Scientific Paper

Characterization of agroproductive systems of the Colonche parish, Santa Elena province, Ecuador

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Abstract

Objective: To characterize the agroproductive systems of the Colonche parish in Santa Elena, Ecuador.

Materials and Methods: Data were collected through participatory techniques with interviews and the application of surveys carried out in a total of 313 farms, corresponding to eight agroproductive communes. For the characterization, description and grouping of the farms and productive units, descriptive statistics and the hierarchical cluster method were used. The data were processed by the program IBM SPSS® Statistics 22.

Results: The agricultural systems are characterized by monoculture (58,8 %), little diversification and animal husbandry (23,0 %), as well as by the scarce management of agroecological practices. Lack of knowledge and little interest in the adoption of soil use practices and integrated pest management (91,7 %) with chemical control only, low educational level (92,7 %) of primary level, prevailed. From the cluster analysis two groups were formed: 99,4 % of the farms appear in the first group, which has predominance of traditional monoculture; group 2 includes two farms, which have a productive system under agroecological transition.

Conclusions: The agricultural systems in the Colonche parish are in correspondence with the traditional agriculture model and are characterized by monoculture, little diversification and animal production, as well as by scarce management of agroecological practices and little level in their application.

Keywords: diagnosis, agroecosystems, traditional farming

Introduction

The Ecuadorian agricultural sector is and will continue to be very important for national economy, not only for its contribution to the gross domestic product (20,7 %), but due to its strong link with other sectors. Silvoagricultural and agroindustrial exports represent 26,1 % of total exports and, in terms of occupation, employ 23,5 % of the economically active population (MAG, 2019).

Ecuador, specifically in the territory of Santa Elena province, commune inhabitants have valuable agricultural knowledge (ancestral, traditional, contemporary) that is necessary to rescue and socialize to be applied by farmers, so it allows the conservation of natural resources. The identified knowledge is related to agriculture based on agroecological principles.

The oldest and still current piece of knowledge is the use of cisterns as hydraulic structures for water harvest (Balmaseda-Espinosa *et al.,* 2019). However, the need to work with the farmers who show limitations for becoming organized, lack of knowledge about agroecological agriculture and fears in the face of the change of methods in production, is evident. Thus, opportunities of the surroundings are wasted, by not considering the environmental and social cost of productions.

In this context, scientific research constitutes a revitalizing activity that contributes to the development of the agricultural sector. Undoubtedly, agricultural systems are exposed to radical changes regarding productive schemes, addition of value to their main items, development of knowledge about new plant or animal species that allow to identify new items, markets and application of agroecological practices that facilitate articulation between national actors and world markets (Sánchez *et al*., 2018; Tapia-Hermida *et al*., 2018).

At international level, the characterization of farms and agricultural systems is used for the generation and adoption of technological

alternatives and good sustainable and resilient agrifood practices. Authors like García-Pinzón *et al.* (2021) consider in this field that the adequate knowledge of the rural farmer's circumstances is the basis of every research and transference process; they also report that the generated technology should be elaborated according to such circumstances, limitations and possibilities.

Pardo-Rozo *et al.* (2015) corroborate that farm characterization facilitates the analysis of the functioning of rural productive systems, which implies finding and describing the relation among variables. These authors assume that they are complex processes, which demand observing the relation of family groups and communities with the cultural environment, regarding entrepreneurial, economic and financial objectives. From the above-stated facts, the aim of this research was to characterize the agroproductive systems of the Colonche parish in Santa Elena, Ecuador.

Materials and Methods

Description of the research area. The Santa Elena province is located southeast of the Ecuadorian territory, on the coastal profile of the South Pacific, with tropical climate. It has a length of 150 kilometers and is divided into the Santa Elena (periphery), Atahualpa, Colonche, Chanduy, Manglaralto, Simón Bolívar, San José de Ancón parishes. It has an economically active population in the productive areas of agriculture (25 %), commerce (12 %), manufacture (11,4 %), construction (8,6 %) and public, private employment and sub-employees (43 %).

Geographically, the Colonche parish is influenced by the natural ecosystem of the Chongón-Colonche mountain range, with extension of 1 149,33 km², population of 31 322 inhabitants (INEC, 2010), approximate growth of 41 050 by 2020, according to the national information system and the technical secretariat of the Ecuador plan (projection SIN-STPE, 2017). Politically, it is divided into 18 communes and 44 precincts.

It stands out as a strategic sector for short-cycle, perennial, forestry crops and for rearing cattle, pigs, goats and poultry, because it is influenced by irrigation by the basin of the Javita river. It has the San Vicente dam as hydric resource contemplated in the project of inter-basin diversion to the Santa Elena peninsula, which allows to carry out the process of agricultural management and identifies the zone as agroproductive (GAD, 2019).

Experimental procedure. The research was conducted according to the research-action method,

planning, acting, observing and reflecting. It was aimed at knowing which are the characteristics and potentialities of the studied communes for the adoption of agroecological practices. The results were analyzed and studied, which led to the formulation of new strategies for improving the learning process by farmers (Guerrero-Flórez, 2019).

The work started from an initial diagnosis by which social actors were consulted towards the search for appreciations, points of view and opinions about the use of sustainable and resilient technological alternatives and agrifood practices (Guevara-Alban *et al.,* 2020). Through interviews and surveys the possible practices to be performed in their farms were identified: the use of organic fertilizers, crop rotation, production and market diversification, among others.

Samples. The data come from 313 farms representative of the population, belonging to the Colonche parish, Santa Elena province, Ecuador. The existing eight agroproductive communes in Colonche are considered: Calicanto (15), Cerezal Bellavista (116), Las Balsas (71), Loma Alta (27), Manantial de Colonche (5), Manantial de Guangala (59), Salanguillo (16) and San Marcos (4). The farm owners were interviewed and surveyed. The indicators considered in the surveys are shown in table 1.

Table 1. Indicators that were included in the surveys.

No	Cultural practices and soil use
1	Utilizes harvest residues
2	Burns harvest residues
3	Incorporates all harvest residues to the soil
4	Leaves a part and does not reincorporate
5	Gathers the straw
6	Uses green manures
7	Crop rotation
8	Integration of animal and plant production
9	Crops associated with annual plants
10	Crops associated with fruit plants
11	Only one crop the entire time

Statistical analysis. For the characterization and description of the farms and agrifood system descriptive statistics was used, which included: frequency tables, bar chart, measures of central tendency and measures of dispersion. The variables years of experience of the owner in farm

management, owner's educational level, quantity of family members and salary perceived outside the farm, were analyzed. In addition, other variables were analyzed such as total surface of the productive unit, quantity of surface under exploitation and of surface with irrigation, number of plots and daily time dedicated to agriculture (the entire day, 8 h; the morning and part of the afternoon, 6 h; the morning, 4 h; part of the morning, 2 h), types of crops and animal rearing (cattle production, poultry rearing, goat and pig production). With such variables a hierarchical cluster analysis was performed by Ward or Manhattan distance. Descriptive statistical analysis (mean, standard deviation) was carried out. The selection and application of the grouping criterion and determination of the correct structure (election of the number of groups) was the management of the existing agroproductive system. The data were processed by the program IBM SPSS® Statistics 22.

Results and Discussion

The farms of the Colonche parish sectors are representative of the agroecosystems and management forms in the region. The variables associated with the farm owners indicate that these owners have as average 28 years of experience in farm management, and 50,8 % exceed this average value, which shows stability in the traditional farm management. At the same time, it was known that 92,7 % of these farm leader farmers reached primary level and only 3,5 % achieve university studies (fig. 1). This low level of instruction could be a limiting factor when accepting the use of new production technologies that bring about practices on agroecological bases.

Fig. 2 shows that 73,4 % of these farms are integrated by one to three family members. From these owners and their families, 88,2 % do not receive salary for activities outside the farm. This could be explained, among other aspects, because they are traditional agroproductive systems, of subsistence, which constitute a patrimony of family sustenance.

It is observed that 92,0 % of the farms have up to 5 ha in total. Only 8,0 % exceeds this surface (fig. 3). Similar results were reported by Santistevan *et al*. (2015), who in studies associated to the characterization of producing farms in the Manglaralto and Colonche localities, refer that farm sizes vary from 1 to 3 ha. The average number of plot per farm is 1,66 plots, with standard deviation (SD) of 0,91 and each farm is composed of one to five plots.

The total surface in the 313 farms is 1 223 ha: 538 ha are under exploitation. From them, 530 ha correspond to surfaces with irrigation; while the remaining area is covered by forests, fallow areas and natural pastures. The quantity of average hours they dedicate to field work is 6,07 h per day (SD = 1,67). Monoculture prevails (58,8 % of the farms produce only one crop) and the cultivation of *Zea mays* L. prevails, with the utilization of introduced varieties that tend to have better results. Only 41,2 % has at most two crops (*Z. mays* and *Musa* sp.). Authors like Mogro *et al*. (2020) report that, in the Cotopaxi zone, Ecuador, there are few zones dedicated to crop diversification and even with limitations of technological use. This information corroborates the existence of traditional agriculture systems in several zones of Ecuador, without practices of crop rotation, lack of soil conservation and amelioration measures, which causes land degradation.
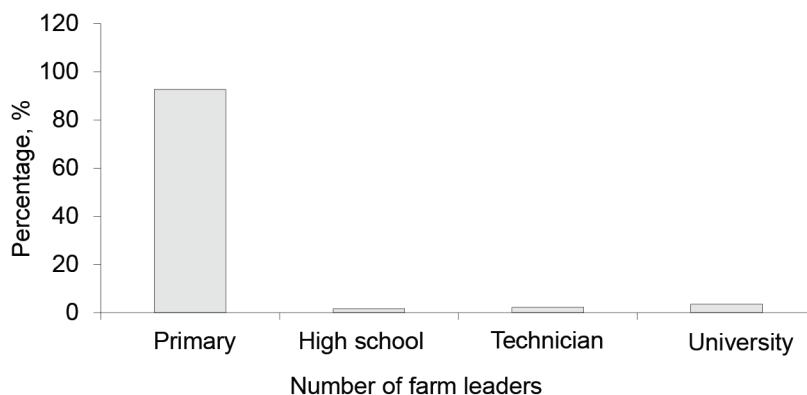

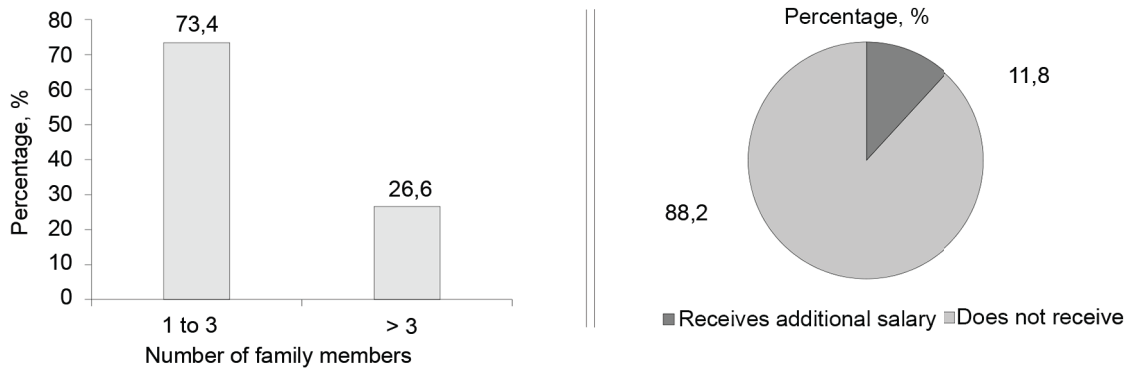Fig. 1. Educational level of the bosses of the studied farms.

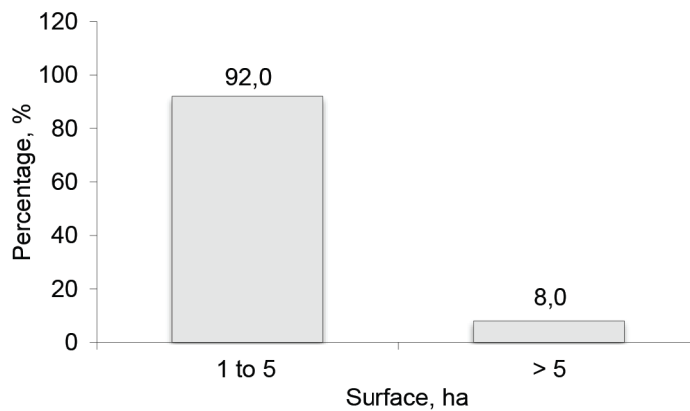Fig. 2. Quantity of members and salary situation of the family.

Figure 3. Surface of the productive units of the parish.

In this parish, animal rearing is mainly for self-supply. Of the farmers, 23,0 % is dedicated to this type of production, 8,6 % is allotted to cattle production, 6,7 % to poultry rearing, 4,2 % to goat production and 3,5 % to pig husbandry. It is important to encourage the increase of animal husbandry in the Colonche parish, not only for the families' self-supply, but for it to be part of agroecosystems. Thus, contribution will be made to family economy and to the sustainability of systems, with the corresponding contribution of inputs for the elaboration of organic compounds aimed at soil fertilization.

From the cluster analysis the existence of two groups was proven (table 2): 99,4 % of the farms appear in the first one, which shows the predominance of a traditional monoculture model. This is due, mainly, to the fact that this type of production provides economic support and responds to a local market. However, there are potential capacities for production diversification according to the availability of natural resources, use of agroecological practices and other alternatives that allow the sustainability of agrifood systems at local level.

The two farms that are placed in the second group are the ones that have a productive system under agroecological transition, because they assume sustainable agricultural practices, practice crop diversification and production and application

Table 2. Table of frequency per farm groups.

Group	Frequency	Percentage	Valid percentage	Accumulated percentage
1	311	99,4	99,4	99,4
2	2	0,6	0,6	100,0
Total	313	100,0	100,0	

of organic matter, besides using biodigester, biol fertilizers and efficient microorganisms. Their owners are willing to aim their productions at sustainable systems on agroecological bases.

Table 3 shows the average values per groups, as well as the differences between them, which have been marked by six of the studied variables: surface of the productive unit under exploitation and with irrigation, number of plots, quantity of crops and quantity of animal types.

Regarding cultural practices and soil use (table 4), in the parish farms 66,8 % of the farmers incorporate all harvest residues to the soil and 50,8 % utilizes harvest residues. These are soil conservation practices that do not depend on external resources, making them economical and allows

the reutilization of the resources of the production system. With them the stability of the conservation agriculture system is improved, biodiversity is favored, nutrients are mobilized and recycled, besides the fact that the soil structure is improved and they can be used to control weeds and pests (FAO and MADS, 2018).

In spite of the above-stated facts, it is proven that less than 7 % of the parish farmers use crops associated with annual plants, crop rotation with animals and green manures, agroeological practices that bring about numerous environmental, social and economic benefits. From them 51,12 % produce only one crop the entire time, that is, monoculture, and 23,0 % develops crops associated with fruit plants. This last practice is used by farmers of

Table 3. Descriptive analysis by groups of farmers and significant variables.

Variable	Group 1			Group 2			P - value
	Mean	N	SD	Mean	N	SD	
Owner's age	51,95	311	13,82	46	2	22,62	0,545
Years of experience	28,1	311	15,19	13	2	3,536	0,147
Total surface, ha	3,29	311	5,92	10	2	0	0,000
Surface under exploitation, ha	1,69	311	1,14	5	2	0	0,000
Surface with irrigation, ha	1,67	311	1,13	5	2	0	0,000
Number of plots	1,64	311	0,87	5	2	0	0,000
Time dedicated to agriculture, hours/day	6,06	311	1,67	8	2	0	0,102
Total number of people who work in the farm	3,75	311	2,66	5	2	0	0,510
Quantity of crops in the farm	1,56	311	0,851	5	2	0	0,000
Quantity of animal species	0,23	311	0,448	1	2	0	0,015

SD: standard deviation

Table 4. Results of the survey to farmers, regarding cultural practices and soil use.

No	Cultural practices and soil use	Utilization, %
1	Utilizes harvest residues	50,8
2	Burns harvest residues	20,1
3	Incorporates harvest residues to the soil	66,8
4	Leaves a part and does not reincorporate	2,8
5	Gathers the straw	16,6
6	Uses green manures	1,2
7	Crop rotation	32,0
8	Integration of animal and plant production	1,0
9	Crops associated with annual plants	4,1
10	Crops associated with fruit plants	22,7
11	Only one crop the entire time	51,1

the zone of the Santa Elena inter-basin diversion, because their productions between crops and animal rearing are diversified (Candell-Soto *et al.*, 2016). Crop rotation is a millenary practice that is increasingly used in sustainable agricultural systems because its multiple advantages have been observed: it improves the mean nitrogen level in the soil, favors the increase of microbial activity and contributes to re-establish the balance of organic matter levels (Nicholls and Altieri, 2019).

Regarding the use of different alternatives for pest management in the farms (table 5), farmers respond in 91,7 % to the application of chemical control in their farms, because the results are immediate, the product is easily accessed, and its use is also simple, in spite of the environmental unbalance it can cause. Nevertheless, this procedure is a contradiction, because in these farms the application of agroecological practices is promoted, although biological pest control does not have noxious collateral effects, pest resistance is very scarce and also prevents secondary pests (Pérez-Consuegra and Caballero-Grande, 2021).

Authors like Andrade-Varela *et al.* (2019) consider that in the Santa Elena peninsula there are pest problems. In this region biological control by farmers is difficult, because traditional planting systems are used, which affects sustainable agricultural production.

As a result of the diagnosis it could be observed that a minority group of farmers develop agroecological agricultural practices with successful results. However, farmers mostly (higher than 91,0 %) use agricultural practices from conventional agriculture. In this sense, Martínez-Castro *et al.* (2015) claim that it is essential to search for alternatives that contribute to the sustainability of different productive options in the agricultural sector.

From the information that could be obtained with this study, developing communication strategies is proposed in order to raise farmers' awareness towards the adoption of agroecological practices. Organizing visits to model farms to share other farmers' experiences is suggested. It is also recommended to develop field days and promotional videos. De La Cruz and Pozo (2022) report agrarian extension models through the application of technologies and information, which will allow in the short and long term the establishment of sustainable and resilient agrifood systems in the region.

Conclusions

The agricultural systems in the Colonche parish are in correspondence with the traditional agriculture method and are characterized by monoculture, little diversification and animal husbandry. The scarce management of agroecological practices, little level in their application regarding soil use and conservation and integral pest management could be noted.

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Conflict of interests

There is no conflict of interests among the authors.

Authors' contribution

- Andrés Enrique Drouet-Candell. Conception and design of the research in field, paper writing and revision.
- Tania Pérez-Castro. Conception and design of the research in field, paper writing and revision.
- Orestes V. Cruz-La Paz. Writing and revision of the paper content.
- Zulema Salguero-Rubio. Writing and revision of the paper content.
- Lucía Fernández-Chuairey: Conception and interpretation of statistical analyses.

Table 5. Utilization of different alternatives for pest management by the farmers of the parish.

No	Alternative	Utilization, %
1	Chemical control	91,7
2	Mechanical control	5,1
3	Botanical insecticide	2,2
4	Repellent plants	0,6
5	Biological products	2,9
6	Combination of organic chemical with inorganic chemical techniques	3,2

• Pedro Pablo del Pozo-Rodríguez. Conception and interpretation of statistical analyses and content revision.

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