Scientific Paper

Characterization of the agroproductive situation of a peasant farm in Matanzas, Cuba

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Abstract

Objective: To characterize the productive system of a peasant farm to establish the strategy that propitiates its productive improvement, sustainability and agroecological transition.

Materials and Methods: To characterize the entity of 40 ha of land in usufruct a structured survey, elaborated by the Local Agricultural Innovation, Program, was used. The information was also complemented with the Farm Plan methodology. The management of the productive system, main agroecological practices used, limitations and potentialities of the farm, were evaluated, as well as the transformations the farmer intends to make, the desired situation and agrobiodiversity.

Results: The productions of the farm were 9 926 kg of milk year^{-1} and 8 740 kg of meat year^{-1}. Two hundred forty-four plants of fruit trees, from 22 species, were found. The farm had varied productions, although it shows deficiencies that limit its development: pastures of low quality and availability, insufficient preserved feedstuffs, scarce utilization of organic fertilizers, deficient practices for pest management and little integration of animal husbandry and agricultural activities. Nevertheless, a strategy was elaborated for its agroecological transition.

Conclusions: The farm shows deficiencies in the agricultural and animal husbandry area that limit its development. The inclusion of diverse crops, of better nutritional quality and higher availability, as well as the utilization of good conservationist and sustainable practices, will allow the transformation of the food basis and improvement of the productive system.

Keywords: biodiversity, diagnosis, experimental farms

Introduction

For years, the Cuban agricultural sector has remained under the shadow of conventional productive systems, simplified and dependent on external inputs, characterized by monoculture, soil degradation, biodiversity loss and appearance of massive pest attacks (Casimiro-Rodríguez and Casimiro-González, 2018; Fernández *et al*., 2018). Thus, they are productive systems that are not desirable from the social, economic and ecological point of view, according to Nicholls *et al*. (2015).

Peasant farms, although in a lower degree, have also been supported on intensive production models, causing their transformation into highly artificial ecosystems under degradation process.

Cuba makes remarkable efforts to counteract the problems generated by conventional agriculture. For such purpose work is done on the redesign of these systems towards others of agroecological character, with the productive diversification and integration of its components, in which the environmentally healthy, ecologically sustainable, economically viable and socially fair agricultural production prevails.

In this context, the function of the farm as basic unit is revalued, and the space is created for local innovation, in order to promote transformations and make the right decisions in the production process. It is also about providing response to complex situations (Casimiro-Rodríguez and Casimiro-González, 2018), in which the knowledge and wisdom of family agriculture are placed at the service of an adequate management of agrobiodiversity and of the sustainable development of natural resources. The farm also represents the ideal place to achieve stable productions, with an agroecological approach and sustainability principles (Morgado-Martínez *et al*., 2019).

The Cuban State promotes the development of small and medium-size farms with the delivery of

Received: June 14, 2021
Accepted: November 01, 2021

How to cite a paper: Lezcano-Fleires, Juan Carlos; Miranda-Tortoló, Taymer; Oropesa-Casanova, Katerine; Alonso-Amaro, Osmel; Mendoza, Ibelice **& León-Hidalgo, Ricardo.** Characterization of the agroproductive situation of a peasant farm in Matanzas, Cuba. *Pastos y Forrajes*. 44:eI29, 2021.

lands in usufruct, to make idle or deficiently cultivated areas produce. However, most of the lands that have been given to farmers have as agroproductive limitations that they are not adequate for cultivation. Some of them are under erosion processes or show biodiversity made up by natural pastures of scarce nutritional quality. This is in addition to the fact that the new farmers, in general, do not have peasant tradition or knowledge rooted in traditional agriculture.

Hence the need to characterize the studied productive system in order to establish the strategy that propitiates its productive improvement, sustainability and agroecological transition.

Materials and Methods

Studied farm. The productive system that was evaluated belongs to the Enhanced Cooperative of Credit and Service (CCSF, for its initials in Spanish) Sabino Pupo, located in the Colón municipality, Matanzas province. Since its creation (10 years ago), it has as social objective animal husbandry, and has ferralitic red and brown without carbonate soils, according to Hernández-Jiménez *et al*. (2015). In addition, it has a total area of 42,3 ha of land, from which 39,6 are aimed at animal husbandry and 2,7 to family self-consumption (table 1). Mainly the farmer (49 years old) and his family (wife, 44 years old, and their two sons, 17 and 27) work in it, although they hire three part-time workers and a full-time milker. All of them are male and older than 35 years old.

Characterization of the entity. It was done through surveys elaborated from participatory workshops, by the Local Agricultural Innovation Program in all the provinces of Cuba, following the recommendations by Ortiz-Pérez *et al.* (2016). In addition, the information was complemented with the Farm Plan methodology, proposed by Palma and Cruz (2010). The diagnosis considered:

- *Socioeconomic characterization of the farm*. The characterization comprised the study of the land stock, work components (number of people members of the family and structure of labor) and capital components, where the equipment and structure of the animal stock were evaluated.
- *Characterization of biodiversity*. The analysis of biodiversity was done by direct count in the field of each individual or was estimated taking into consideration the sowing or planting density and the area occupied by the crop in the farm. The fast biodiversity characterization methodology, proposed by Vázquez and Matienzo (2010), was applied. The crops were identified with the aid of the *Diccionario botánico de nombres vulgares cubanos* (Botanical dictionary of Cuban common names) (Roig, 1975).
- *Diagnosis of noxious organisms and disease-causing agents*. The diagnosis of noxious organisms and disease-causing agents started with samplings, which served to capture the insect pests (that is: insects or larvae) or collect the damaged plants or organs (by insect pests as well as by disease-causing agents), and with the monitoring of insect populations and diseases. The samplings varied in time and frequency, according to the studied crop, and in correspondence with the description in the monitoring and signaling methodologies (CNSV, 2005).

For erect crops, the samplings were conducted on the diagonals of the fields, with 15-day frequency. Ten plants were selected and 30 plants were randomly checked. From each plant the damaged parts were taken and the present insects and larvae were collected.

In the creeping crops, the samplings were carried out every 15 days by the English flag or closed envelope method and 10 plants were randomly evaluated per sampling point. In each one of them, the

Table 1. Structure of the land stock of the farm.

Concept	Quantity, ha
Total area	42,3
Agricultural area	42,3
Cultivated surface	42,3
Temporary crops (dedicated to self-consumption)	2,7
Permanent crops (pastures, forestry, timber, among others) dedicated to animal husbandry	39,6
Non-cultivated surface	-
Non-agricultural area	-

number of larvae per branch was recorded, the insect species were collected and the affected organs were taken.

The collected samples (plant as well as animal ones) were transferred to the plant protection laboratory of the Pastures and Forages Research Station Indio Hatuey for their later study. In this facility, the insects were preserved in 15-ml glass flasks, which contained a 70 % hydroalcoholic solution. The disease-causing microorganisms were isolated and characterized culturally, morphologically and pathogenically. Their identification was carried out, just like in insects, with the aid of taxonomic keys.

Identification of the agroecological practices. The agroecological practices that should be used for the improvement of nutrition and soil, pest management and fertilization, to cite some examples, were identified. To obtain such information, the farm was visited to exchange with the farmer and his family. With this purpose, diverse participatory techniques were used: group work, participant observation and group and informative interviews. The information was complemented with the application of the methodology proposed by Vázquez and Matienzo (2010).

Elaboration of the strategy of agroecological transition. In order to develop the elaboration of the transition strategy of the farm, the main practices to be developed, the transformations to be carried out, the desired situation and the biodiversity that the agroecosystem should have, were considered.

Results and Discussion

Socioeconomic characterization. It was noted that the farm was not highly technified, because it only has an irrigation system, a chainsaw, a windmill and an electrical fence, as material goods of support to production. In addition, it has a patrimony that amounts to 211 heads of small livestock, 3 horses and 64 cattle, where dairy cows of the genotypes Siboney, Mambí and Zebu and Zebu bulls, are included (fig. 1).

In the year that was evaluated, its main productions amounted to 9 926 kg of milk year^{-1} (with 70 % of the milking cows) and 8 740 kg of meat year^{-1} of cattle, both aimed at industry. Meanwhile, pork and rabbit meat productions reached 2 913 kg and 141 kg, respectively, and were sold to other enterprises, such as the one of small livestock (EGAME, for its initials in Spanish), and the pig production enterprise. There was no mortality in any species. The cost-benefit ratio was $ 0,61, which proved efficiency in production. This allows a profit margin of approximately 0,40 cents for every invested peso. With regards to plant production, its destination was family self-consumption.

The characterization of the farm allowed to know other limitations: low pasture availability, scarce presence of species of herbaceous legumes in association with cultivated pastures, deficient use of preserved feedstuffs and little integration of animal husbandry with agriculture in the system (fig. 2), which limited the productive performance

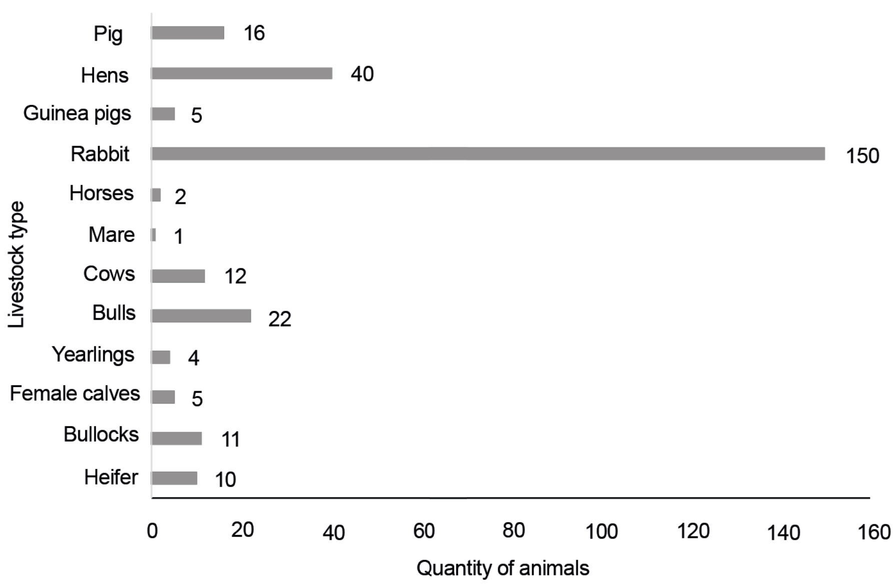

Figure 1. Animal component in the farm.

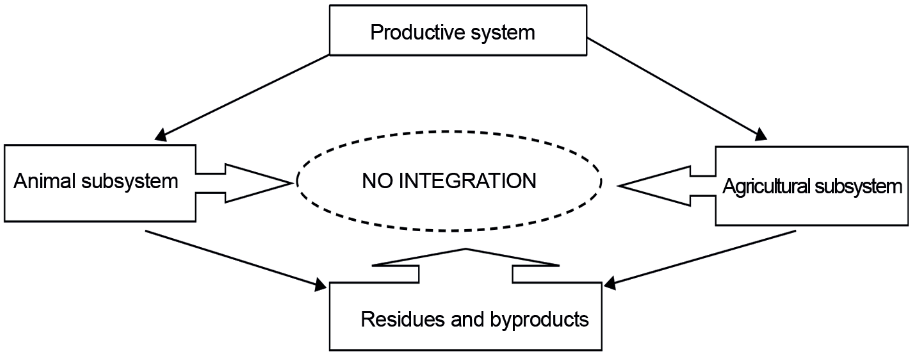

Figure 2. Interaction among the subsystems that compose the farm.

reached by the animal subsystem and, in turn, the preservation of functional biodiversity, as reported by Kronberg and Ryschawy (2018) and Rosa-Schleich *et al*. (2019).

Smith and Lampkin (2019) stated that with the animal husbandry-agriculture integration the productive capacity of an entity is enhanced. This allows the reduction of costs, higher utilization of the area, soil amelioration and weed reduction, which favors biotic regulation or pest control in the farm (Iermano and Sarandón, 2016).

Characterization of biodiversity. The biodiversity aimed at animal feeding is shown in table 2. The natural pastures prevail due to their extension and the quantity of identified species (eight in total). However, according to Pezo (2018), pastures can decrease livestock productivity, because some of them have low availability and nutritional quality.

The existence of a silvopastoral system, composed by *L. leucocephala* and natural grasses in 7 ha of land, a forage bank of *Saccharum officinarum* and *Cenchrus purpureus* x *Cenchrus americanus* which occupies 1 ha, the establishment of an area of 0,041 ha of *Morus alba* and *Moringa oleifera* and planting of 8 ha with forestry plantations, were corroborated. The presence of diverse shrubs (*Albizia lebbeck* and *Gliricidia sepium*) and two herbaceous legumes was observed on grazing areas.

In the area of family self-consumption diverse crops, such as beans (*Phaseolus vulgaris* L.), rice (*Oriza sativa* L.), cassava [*Ipomoea batatas* (L)], and others, were found (table 2).

A total of 244 plants of fruit trees from 22 species were found, which have as goodness that they mitigate the climate change and harbor organisms that constitute source of alternative food and refuge for predator and parasitoid mites, conditions that are beneficial according to Hernández-Triana *et al.* (2019). Likewise, plants with bioinsecticide effects [(*Sassafras albidum* (Nutt.) Nees, *Azadirachta indica* A. Juss and *Melia azedarach* L.)], soil fertility ameliorators, like *Canavalia ensiformis* L., were found (Lezcano-Freires *et al*., 2020).

In general it can be stated that in this study biodiversity is in agreement with the report by Oropesa-Casanova *et al.* (2020) in farmer scenarios of Matanzas, and with the results obtained by Hernández-Guanche *et al.* (2019) and González-Portelles *et al.* (2020) in peasant and urban agriculture farms, in the Pinar del Río and Camagüey provinces, respectively.

Regarding the beneficial agents in the productive system, the presence of *Apis melifera*, bees that fulfill the function of pollinating crops, was notified. Several noxious organisms (16 insects, three fungal agents and an animal parasite) were identified, as well as the disease known as cattle mastitis (fig. 3), which can be controlled with adequate pest management, as referred by Vázquez (2015).

Identification of the agroecological practices. In this farm, the agroecological practices that were used with higher frequency were: the application of organic fertilizers (fundamentally, earthworm humus and cattle manure to fertilize the areas of natural pastures and fruit trees), perimeter living fences, trees and shrubs in the paddocks and the biofertilizers FitoMas-E and IHPLUS® BF. In decreasing order, the use of living barriers of corn in the bean crop, the crop association and intercropping and utilization of *Trichoderma* as biocontrolling agent, were also diagnosed. These practices have been used in the agricultural and private farms of the Pinar del Rio, Matanzas and Camagüey provinces, respectively (Tamayo-Escobar *et al.,* 2017; Rodríguez-Izquierdo *et al*., 2017).

When considering the elements approached above, the transit of the studied farm towards alternative production

Table 2. Plant species used in livestock feeding and family consumption.

Subsystem type	Classification	Species
Animal subsystem	Herbaceous and tree legumes	*Desmodium triflorum* (L.) DC, *Alysicarpus vaginalis* (L.) DC, *Tamarindus indica* L., *Albizia lebbeck* Benth, *Leucaena leucocephala* Lam. de Wit and *Gliricidia sepium* (Jacq.) Walp.)
	Forestry	*Gmelina arborea* Roxb
		Ceiba pentandra (L.) Gaertn
		Eucaliptus globulus Labill.
	Forage plants	*Saccharum officinarum* L. and *Cenchrus purpureus* (Schumach.) Morrone x *Cenchrus americanus* L. Morrone, *Morus alba* L. and *Moringa oleifer*a Lam
	Natural and cultivated pastures	*Digitaria eriantha* Stent., *Paspalum notatum* Flüggé, *P. virgatum* L., *Sporobolus indicus* (L.) R. Br., *Hyparrhenia rufa* (Nees) Stapf, *Urochloa distachya* L.T.Q., *Cynodon dactylon* L. *Dichanthium caricosum* Pers. and *Megathyrsus maximus* (Jacq.) B. K. Simon & Jacobs
Agricultural subsystem	Grasses	*Zea mayz* L. and *Oryza sativ*a L.
	Legumes	*Phaseolus vulgaris* L.
		Vigna unguiculata (L.) Walp.
	Fruits	*Persea americana* Mill, *Carica papaya* L., *Pouteria sapota* (Jacq.) and *Annona cherimola* Mill
	Staple crops	*Manihot sculenta* Crantz, *Ipomoea batatas* L. and *Cucurbita pepo* L.
	Vegetables	*Phaseolus vulgaris* var. *vulgaris, Solanum lycopersicum* L. and *Cucumis sativus* L.

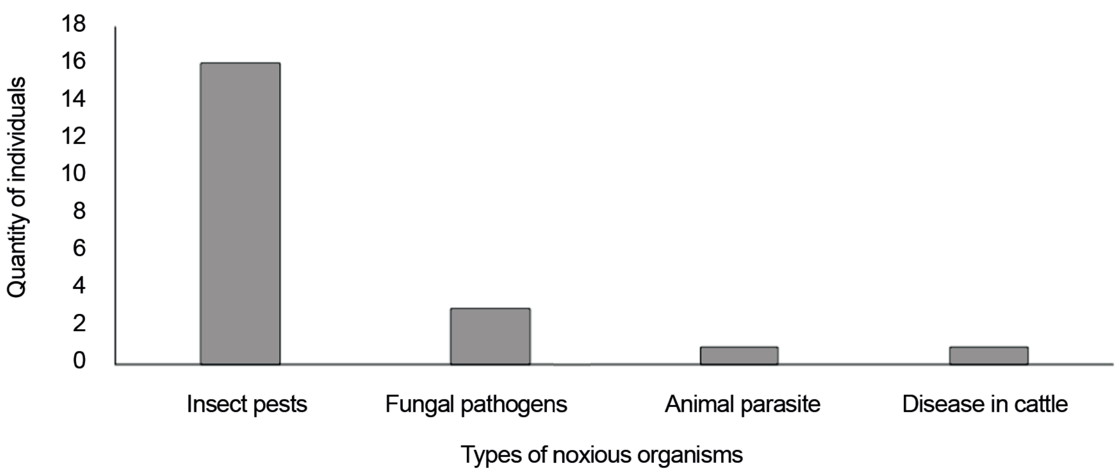

Figure 3. Noxious biodiversity present in the farm object of study

models is proposed, based on cycles that are adapted to local conditions and favor the set of agricultural practices that mobilize diverse ecological processes and contribute a higher variety of available plant genetic resources, as referred by Rodríguez-Izquierdo *et al.* (2017), Stark *et al*. (2018) and Bover-Felices and Suárez-Hernández (2020). It is required that farmers unlearn the conventional model of agriculture and learn to make the planning of their farm as a managerial process, as suggested by Palma and Cruz (2010).

Elaboration of the agroecological transition strategy. According to the results of the study and what was expressed by the farmer in the farm plan, the agroecological transition strategy was elaborated, whose actions will propitiate to have a diversified and sustainable integral farm, with good quality food and renewable energy, where there are ecological interactions that improve soil fertility, nutrient cycle and biotic regulation of pests, which ratifies the good conservationist and sustainable practices, described by Nicholls *et al.* (2015; 2016) and Rodríguez-Izquierdo *et al*. (2017). In addition, this strategy was done in order to guarantee an improvement in the technological, environmental, economic and training area of the farmer and his family (table 3).

The designed strategy is in agreement with the proposal of actions reported by Carmenate-Figueredo *et al.* (2019) for the agroecological reconversion of a farm in Las Tunas municipality. These authors also indicate as other actions to be followed, the implementation of the use of dead and living barriers; the introduction of other forage species to favor animal feeding, such as *M. alba* L. (mulberry), *Tithonia. diversifolia* (Hemsl.) A. Gray (Mexican sunflower) and the cultivation of an area dedicated to the production of seedlings of forestry and ornamental species. They also refer the use of harvest waste, such as sweet potato vine, leaves and stems of *Manihot esculenta* Crantz (cassava) for feeding cattle and sheep or their incorporation to the soil, as well as the utilization of the fruit trees that cannot be commercialized in the production of preserves and the promotion of an area dedicated to earthworm humus.

Conclusions

It could be observed that, although the farmer has done improvements in this farm, in the agricultural and animal husbandry area there are deficiencies still that limit its development. Nevertheless, work is done on the transformation of the agrifood basis with diverse crops, of better nutritional quality and higher availability. In addition, if good conservationist and sustainable practices are performed, an improvement of the productive system and its transit towards an alternative production model, based on agroeological principles, would be reached.

Acknowledgements

The authors thank the Local Agricultural Innovation Program (Matanzas Coordination), promoted by the Swiss Development and Cooperation Agency (SDC), which contributed the funding and logistical support for conducting the research.

Table 3. Proposal of actions in the technological, environmental, economic and training field.

Actions			
Technological	Environmental	Socioeconomic	Training
Improve the cattle breed. Establish agroforestry systems and increase the varietal structure of pastures, forages and trees. Increase the planting of protein plants and enhance the association of herbaceous, tree legumes and cultivated grasses. Utilize polycrops due to their importance and the ecological services they provide.	Utilize the residues and by products from the harvest, as feed for animals and different energy alternatives. Utilize cattle manure, not only in the fertilization of pasturelands, but in the different crops of higher importance in the farm. Introduce a biodigester to use the effluents as fertigation. Utilize the cover crops and/or green manures in soil amelioration. Use the biopesticides of microbial and botanical origin, reservoirs of natural enemies and use of living fences and barriers in pest management. Utilize biofertilizers (such as mycorrhizae) in the crops.	Promotion of projects	Carry out training workshops, on topics such as agroecological management of the production system, pests, nutrient recycling, use of renewable resources and energy sources, utilization of green manures, organic fertilizers and biofertilization. Propitiate exchange and visits of successful experiences.

Conflicts of interests

The authors declare that there is no conflict of interests among them.

Authors' contribution

- *Juan Carlos Lezcano-Fleires*. Generated the idea of the research, executed the experiments with the corresponding measurements, participated in the identification of biodiversity, wrote and revised the manuscript.
- *Taymer Miranda-Tortoló*. Contributed with the idea of the research, revised the experimental methodology and collaborated with the revision of the manuscript.
- *Katerine Oropesa-Casanova*. Contributed to data processing.
- *Osmel Alonso-Amaro*. Contributed in the search for bibliographic information and in the revision of the manuscript.
- *Ibelice Mendoza*. Participated in the performance of the measurements and in the identification of the noxious organisms collected in the research.
- *Ricardo León-Hidalgo*. Contributed in the search for bibliographic information and in the revision of the manuscript.

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