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Diversity of plant species on suburban farms in Santiago de Cuba

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ABSTRACT

The aim of the study was to evaluate the behavior of arborescent and shrub-like activity on four suburban farms in the province of Santiago de Cuba, Cuba. 100 m^2 plots were created for species count. A flower list was made after species identification, then the alpha (α) diversity indicators were calculated (Species abundance (S), Dominance (Simpson D), and General Diversity (Shannon, H). The indicators for the beta diversity were Jaccard (Ij), Morisita-Horn (IM-H), and Ecological Subordination (ES). The data collected included 62 509 individuals from 65 families, 154 genders, and 183 species. For both groups, the alpha indicators showed an increasing trend between periods, with values ranging within the parameters for each indicator. La Caballería farm was the exception, where the Shannon diversity index (H) was not within the set range for proper diversity and abundance during the dry season. The beta diversity indicators showed differing values among the samples studied, which prove the existence of specific species adapted to the environmental conditions of the place.

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Key words/agrobiodiversity, diversity on the farm, suburban farming

INTRODUCTION

Foodstuffs are a key element to life. According to Zambrano (2011), their production is both a national and international priority, since they are critical to achieve economic and social development. In that sense, Cuba has developed the National Program of Urban and Suburban Farming, which included the term Family Agriculture, later, in 2014 (Ministry of Agriculture [MINAG], 2015). The implementation of the program led to a new approach on agriculture production.

The program meant a less conventional way of food production, progressively embracing the agroecological production approaches (Funes, 2009). One of the principles of the agroecological approach is to keep, both spatially and temporarily, adequate levels of diversity and abundance of the agricultural systems, because they help sustain the ecological and productive processes that take place.

Diversification of productive farms in Cuba and the rest of the world is a crucial element, not only because it contributes to keeping with homeostatic mechanisms of the system, but also because it is a source of raw materials and nutrition to humans. In addition to it, available local resources may be part of the system, as a way to achieve optimum productivity of the system. As a result, it will be in a better position to hold the introduction of the said farming practices (Funes et. al, 2009).

The number of small-scale farms spread around the world is approximately 450 million (Murphy, 2012). According to the Memoirs of the Management of Diversity Cultivated in Traditional Agroecosystems Symposium, globally, in these production systems, studies for better understanding of biodiversity are mainly focused on morphoagronomic analysis, in situ preservation and cultivar assessment, and germplasm bank evaluation (Chávez et al., 2002). In Cuba, studies of farm biodiversity comprise fruit tree diversification on Community Farms (Pino, 2008); as well as complexity analysis of suburban farms, based on the state of biodiversity components (Vargas et al., 2014).

According to Hernández (2006), all the topics dealt with hereto are the main requirements of urban, suburban, and family farming. Consequently, conducting studies that comprise the various elements related to plant diversity in agrosystems is critical, especially considering the existing biodiversity of all the organizational types of agriculture. The suburban farms, as organizational types of production, have a remarkable influence on the development of productive processes, by encouraging system diversification. However, research on behavioral analysis of all the diversification elements, particularly in Cuba,

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is still insufficient (Candó, 2014). The aim of this study is to assess the behavior of plant species diversity on four suburban farming in Santiago de Cuba.

MATERIALS AND METHODS

The study was developed on four suburban farms in the municipality of Santiago de Cuba, in the province of Santiago de Cuba, between December 2013 and May 2014. The period includes the two stages taken into account for agricultural work in Cuba (rainy and dry seasons). The weather data collected (rainfall and temperatures) are shown in Table 1. The procedure used for each working stage is described below.

Table 1. Behavior of rainfall and temperatures

Variables	Dry season				Rainy season			
	Dec. 2013	Jan. 2014	Feb. 2014	Average	Mar. 2014	Apr. 2014	May. 2014	Average
Rainfall (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 inspected for selection, according to the Technical and Operational Manual for Didactic Integrated Farms, recommended by the Ministry of Agriculture and Livestock Production (MINAG, 2008). Only criteria applicable to farms were considered from the above document (location, representativeness of production systems, farm use diversity, integration of uses, conformity of soil use and logistics). Eventually, farms I, IV, V, and VI were chosen, as they complied with most positive requisites (Table 2).

Table 2. Farm selection criteria

Criteria	Value					
	Farm I	Farm II	Farm II	Farm IV	Farm V	Farm VI
Location and accessibility	+	+	+	+	+	+
Representativeness of production systems (plant and animal), in terms of 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

After selection of the production locations, general characterization and species sampling were made. For species count, 100 m^2 plots (10 m X 10 m) were established as sampling units, according to Zarco et al. (2010), and Zacarías et al. (2012). The plots were separated by wood stakes on the four corners, and laid out clockwise. The number of plots and the sampled area (70% of the total number) are shown in Table 3. The same plots were used for sampling in the two periods assessed.

Table 3. Number of plots and sampled areas per farm

Farms	Sampled area (70% of total)	Number of plots assessed
Farm I	1.638 Ha. (16 380 m^2)	164
Farm IV	0.896 Ha. (8 960 m^2)	90
Farm V	1.302 Ha. (13 020m^2)	130
Farm VI	7 Ha. (70 000 m^2)	700

The counting data (common names and amount) in every plot were collected in field sheets 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). The uncertain species were taken to the herbarium of the Eastern Center for Ecosystems and Biodiversity (BIOECO), for identification by specialists. All the scientific names were matched according to Acevedo and Strong (2012).

A flower list was made when all the species were identified for characterization of the botanical composition, and estimation of various ecological indicators assessed. During the evaluation of the ecological indicators, some indicators suggested by Mijaíl (2004) and Moreno (2006) were considered for biodiversity studies.

Two species groups (weeds, and tree like and shrub-like plants) were included for determination of diversity indexes. The indicators related to alpha diversity (Species abundance (S), Dominance (Simpson D), and General Diversity (Shannon (H)) were determined through Biodiversity Calculator, Danoff-Burg / Chen (2005). The indicators for beta diversity were Jaccard (Ij), Morisita-Horn (IM-H), and Ecological Subordination (ES). The first two were determined by SIMIL.exe, Franja (1993); and the third one used the following formulae:

Ecological subordination

ES = C/N

C = number of common species between A and B

N = number of species in the community with less species abundance between the species compared.

RESULTS AND DISCUSSION

The farms evaluated (Table 4) are located in the same geographic area, between 20 and 50 m above sea level. They are legally registered under their names; except Farm I, which is registered under the name of its proprietor.

Table 4. Main features of the farms in the study

Farm features	Farm I	Farm IV	Farm V	Farm VI
Name	Inexistent	La República	La Caballería	Los Cascabeles
Proprietor	Erick Vega	Ismael Barroso	José L. Isalgué	Reivis Rodríguez
Latitude (north)	20.091236	20.068167	20.047843	20.057827
Longitude (west)	75.786977	75.801893	75.794819	75.800777
Altitude (meters above sea level)	50	20	20	50
Total area (Ha)	2.34	1.28	1.86	10
Cultivated area percent	61.90	89.10	52.91	90.00
Relief	Slightly mountainous	Plain with minor slopes	Plain	Slightly mountainous
Soil features according to visual evaluation	42 (Generally considered good)	42.5 (Generally considered good)	42.1 (Generally considered good)	38.34 (Generally considered good)
Main crop	Various crops (sweet potato, plantain, cassava, maize, pumpkin)	Various crops (mainly greens)	Ornamental plants	Mango
Family composition	5	3	3	3
Proprietor´s expertise	Empirical	Empirical	Empirical	Empirical
Land acquisition procedure	Family inheritance	Family inheritance	Family inheritance	Family inheritance

In all the farms, over 50% of total area is used for production. It is important to highlight that there are production differences, since farms I and IV are engaged in various crops, the former focuses on crop vegetables and plant protein; whereas the latter is more engaged in greens. Farm V is involved in ornamental plant production, and farm VI focuses on mangoes. The local topography ranges from flat to slightly hilly, but the quality is good, according to the scale reported by Lambert (2010), since the visual quality of the soil is over 30.

Socially, the farms are family-oriented, with three members per farm, except farm I, with five. Overtime, land property has been transferred from one family member to another, along with empirical knowledge about traditional management of productive systems. However, with the green revolution, much of that knowledge was influenced, and there are still some approaches with single-tactical criteria that have a negative effect on resource and area component management.

Plant diversity has been affected by the simplified approach of the productive systems, especially biodiversity. The data collected included 62 509 individuals from 65 families, 154 genders, and 183 species. The behavior of each taxonomical category was assessed according to the period (Table 2).

Table 2. Behavior of botanical composition in both periods

Period assessed	**Taxonomical categories**			
	Total individuals	**Families**	**Genders**	**Species**
Dry season	36 232	63	142	168
Rainy season	26 277	62	147	171

The total number of individuals for each period assessed had a changing behavior, with a decreasing tendency. It was different from the rest of the categories, where very little variation was observed. The variation observed in the number of individuals was probably caused by some of the species cultivated, because their optimal stage occurs in the dry season. Accordingly, when the season changes, they disappear, but if they remain, their number is low. Moreover, some non-targeted species are affected by manipulation from one season to another, which is always influenced by the use the area may have, partially or completely eliminating them, and causing the loss of individuals.

Concerning the families, their number continues to have little variation from one season to another (63 and 61). Of the total families for each season, 60 are common to both. Only three of them, Canellaceae, Dioscoreaceae and Marantaceae, emerged in the dry season, but never in the other season, when the Nyctaginaceae families were spread.

Something similar occurred for species. It is explained, because out of the total species found, 170 are common to the two seasons evaluated. Other 13 different species appeared in either season. Furthermore, the little variation observed in families and species may have been related to the existence of many perennial species, which favored the permanence of lots of species in the production areas from one season to another.

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Based on the behavior shown by the composition of species in either season, the indicator was evaluated on all the farms (Table 3).

Table 3. Botanical composition in both periods evaluated

Taxonomical categories	Erick Vega		La República		La Caballería		Los Cascabeles	
	DrS	R.	DrS	R	DrS	R	DrS	R
Number of individuals	4 293	4 644	11 899	8 255	8 415	6 315	11 625	6 865
Number of families	31	40	45	50	30	29	41	43
Number of genders	55	80	76	89	56	58	82	79
Number of spp. - gender -	2	5	4	4	5	5	4	5
Number of species	62	84	82	95	55	58	89	86

Legend: DrS: dry season
R: rainy season

According to the results from the above table, the structure of the botanical composition of the farms studied, varied a lot, both by farm and by season. The fewest number of individuals for either season was observed on the Erick Vega Farm, though it was the only one that experimented an increase, when the others underwent a decrease.

The increase in the number of individuals observed on Erick Vega owed to an increase in the number of species from one season to another. Out of the 64 species reported in the dry season spleen amaranth (Amaranthus dubius Mart.), bellyache bush (Jatropha gossypiifolia L.), prayer plant (Maranta leuconeura Kerc.), Turkey berry (Solanum torvum Sw.), and tomato (Solanum lycopersicum L.) disappeared in the rainy season. Thirty new species were reported in the rainy season, which means that a larger number of individuals emerged, in comparison to the number of species eliminated.

On La República Farm, common zinnia (Zinnia elegans Jacq.), Koanophyllon (Koanophyllon villosum (Sw.) R. M King), climbing dayflower (Commelina diffusa Burm.), cinnamon bark (Canella winterana (L.) Gaertn.), climbing dayflower (Commelina diffusa Burm. F.), garden croton (Codiaeum spp), jack bean (Canavalia ensiformis (L.), tomato (S. lycopersicum), and carrot (Daucus carota L.) were reported in the dry season. Although 22 new species were reported in the rainy season, they did not include a larger number of individuals than the ones eliminated.

Species globe amaranth (Gomphrena globosa L.), common asparagus fern (Asparagus setaceus (Kunth.) Jessop.), crêpe ginger (Cheilocostus speciosus J. Köing.) C. Specht.), purple yam (Dioscorea alata L.), Cowpea (Vigna unguiculata

(L.) Walp.), bushy matgrass (Lippia alba (Mill.) N. E. Br.), fireplant (Euphorbia heterophylla L.) and anamu herb (Petiveria alliacea L.) were reported in La Caballería during the dry season, exclusively. The three first are ornamental plants that ended production in that season, like the following two, which are important nutritional sources. These factors led to a decrease in the number of individuals, though 11 new species were reported in the rainy season.

Similarly, on Los Cascabeles, with areas for self-consumption, the main crop is mangoes (Mangifera indica L.), which presupposes some anthropogenic management. In addition to it, fallow land was prepared, which may have influenced on the reduction of individuals from one season to another; as well as a reduction in the number of species. But the location had the best botanical composition in the dry season; whereas La República had the best outcome for that indicator during the rainy season.

Regardless of the above, the rest of the taxonomic categories was more inclined to increase from one period to another, which shows greater complexity in terms of botanical composition. Only La Caballería lost one family, since in the dry season three disappeared (Costaceae, Dioscoreaceae and Phytolacaceae). In the rainy season, only two new families were reported (Lauraceae and Rutaceae); this area experienced the least variability from one season to another. A similar report was observed on Los Cascabeles, but for number of genders and species in the rainy season, which was downsized to three, in comparison to the previous season.

Of the 65 families reported during the study (Table 4), 7 have contributed the most to farm diversification, because they were present on all the farms and in both seasons. Besides, these families had a total of species equal or higher than six. This behavior may be influenced by two factors: various crops present on the farms studied are within those families, and, according to the new standards for plant systemics, many families join and form super families, like the Leguminosae.

Table 4. Taxonomical categories in suburban farming, in Santiago de Cuba

Family	Erick Vega		La República		La Caballería		Los Cascabeles		Total
	Species		Species		Species		Species		
	DrS	R	DrS	R	DrS	R	DrS	R	
Amaranthaceae	2	1	3	3	2	1	4	4	6
Asteraceae	3	6	8	8	7	7	4	3	15
Euphorbiaceae	6	5	7	6	3	3	3	4	9
Leguminosae	5	1	8	9	6	6	15	15	18
Malvaceae	4	7	4	6	3	3	4	6	8
Poaceae	5	5	5	9	4	7	3	2	9
Solanaceae	2	0	2	1	3	3	6	4	6
Other representative families									
Amaryllidaceae (5), *Apiaceae* (4), *Araceae* (4), Boraginaceae (2), *Meliaceae* (4), *Rubiaceae* (3), *Rutaceae* (3), *Verbenaceae* (5)									
Families represented in all the farms									
Anacardiaceae (4),Annonaceae (3), Arecaceae (3), Caricaceae (1), Convolvulaceae (4), Cucurbitaceae (3), Lamiaceae (3), Lauraceae (1), Musaceae (3),Myrtaceae (1), Rosaceae (1), Sapindaceae (2)									

Legend: DrS: dry season R: rainy season

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Other families were not present on all the farms, or the two seasons. Generally, however, they provided a number of species, starting from 3 or lower, or equal to 5, contributing to diversification on the location they were observed.

Moreover, the Anacardiaceae, Annonaceae, Arecaceae, Caricaceae, Convolvulaceae, Cucurbitaceae, Lamiaceae, Lauraceae, Musaceae, Myrtaceae, Rosaceae and Sapindaceae families were present in all the farms, though they were not the most representative by the number of species. Remarkably, though these families were present on all the farms, they not always were the same species from one season to another. The remaining families with no representativeness were found on one or two farms, and no more than two species were reported on each.

Overall, the most representative families were Leguminosae, Asteraceae, Poaceae, Euphorbiaceae, and Malvaceae. Several studies made on flower diversity have proven that these families are usually found in certain ecologic systems (natural or anthropic). Terán (2013) and Machado (2013) analyzed the existing diversity in two Centers for Wide Spreading of Agricultural Biodiversity (CDBA) for further assimilation on farms, reported the predominance of species from these families. The former author also reported weed species and perennial plants with the highest number of species during the study.

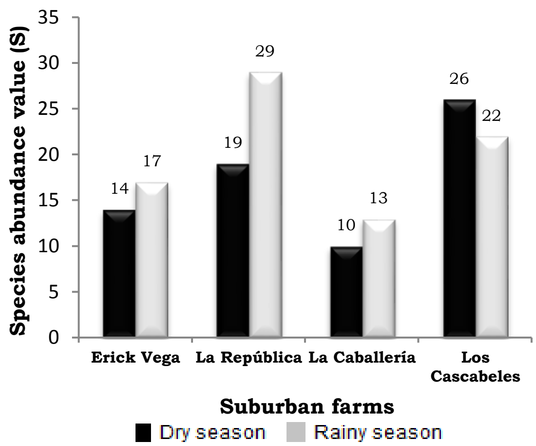

Figure 1. Abundance of weed species in the farms studied in the seasons assessed. Number of species

Regarding the areas of production studied, these groups of plant species are important diversifying elements. Accordingly, they are essential to evaluate their influence on diversification of suburban farms.

Generally, weed species abundance (Figure 1.) was more prone to increase from one season to another in all the areas, except on Los Cascabeles, with a decrease. In the dry season the greatest abundance was observed on Los Cascabeles; in the rainy season, it was observed on La República. La Caballería was the agroecosystem with the lowest abundance for the two seasons evaluated. Although Los Cascabeles had the highest abundance of species, it is not contradictory, though mango was the main item. The reason was that many herbal and shrub-like species may grow freely. However, the decrease observed for this index was caused by human manipulation. The farm had fallow land in the dry season, where spontaneous vegetation grew. It was killed when the area was being prepared for production in the rainy season.

Something similar occurred on La Caballería, with ornamental plants. This production system favored weed elimination almost completely, as part of cultivation procedures practiced to the plants in the field. Just a few of them grew along hedges, or small areas used for draft animal grazing.

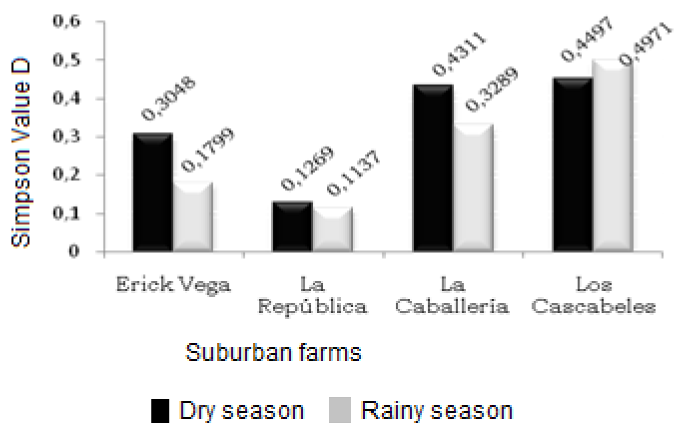

Figure 2. Predominance of weed species in the farms studied, in the two seasons. Simpson Index.

Accordingly, when analyzing species abundance, it is important to consider dominance (Figure 2). Moreno (2006) said that dominance is an indicator which is contrary to uniformity and equity of the samples studied. It includes representativeness of species with the highest importance, regardless of the contribution given by the other species; that indicator gives the possibility that two individuals from the same sample may belong to the same species. The values for that indicator for each species in the sample must be between 0 and 1.

Considering a general evaluation of dominance, the values decreased from one season to another, except for Los Cascabeles, which underwent a slight increase. The highest dominance values were also observed on this farm, during both seasons. The lowest values were observed on La República. However, for all the farms and seasons evaluated, the dominance values observed were within the set up ranges for the indicator.

In Erick Vega, Bothriochloa pertusa (L.) A. Camus. in the dry season; and Megathyrsus maximus (Jack.) Sam. & Jac. in the rainy season, with 52% and 28% abundance, respectively, were the most widely spread species. Cynodon dactylon (L.) Pers. (25 % and 27 % for either season) on La República, and on Los Cascabeles (67% in the dry season, and 68% in the rainy season); and B. pertusa turned out to be the most dominant species. On la Caballería, species Partthenium hysterophorus L. (50% in the dry season), and Sorghum halepense (L.)Pers. (51% in the rainy season), were the most representative.

Generally, of the five species found as dominant, four belonged to the same botanical family (Poaceae). This is explained by reports of González and Regalado (2012), as within the top 100 invading plants in the world. They also noted that the native distribution range (except for P. hysterophorus) is the tropical American continent, Africa, Asia, and Europe.

Another interesting point is the fact that La República is where the lowest dominance values were reported, though it was not the one with highest abundance. The fact is that the location undergoes a strong effect of agroecological principles, and it is also used for permaculture. As a result, that kind of vegetation is kept within the system, without forming large populations, as patterns of new food production systems moving around their diversification.

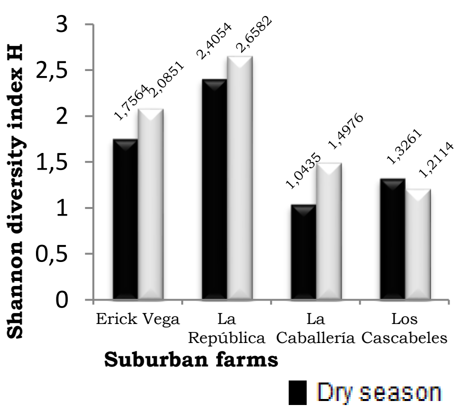

Figure 3. Diversity of weed species in the farms studied, during the periods evaluated. Shannon diversity index

The behavior of weed diversification, according to the Shannon diversity index (H)

(Figure 3) was variable, toward increases from one season to another in all the production systems evaluated. Los Cascabeles was the only farm that reported a slight decrease in diversity during the rainy season, in comparison to the dry season. For either period assessed, the highest diversity values were observed on La República, whereas the lowest values were reported for La Caballería and Los Cascabeles, in the dry and rainy seasons, respectively.

Despite the outcome of the study, Gardner et al., (2011) noted that the values observed in this group of plants for the indicator in every farm and season, were within the range set up for proper diversity and abundance (1-5).

Therefore, the species included in the samples have an equitable distribution. On the farms and seasons where the values were higher, the species in the sample were less dominant than on those where the values achieved were lower. In addition to it, the behavior shown by this indicator has been directly influenced by the behavior of species abundance and dominance.

In spite of all the data presented so far, the group of weed species had no significant representation, and it often underwent human manipulation. Vargas et al. (2011) stated that a weed´s value is unquestionably determined by the closest social perception environment, also adding that such perception will have an impact on management actions. Vargas et al. (2014), when assessing the complexity of four production systems, noted that the component related to harmful biodiversity (weed species) was one with the lowest values, remarkably contributing to simplification of the area.

However, the increase produced in some indicators associated with the number of species, is caused, according to Candó et al., et al. (2015), by the long life of several weed species, which remain latent and viable until they find proper conditions for germination. Such conditions are created by rain, which favors weed-like species.

As to the similarity of these fields in terms of diversity in the behavior of weed species (Table 5), the comparative values shown for each of the indicators assessed varied. For all comparisons based on the Jaccard index (Ij), similarity among them was below the mean values (0.5000) in the dry season. The highest values observed were found on Erick Vega-La Caballería, and Erick Vega- La República (0.3333 and 0.3200, respectively). The behavior previously described continues in the rainy season, with the highest values produced for the same combinations of the previous season, but with the addition of La República- Los Cascabeles, with 0.3421.

Ij is a similarity indicator that relates the exclusive species within the samples compared. According to Moreno (2006), the values observed were between 0 (no shared species), and 1 (all species shared). Consequently, this indicator was observed in all the cases and both seasons, within the set ranges. However, the common species among associations were below the total of exclusive species, so similarity among the farms was low, regardless of that from one season to another, the value of the indicator increased, with the exclusion of Erick Vega-Los Cascabeles.

Table 5 Behavior of Beta diversity in relation with the weed species group

Farms compared	Jaccard (Ij)		Morisita– Horn (I_{M-H})		Ecological subordination (ES)	
	DrS	**R.**	**DrS**	**R**	**DrS**	**R**
Erick Vega – La República	0.3200	0.3939	0.5341	0.2241	0.5714	0.7647
Erick Vega – La Caballería	0.3333	0.3636	0.1366	0.0873	0.6000	0.9231
Erick Vega – Los Cascabeles	0.2903	0.2581	0.9111	0.5703	0.6428	0.4706
La República - La Caballería	0.1600	0.2727	0.1145	0.1318	0.4000	0.6923
La República - Los Cascabeles	0.2500	0.3421	0.4294	0.0400	0.4737	0.5909
La Caballería - Los Cascabeles	0.1250	0.2500	0.0004	0.0362	0.4000	0.5385

Legend: DrS: dry season R: rainy season

The Morisita – Horn Index (I M-H) is an indicator that relates specific abundance to relative or total abundance, and it is influenced by species abundance and the size of samples. Ramírez et al. (2013) stated that it has values between 0 and 1, whether similarity of the samples compared goes up or down.

Overall, the behavior of that indicator for both periods in all the associations evaluated was within the range set, though it tended to decrease from one season to another. The acquired value for the farms compared, was below the mean value, except for the Erick Vega- La República (0.5341), and Erick Vega-Los Cascabeles (0.9111). The latter comparison stayed above the mean value of similarity in the rainy season (0.5703).

Based on the results achieved, a similarity between the farms compared was observed, which went up with the start of the rainy season. This might have been related to an increase in species abundance (S), impacting on the number of species; thus the possibility of overdominace of one species within a sample, is reduced.

Furthermore, according to Vargas (2011), ecological subordination (ES) may be understood as an indicator of similarity, though it compares the least abundant species to the most abundant one. Besides, subordination is effective when the value observed is ≥ 66%.

Accordingly, ES on the farms compared had a changing behavior, with a tendency to increase from one season to another. However, in the dry season, none of the associations showed effective subordination values, though the highest values were produced for the first three associations (above 5.000). In the rainy season, the third association was the only that failed to overcome the mean subordination value, though the rest did, even comparisons No. 1, 2, and 4, had an effective subordination.

Concerning perennial species abundance (arborescent and shrub-like) (Figure 4), an increase tendency was observed from one period to another, in all the farms studied, except Los Cascabeles, where the number of species was constant. The largest species abundance for both seasons was reported on Erick Vega. La Caballería, however, reported the lowest values.

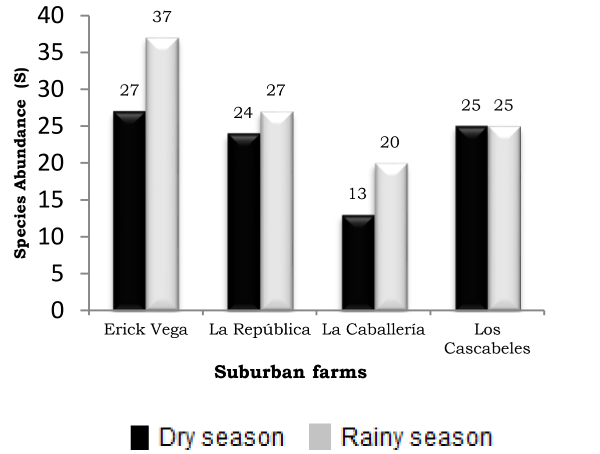

Figure 4. Behavior of perennial species abundance in the farms studied in the seasons assessed

The fact that the largest abundance of perennial species for both seasons was observed in Erick Vega, had to do with the existence of several spots where fruit and forest species grew together, along with other species used in the hedges. However, a decline in the value for the index evaluated on La Caballería was related to the kind of crop used in the system.

Tree- and shrub-like species dominance (Figure 5) has an inverse behavior in relation to reports on species abundance. It is so because the values for this indicator generally decrease from one season to another in all the areas, except Erick Vega. On that farm, the behavior of the indicator may be caused by the dominance of candelabra plant (Euphoria lactea Haw.) in the rainy season (28%), surpassing the most dominant species in the dry season, coffee (Coffea arabica L.), with 23% dominance. As the former species was more dominant than the latter, it is more likely to be more dominant, despite the increase in the number of species and individuals.

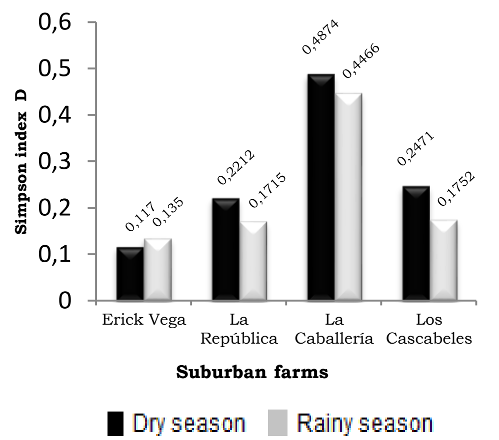

Figure 5. Behavior of dominance of perennial species in the farms studied during the periods assessed

The same species (E. lactea) was the most dominant in the two seasons, on La República (37% and 31% abundance, respectively). A similar fact was reported on La Caballería, where Barbados nut (Jatropha curcas L.) was reported as the most dominant in the rainy season (62%), and the dry season (57%). E. lactea (37%) was again the most dominant during the dry season on Los Cascabeles, where mango (Mangifera indica L.) was the most dominant species (27%) in the rainy season.

According to González and Regalado (2012), of the most dominant species, E. lactea has been reported as an invading species, with a native occurrence in Africa and Asia. J. lactea and M. curcas y M. indica are considered potential invaders, with native occurrence in the tropical Americas and India, respectively. Neither of them, though, has been included in the top 100 important species. The fact that E. lactea and J. lactea, and J. curcas were the most widespread, is explained by their use a hedges by farmers. For M. indica, it is the main species cultivated on Los Cascabeles.

The behavior of arborescent and shrub-like species, according to the Shannon diversity index (H) (Figure 6), was more inclined to increase from one season to another, on all the farms studied. Erick Vega was the only farm with a decline report in the rainy season. However, for the two seasons evaluated, this indicator had the highest values. The lowest diversity values for the two seasons were reported on La Caballería. All the farms in the two seasons had values that fit the set range for proper diversity and abundance. During the dry season, however, on La Caballería, the values were below normal.

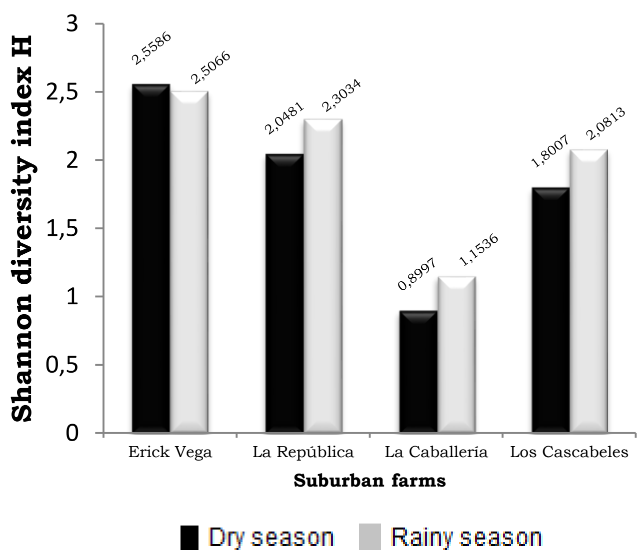

Figure 6. Behavior of perennial species diversity in the farms studied, in the two seasons evaluated

The result for diversity on Erick Vega was related to the factors that effected on dominance behavior. These two indicators had an inversely proportional tendency, and referred to equity of species within the samples compared.

According to the study, the group of perennial species had little variation during the two seasons. Generally, 44 perennial species were reported in the dry season, and 47 in the rainy season. In agricultural ecosystems, these plants are mainly forest and fruit species, and others are used for hedges (E. lactea, Gliricidia sepium, and J. lactea, Gliricidia sepium, and J. curcas). Salmón et al. (2012), when evaluating the components of biodiversity on an agroecological farm also reported melliferous species, groups of species used for hedges, wood and fruit species.

Fruit trees was the perennial plant studied in the two seasons with the highest representativeness. Of all the tree- and shrub-like plants found in the dry season, 16 were fruit trees. In the rainy season, 19 species were observed, above the findings of Pérez et al. (2014), in cultivated systems; they also reported species abundance of 12 for those fields. In that sense, Pino (2008), in a study on fruit diversity in a farming environment, La Caoba community, reported 29 fruit species on 27 farms. Moreover, Gutiérrez et al. (2014), after evaluation of fruit tree biodiversity on different production locations, in central Cuba, reported that for all the indicators evaluated (species abundance, dominance, and diversity), the values remained within the normal range. However, they said that the best results were observed in areas from the urban, suburban and family farming.

Remarkably, in each of the previous studies most species that contributed to diversification in the group, were related to low profile fruit trees. According to Fundora et al. (2007), Nangka blanda (Annona muricata L.), custard apple (Annona reticulata L.), sugar-apple (Annona squamosa L.) cashew tree (Anacardium occidentale L.) cherries (Malpighia glabra L.) Genip (Melicoccus bijugatus Jacq.), noni (Morinda citrifolia L.) and plums (Spondias purpurea L.), are considered sub utilized species. However, some of them (A. muricata, A. squamosa, M. glabra, M. citrifolia) are already part of the fruit production program of the urban, suburban and family farming.

Table 6. Behavior of beta diversity in relation with the group of perennial species

Associations	Jaccard (Ij)		Morisita – Horn (I_{M-H})		Ecological subordination (ES)	
	DrS	R	DrS	R	DrS	R
Erick Vega – La República	0.4571	0.5609	0.4086	0.6993	0.6667	0.8518
Erick Vega – La Caballería	0.2121	0.4250	0.1594	0.4831	0.5385	0.8500
Erick Vega – Los Cascabeles	0.4444	0.5500	0.4208	0.5757	0.6400	0.8800
La República - La Caballería	0.2333	0.3428	0.0969	0.4152	0.5385	0.6000
La República - Los Cascabeles	0.4848	0.5294	0.6961	0.6259	0.6667	0.7200
La Caballería - Los Cascabeles	0.3571	0.4516	0.0892	0.3703	0.7692	0.7000

Legend: DrS: dry season **R: rainy season**

The Ij for perennial species was observed in the two seasons, within the set parameters. However, farm similarity was low, regardless the increase observed in the indicator for all the associations. The Morisita – Horn (I M-H) index for all the comparisons behaved within the set parameters. Like the previous indicator, it tended to increase from one season to another, except for the pair La República-Los Cascabeles. The values achieved for the comparisons is below the mean values, except for La República- Los Cascabeles (0.6961), for the dry season, and Erick Vega-La República, Erick Vega-Los Cascabeles, and La República-Los Cascabeles, in the rainy season. It means that the start of precipitations triggered processes that favored system similarity, though it was not fully produced.

Accordingly, ES in the farms compared had a changing behavior, with a tendency to increase from one season to another. However, in the dry season, the pairs Erick Vega-La Caballería, Erick Vega-Los Cascabeles, and La República-La Caballería did not reach effective subordination values. Besides, the minimum value set for effective subordination was surpassed in the other associations. In the rainy season, La República-La Caballería pair was the only that did not overcome the effective value of subordination.

The associations with effective subordination values (for both species groups in the study) were produced because the common species on the farms compared, were over 66% in the most abundant samples. In all the cases where subordination was not effective, the reason was the presence of specific species adapted to the environmental conditions of the location. Similar behavior was described by Candó (2014), when analyzing the behavior and workability of the existing flora on suburban farms in Santiago de Cuba.

CONCLUSIONS

1. The botanical composition varied for all the farms in the two seasons, with an increasing tendency, except for the number of individuals, which always tended to decline.

2. Overall, the most representative families were Leguminosae, Asteraceae, Poaceae, Euphorbiaceae, and Malvaceae.

3. The alpha diversity showed an increasing trend between periods, with values ranging within the set parameters for each indicator, except for the Shannon diversity index (H) on La Caballería, in the dry season. La Caballería was the exception, where the Shannon diversity index (H) was not within the set range for proper diversity and abundance during the dry season.

4. The beta diversity showed differing values among the farms compared, which proved the existence of specific species adapted to the environmental conditions of the location.

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