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Biodiversity, management, and commercialization of ornamental plants at nurseries in Fortin de las Flores, Veracruz

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ABSTRACT

Objective: The aim of this study was to create an inventory of the biodiversity, management, and commercialization of ornamental plants at nurseries in the municipality of Fortín de las Flores in the State of Veracruz, Mexico.

Design/methodology/approach: Semi-structured interviews were carried out with 150 nursery owners.

Results: The respondents reported a total of 230 different plants. With regard to commercialization, 20 species were reported as the most sold. The most notable species were: *Syagrus romanzoffiana* (Cham.) Glassman, *Caesalpinia echinata* Lam., *Anthurium andreaeanum* Linden, and *Phoenix roebelenii* O'Brien. The biggest problem was the sale price; 65% of the nursery owners reported that they sold their plants to strangers, and that they did not belong to any organization or cooperative.

Limitations on study/implications: The poor local technological development characterized by unspecialized small and medium-sized businesses that compete with each other with little trade organization is a result of the sociocultural context of the region. This context limits regional development. Therefore, more research regarding sociocultural aspects should be promoted.

Findings/conclusions: We have concluded that there is an underutilization of the native agrobiodiversity, since species originating in other parts of the world are what is most often sold. This is evidenced in the main species sold as well as those that generate the highest profits for the nursery owners.

Keywords: Agrobiodiversity, economic botany, flowers, native plants, market

INTRODUCTION

The ornamental horticulture industry is made up of producers of plants in nurseries and greenhouses, landscaping companies, suppliers of raw materials, and sellers of a variety of products that include: potted flowers, cut flowers, landscaping trees, foliage plants, shrubs and woody ornamentals (Di Vita *et al.*, 2015). This is a global industry which, in addition to providing jobs, generates income that has an impact at the local level. In the United States, 2014 sales of horticultural specialties totaled over 13 billion dollars, of which over five billion dollars were from floriculture, which mainly comprises garden plants, potted flowers, and foliage plants (USDA, 2015). In Mexico, the farm-gate value of ornamental horticulture production was \$468,000 USD in 2019 (SEDARPA, 2020), including cut flowers (81% of the value and 84% of the surface area), grass (2% of the value and 4% of the surface area), as well as potted flowers, Christmas trees, foliage plants, and other garden plants (16% of the production value and 12% of the surface area). In that year, the two cut flowers with the highest production value were: *Rosa* L. (23% of the value) and *Chrysanthemum* L. (20% of the value); and those with the largest surface area were *Gladiolus* L. (23%) and *Chrysanthemum* L. (13%). The two plants with the highest production value were: *Euphorbia pulcherrima* Willd. ex Klotzsch (46%) and Christmas trees (15%), while those with the largest surface area were: *Euphorbia pulcherrima* Willd. ex Klotzsch (39%) and *Geranium* L. (14%).

Some of the problems faced by the ornamental horticulture industry at a global level are increased international competition due to the entry of plants from countries with lowcost production (Galati *et al.*, 2015), the impact on producers of the international financial and economic crises (Rihn *et al.*, 2016), the negative effect on ecosystems of the growth of invasive species (van Kleunen *et al.*, 2018), the lack of practices ensuring the sustainability of the sector (Castillo Nonato *et al.*, 2018), and the lack of adoption of traceability systems by producers and nursery owners in developing regions (García-Mejía *et al.*, 2018), among others.

Mexico is considered a megadiverse country, as it has a variety of genetic resources including higher plants, some of which have ornamental, social, and commercial value. This value is derived from the type of flower or inflorescence, the fruits or infructescence, the leaves, and the architecture of the plant (Guadarrama-Martínez

et al., 2012). Such are the cases of some fruit trees that are used in gardens and backyards as well as plants that are used for their flowers in activities such as offerings on the Day of the Dead, religious events, or special days such as Valentine's Day (February 14) or Mother's Day (May 10) (Rubí-Arriaga *et al.*, 2014).

Cut flower production has been recorded in 18 states of Mexico, however, the State of Mexico has 39% of the national surface area and 75% of the farm-gate production value. It is followed by Puebla in surface area (32%) and 13% of the value; Veracruz has 5% of the national surface area but only 1% of the value (SEDARPA, 2020) because, unlike the State of Mexico, it is not oriented towards exportation. As for potted plants and Christmas trees, production is recorded in 12 states, where Puebla represents 48% of the surface area and 22% of the production value; Puebla is followed by the State of Mexico (31% of the surface area and 24% of the value) and Mexico City (9% of the surface area and 26% of the value) (SEDARPA, 2020). Puebla and the State of Mexico achieve better prices due to their proximity to Mexico City, the most populated city in the country.

The municipality of Fortín de las Flores is located in the State of Veracruz in eastern Mexico. It is characterized by a microclimate conducive to the production of ornamental plants; these meteorological conditions have caused the inhabitants' preference for nurseries that grow commercial crops (Major *et al.*, 2005), e.g. sugar cane. This has made the state a popular place to purchase such products among the regional population. Despite this recognition, the number of scientific publications that account for the diversity of plants that are commercialized by the nursery owners is small and limited to studies by family, e.g. orchids (Murguía-González *et al.*, 2016) or species, e.g. anthurium (Murguía-González *et al.*, 2003). The aim of this study was to create an inventory of the biodiversity, management, and commercialization of ornamental plants at nurseries in the municipality of Fortín de las Flores in the State of Veracruz, Mexico, in order to identify the plants that are used for commercial purposes.

MATERIALS AND METHODS

The study was conducted during the months of May to August in 2017 in the municipality of Fortín de las Flores, Veracruz (18° 48' and 18° 59' north latitude; meridians 96° 56' and 97° 02' west longitude) at an altitude between 585 and 1400 m (Figure 1). The climate is semi-warm humid

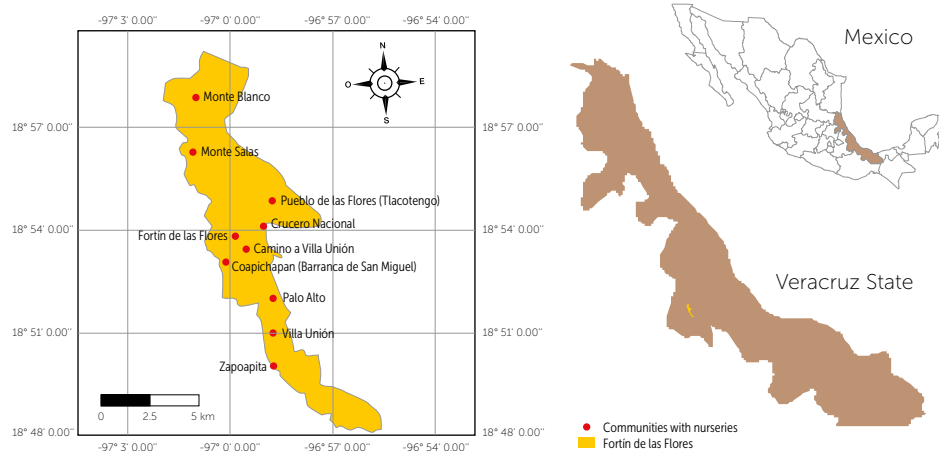


Figure 1. Towns included in the study.

Source: Own elaboration with QGIS[®] 3.8 Zanzibar with vector data from CONABIO.

with abundant rain in the summer (81%), warm humid with abundant rain in summer (10%), and semi-warm humid with rain all year round (9%). The municipality has an average precipitation of 1900 to 2100 mm and a temperature range of 18–24 °C. The region's ecosystem type is tropical evergreen forest (INEGI, 2009).

Before the study was commenced, the Agricultural Development Office of the Municipality of Fortín de las Flores was contacted, and the objective of the study was discussed. The Agricultural Development Office showed interest and later supported the investigation by indicating the towns that had nurseries registered with the municipality. These nurseries were visited by town following the census registration technique, and their owners or managers were invited to participate. Once permission was granted for the interview, a semi-structured questionnaire with 5 closed questions and 16 open questions was administered, containing the following sections: general information, surface area, plants produced, growing season, general and post-harvest management, infrastructure, plants sold, main client, presentation for sale, problems, associations, and government support. In total, 150 nursery owners in the region were interviewed, and a regional census was taken. The analysis of the qualitative information was done with NVivo[®] v. 10 and the analysis of the quantitative information was performed with IBM-SPSS[®] v. 20.

RESULTS AND DISCUSSION

Of the total number of nursery owners, 65.3% were men and the rest were women, in the following communities: Monte Blanco (1.3%), Monte Salas (4.0%), Pueblo de las Flores-Tlacotengo (22.0%), Crucero Nacional (3.4%),

Fortín de las Flores (16.7%), Camino a Villa Unión (16.7%), Coapichapa-Barranca de San Miguel (15.3%), Palo Alto (7.3%), Villa Unión (11.3%), and Zapoapita (2.0%) [Figure 1].

Biodiversity inventory

In total, the respondents reported 230 different plants at their nurseries. 37% of these originate from America, 30% from Asia, 19% from Africa, 11% from Europe, and the rest from Oceania. Of those originating in America, there are plants in Brazil, Peru, Argentina, Paraguay, Chile, Colombia,

Venezuela, Uruguay, Ecuador, and the United States. Of the total, 87% were non-native and the rest were Mexican. The following Mexican plants were reported: *Arecaceae* Bercht. & J. Presl, *Agave tequilana* F.A.C. Weber, *Taxodium mucronatum* Ten., *Beaucarnea recurvata* Lem., *Cedrus* Duhamel, *Capsicum annum* L., *Spathiphyllum cochlearispathum* (Liebm.) Engl., *Dioon edule* Lindl., *Plumeria rubra* L., *Galeana hastata* La Llave, *Yucca elephantipes* Regel ex Trel., *Xanthosoma* Schott, *Agave Dumort.*, *Euphorbia pulcherrima* Willd. ex Klotzsch, *Pinus montezumae* Lamb, *Orchidaceae* Juss., *Orchidaceae* spp., *Cattleya* Lindl., *Oncidium maculatum* (Aubl.) Urb., *Oncidium sphacelatum* Lindl., *Brahea armata* S. Watson, *Chamaedorea elegans* Mart., *Acrocomia aculeata* (Jacq.) Lodd. ex Mart., *Chamaedorea metallica* O.F. Cook ex H.E. Moore, *Ceiba aesculifolia* (Kunth) Britten & Baker f., *Chamaedorea tepejilote* Liebm., *Sedum morganiatum* E. Walther, *Begonia tuberosa* Lam, *Juniperus communis* L., and *Polianthes tuberosa* L.

Of the plants listed by the respondents, only 28 were frequently mentioned as being grown; of these, 3 plants were reported by more than 20 nursery owners, making them the most-frequently-produced plants (Table 1): *Caesalpinia echinata* Lam., *Syagrus romanzoffiana* (Cham.) Glassman, and *Anthurium andreaeanum* Linden; 2 were reported by 5 nursery owners: *Arecaceae* and *Phoenix roebelenii* O'Brien, and 22 plants had fewer than 5 mentions.

Infrastructure and management

On average, the surface area (cultivation area and point of sale) reported by the nursery owners, was

Table 1. Principal plants reported by nursery owners as produced, sold, and that generate profits in nurseries of the municipality of Fortín de las Flores, Veracruz, number of times a specie is mentioned, only the first mention is considered.

Scientific name	Local common name	Production	Sale	Gen. profits	Total
<i>Anthurium andreanum</i> Linden ^{NN}	Anturio	21	18	17	56
Arecaceae Bercht. & J. Pres. ^{M,NN}	Palmas en general	9	7	8	24
<i>Asparagus virgatus</i> Baker ^{NN}	Trifer	3	4	7	14
Balsaminaceae A. Rich. ^{NN}	Belén (chino)	1	2	2	5
<i>Beaucarnea recurvata</i> Lem. ^M	Pata de elefante	1	1	3	5
<i>Bougainvillea</i> Comm. ex Juss. ^{NN}	Buganvilia	1	1	1	3
Cactaceae Juss. ^{M,NN}	Cactus	1	1	1	3
<i>Caesalpinia echinata</i> Lam. ^{NN}	Maicera (Palo de Brasil)	34	31	27	92
<i>Chamaedorea elegans</i> Mart. ^M	Palma camedor	1	1	1	3
<i>Chamaedorea tepejilote</i> Liebm. ^M	Tepejilote	1	1	1	3
<i>Chlorophytum comosum</i> (Thunb.) Jacques ^{NN}	Listón (Listoncillo)	2	1		3
<i>Chrysalidocarpus lutescens</i> H. Wendl. ^{NN}	Areca		1		1
<i>Chrysanthemum</i> L. ^{NN}	Crisantero			1	1
<i>Citrus × limon</i> (L.) Osbeck ^{NN}	Limón			1	1
<i>Cycas</i> L. ^{NN}	Cica			3	3
<i>Cymbidium</i> Sw. ^{NN}	Orquídea barco (Cymbidium)	1		1	2
<i>Cynodon dactylon</i> (L.) Pers. ^{NN}	Pasto	3	4	4	11
<i>Dracaena deremensis</i> var. <i>Warneckeii</i> Engl. ^{NN}	Guarneque (Warneckii)	2	2	1	5
<i>Dracaena marginata</i> Lam. ^{NN}	Dracena (Marginata, Tricolor, Marquinata)	4	1	3	8
<i>Heliconia caribaea</i> Lam. ^{NN}	Heliconia	2	1	1	4
<i>Heliconia rostrata</i> Ruiz & Pav. ^{NN}	Trenza de indio	1			1
<i>Hydrangea macrophylla</i> (Thunb.) Ser. ^{NN}	Hortensia	1			1
<i>Hyobanche sanguinea</i> L. ^{NN}	Parásito			1	1
<i>Hyophorbe</i> Gaertn. ^{NN}	Palma Mascareña (de botella, Cuello de botella)	2	2	3	7
<i>Gardenia jasminoides</i> J. Ellis ^{NN}	Gardenia	1	2	2	5
<i>Juniperus communis</i> L. ^{M,NN}	Junipero		1		1
<i>Ligustrum lucidum</i> W.T. Aiton ^{NN}	Trueno	1		1	2
<i>Lilium candidum</i> L. ^{NN}	Azucena (Lirio, Liris)	2	1	1	4
<i>Oncidium sphacelatum</i> Lindl. ^M	Orquídea flor de mayo		1		1
Orchidaceae Juss. ^{M,NN}	Orquídeas en general		2	2	4
<i>Phoenix roebelenii</i> O'Brien ^{NN}	Palma robelina	7	5	13	25
<i>Rosa</i> L. ^{NN}	Rosa		3	2	5
<i>Rumohra adiantiformis</i> (G. Forst.) Ching ^{NN}	Helecho cuero (Leder)	1	1	2	4
<i>Strelitzia reginae</i> Aiton ^{NN}	Ave de paraíso	3	3	5	11
<i>Syagrus romanzoffiana</i> (Cham.) Glassman ^{NN}	Palma coco plumoso	29	35	23	87
<i>Zingiber spectabile</i> Griff. ^{NN}	Maraca	2	2	2	6

M = Mexican; NN = Non-native. Source: Own elaboration with field data.

7,332.71 ± 11,870.37 m², with a maximum of 90,000 m² and a minimum of 2 m². 29.9% of the respondents had between 2 and 500 m², while 70% had less than 7,500 m². Regarding infrastructure, 7 nursery owners did not respond to the question on the subject, and of the

rest, 99 mentioned that they do not use any infrastructure and grow their plants in the open field, while 20 reported using shade mesh and only 2 have nurseries. The rest of the respondents (22) reported having combinations of the above; the mixture of open field and shade mesh was

the most common combination while only 2 reported having open field with greenhouse production.

46.6% indicated that they use fertilizers and 4.4% did not answer the question. Among the products mentioned are: urea, 17-17-17, potassium nitrate, ammonium sulfate, phosphonitrate, chicken manure, filter cake, compost, foliar Nitrofoska[®], blue Nitrofoska[®], Gro-green[®], Nutrigen[®], Solucat[®], Osmocote[®], and Poly-feed[®]. Other products mentioned were rooting agents such as Raizal[®], and agrochemicals such as fungicides (Promyl[®], Ridomil Gold[®], Aliette[®] WG, Cupravit[®], Daconil[®]); insecticides (Foley Rey[®], Pirecris[®], Arrivo[®] 200CE, Dimetri[®] 400, Raid Casa y Jardín[®], Malathion[®], Ambush[®], Furadan[®]); rodenticides (compound 1080, poison bait, generic poison pills); and other products such as water pH regulators (Agrex[®]abc, Adherex Acid[®]); hormones (Foltron[®] Plus) and substrates (Mapito RFX-1 from Agra-Wool).

When asked about diseases, 15 out of 150 nursery owners reported that they have problems with fungi and 1 had problems with bacteria. With regard to pests, the cricket is the most common (52 out of 150 mentioned this pest); then there is the gopher (13), the Mayate beetle (11) and rabbits (7); spiders, ladybugs, ants, and red mites (4 of 150); worms, the butterflies, and slugs (3 out of 150); while birds, moths, mealybugs, aphids, and moths were mentioned infrequently.

Of the total number of respondents, 18 indicated that they had problems such as lack of water or lack of irrigation systems and 1 reported having problems due to excess moisture. Most of the nursery owners reported that they did not have problems attributable to weather. For those who do have problems in this area, the main issues were meteorological in nature: southerly winds (20 of 150), heat (15), hail (11), and low temperatures (7).

Commercialization

The nursery owners mentioned 20 plants as the most frequently sold, of which only 8 are Mexican, and these are the same as those that were most frequently produced (Table 1); however, the order of the three main plants varies slightly, since *Syagrus romanzoffiana* (Cham.) Glassman ranks first in sales and second in production, *Caesalpinia echinata* Lam. The respondents mentioned 31 plants as those that generate the highest amount of profits, the first three of which correspond to the same three that were most frequently produced.

Phoenix roebelenii O'Brien was notable as the fourth plant mentioned for generation of profit.

26% said that they have regular customers, while 65%, reported that they sell their products to strangers, and the rest did not answer the question. A third of the nursery owners reported that they sell their plants in a plastic bag and/or with root balls, 32 of the 150 respondents indicated that they sell cut flowers, 4 nursery owners reported that they sell in pots, and the rest of the nursery owners sell combinations of the above. Three of them indicated that they sell plants in bulk with bare roots, and only 1 reported selling bouquets and 1 reported selling arrangements. Those who deliver cut anthuriums (5) mentioned that they sell the product in a box, and grass is sold in rolls.

90 of the 150 interviewees do not carry out any post-harvest handling; in some cases it was reported that the client is the person responsible for this activity. Those who did report post-harvest activities indicated that these activities vary according to the product that they grow and sell the most. Those who grow anthuriums generally cut them and leave them resting in buckets of water. In this case, there are two options: Either the client comes and takes them as they are (7 nursery owners), or, the owners classify the flowers by size and color, and then pack and deliver them to vendors in markets or to wholesalers who take them to Mexico City markets (4 nursery owners). Those whose main product are ferns and palms reported that they clean, roll, interweave, ball or tie them, and bag them (7 nursery owners). Those who mainly sell plants clean them, some bag them or pot them, while others sell them with bare roots, and those who sell grass roll it up and put it in sacks. The rest of the nursery owners indicated that they sell a variety of products, so they reported combinations of the above.

The most frequent period reported as the one with the highest sales was March-May, followed by June-October, November-December, and to a lesser extent January-February and various combinations of periods. The holidays were February 14, May 10, November 2, and December 12.

Commercialization problems

Successful commercialization is a fundamental aspect of any agricultural activity and 25% of the nursery owners reported that they did not have any problems in this regard. The rest gave different answers, which are shown

in Figure 2. The first problem is the price. In general, the complaint is that whoever the buyer is always buying at low prices. It was reported that the buyers haggle with them for the amount. This occurred with both the final consumers and the intermediaries, while the producers do not receive any discounts whatsoever on the cost of the materials that they need in order to grow their products. Thus, they are price-takers who sell commodities in a mature market. The second problem is related to aspects such as size, leaves and demand by customers for quality plants. For example, they ask for plants with: leaves/flowers without chopping, scraping, shaving, or breakage, as well as specifications about the size of the leaves or the thickness of the stems and flowers with good vase life. Problems with nonpaying clients and unfair competition among nursery owners were reported to a lesser extent. The remoteness of the nurseries, the lack of organization among them, the lack of advertising, the seasonality of production and demand, the lack of plant diversity or of whatever the customer was looking for, and the lack of an attractive presentation for their customers were other problems mentioned by the respondents.

Associations and government support

Belonging to associations is a relevant factor to achieve common benefits such as the management of government support and consolidated purchasing. Despite the benefits that could be obtained, only 35 of the respondents (24%) indicated that they belonged to

an association, such as "los Amigos de las Orquídeas de Paso Coyol," "Anturios Selectos de Fortín," and the "Parque Florístico de Fortín" Associations. 19% reported that they had no interest in belonging to any association, due to the problems that would arise among the members, and they did not see any usefulness in it, preferring independence. The rest of the respondents reported that they would be interested in belonging to an association in order to obtain training, government support, increase sales, and management support.

With regard to government support, 9.5% of the respondents (14) reported that they had received some sort of it. Most were from the government of the State of Veracruz. Only one mentioned the Federal Ministry of Agriculture. The support they received was in the form of infrastructure for greenhouses, shade netting, pumps, and in one case financial support.

The production of ornamental plants is an activity for which the municipality of Fortín de las Flores is recognized at the regional level (Murguía-González *et al.*, 2003). The present study aimed to construct an inventory of biodiversity, management, and commercialization of ornamental plants in the nurseries of the municipality. Regarding the variety of biodiversity, 230 common names of plants were mentioned. Of all those listed, 28 were the most frequently sold. A study in Brazil found that in the market, 45 species were preferred (Muraro *et al.*, 2016). Therefore, markets tend to focus on certain species despite the abundance of them that could be offered.

Unlike other regions of the world that have been characterized by the production of native and exotic species (Junqueira y Peetz, 2018), Fortín de las Flores has specialized in the reproduction and commercialization of non-native commercial plants such as anthuriums, palms, and foliage plants. In fact, the vast majority of plants that are sold are introduced species. Underutilization of native species in Mexico and other parts of the world has been previously documented (Pietersen *et al.*, 2018), where a market orientation is predominant (Major *et al.*, 2005), and determined by the sociocultural context and the networks of the producers (Cleveland *et al.*, 2000). This is exacerbated by consumers who are ignorant and have no interest in knowing the origin of the plants they are buying (Mayett-Moreno *et al.*, 2018), so there is not a specific demand for native plants; to the contrary, the consumers of ornamental plants are characterized by



Figure 2. Word cloud with the most occurrence mentioned by the respondents when describing commercialization problems.

Source: Own elaboration.

the acquisition of imported exotic plants (Poot–Pool et al., 2015).

One should also consider the changes in the legislation for the protection of native species prohibiting the extraction and sale thereof. This limits their propagation (Dénes, 2017). Also worthy of concern is the loss of native species due to overexploitation (Wong y Liu, 2019).

Despite the fact that Veracruz is one of the states with the largest amount of native species with flowers (angiosperms) endemic to Mexico and in particular to the State (Villaseñor y Ortiz, 2014), and as has been identified in previous studies, small producers tend to collect and breed plants that may be of some use, be that medicinal, edible, or as wood material that can be easily consumed or commercialized (Díaz-Forestier et al., 2019). This explains why native plants are not the species that are the most often sold in the studied nurseries.

In a study on nurseries done in Florida, United States, the authors found that 21.5% of the nurseries' sales was palm trees and tropical foliage plants (Hodges et al., 2016), which were the main products sold, a finding similar to what was observed in this study. It is likely that the tropical climate contributes to the decision to mainly produce these types of plants instead of cut flowers, which are produced in colder areas (Castillo Nonato et al., 2018). This represents a business opportunity.

The nurseries, in general, have little technology, and there have been no significant changes in the last two decades (Murguía-González et al., 2003). Low technological levels are related to a lack of training of the nursery owners, which has resulted in a type of production in which there no quality standards oriented to the local market (Fernández-Zamudio et al., 2012). These low standards are in contrast with what is happening in other regions of the world, where high-quality flowers are produced at high technological levels. One such region is the Netherlands (Verdouw et al., 2013). As for innovations such as robotization, water recycling, energy cogeneration, the use of solar panels, alternative methods for pest control, novel packaging, labels, web pages, marketing organizations, or other innovations (Lambrecht et al., 2015), these have not been utilized in the region.

With regard to commercialization, due to the fact that they breed commercial plants, the price of their

products is subject to the market prices, which is a weakness for producers (Fernández-Zamudio et al., 2012). Previous results show that producers sell their plants to housewives, as well as to some shops and trade fairs (Murguía-González et al., 2003), which is consistent with our findings. This is also evidence that the marketing systems have not changed. The focus continues to be on the local market or casual clients, with no formation of cooperatives or trading companies in order to export the plants and flowers that they grow. Disorganization among plant traders has also been observed in Brazilian markets (Muraro et al., 2016), especially among small and medium-sized enterprises.

The limited growth of small nurseries is a phenomenon that has already been documented and explained as a lack of specialization, where the owner has the dual role of grower and merchant (Di Vita et al., 2015). This is in contrast with producers from other states in Mexico, where some have attained success as exporters of cut flowers, probably as a consequence of the presence of foreign producers who brought investment and introduced technology (Castillo Nonato et al., 2018). This shows how important the region's sociocultural context is for local development.

CONCLUSION

There is an interdependence between the commercialization of ornamental plants and their propagation, in which the laws of the market are decisive for the floristic landscape of the nurseries in regions that could make better use of their local biodiversity. The case analyzed in the region of Fortín de las Flores, Veracruz is a clear example of the above. We conclude that when imported exotic plants have been sold locally, there has been a resulting underutilization of native agrobiodiversity. This is evident from the main species that are sold as well as those that generate the highest profits for the nursery owners. This goes hand in hand with poor local technological development characterized by small and medium-sized enterprises with no specialization or trade organization, that compete with each other, which occurs, to a certain degree, as a result of the sociocultural context of the region.

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