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# Plant Diversity Study on Four Suburban Farms in Santiago de Cuba

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## ABSTRACT

The aim of this paper was to evaluate the diversity behavior of plants grown on four suburban farms in the province of Santiago de Cuba, Cuba. Lots of 100 $m^2$ were made for species count. After identification, a floristic list was made. The plants within the same taxonomic category were counted, and the botanical composition was evaluated based on the number of individuals, family, genuses, and species. The group abundance criterion was used to include food plant species, and ecosystem, ornamental, and medicinal services, which were calculated as diversity indicators of alpha diversity (S), Berger-Parker Dominance (d), and general diversity (Shannon H´). For the Beta diversity, the Jaccard index (Ji), Sorenson index (SSi), and Ecological Dependence (ED) were taken into consideration. A total of 39 269 individuals from 45 families, 72 genuses, and 87 species were identified. The botanical composition varied, with an increasing tendency in the number of individuals of the ornamental and medicinal species; the most numerous families were Asteraceae, Leguminosae, Musaceae, Poaceae and Solanaceae. The alpha diversity underwent an increase from one season to another, with values within the set range for each indicator, except for the Shannon H´ index on La Caballería Farm in both periods. The similitude moved between low and dissimilitude, which evidenced the presence of very specific species adapted to the particular environmental conditions of each place.

**Key words/: agrobiodiversity, diversity indexes, suburban agriculture**

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## INTRODUCTION

According to Hermi (2011), urban agriculture is linked to sustainable development, food insufficiency, organic agriculture, environmental education, quality of life, and environmental degradation. Although its origin goes beyond modern times, it began to fuel increasingly heated debates in the 1980s.

Fernández and Morán (2012) noted that the spaces associated to urban agriculture are much more diverse than mere lots with furrows. The variety of places, formats, motivations, and social groups that promote urban agriculture demonstrate that the most common feature is horticulture diversity. It is manifested in different garden typologies that should be encouraged within the framework of an integrated program. In Cuba, Escobar (2016), noted that some of the main typologies are intensive gardens, organoponics, family yards, and protected and semiprotected crops. Suburban farms were also included, following FAO´s recommendation to term them Peri-urban or Suburban farms, in 1999.

In Cuba, this type of agriculture was incorporated with the implementation of the National Program of Urban Agriculture (UA), Suburban Agriculture (SUA), and Family Agriculture (FA), that began with the onset of organoponics, in 1987. It started with garden vegetables, but other subprograms have been added since. The major outcomes include food production with positive impacts on the economy and the society, and on biodiversity (Ministry of Agriculture [MINAG], 2015).

Cuban suburban agriculture comprises 142 000 suburban farms; i.e., 142 000 families working. Suburban farms extend to almost 2 million ha nationally. They are mostly engaged in fruit production, tropical crops, beans, and livestock, on integrated farms, intensive gardens, protected crops, and mini-dairies (Companioni, 2013). This type of agriculture fosters best environmental practices, and high diversification and preservation of natural resources, which play a major role in production. According to Hodgkin *et al.* (2012), biodiversity is the groundwork of food chain, and its use is important to achieve food and nutritional safety.

According to Yong (2010), agricultural biodiversity or agrodiversity is biological diversity necessary for agriculture. In all agricultural ecosystem, soil worms and microorganisms, as well as animals, insects, and plants (native or cultivated) are key elements in diversity. Vargas (2011) said that yield increases are related to adequate biodiversity levels in production systems.

However, Vargas *et al*. (2016), pointed that despite the importance given to diversification of agriculture, the studies made on suburban farms, particularly in the east of Cuba, are very particularized, since they only consider very specific aspects within production. Therefore, it is important to study different diversification indicators that can be used to improve farm yields, decision making on diversification elements, and the design of agricultural systems.

The aim of this research was to evaluate the behavior of plant diversity on four suburban farms in Santiago de Cuba.

## MATERIALS AND METHODS

The study comprised four suburban farms in the municipality of Santiago de Cuba, in the province of Santiago de Cuba, Cuba, between December 2013 and July 2017. This period included the two seasons considered for agricultural studies in Cuba (rainy and dry seasons). The temperature and precipitations data are shown in Table 1. The procedure used in each research stage is described below,

**Table 1. Behavior of precipitations and temperatures**

| Variables | Dry season | | | | Rainy season | | | |
|---|---|---|---|---|---|---|---|---|
| | Dec. 2013 | Jan 2014 | Feb 2014 | Average | Mar 2014 | Apr 2014 | May 2014 | Average |
| Precipitations (mm) | 23.8 | 72.2 | 78.9 | 59.8 | 9.2 | 78.1 | 127.7 | 71.67 |
| Temperatures (°C) | 25 | 25.7 | 25.1 | 25.27 | 25 | 26.7 | 26.9 | 26.2 |

**Source: Reports from the Provincial Weather Center, Santiago de Cuba**

Initially, six farms were evaluated, according to the method used by the Ministry of Agriculture [MAG] (2008). Only the criteria applicable to the farms were considered (location, representativeness of production systems, diversity of farm use, integration of different uses, use according to the soil type, and logistics). Finally, farms I (Erick Vega), IV (La República), V (La Caballería) and VI (Los Cascabeles) were selected based on the highest number of positive requisites shared (Table 2).

**Table 2 Farm selection**

| Criteria | Value | | | | | |
|---|---|---|---|---|---|---|
| | Farm I | Farm II | Farm II | Farm IV | Farm V | Farm VI |
| Location and accessibility | + | + | + | + | + | + |
| Representation of production systems (plants and animals), according to size and use | o | o | - | o | o | + |
| Diversity of farm use | + | - | o | + | + | + |
| Integrity of use diversity | + | o | o | + | + | + |
| Use according to the soil | + | + | o | - | + | o |
| Logistics (conditions to receive people) | o | + | + | + | - | + |
| **Overall positive aspects** | 4 | 3 | 2 | 4 | 4 | 5 |

**Legend: (+): Positive aspect, (-): Negative aspect, (o): Indifferent aspect**

General characterization and species sampling were made after selection of the production locations. For species count, 100 $m^2$ lots (10 m X 10 m) were established as sampling units, according to Zarco *et al*. (2012). The lots were laid out clockwise, and separated by wood stakes on their corners. The number of lots and the sampled area (70% of the total number) are shown in Table 3. The same lots were used for sampling in the two seasons evaluated.

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**Table 3. Number of lots and sampled areas per farm**

| Farms | Sampled area (70% of total) | Number of lots evaluated |
|---|---|---|
| Erick Vega | 1.638 Ha. (16 380 $m^2$) | 164 |
| La República | 0.896 Ha. (8 960 $m^2$) | 90 |
| La Caballería | 1.302 Ha. (13 020$m^2$) | 130 |
| Los Cascabeles | 7 Ha. (70 000 $m^2$) | 700 |

The counting data (common names and amount) in every lot were collected in field charts designed for the study. Identification was made at the Department of Applied Sciences, Faculty of Agricultural Sciences, University of Oriente, using the Botanical Dictionary of Cuban Common Names, according to Roig (1988). Species with uncertain identification were taken to the herbarium of the Eastern Center for Ecosystems and Biodiversity (BIODECO), for identification by specialists. All the scientific names were matched according to Acevedo and Strong (2012).

A floristic list was made following species identification, for characterization of the botanical composition, and estimation of various ecological indicators evaluated (APPENDIXES 1-3). the species were identified. Evaluation was made according to the ecological indicators used by Vargas *et al*. (2016).

The determination of diversity indexes was made in the three groups of species listed below. The species´ main usefulness was considered for inclusion in a particular group, regardless of other useful traits.

1. Food Species (FS)
2. Ornamental species (OS)
3. Medicinal species (MS)

The indicators related to alpha diversity (α) (species abundance (S), Berger-Parker Dominance (d), frequency according the representativeness and General Diversity percentage (Shannon H´)) were determined through Biodiversity Calculator, Danoff-Burg & Chen (2005). For the beta diversity (β), the Jaccard index (Ji), Sorenson index (SSi), and Ecological Dependence (ED) were considered. The first two were determined by SIMIL.exe, Franja (1993), according to Cursach *et al*. (2011); and the third one was estimated with the formula used by Vargas, Pupo, and Puertas (2015). Classification of similitude, according to Iss was made with the Ratliff index (1993), cited by Rodríguez *et al*. (2016), as follows:

| Range | Description | Symbol |
|---|---|---|
| 0 | Indicates dissimilitude | D |
| 0-0.25 | Low similitude | B |
| 0.26-0.50 | Moderate similitude | M |
| 0.51-0.75 | High similitude | A |
| 0.76-1 | Total similitude | T |

## RESULTS AND DISCUSSION

The characterization of four suburban ecosystems in the study revealed a coincidence to the others described by Vargas *et al*. (2016). Furthermore, the data collected included 39 269 individuals from 45 families, 72 genuses, and 87 species. The behavior of each taxonomical category in every plant group studied in the period evaluated, is shown in Table 4.

The total number of individuals in species for food decreased in the rainy season, same as the number of families and species, whereas the genus number remained constant. This decrease might have been influenced by different factors, one of which could be that many crops are under their optimum stage in the dry season, and disappear when the season changes, or remain in a reduced number of individuals. Moreover, the likelihood that the number of individuals in crops that emerge in place of previous crops is not so high.

**Table 4 Behavior of botanical composition in both periods**

| Plant groups | Taxonomical categories | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total individuals | | Families | | Genuses | | Species | |
| | Dry. | Rny. | Dry. | Rny. | Dry. | Rny. | Dry. | Rny. |
| FS | 19 785 | 12 484 | 18 | 17 | 28 | 28 | 35 | 33 |
| OS | 2 729 | 3 290 | 34 | 36 | 31 | 34 | 25 | 27 |
| MS | 361 | 585 | 11 | 11 | 11 | 11 | 8 | 8 |

**Legend**
FS: food species
OS: ornamental species
MS: medicinal species
Dry: dry season
Rny: rainy season

All the taxonomic categories increased in all the ornamental plants; the number of individuals was the most outstanding. A significant increase was also observed in the number of individuals in the medicinal plants; however, the rest of the taxonomic categories remained constant from one season to another. The behavior of number of individuals in these species may have been related to the influence these groups received from man, trying to provide the best conditions for plant reproduction.

Furthermore, many of these plants had a similar behavior to arvenses species, as precipitations increase they find proper reproduction conditions. However, the permanence of all taxonomic categories of medicinal plants was in relation to the appearance of the same species in both

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seasons. Based on the behavior shown by the botanical composition of these plant groups in the two seasons, it is important to study the behavior of this indicator on the farms (Table 3).

**Table 5 Botanical composition of food species on the farms in each season**

| | Taxonomical categories | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total individuals | | Families | | Genuses | | Species | |
| **Farms** | **Dry.** | **Rny.** | **Dry.** | **Rny.** | **Dry.** | **Rny.** | **Dry.** | **Rny.** |
| Erick Vega | 3 368 | 3 345 | 9 | 10 | 10 | 14 | 11 | 16 |
| La República | 10 239 | 6 057 | 12 | 15 | 18 | 19 | 20 | 21 |
| La Caballería | 3 271 | 1 389 | 14 | 12 | 17 | 15 | 20 | 17 |
| Los Cascabeles | 2 907 | 1 693 | 9 | 11 | 14 | 15 | 19 | 19 |

**Legend**
Dry: dry season
Rny: rainy season

Although in Erick Vega and La República there was a slight increase in the number of food producing species (Table 5), and it remained constant in Los Cascabeles, the total number of individuals decreased in all the farms from one season to another. The largest number of individuals in both seasons was observed in La República. The lowest number of individuals was reported on Los Cascabeles, in the dry season, and on La Caballería, in the rainy season.

The decrease in the number of individuals for this group of plants was associated to the causes previously described. Although on Erick Vega all the categories increased, the decline in the number of individuals was associated with the usefulness granted to these plants by the farmers, mostly used for food. Moreover, this agricultural system focuses basically on various crops, particularly root vegetables and plantain, in which recovery of individuals is slow. Of the 40 species reported for the dry season, only tomato (*Solanum lycopersicum L.*) was absent in the rainy season. In the last stage, six more species were reported in comparison to the first stage. However, it did not mean greater incorporation of individuals than the ones eliminated.

Of the total species reported on La República (24), 17 were observed in the two seasons. Carrots (*Daucus carota* L.), garden onion (*Allium cepa* var. *aggregatum Dom*.) and tomatoes only appeared in the dry season. In the other season, maize (*Zea mays L*.), cilantro (*Eryngium foetidum* L.), sugar cane (*Saccharum officinarum* L.) and bananas (*Musa sapientum* L.), were introduced. It explained an increase in one of the species when the season changed; however, the new species incorporated did not involve a number of individuals greater than the one eliminated. It explained the reduction observed in this indicator, especially if farmers are more inclined to garden vegetables, which are generally affected by season changes.

On La Caballería, the decline in the number of individuals may have been related to the decrease found in the species observed. Of the 20 species reported in the dry season, tomatoes, green beans (*Vigna unguiculata* (L.) Walp.) and yam (*Dioscorea alata* L.) did not show up in the next season; the first two species underwent a significant decline in the number of individuals. Moreover, the

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species that left the system had no replacements in the rainy season. The previous became more evident considering that the farm was basically engaged in ornamental plant production.

On Los Cascabeles, the same amount of species (19) was reported in both seasons; however, two of them were not commonly observed in the two seasons evaluated. Green beans and pepper (*Capsicum annuum* L.) were found only in the dry season, and were replaced by sweet potato (*Ipomoea batatas* (L.) Lam. and cassava (*Manihot esculenta Crantz*.) in the rainy season. Although this system was mostly engaged in mango (*Mangifera indica* L.) production, the presence of the previous species owed to the existence of self-consumption areas with a strong trend to garden vegetables.

These results showed that the suburban farms studied as part of agricultural ecosystems are committed to supply services, according to Valdéz (2017). These services are long lasting, considering that the different categories within the botanical composition have little variance. However, the existence of more than 69% of species common to the two seasons on the farms demonstrated that their presence in the system did not respond to an even temporary diversity design in terms of ecology and diversification of the eco-systemic service based on food proportion.

In the ornamental species (Table 6), all the taxonomic categories evaluated increased from one season to another, except for La Caballería, where the number of families, genuses, and species declined with the coming of precipitations. Generally, the most remarkable rise occurred in the number of individuals, except for La Republica, with only one.

**Table 6 Botanical composition of food species on the farms in each season**

| | | | Taxonomical categories | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total individuals | | Families | | Genuses | | Species | |
| **Farms** | **Dry.** | **Rny.** | **Dry.** | **Rny** | **Dry.** | **Rny.** | **Dry.** | **Rny.** |
| Erick Vega | 43 | 107 | 11 | 15 | 11 | 17 | 11 | 17 |
| La República | 146 | 147 | 12 | 14 | 13 | 15 | 14 | 15 |
| La Caballería | 2 467 | 2 871 | 10 | 9 | 13 | 10 | 13 | 10 |
| Los Cascabeles | 73 | 159 | 12 | 12 | 15 | 16 | 16 | 17 |

**Legend**
Dry: dry season
Rny: rainy season

Of the total of species reported on Erick Vega (18), only 10 were common to both seasons, prayer plant (*Maranta leuconeura* Kerc.) was only reported in the dry season. In the rainy season, dumb-cane (*Dieffenbachia seguine* (Jacq.) Shott.), fern (*Adiantum* spp.), rockweed (*Pilea microphylla* (L.) Lebm., asparagus fern (*Asparagus setaceus* (Kunth.) Jessop., waxvine (*Hoya australis* R. Br. ex Trail), hollyhock (*Alcea rosae* L.), and orchids (*Cattleya* spp.) were observed. The previous caused an increase in all the botanical composition indicators evaluated. Its rise was influenced by the introduction of species by farmers near their home gardens.

La República reported a total of 17 ornamental species; among them, youth-and-age (*Zinnia elegans* Jacq.) and crotons (*Codiaeum* sp.) were only reported in the dry season, and replaced in the rainy season by asparagus fern, rockweed and caladium (*Caladium bicolor* (Aintom) Vent. The little variation in the number of individuals may be related to the increase of only one species, along with the fact that the new species in the system had few individuals. On this farm, these plants were planted in the flower garden.

A contradictory event for this group of plants took place on La Caballería, mostly engaged in ornamental plant production. It was the only farm with a decrease in species, whereas an increase was observed in the total number of individuals. Crêpe ginger (*Cheilocostus speciosus* (J. Koing.) C. Specht), globe amaranth (*Gomphrena globosa* L.) and asparagus fern, only appeared in the dry season, whereas the other species were common in the two seasons. This behavior explained the decline in the number of species, and, in consequence, the rest of the taxonomic categories. The increase in the total number of individuals was produced thanks to species like tuberose (*Polianthes tuberosa* L.), rose (*Rosa* spp.) and heartsease (*Viola tricolor* L.) increased in number during the rainy season, due to vegetative multiplication made by the farmers.

Although Los Cascabeles is committed to mango production, the existence of houses near the plantations favored the presence of ornamental plants. Spider lily (*Crinum asiaticum* L.), China Aster (*Callistephus* x sinensis Bergamans.) and rose were observed in the dry season, whereas caladium, elongated-lip, great bougainvillea (*Bouganvillea spectabilis* Wild.) and fern appeared in the rainy season. These species had an impact on the total number of individuals, particularly *B. spectabilis*, with 65 individuals scattered throughout the farm. The other species had a less prominent increase in the number of individuals, perhaps encouraged by the farmers´ will to preserve the species in the flower garden areas of the farms.

The group of medicinal species (Table 7) underwent the least variation with season change. No medicinal species were reported on Erick Vega, whereas it was constant on La República and Los Cascabeles. La Caballería decreased in one. The absence of plant reports on Erick Vega may have been associated with the non-existence of species whose main usefulness is drug manufacturing, though some plants had it as a secondary purpose.

**Table 7 Botanical composition of food species on the farms per season evaluated**

| Farms | Taxonomical categories: Total individuals | | Families | | Genuses | | Species | |
|---|---|---|---|---|---|---|---|---|
| | **Dry.** | **Rny.** | **Dry.** | **Rny.** | **Dry.** | **Rny.** | **Dry.** | **Rny.** |
| Erick Vega | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| La República | 119 | 126 | 5 | 5 | 6 | 6 | 6 | 6 |
| La Caballería | 210 | 412 | 4 | 3 | 4 | 3 | 4 | 3 |
| Los Cascabeles | 32 | 47 | 5 | 5 | 6 | 6 | 6 | 6 |

**Legend**
Dry: dry season
Rny: rainy season

The constant behavior observed on La República and Los Cascabeles was produced by the existence of the same medicinal species in both seasons. Mirto (*Lippia alba* (Mill.) N.E Br.) was common to all the farms during the dry season, whereas, sweet basil (*Ocimum basilicum* L.) was commonly observed on the farms in the two seasons, like Aloe vera (*Aloe vera* L.), but only for La Caballería and Los Cascabeles.

The presence of these two plant groups in the agricultural ecosystems was associated to handling, based on the definition by Zaccagnini (2014). These results evidenced the presence of this group of ecosystem services throughout time, and did not respond to a temporary design, as for the species used for food production. It may be influenced by the likes and conditions of the people who live and work on the farms. The previous might be oriented against ecological diversification, and the service type these botanical groups belong to. classifications.

Of the 45 families reported during the study, 10 stood out (Table 8), including the two periods. Asteraceae, Leguminosae, Musaceae, Poaceae and Solanaceae contributed significantly to the behavior of botanical composition in the two seasons. During the dry season there were also reports of *Amaranthaceae, Amaryllidaceae and Asparragaceae, as well as Araceae and Malvaceae* in the rainy season.

**Table 8 Botanical families with the largest contribution to diversification in the two groups, based on the seasons evaluated**

| Botanical families | Seasons | | | | | | | | Plant groups | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Dry. | | | | Rny. | | | | | |
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) | Dry. | Rny. |
| *Amaranthaceae* | | | 2 | 2 | | | | 2 | FS, OS | FS |
| *Amaryllidaceae* | | 2 | | 2 | | | | 2 | FS, OS | FS |
| *Araceae* | | | | 2 | 2 | 2 | | 3 | OS | OS |
| *Asparragaceae* | | | 2 | 2 | | | | 2 | OS | OS |
| *Asteraceae* | | 4 | 2 | 3 | | 2 | 2 | 3 | OS, MS | OS, MS |
| *Leguminosae* | | 2 | 2 | 3 | 3 | 2 | | 2 | FS | FS |
| *Malvaceae* | | | | | 2 | | | 2 | OS | OS |
| *Musaceae* | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | FS | FS |
| *Poaceae* | 2 | | 3 | | 2 | 3 | 3 | | FS | FS |
| *Solanaceae* | | 2 | 3 | 4 | | | 2 | 3 | FS | FS |

**Legend: (1) Erick Vega, (2) La República, (3) La Caballería, (4) Los Cascabeles**
FS: food species
OS: ornamental species
MS: medicinal species
Dry: dry season
Rny: rainy season

The plant groups with the highest influence from these families were food species and ornamental species. Outside the ornamental plants, only *Asteraceae* contributed with medicinal species. These results strengthened the behavior of botanical composition, whose best values corresponded to these plant groups within all the taxonomical categories.

The high representation of these families was not a contradictory fact. Many plants of interest to humans belong to these botanical families; therefore they are commonly found in agricultural ecosystems. Vargas *et al.* (2016) after evaluation of plant diversity on suburban farms, reported *Leguminosae, Asteraceae, Poaceae and Malvaceae* as the most representative families, whereas *Musaceae* was also found with certain representation.

Vélez and Herrera (2015) found that family *Araceae* was one of the most represented plants, during a floristic study in urban areas. Moreover, Mendoza *et al.* (2011) found that the group of

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medicinal plants was the least represented botanically, in a study of use and management of plant groups in urban ecosystems.

The behavior previously described was related to the results achieved for species abundance (Table 9). Generally, this indicator tended to variability in all the plant groups from one season to another. Species abundance for all the botanical groups increased or remained constant after season change on Erick Vega, La República, and Los Cascabeles; only La Caballería tended to decline.

**Table 9 Species abundance per plant group on every farm, based on the seasons evaluated**

| Plant groups | Farms | Species abundance (S) | |
|---|---|---|---|
| | | Dry season | Rainy season |
| Food species | Erick Vega | 11 | 16 |
| | La República | 20 | 21 |
| | La Caballería | 20 | 17 |
| | Los Cascabeles | 19 | 19 |
| Ornamental species | Erick Vega | 11 | 17 |
| | La República | 14 | 15 |
| | La Caballería | 13 | 10 |
| | Los Cascabeles | 16 | 17 |
| Medicinal species | Erick Vega | 0 | 0 |
| | La República | 6 | 6 |
| | La Caballería | 4 | 3 |
| | Los Cascabeles | 6 | 6 |

The best results for this indicator in both seasons were reported for food species, which was associated with the kind of ecosystem studied. However, the reports of plants sharing ornamental and medicinal features in the suburban ecosystems studied was a remarkable result. It indicated the capacity of these productive systems to generate ecosystem services other than foods, which are still misused due to the lack of proper space and time design.

The behavior and existence of these plant groups within the existent flora must be taken into account. Brack (2014) noted that biodiversity produces goods and services to satisfy human needs, including nutrition, medication, and protection. It also provides recreation, inspiration, and emotions.

Avilés *et al.* (2012) pointed that the urban and suburban agriculture programs should meet both the nutritional and spiritual needs, considering ornamental plant production is one of their subprograms. Therefore, this program contributed to better ecosystem services of the farms.

Accordingly, when analyzing species abundance it is important to consider dominance (Table 10). The behavior of the dominance indicator varied. In general terms, the highest values were reported for the plants with the least species abundance. The farms and plant groups with the highest values and constant numbers were close to mid values.

**Table 10 Species abundance per plant group on every farm, in each season evaluated**

| Plant groups | Farms | Species abundance (a) | |
|---|---|---|---|
| | | Dry season | Rainy season |
| Food species | Erick Vega | 0.3783 | 0.4164 |
| | La República | 0.4200 | 0.5405 |
| | La Caballería | 0.3634 | 0.2441 |
| | Los Cascabeles | 0.4334 | 0.6881 |
| Ornamental species | Erick Vega | 0.2558 | 0.3458 |
| | La República | 0.3767 | 0.3537 |
| | La Caballería | 0.3989 | 0.4194 |
| | Los Cascabeles | 0.2055 | 0.4088 |
| Medicinal species | Erick Vega | 0 | 0 |
| | La República | 0.4202 | 0.3730 |
| | La Caballería | 0.9667 | 0.9927 |
| | Los Cascabeles | 0.6875 | 0.5532 |

According to Moreno (2006), this indicator considered the behavior of the most abundant species, so any value increases also represented increase in equity and a decrease in abundance. Hence, the farms and groups with increased values, had greater distribution equity and less influence of the most abundant species. The opposite occurred when the Berger-Parker value declined. Although the group of medicinal species was the least abundant, the species individuals in the samples were more appropriately distributed, followed by the food species and ecosystem services. The ornamental group showed the least equitative distribution.

As a consequence, the group of species reserved for food consumption reported the best distribution in the rainy season on all the farms, except on La Caballería. Something similar was observed in the ornamental species in the same season, on all the farms, except on La República. The best distribution of medicinal species was reported in the dry season in all the suburban ecosystems studied, except on La Caballería. Hence, for these seasons, the samples were more homogeneous, and had little influence from the most dominant species. The reason for that was that the lower the value of the most dominant species, the lower the value of the index.

The most dominant species (Table 11) had a varying tendency which depended on the botanical group. The food and ornamental species had an increasing tendency from one season to the other; whereas the medicinal species underwent a decrease. This behavior was linked to the response of the dominance indicator evaluated.

**Table 11 Most abundant species in each group studied, according to the farms and seasons evaluated**

| | Farms | Aspects | Dry season | Rainy season |
|---|---|---|---|---|
| Food species | Erick Vega | Species | *M esculenta* | *M esculenta* |
| | | Abundance % | 37.83 % | 41.64 % |
| | | Classification | Occasional | Not often |
| | La República | Species | *A. ampeloprasum* | *A. ampeloprasum* |

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| | | | | |
|---|---|---|---|---|
| | | Abundance % | 41.99 % | 54.05 % |
| | | Classification | Not often | Not often |
| | La Caballería | Species | *A. ampeloprasum* | *H. annuus* |
| | | Abundance % | 36.32 % | 24.41 % |
| | | Classification | Occasional | Occasional |
| | Los Cascabeles | Species | *Musa* sp. | *B pinguin* |
| | | Abundance % | 43.34 % | 68.81 % |
| | | Classification | Not often | Often |
| Ornamental species | Erick Vega | Species | *Begonia* spp. | *Rosa* spp. |
| | | Abundance % | 25.58 % | 34.58 % |
| | | Classification | Occasional | Occasional |
| | La República | Species | *C. hyssopifolia* | *C. hyssopifolia* |
| | | Abundance % | 37.67 % | 35.37 % |
| | | Classification | Occasional | Occasional |
| | La Caballería | Species | *P. tuberosa* | *P. tuberosa* |
| | | Abundance % | 39.89 % | 41.94 % |
| | | Classification | Occasional | Not often |
| | Los Cascabeles | Species | *P. scutellarioides* | *B spectabilis* |
| | | Abundance % | 20.55 % | 40.88 % |
| | | Classification | Scarce | Not often |
| Medicinal species | La República | Species | *J pectoralis* | *J pectoralis* |
| | | Abundance % | 42.02 % | 37.30 % |
| | | Classification | Not often | Occasional |
| | La Caballería | Species | *O. basilicum* | *O. basilicum* |
| | | Abundance % | 96.67 % | 99.27 |
| | | Classification | Abundante | Abundante |
| | Los Cascabeles | Species | *P. major* | *P. amboinicus* |
| | | Abundance % | 68.75 % | 55.32 % |
| | | Classification | Often | Not often |

The most dominant food species on La Caballería and Los Cascabeles varied as seasons changed. However, during the dry season La República and La Caballería shared the same species. Moreover, 80% of the most dominant plants were occasional and not often; only B. pinguin was classified as often.

The most abundant ornamental species had only one variation during season change on Erick Vega and Los Cascabeles; no farms shared the most dominant species. Of the species reported as most dominant, 83.33 % classified as occasional and not often; only *P. scutellarioides* (16.77 %) classified as scarce.

The most dominant medicinal plant species only changed between seasons on Los Cascabeles. It was the group with the highest values reported for abundance percentage. The species in this group classified as occasional and abundant. *O. basilicum* was the only species classified as abundant in the group, and overall.

The presence of many of these within the most abundant species had to do with the farmers´ own interests, along with social, economic, traditional, and cultural aspects. However, many of them

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shared traits that placed them in ecological niches, and must, therefore be protected to prevent possible negative impacts. Oviedo *et al.* (2012) provided data about some of these species.

| | | |
|---|---|---|
| Great bougainvillea | *Bougainvillea spectabilis* | Potentially invasive, transforming and invasive outside Cuba, with a native distribution in South America. |
| Mexican heather | *Cuphea hyssopifolia* | Invasive outside Cuba, and ecosystem transforming. Its native distribution is in Mexico and Central America. |
| Broadleaf plantain | *Plantago major* | Invasive species inside and outside Cuba, also a transformer. Its native distribution is in Europe. |
| Oregano | *Plectranthus amboinicus* | Invasive species inside and outside Cuba, with native distribution in Asia. |
| Penguin | *Bromelia pinguin* | Invasive species inside and outside Cuba, within the most harmful species. It transforms ecosystems. Its native distribution is in Mexico and Central America. |

The behavior of all the aspects related to species dominance showed that the standards met on the farms were linked to resource availability, on one hand; and the people´s interest of what should be left in the system, on the other. These criteria repeatedly opposed the productive purpose of the farms, with no agroecological designs that stimulate the social scope of every agricultural system. The ecological behavior of the most dominant species must be considered for decision making on the dynamics of the ecosystem, keeping their production capacity based on space and time designs that promote benefits and minimize risks.

In terms of general diversity in the three groups (Table 12), the behavior corresponded to the botanical groups. The highest values for that indicator were reported for the group of ornamental species, followed by the food and medicinal species, respectively.

**Table 12 Species diversity per plant group on every farm in the seasons evaluated**

| Plant groups | Farms | Species diversity (Shannon H´) | |
|---|---|---|---|
| | | Dry season | Rainy season |
| Food species | Erick Vega | 1.6207 | 1.8013 |
| | La República | 1.6670 | 1.5263 |
| | La Caballería | 2.0625 | 2.0670 |
| | Los Cascabeles | 1.4561 | 1.2751 |
| Ornamental species | Erick Vega | 2.1076 | 2.1682 |
| | La República | 2.1220 | 2.1791 |
| | La Caballería | 1.4173 | 1.2674 |
| | Los Cascabeles | 2.3462 | 2.0990 |
| Medicinal species | Erick Vega | 0 | 0 |
| | La República | 1.4012 | 1.5091 |
| | La Caballería | 0.1727 | 0.0477 |
| | Los Cascabeles | 1.0644 | 1.0744 |

The highest values for ornamental species were reported on Los Cascabeles (dry season), and La República (rainy season). The lowest values were reported for La Caballería. These values were influenced by the size of the land areas for ornamental species, bigger than the rest. The low values on La Caballería (though it is engaged in ornamental plant production) owed to the constant modification of vegetation caused by production.

The values for the two seasons were highest for the food species on La Caballería; the lowest values were observed on Los Cascabeles. It was related to the existence of lots for self-consumption on the farm, and occasionally, when the ornamental areas were idle, they were planted with food species.

The medicinal plants had the lowest diversity values; the highest values were observed on La República and the lowest on La Caballería. The low values owed to reduced areas for species preservation and ornamental species. Besides, this research only included the species with medicinal properties as their main use. The previous was also associated to the fact that no reports were made of such plants on Erick Vega, because their medicinal use was secondary.

The values achieved in the two seasons were within the established range for proper diversity and abundance, except on La Caballería. Gardner *et al*. (2011) noted that when heterogeneous samples were used, with variations in the total number of species and the number of individuals in the species, the expected value was 1-5.

Generally, the values achieved in this study were between 0.04 and 2.35, which coincided with the previous author. Nevertheless, the values above 2 coincided with the values reported by Pauro *et al.* (2011), also using heterogeneous samples in two different locations. In spite of it Yong and Leyva (2010), considered that an agricultural ecosystem evaluated as having good diversity should have a diversity of at least 150 species. However, species abundance (only considering S), was not always associated with the existence of adequate levels of proper diversity and abundance.

It did not mean that though ecological diversity remained, and supplying and cultural services were maintained from one season to another, there would be diversification of ecosystem services. Yet, it is important to consider that these results may be a starting point of agroecological designs (space and time), in order to accomplish true sustainability on the farms, along with ecological diversification and diversification in the supplies and culturing of the urban systems studied.

Concerning the similitude (Table 10) of these farms in terms of diversity based on the various botanical groups, the values came close or under the median. Considering the food species, the similitude indicators tended to increase, except for Ij for comparisons of La República-Los Cascabeles; La Caballería-Los Cascabeles; Erick Vega-Los Cascabeles; and La Caballería-Los Cascabeles, with a slight decrease. According to the Iss, similitude was low only for comparisons of La República-La Caballería (dry season); and La Caballería-Los Cascabeles (rainy season). The values showed a slight tendency to moderate similitude. The ED values were mostly under effective dependence, only for comparisons of Erick Vega-La Caballería (dry season); Erick

Vega-La República; and La República-La Caballería (rainy season), with effective dependence values in communities with the least species abundance (Erick Vega and La Caballería) to the ones with the highest species abundance.

The indicators for the ornamental species were near the mid values or under. The indicators for this botanical group in 50 % or more of the comparisons tended to decline from one season to the other. Only for the Erick Vega-La República (rainy season) comparison, an effective ED value was observed, which demonstrated that La República was dependent from the other farm. The Iss showed that the similitude of the suburban agricultural ecosystems studied, including the ornamental plants, could be classified as low.

**Table 13 Behavior of beta diversity in relation to the botanical groups studied**

| Comparisons | Jaccard (*Ij*) | | Sorenson (*Iss*) | | Ecological dependence (ED) | |
|---|---|---|---|---|---|---|
| | Dry. | Rny. | Dry. | Rny. | Dry. | Rny. |
| | | | **Food species** | | | |
| Erick Vega – La República | 0.240 | 0.480 | 0.045 | 0.071 | 0.545 | 0.750 |
| Erick Vega – La Caballería | 0.348 | 0.435 | 0.206 | 0.210 | 0.727 | 0.625 |
| Erick Vega – Los Cascabeles | 0.200 | 0.346 | 0.018 | 0.047 | 0.454 | 0.562 |
| La República - La Caballería | 0.429 | 0.583 | 0.265 | 0.122 | 0.600 | 0.823 |
| La República - Los Cascabeles | 0.393 | 0.379 | 0.073 | 0.098 | 0.579 | 0.579 |
| La Caballería - Los Cascabeles | 0.393 | 0.385 | 0.135 | 0.265 | 0.631 | 0.588 |
| | | | **Ornamental species** | | | |
| Erick Vega – La República | 0.316 | 0.455 | 0.180 | 0.252 | 0.545 | 0.667 |
| Erick Vega – La Caballería | 0.091 | 0.080 | 0.008 | 0.026 | 0.182 | 0.200 |
| Erick Vega – Los Cascabeles | 0.227 | 0.400 | 0.190 | 0.191 | 0.454 | 0.588 |
| La República - La Caballería | 0.125 | 0.042 | 0.029 | 0.002 | 0.231 | 0.100 |
| La República - Los Cascabeles | 0.250 | 0.222 | 0.201 | 0.173 | 0.428 | 0.400 |
| La Caballería - Los Cascabeles | 0.208 | 0.120 | 0.010 | 0.007 | 0.385 | 0.300 |

**Legend**
Dry: dry season
Rny: rainy season

The value assumed by the similitude indicators for all the comparisons, considering the medicinal species, equaled 0, which showed a dissimilitude between the comparisons made. This behavior occurred due to the lack of common species, or because there were very few of them during the comparisons. It may have also been influenced by the selection criterion for this botanical group.

In general terms, a relationship was observed among these farms, which ranged from moderate similitude (slight), and dissimilitude, with a tendency to dissimilitude and low similitude.

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Villa (2014), after evaluation of various gardens, also found values of 0.300 (30%, using the same indexes of this study). Candó (2014) demonstrated association levels below 0.500 in the comparisons. Besides, he reported values of ecological dependence below the effective levels in most comparisons. After analyzing the contribution of the existing vegetation to food safety in suburban farms in Santiago de Cuba, González (2017) found low similitude in most comparisons, with ecological dependence below the effective value.

The existence of these botanical groups with an influence on the diversity of all the production systems was relevant. Firstly, food production was guaranteed; secondly, there was a potential for self-sufficiency on the farms, with the delivery of various services other than food production, especially ornamental and medicinal plants. It will be more or less influenced by each system´s conditions, and the social, economic and cultural aspects. Kehlenbeck, Arifin and Maass (2007) claimed the existence of three groups of factors that may explain species abundance and diversity in small-scale systems. They include garden characteristics, agroecological factors and social and economic factors.

## CONCLUSIONS

The current vegetation in the agricultural ecosystems is diverse, but it does not represent diversification of ecosystem services associated with supplies and culture.

The plant species cultivated on the suburban farms studied ensured the production of food, ornamental, and medicinal species, which is more associated with social, economic, and cultural factors of the population that lives, works, and makes decisions on the farms.

The ecosystem services that provide the plants cultivated on the farms does not respond to set agroecological designs of space and time that include the sinecological behavior of these botanical groups.

The results of this study can be used as a starting point to encourage changes in the farmers´ minds, in terms of decision making toward farm space and time arrangement.

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