section, Palenque, Chiapas.

MATERIALS AND METHODS

Study area location

The research was conducted in the Ejido Nueva Esperanza 1st Section, Palenque, Chiapas, located at Km. 96 of Federal Highway 186 Villahermosa-Escárcega, between geographical coordinates Longitude: 92.188056 and Latitude: 17.701944, at an average altitude of 30 m. The climate is warm humid with rain all year round and warm humid with abundant summer rains (INEGI, 2020).

Sample size

The equation proposed by Linch *et al.* (1974) was used to determine the sample size of the total registered households:

$$n = \frac{NZ^2 p(1-p)}{Nd2 + Z^2 p(1-p)}$$

Where: n=sample size, N=number of households with gardens in the study area, Z=value of a normal distribution $Z\alpha/2$ (1.96) for a 95% confidence level, p=probability of success (0.95), d=sampling error (0.05).

Based on the calculated sample size, 43 semi-structured interviews were randomly conducted with household heads from May to November 2021. The interviews were conducted informally under the interviewees' consent. The interview consisted of four sections to understand the families' sociodemographic situation, the current condition of the garden, identification of plant species found in the gardens, and their satisfiers.

Sociodemographic situation

The sociodemographic situation of the surveyed families was described by considering the following factors: name, gender, number of family members, educational level, productive activities, occupation, family income, and access to basic services.

Current condition of home gardens

In order to understand the current condition of the gardens, the names given by the owners, as well as the activities and family participation in the gardens, were researched.

Classification of gardens

Due to the non-uniform surface areas, gardens were grouped by size: small (120 to 425 m^2), medium (425 to 800 m^2), and large (800 to 2500 m^2), following the methodologies of Van der Wal and Bongers (2012) and Agustina *et al.* (2019). Similarly, based on their location in the community, they were classified as center, intermediate, and periphery (García de Miguel, 2004).

Composition of plant species

In each garden, plants were recorded with their common name, afterwards their scientific name was registered and verified on the websites: https://www.tropicos.org (Tropicos), *http://www.theplantlist.org/* (*The Plant List* (TPL), and some records were corroborated on the consultation platform Enciclovida: *https://enciclovida.mx/* (CONABIO, 2022) and *https://www.naturalista.mx/* (Naturalista, 2022). Additionally, the origin of the plants and their growth habit were consulted (Flores, 2012; Villaseñor, 2016).

Diversity of plant species in home gardens

In order to determine the diversity of plant species in each size category, the following indices were used: Fisher's Alpha, Shannon-Wiener, and Simpson.

Fisher's Alpha Index (α) is an abundance model derived from a logarithmic series and only uses the number of species (S) and the total number of individuals (N). Its calculation is performed using the following equation:

$$S = \alpha \ln\left[1 + \left(N / \alpha\right)\right]$$

Where: S=number of species in the sample, and N=total number of individuals in the sample.

Shannon-Wiener Diversity Index (H'), based on the proportional abundance of species (Equation 2).

$$H' = \sum_{i=1}^{S} pi \ln\left(pi\right) \tag{2}$$

Where: S=number of species, pi=proportion of individuals of each species i, and ln=natural logarithm. Higher H''values indicate greater species diversity (Sánchez-Gutiérrez *et al.*, 2021).

Simpson's Index (S) measures the probability that two individuals randomly selected from each size category are of the same species (Equation 3).

$$S = \frac{1}{\sum \frac{ni\left(ni-1\right)}{N\left(N-1\right)}} \tag{3}$$

Where: ni=number of individuals in the i-th species, N=total number of individuals. Higher S values indicate lower dominance of one (or a group) species (Zarco *et al.*, 2010).

Uses of plant species in home gardens

Considering the plant species found in the gardens, their uses were identified according to the interests of the families and classified as: fruit, medicinal, ornamental, horticultural, timber, spices, fuel, spice-timber, and medicinal-vegetables.

The experimental data obtained were analyzed for frequency, percentages, and averages using Microsoft Excel 2013 software.

RESULTS AND DISCUSSION

Productive activities and family occupation

The productive activities of the families include agriculture (56%), commerce (11%), livestock (9%), professional services (4%), and government employment (2%). Agriculture is the predominant activity, with most families involved in oil palm (*Elaeis guineensis* Jacq) and rubber (*Hevea brasiliensis* Muell Arg) production, or working as laborers in these monocultures (Castellanos Navarrete, 2018; Méndez-Rodríguez and Giménez-Cacho, 2020). This focus on monocultures has reduced livestock activity in the region since 1998 (Castellanos Navarrete, 2018; Méndez-Rodríguez and Giménez-Cacho, 2020). Additionally, about 20% of the population engages in occasional activities such as blacksmithing, painting, beekeeping, mechanics, and other trades. The rural population is currently involved in various productive and commercial activities (Van der Wal *et al.*, 2011).

Family economic income

Family economic income ranges from $200.00 to $14,500.00 pesos per month, with an average of $3,234.00 pesos. Our results show that family incomes in the ejido do not exceed the extreme poverty line established by CONEVAL (2019). According to CONEVAL (2020), a family of four with an income below $13,133.30 pesos per month is considered to be in poverty. Furthermore, as of December 2021, CONEVAL established that rural families are considered to be in extreme poverty if they do not have incomes above $1,463.43 pesos per person (for the basic food basket) and in poverty if they do not have incomes above $2,784.70 pesos per person (for the food and non-food basket) (CONEVAL, 2021).

Basic services available to families

All surveyed families have piped water and electricity services, while 98% have sewage systems, 91% use LP gas, 79% have cell phone service, and 47% pay for private satellite television services. The recorded data exceed what was reported by CONAPO (2015), as basic services have been introduced, improved, and expanded in the past five years. However, in terms of health, education, and economic income, it is still categorized as a marginalized community.

Current condition of home gardens

Name, ages, and sizes of gardens

In the Ejido Nueva Esperanza 1st Section, the home garden is known as "solar", similar to what Vogl *et al.* (2002) reported in Palenque. In southeastern Mexico, it is called "patio" and "traspatio" (Mariaca, 2012; Chablé-Pascual *et al.*, 2015), and they are located in spaces adjacent to the houses (Pulido *et al.*, 2008; Mariaca, 2012).

The research recorded that 93% of families have their own "solar", most of which were inherited from parents to children and are considered the main resource (Cruz, 1990).

About 5% rent the house, and 2% lend it to a family member. Furthermore, 42% are ejido members, and 58% are residents.

The ages of the gardens vary. Gardens from 87 years old (since the ejido's founding) to one year old were recorded, similar to what Jiménez-Osornio *et al.* (2015) reported for the gardens in Tahdziu, Yucatan.

Additionally, gardens ranging from 120 to 2,500 m^2 in surface area were observed, with an average size of 749 m^2. The areas allocated for housing varied from 30 to 300 m^2, averaging 91 m^2. The spaces where plant and animal species were recorded ranged from 15 to 2,200 m^2, with an average of 658 m^2. These areas were divided into sections for chicken coops, pigsties, vegetable cultivation, medicinal plants, ornamental plants, and other uses. These findings are similar to what Vogl *et al.* (2002) reported in Palenque. Similarly, Sol (2012) noted that in Tabasco, garden sizes range from 3 m^2 in urban areas to 400 m^2 in rural areas. Pulido *et al.* (2008) mentioned that garden sizes in Latin America vary from 0.05 ha to 2.5 ha. The size of the gardens is related to the family's land dimensions (Pantoja, 2014), resulting in diverse garden sizes and types (Sol, 2012).

In the ejido studied, gardens measuring 0.25 ha (2500 m^2) were originally allocated to each ejido member at the time of the ejido's establishment. However, due to family growth, the garden sizes have decreased, and their organization has diversified, resulting in microenvironment mosaics that contribute to a spatial-temporal organization of biotic and abiotic components (Lope-Alzina *et al.*, 2018).

Family activities and participation in gardens

The management activities carried out in the gardens are: weeding (29%), watering (22%), permanent planting (8%), grafting (3%), pest and disease control (4%), pruning (3%), organic fertilization (11%), and chemical fertilization (3%). However, 17% stated that they do not perform any management in their gardens. These results are similar to what Reyes-Betanzos (2014) observed in Bandera de Juárez, Paso de Ovejas, Veracruz, and also align with their agricultural activity calendar. Agricultural activities are carried out according to lunar cycles (Castañeda-Guerrero, 2020). It was recorded that in 29 gardens, vegetables are cultivated, of which 16 have scattered plantings without care or management, and only six receive minimal attention.

Regarding the labor time families dedicate to the garden, they mentioned that it averages one hour per week, less than what Reyes-Betanzos (2017) reported in Bandera de Juárez, Veracruz, where families dedicated five hours a week. Maroyi (2009) indicated that families allocate an average of 1.6 hours daily to the garden in Hehema, Zimbabwe, suggesting that the time families invest varies according to the size and whether production is for self-consumption or commerce (Torquebiau, 1992).

Regarding participation in the garden, women (66%) dedicate more time to tasks, deciding mainly what plants to sow and having more knowledge about their uses and management (Cruz, 2016; Pulido *et al.*, 2018). Men's participation is 34%, mainly performing these tasks in the evenings since they engage in their primary productive activities in the mornings. The activities they mostly perform in the garden are: weeding, fruit planting, pruning, fertilization, and pest and disease control.

The participation of girls and boys is low, at 21% and 24%, respectively. This may be because garden learning is not significantly promoted at home or school as part of their daily practices or cultural heritage from generations. The situation differs in indigenous communities, where children and youth are commonly involved in family agriculture (Gutiérrez-Sánchez, 2017). In Choles communities in Chiapas, children perceive backyard elements as part of their life experience (Ubiergo-Corvalan *et al.*, 2021). In Oaxaca, children and women play an important role in garden care and management (Manzanero-Medina *et al.*, 2018). This may be due to the idiosyncratic and cultural differences of mestizo families, as in our research community.

Floristic composition of plant species in gardens

A total of 3,279 plant individuals were recorded, grouped into 46 botanical families, 82 genera, and 89 species. These results were higher than those recorded in 66 gardens in Bandera de Juárez, Veracruz, by Reyes-Betanzos and Álvarez-Ávila (2017), who identified 75 plant species and 39 botanical families. However, Vogl *et al.* (2002) listed a total of 241 species in 30 households in two indigenous migrant localities in southeastern Palenque, Chiapas. Sol (1993) obtained 144 species in the Ejido Lindavista of the same municipality, and Flota-Bañuelos *et al.* (2016) reported 223 species in Campeche, Mexico. Similarly, Castañeda-Guerrero *et al.* (2020) listed 357 species belonging to 263 genera and 102 botanical families in Totonac gardens, in Puebla, Mexico. In Bangladesh, Kabir and Webb (2008) reported 419 species belonging to 109 botanical families. Additionally, Akinnifesi *et al.* (2010) obtained 186 plant species in urban and suburban gardens in Brazil, suggesting that the floristic composition of gardens is determined by species use and family culture.

Frequency and origin of plants

Among the recorded species, those with the highest frequency were: cilantro (*Coriandrum sativum* L.), chives (*Allium schoenoprasum* L.), and banana (*Musa*×*paradisiaca* L.). Native species were the most dominant with 46 species (52%), with the most common being: parsley (*Eryngium foetidum* L.), tomato (*Solanum lycopersicum* L.), and cacao (*Theobroma cacao* L.). Introduced species accounted for 43 species (48%), with the most dominant being: cilantro (*C. sativum*), chives (*A. schoenoprasum*), and banana (*M. paradisiaca*), as shown in Table 1. These results are similar to what Castañeda-Guerrero (2020) recorded in Caxhuacan, Puebla, where native species represented 58%, and introduced species 42%. The similarity in species origin percentages could be due to the utility value and importance families attribute to the plants present in the gardens. This aligns with the results of Pulido *et al.* (2008) in Latin America, where native species represent more than 50% of the plants in gardens.

Growth habit

A total of 33 tree species (37%) were recorded, used for fruit, medicinal purposes, fuel, and shade. Additionally, 33 herbaceous species were noted for their use in vegetables, medicinal purposes, and ornamentation, 15 shrub species for ornamental and medicinal uses, five rosettes, and three arborescent species. These results are similar to those obtained by Guzmán *et al.* (2012) in Ocuatitlán, Nacajuca, Tabasco, and Montañez-Escalante (2014) in Yucatan. In contrast, Guerra (2005) in Yaxcabá, Yucatan, reported a greater abundance of ornamental species.

Diversity of plant species in home gardens

Large home gardens recorded the highest specific richness (61), followed by small (51), and finally medium (47). However, small gardens have the highest diversity (H′=2.8), while medium and large have lower values (H′=1.9 and 2.7, respectively). Simpson's index indicated that small and large gardens have no dominant species and are more equitable (E=7) than medium gardens (E=0.5). Fisher's alpha index showed greater diversity in small gardens (13.0) (Table 2).

The greater richness in large gardens could be due to recording a higher number of unique species, as described by Van der Wal and Bongers (2012) in 61 gardens in Tabasco. However, large gardens recorded lower diversity, consistent with Martínez and Juan (2005), who determined that large gardens in 24 municipalities in southern Mexico have lower diversity than small gardens, similar to what Lok (1998) found in Costa Rica and Agustina *et al.* (2019) in Pujon, Malang Regency, East Java, Indonesia. This is mainly because small gardens cultivate more densely small species (mainly vegetables and ornamental) and establish many species in pots and containers as Martínez and Juan (2005) and Sol-Sánchez (2012) indicated.

Regarding garden location, the periphery has greater species richness (R=66) compared to gardens in the center (R=39). In terms of diversity, Fisher's alpha shows a higher value for peripheral gardens (13.8), while Shannon indicates that intermediate and peripheral gardens are equal (H′=2.6) and the center has a lower value (H′=2.3) (Table 2).

These results may be attributed to peripheral gardens being less fragmented than those in the center, where ornamental species predominate. Additionally, peripheral gardens border ejidal plots and are often used in conjunction. This aligns with García de

Table 1. Origin and density of plants in the 43 family gardens in the Ejido Nueva Esperanza 1st Section, Palenque, Chiapas.

Introduced	Number	%	Native	Number	%
Coriandrum sativum L.	1020	31.1	*Eryngium foetidum* L.	235	7.2
Allium schoenoprasum L.	360	11.0	*Solanum lycopersicum* L.	210	6.4
Musa×paradisiaca L.	287	0.9	*Theobroma cacao* L.	113	3.4
Aloe vera (L.) Burm. f.	80	8.8	*Tradescantia spathacea* Sw.	75	2.3
Nephelium lappaceum L.	52	2.4	*Annona muricata* L.	45	1.4
Hibiscus rosa-sinensis L.	35	1.6	*Capsicum annuum* L.	39	1.2
Euphorbia milii Des Moul.	31	1.1	*Carica papaya* L.	34	1.0
Brassica oleracea L.	30	0.9	*Zinnia violacea* Cav	30	0.9
Hibiscus sabdariffa L.	30	0.9	*Solanum torvum* Sw.	26	0.8
Ananas comosus (L.) Merr.	26	0.8	*Cedrela odorata* L.	21	0.6
Subtotal	1951	59.5	Subtotal	828	25.3
33 remaining especies	270	8.2	36 remaining especies	230	7.0
Total	2221	67.7	Total	1058	32.3

Table 2. Diversity of plant species by size and location of the family garden.

Indice	Orchard size (m)			Orchard location		
	small	medium	large	central	Intermediate	Periphery
Wealth	51	47	61	39	41	66
Number of individuals	645	1201	1433	1086	534	1659
Simpson	0.9	0.7	0.9	0.8	0.9	0.8
Shannon H′	2.8	1.9	2.7	2.3	2.6	2.6
Equity	0.7	0.5	0.7	0.6	0.7	0.6
Fisher's alpha	13.0	9.7	12.9	7.9	10.4	13.8

Miguel's (2004) research in the Yucatan Peninsula, which reported that peripheral gardens exhibit greater species richness and diversity, emphasizing the importance of considering families' cultural parameters. However, the richness and diversity of garden species are also influenced by families' preferences and interests, local conditions, and management practices.

Uses of plant species in home gardens

The plant species recorded in the gardens were grouped into the following: fruit, medicinal, ornamental, horticultural, timber, spices, fuel, spice-timber, and medicinal-vegetables (Table 3). Table 4 presents the main plant species found in the gardens, their reported uses by families, and the parts used.

Similar results were presented by Pulido *et al.* (2008) in their study on family gardens in Latin America, where they regrouped nine categories of use. Lower results were reported by Chablé-Pascual *et al.* (2015) in Chontalpa, Tabasco, where they identified three categories of use: food, medicinal, and ornamental. Ordoñez et al. (2018) showed higher results, recording 31 uses of plant species in the gardens of Oaxaca, with the main categories being food, ornamental, medicinal, construction, and small-scale sale.

Fruit trees are the main source of benefits for families, with 28 species (20.4%) reported, similar to what Castañeda-Guerrero (2020) found in Caxhuacan, Puebla. Spices and fuel reported the lowest benefits at 0.1%.

Table 3. Uses, richness, and percentage in the family gardens of the Ejido Nueva Esperanza 1st Section.

Satisfactories/uses	Species (number)	Density (number)	(%)
Fruit trees	28	725	20.4
Medicinal	19	329	9.3
Ornamental	18	163	4.6
Horticultural	13	2251	63.4
Timber	6	49	1.4
Season them	2	3	0.1
Fuels	1	4	0.1
Seasoning-timber	1	7	0.2
Medicinal-vegetables	1	18	0.5

Among the fruit trees, the most dominant species were banana (*M. paradisiaca* L.) with 287 individuals, cacao (*T. cacao*) with 113 individuals, and rambutan (*Nephelium lappaceum* L.) with 52 individuals. Medicinal plants included 19 species, with notable ones being aloe vera (*Aloe vera* L. Burm.f.) with 80 individuals, purple heart (*Tradescantia spathacea* Sw) with 75, guaco (*Mikania congesta* DC), and turkey berry (*Solanum torvum* Sw) with 26 individuals.

Ornamental plants included 18 species, with the most common being hibiscus (*Hibiscus rosa-sinensis* L.) with 53 individuals, crown of thorns (*Euphorbia milii* Des Moul.) with 31, and zinnia (*Zinnia violacea* Cav) with 30 individuals. Vegetables formed the fourth group of beneficial plants with 13 species and 1981 individuals, including cilantro (*C. sativum*) with 1020 individuals, chives (*A. schoenoprasum*) with 360, and parsley (*E. foetidum*) with 235 individuals. The dominance of these vegetable species is due to their daily use in cooking (Sol, 2012).

Although vegetables are mainly used for self-consumption, they also have economic value as they contribute to family well-being, as reported by Chi-Quej *et al.* (2014). Due to their easy adaptation, they can be grown in small pots, raised beds, or intensively. They do not require complex agronomic management, they grow quickly, and have high demand for commercialization among neighbors and family due to their frequent consumption. Despite the high dominance and use of vegetables, they were only present in 13 of the 43 gardens studied, indicating little interest in their production. This is similar to the study by Van der Wal *et al.* (2011) in Cárdenas, Tabasco, where there is a higher presence of fruit trees than vegetables.

Although the participants reported specific uses for plant species, come plants can have multiple uses (López-Armas, 2017). For example, papaya (*Carica papaya* L.) is reported primarily as a fruit, but families in the ejido also attribute other uses to it, such as medicinal (seeds), forage (leaves), and desserts (green fruits for sweets and preserves). Similarly, the banana (*M. paradisiaca*) is used for various purposes: medicinal (stalk, fruits, fresh leaves), ritual (stalks used to hold candles during wakes or rosaries on Day of the Dead), wrapping (fresh leaves for pozole or tamales), and covering (dried leaves used to cover seedbeds). All

Table 4. Most common plant species in home gardens, uses reported by families, and parts used.

Common name	Scientific name	Reported uses Part used	Part used
Papaya	*Carica papaya* L.	Fru	Fr
Tamarind	*Tamarindus indica* L	Fru	Fr
Mango	*Mangifera indica* L	Fru	Fr
Banana	*Musa×paradisiaca* L.	Fru	Fr
Cocoa	*Theobroma cacao* L.	Fru	Se
Orange	*Citrus sinensis* (L.) Osbeck	Fru	Fr
Soursop	*Annona muricata* L.	Fru	Fr
Annatto	*Bixa orellana* L.	Con, Mad	Se, Ra
Rambutan	*Nephelium lappaceum* L.	Fru	Fr
Lemon	*Citrus limon* (L.) Osbeck	Fru	Fr

Use (Fru: fruit, Mad: Wood, Con: condiments; use part (Fr: fruit, Se; seeds, Ra: Branches).

these uses of plant species provide families with food, health, security, comfort, and well-being, among other benefits, as classified by Mariaca (2012) in the gardens of Chiapas and Tabasco and Cahuich-Campos (2012) in Campeche.

In addition to the benefits provided by plant species, other benefits identified in the community's family gardens include recreation areas, family gatherings, workspaces, and rest areas for pack animals, as highlighted by Sol (2012) in Tabasco.

CONCLUSIONS

The size of the gardens is determined by the family's size, as the more children there are, the smaller the gardens. This condition is acceptable because, in certain rural areas, children tend to stay living close to their parents. Species diversity is variable, and floristic composition depends on the family's primary use or requirement. Small gardens were the most diverse, although with fewer individuals.

The diversity of satisfiers ranges from edible to medicinal uses. Other known uses were not reported but are known, such as toys made from flowers of Erythrina (Fabaceae) and bean pods (*Phaseolus* sp.). Although gardens generate products that support family economics, these incomes are minimal and below the extreme poverty line.

In general, the area's gardens show potential for short-cycle vegetable production; however, seed availability is scarce and only obtained in cities. This is because the population has lost the diversity of native seeds and relies on commercial varieties.

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REFERENCES

Agustina, T. P., Nisyawati. and Walujo, E. B., 2019. Plant diversity and uses of the home garden in Pujon sub-district, Malang Regency, East Java, Indonesia. *AIP Conference Proceedings, 2120*(040021), pp. 1-7. https://doi.org/10.1063/1.5115659

Akinnifesi, F. K., Sileshi, G. W., Ajayi, O. C., Akinnifesi, A. I., de Moura, E. G., Linhares, J. F. and Rodrigues, I., 2010. Biodiversity of the urban homegardens of São Luís city, Northeastern Brazil. *Urban Ecosystems*, 13, pp. 129-146. https://doi.org/10.1007/s11252-009-0108-9

Bautista-García, G., Sol-Sánchez, Á., Velázquez-Martínez, A. and Llanderal-Ocampo, T., 2016. Composición florística e importancia socioeconómica de los huertos familiares del Ejido La Encrucijada, Cárdenas, Tabasco. *Revista mexicana de ciencias agrícolas, 7*(SPE14), pp: 2725-2740. https://www.redalyc.org/comocitar.oa?id=263144474007

Cahuich-Campos, D., 2012. El huerto maya y la alimentación cotidiana de las familias campesinas de X-Mejía, Hopelchén, Campeche. *In*: R. Mariaca Méndez, ed. 2012. El huerto familiar del sureste de México. México: Secretaría de Recursos Naturales y Protección Ambiental del Estado de Tabasco: ECOSUR. pp. 197-229.

Cano Contreras, E.J., 2015. Huertos familiares: un camino hacia la soberanía alimentaria. *Revista Pueblos y Fronteras digital, 10*(20), pp.68-89. https://doi.org/10.22201/cimsur.18704115e.2 015.20.33

Castañeda-Guerrero, I., Aliphat-Fernández, M. M., Caso-Barrera, L., Lira Saade, R. and Martínez Carrera, D. C., 2020. Conocimiento tradicional y composición de los huertos familiares totonacas de Caxhuacan, Puebla, México. *Polibotánica*, (49), pp. 185-217. https://doi.org/10.18387/polibotanica.49.13

Castañeda-Navarrete, J., 2021. Homegarden diversity and food security in southern México. *Food Security, 13*(3), pp. 669-683. https://doi.org/10.1007/s12571-021-01148-w

Castellanos Navarrete, A., 2018. Palma de aceite en tierras campesinas: la política de las transformaciones territoriales en Chiapas, México. *Revista Pueblos y Fronteras Digitales*, 13, pp. 1-34. https://doi.org/10.22201/cimsur.18704115e.2018.v13.357

Chablé-Pascual, R., Palma-López, D. J., Vázquez-Navarrete, C. J., Ruiz-Rosado, O., Mariaca-Méndez, R. and Ascensio-Rivera, J. M., 2015. Estructura, diversidad y uso de las especies en huertos familiares de la Chontalpa, Tabasco, México. *Ecosistemas y recursos agropecuarios, 2*(4), pp, 23-39.

Chávez García, E., 2012. Desarrollo modernizador y manejo tradicional del huerto familiar: dos paradigmas diferentes. In: R. Mariaca Méndez, ed. 2012. El huerto familiar del sureste de México. México: Secretaría de Recursos Naturales y Protección Ambiental del Estado de Tabasco: ECOSUR. pp. 391-419

Chi-Quej, J., Alayón-Gamboa, J., Rivas, G., Gutiérrez, I., Detlefsen, G. and Ku-Quej, V., 2014. Contribución del huerto familiar a la economía campesina en Calakmul, Campeche. In: Alayón-Gamboa and A, Morón, ed. 2014. El Huerto Familiar: Un Sistema Socioecológico y Biocultural para Sustentar los Modos de Vida Campesinos en Calakmul, Mexico. pp. 75-90.

Consejo Nacional de Evaluación de la Política de Desarrollo Social (CONEVAL), 2019. Construcción de las líneas de pobreza por ingresos. Documento metodológico. México. CONEVAL. https://www.coneval.org.mx/InformesPublicaciones/InformesPublicaciones/Documents/Lineas_pobreza.pdf [Consulta: 10 de enero 2022]

Consejo Nacional de Evaluación de la Política de Desarrollo Social (CONEVAL), 2020. ¿qué son líneas de pobreza por ingresos y pobreza extrema por ingresos?. México. CONEVAL. https://www.coneval.org.mx/SalaPrensa/Documents/INGRESOPOBREZA-SALARIOS.pdf [Consulta: 10 junio 2022].

Consejo Nacional de Evaluación de la Política de Desarrollo Social (CONEVAL), 2022. Líneas de Pobreza por Ingresos, Junio 2022. https://www.coneval.org.mx/Medicion/Documents/Lineas_de_Pobreza_por_Ingresos/Lineas_de_Pobreza_por_Ingresos_jun_2022.pdf [Consulta: 10 junio 2022].

Consejo Nacional de Población (CONAPO), 2011. Índice de marginación por entidad federativa y municipio 2010. México. http://www.conapo.gob.mx/work/models/CONAPO/indices_margina/mf2010/CapitulosPDF/1_4.pdf

Cruz Yánez, L. A., 2016., El papel de las mujeres en los huertos familiares. *Revista Alternativas en Psicología*, 36, pp, 46-60. https://www.alternativas.me/attachments/article/134/El%20papel%20de%20las%20mujeres%20en%20los%20huertos%20familiares.pdf

Cruz, N. G., 1990. El Solar en la economía Familiar. Villahermosa, Tab.: Inteli, Impresores y Sistema DIF-Tabasco/Dirección de Desarrollo Integral de la Comunidad.

Dussel, E., 2014. 16 tesis de economía política: interpretación filosófica. México. Siglo XXI editores.

Escobar Hernández, M. E., Bello Baltazar, E., y Estrada Lugo, E. I. J. 2015. Intercambio de plantas entre huertos y otros espacios: ¿Una estrategia de conservación para el bosque mesófilo de montaña del volcán Tacaná, Chiapas, México? *Revista Pueblos y Fronteras Digital, 10*(20): 92-114.

Flores Guido, J. S., 2012. Diversidad florística, usos y origen de material genético de las especies de los huertos familiares de la Península de Yucatán. In: R. Mariaca Méndez, ed. 2012. El huerto familiar del sureste de México. México: Secretaría de Recursos Naturales y Protección Ambiental del Estado de Tabasco, ECOSUR. pp. 149-175.

Flota-Bañuelos, C., Ramírez-Mella, M., Dorantes-Jiménez, J., José-García, G., Bautista-Ortega, J., Pérez-Hernández, P. and Candelaria-Martínez, B., 2016. Descripción y diversidad de solares familiares en zonas rurales de Campeche, México. *Agroproductividad, 9*(9), pp, 38-43. https://revista-agroproductividad.org/index.php/agroproductividad/article/view/815

García de Miguel, J., 2004. Etnobotánica maya: origen y evolución de los huertos familiares de la Península de Yucatán, México. Tesis doctoral, Universidad de Córdoba.

González Jácome, A., 2007, Agroecosistemas mexicanos: pasado y presente. Itinerarios: *Revista de estudios lingüísticos, literarios, históricos y antropológicos*, 6, pp. 55-80.

Guerra, M. R., 2005. Factores sociales y económicos que definen el sistema de producción de traspatio en una comunidad rural de Yucatán, México. Tesis de Maestría. Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional Unidad Mérida: Departamento de Ecología Humana.

Guzmán, G., López, E. and Gispert, M., 2012. Huertos familiares y estrategias de educación ambiental con chontales de Olcuatitán, Nacajuca, Tabasco. In: R. Mariaca Méndez, ed. 2012. El huerto familiar del sureste de México. México: Secretaría de Recursos Naturales y Protección Ambiental del Estado de Tabasco, ECOSUR. pp, 460-486.

Instituto Nacional de Estadística, Geografía e Informática (INEGI), 2010. Censo de población y vivienda. México. INEGI.

Jiménez-Osornio, J. J., Zarco Salgado, M., Lendechy Grajales, Á. and Becerril García, J., 2015. Los solares: una oportunidad para contribuir a la seguridad alimentaria, mitigación y cambio climático en Yucatán. In R. Canto Sáenz y M. Zarco Salgado, eds. Extensión y responsabilidad social: los proyectos sociales en comunidades de aprendizaje implementados en la Universidad Autónoma de Yucatán. México: Universidad Autónoma de Yucatán. pp. 237-266.

Kabir, E. and Webb, E. L. 2008. Floristics and structure of southwestern Bangladesh homegardens. *International Journal of Biodiversity Science and Management, 4*(1), pp, 54-64. https://doi.org/10.1080/17451590809618183

Krishnamurthy, L. R., Krishnamurthy, S., Rajagopal, I. and Peralta Solares, A., 2017. Agricultura familiar para el desarrollo rural incluyente. *Terra Latinoamericana, 35*(2), pp. 135-147. https://doi.org/10.28940/terra.v35i2.145

Lok, R., Wieman, A. and Kass, D., 1998. Influencia de las características del sitio y el acceso al agua en huertos de la Península de Nicoya, Costa Rica. En: R. Lok, ed. Huertos caseros tradicionales de América Central: características, beneficios e importancia, desde un enfoque multidisciplinario. Turrialba, Costa Rica: Centro Agronómico Tropical de Investigación y Enseñanza. pp. 29-59.

Lope-Alzina, D. G., Vásquez-Dávila, M. A., Gutiérrez-Cedillo, J.G., Juan Pérez, J.I., Pedraza Pérez, R. A. and Ordoñez-Díaz, M. J., 2018. Una propuesta conceptual para abordar la complejidad del huerto familiar. En: M. J. Ordoñez, Coord. Atlas biocultural de huertos familiares en México: Chiapas, Hidalgo, Oaxaca, Veracruz y península de Yucatán. México: CRIM-UNAM. pp. 99-119.

López-Armas, M. H., Álvarez- Ávila, M. C. and Olguín-Palacios, C., 2017. Diversidad de huertos familiares: diseño de una estrategia de desarrollo comunitario en una microrregión de Veracruz. *Agroproductividad, 10*(7), pp. 9-14. https://revista-agroproductividad.org/index.php/agroproductividad/article/view/1049

Manzanero-Medina, G. I., Vásquez- Dávila, M. A., Lustre–Sánchez, H., and Gómez Luna, R. E., 2018. Los huertos familiares de Oaxaca. En: M. J. Ordoñez, Coord. Atlas biocultural de huertos familiares en México: Chiapas, Hidalgo, Veracruz y península de Yucatán. México: CRIM-UNAM, pp. 221-273.

Mariaca M, R., 2012. La complejidad del huerto familiar maya del sureste de México. In: R. Mariaca Méndez, Ed. El huerto familiar del sureste de México. México: Secretaría de Recursos Naturales y Protección Ambiental del Estado de Tabasco, ECOSUR. pp. 7- 97.

Maroyi, A., 2009. Traditional homegardens and rural livelihoods in Nhema, Zimbabwe: a sustainable agroforestry systems. *International Journal of Sustainable Development & World Ecology, 16*(1). pp. 1-8. DOI:10.1080/13504500902745895

Martínez Bustamante, R. and Juan Pérez, J. I., 2005. Los huertos: una estrategia para la subsistencia de las familias campesinas. *Anales de Antropología, 39*(2). pp. 25-50.

Méndez-Rodríguez, J. L. and Giménez-Cacho, M. M T, 2020. Expansión de la producción de aceite de palma en territorios campesinos, el caso de Palenque, Chiapas (1996-2018). *Revista Pueblos Y Fronteras Digital*, 15, 1–28. https://doi.org/10.22201/cimsur.18704115e.2020.v15.445

Montañez-Escalante, P. I., Ruenes-Morales, M. R., Ferrer-Ortega, M. M: and Estrada-Medina, H., 2014. Los huertos familiares Maya-Yucatecos: situación actual y perspectivas en México. *Ambienta*, (107), pp. 100-109.

Montemayor MMC, Estrada BPC, Packard JM, Treviño GEJ, Villaón MH. 2007. El Traspatio un recurso local en los servicios de turismo rural familiar: Alternativa de desarrollo sustentable municipal Caso: San Carlos, Tamaulipas. México. *Revista de Investigación en turismo y desarrollo local* 1:1-13.

Olvera Hernández, J.I.; Álvarez-Calderón, N.M.; Aceves-Ruiz, E.; Guerrero-Rodríguez, J. de D. 2017. Perspectivas del traspatio y su importancia en la seguridad alimentaria. *Agroproductividad, 10*(7): 39-45.

Ordoñez Díaz, M. de J., Lope-Alzina, D. G. and Pulido-Salas, M. T., 2018. Estado actual de los huertos familiares en siete estados del sur y sureste de México. In: M. de J. Ordoñez, Coord. Atlas biocultural de huertos familiares en México: Chiapas, Hidalgo, Oaxaca, Veracruz y península de Yucatán, México: CRIM-UNAM. pp 391-417.

Pulido, M. T., Pagaza-Calderón E. M., Martínez-Ballesté, A., Maldonado-Almanza, B., Saynes, A. and Pacheco R. M., 2008. Home gardens as an alternative for sustainability: challenges and perspectives in Latin America. In: U. P. de Albuquerque y M. Alves Ramos, eds. Current topics in ethnobotany. Kerala, India: Research Signpost. pp. 55-79.

Pulido-Salas, M. T., Ordóñez Díaz, M. de J. and Cálix de Dios, H., 2017. Flora, usos y algunas causales de cambio en quince huertos familiares en el municipio de José María Morelos, Quintana Roo, México. *Península, 12*(1), pp. 119-145. http://dx.doi.org/10.1016/j.pnsla.2017.01.006

Reyes-Betanzos, A. and Álvarez–Ávila, M. C., 2017. Agrobiodiversidad, manejo del huerto familiar y contribución a la seguridad alimentaria. *Agroproductividad, 10*(7), pp. 58-63. https://www.revista-agroproductividad.org/index.php/agroproductividad/article/view/1058

Salazar-Barrientos, L. D. L., Magaña-Magaña, M. A., y Latournerie-Moreno, L. 2015. Importancia económica y social de la agrobiodiversidad del traspatio en una comunidad rural de Yucatán, México. *Agricultura, sociedad y desarrollo, 12*(1): 1-14.

Sánchez-Gutiérrez, F., Valdez-Hernández, J. I., Hernández-de-la-Rosa, P., Sánchez-Escudero, J., Sánchez, A. S., Castillejos-Cruz, C. and Brindis-Santos, A. I., 2021. Estructura y composición arbórea en un gradiente altitudinal del Área Natural Protegida Metzabok, Chiapas. *Revista de Biología Tropical, 69*(1), pp. 12-22. http://dx.doi.org/10.15517/RBT.V69I1.40689

Sol, S. A., 1993. Utilización de los recursos vegetales por los habitantes del ejido Linda Vista, Palenque Chiapas, México. Tesis de licenciatura. Universidad Juárez Autónoma de Tabasco: División Académica de Ciencias Biológicas.

Sol, S. A., 2012. El papel económico de los huertos familiares y su importancia en la conservación de las especies y variedades locales. In: R. Mariaca Méndez, ed. El huerto familiar del sureste de México. México: Secretaría de Recursos Naturales y Protección Ambiental del Estado de Tabasco, ECOSUR. pp. 361-370.

Toledo V.; Barrera N.; García E.; Alarcón P. 2008. Uso múltiple y biodiversidad entre los mayas yucatecos. *Interciencia: México. 33*(5): 345-352.

Torquebiau, E., 1992. Are tropical agroforestry home gardens sustainable?. *Agriculture, ecosystems & environment, 41*(2), pp. 189-207. https://doi.org/10.1016/0167-8809(92)90109-O

Ubiergo-Corvalán, P., Rodríguez-Galván, G., Zaragoza-Martínez, L. and Casas, A., 2021. Elementos de la agricultura familiar percibidos por niñas y niños ch'oles en Tumbalá, Chiapas. *Revista Mesoamericana de Investigación, 1*(1), pp. 24-32.

Van der Wal, H. and Bongers, F., 2012. Biosocial and bionumerical diversity of variously sized home gardens in Tabasco, Mexico. *Agroforestry Systems*, 87, pp. 93-107. https://doi.org/10.1007/s10457-012-9526-4

Van der Wal, H., Huerta Lwanga, E. and Torres Dosal, A., 2011. Huertos familiares en Tabasco. Elementos para una política integral en materia de ambiente, biodiversidad, alimentación, salud, producción y economía. México: Gobierno del Estado de Tabasco: Secretaria de Recursos Naturales y Protección Ambiental, El Colegio de la Frontera Sur.

Villaseñor, J. L., 2016. Checklist of the native vascular plants of Mexico. *Revista Mexicana de Biodiversidad, 87*(3), pp. 559-902. https://doi.org/10.1016/j.rmb.2016.06.017

Vogl, C. R., Vogl-Lukasser, B. and Caballero, J., 2002. Homegardens of Maya migrants in the Palenque District (Chiapas/Mexico): Implications for sustainable rural development. In: J. R., Stepp, F. S. Wyndham y R. K. Zarger, eds, Ethnobiology and Biocultural Diversity. Athens, Georgia, USA: University of Georgia Press. pp. 631- 647.

Watson J. W. and Eyzaguirre P. B. 2002. Home gardens and agrobiodiversity: an overview across regions. In: J.W. Watson and P.B. Eyzaguirre, eds. Homegardens and *in situ* conservation of plant genetic resources in farming systems: Proceedings of the second international home garden workshop. Rome, Italy: International Plant Genetic Resources Institute. pp 10-13. https://hdl.handle.net/10568/105342

Zarco-Espinosa, V.M., Valdez-Hernández, J.I., Ángeles-Pérez, G. and Castillo-Castillo, O., 2010. Estructura y diversidad de la vegetación arbórea del parque estatal Agua Blanca, Macuspana, Tabasco. *Universidad y Ciencia, 26*(1), pp. 1-17.