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Scientific Paper

Sustainability in peasant farms of the Perico municipality, Matanzas, Cuba

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Abstract

Objective: To propose a system of multidimensional indicators that allows to evaluate the sustainability of productive systems within the framework of municipal development programs.

Materials and Methods: Indicators were adapted from multi-criteria methods and tools for the analysis of sustainability, which were standardized and weighed. The methodological proposal was validated in five farms in the Perico municipality, in Matanzas province.

Results: The most influential indicators per dimension were: food self-sufficiency in the economic dimension, satisfaction of basic needs, housing and degree of acceptability of the productive system in the sociocultural dimension. Regarding the ecological dimension, the indicators linked to the study of crop systems, the analysis of water supply sources for agricultural use and its drainage, as well as those associated with the design of the system, stood out. The farms were biodiverse, although according to the degree of complexity of the design and management, they were moderately complex. The general sustainability index showed that only the Palo Lindo farm did not meet the sustainability criteria.

Conclusions: The methodology for evaluating sustainability in its multiple dimensions is an important tool at the local level. The validation of this methodological proposal allows to find trends in the field of sustainability, establish their causes and propose medium-term solutions.

Keywords: development, indicators, methodologies

Introduction

According to Díaz-Canel-Bermúdez and Delgado-Fernández (2021), local development plays an important role in government management, for which it must be an inherent part of the government management system and model in Cuba. There are several experiences that have been accumulated over the years (Guzón-Camporredondo, 2016), which correspond to the general objectives of sustainable local development, but there are also challenges and risks.

In Matanzas province, specifically the Perico municipality was one of those designated in 2010 to develop a pilot experience in Cuba, in order to achieve sustainable local development, fundamentally based on the intensive use of knowledge and local resources. (Alfonso-Llanes, 2017). This experience, which is called the Municipal Integral Development Program (MIDP), approved in 2012, had the purpose of promoting the economic-productive and socio-cultural development of the territory by strengthening the infrastructure. This strategy also had the objective of increasing social equity and improving the quality of life.

The program identifies the main difficulties that slow down or hinder the progress of the territory: the deterioration of agricultural production, with emphasis on the land stock without adequate use and the low diversity of agricultural production, degree of conservation and degradation of the ecosystem (deforestation, compaction and loss of soil fertility, loss of biodiversity, as well as environmental education).

Within the framework of this implementation process of the approved plan for transformation, multiple projects were inserted that are directly linked to work with farmers associated with Cooperatives of Credit and Services (CCS). In general, the aim was to incorporate technological advances into production practices and propitiate the increase of production levels, without neglecting environmental sustainability; in addition, social aspects related to equity were taken into account (Miranda-Tortoló, 2018).

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The application of methodologies that allow to evaluate the sustainability of these production systems and their validation will provide a very useful tool to monitor advances in the fulfillment of agricultural development strategies within the territory. Hence, the objective of the work was to propose a system of multidimensional indicators, which allow to evaluate the sustainability of productive systems within the framework of municipal development programs.

Materials and Methods

Location and edaphoclimatic description. The research was conducted in five farms belonging to two Cooperatives of Credits and Services (CCS) in the Perico municipality: CCS Ramón Rodríguez Milian and CCS Julio Antonio Mella. The farms were selected according to the following criteria: link to different innovation and local development projects, access roads, existence of historical information, exploitation time (not less than five years), presence of biodiversity, use of traditional agroecological practices and level of productivity.

The farms had a variable area (from 13 to 94 ha) and their social purpose is described in Table 1.

Experimental procedure. The study methodology was based on the principles of participatory research-action and multicriterion analysis methods and tools were adapted for the study and evaluation of sustainability.

The general scheme of research was supported on three fundamental stages:

- Stage 1: Participatory construction of a group of indicators to assess the sustainability of agroecosystems.
- Stage 2: Standardization and weighing of the indicators to compare the farms and facilitate the analysis of the dimensions.
- Stage 3: General diagnosis and evaluation of sustainability in the farms.

For the research, the methodology suggested by Sarandón *et al*. (2006), adapted and enriched with indicators of the proposal by Vázquez-Moreno (2013), was taken as reference. Both have common characteristics, in terms of the performance scale (0 to 4), which facilitates the standardization process of the indicators, as well as the processing of information.

Stage 1. Construction of indicators to assess sustainability. The indicators were chosen by participatory methods, based on different criteria: that they were easy to obtain and interpret, that they provided the necessary information, and that they allowed to find trends within the farm.

The indicators proposed by Sarandón *et al.* (2006) were taken as reference for the economic and sociocultural dimensions; while for the ecological dimension indicators suggested by Vázquez-Moreno (2013) were adapted. These were validated through discussion and consensus among the members of the work group and the multi-stakeholder management platform (MMP) led by the government, in which decision-makers and farmers participate. Seventy-four indicators were constructed, grouped into thirteen variables, included in the three analyzed dimensions (economic, ecological and sociocultural). All of them were standardized and weighed as described below:

Economic dimension (DK): it grouped three variables and indicators, which allowed to evaluate whether the agroecosystems were economically viable:

A. Food self-sufficiency. It was estimated through the indicators A1- Production diversification and A2- surface of self-consumption production.
B. Monthly net income per group. It was estimated by the indicators B1. The system is sustainable, if it can satisfy the economic needs of the family group.
C. Economic risk. It was established through the indicators C1- Diversification for sale, C2- number

Table 1. General characteristics of the five farms.

No	Name of the farm	CCS	Size, ha	Social object
1	El Campero	Ramón R Milian	13,4	Agricultural
2	Mercedita	Ramón R Milian	5,1	Agricultural
3	Santa Rosa	Ramón R Milian	30,0	Agricultural
4	Santa Gertrudis	Ramón R Milian	2,40	Agricultural
5	Palo Lindo	Julio A. Mella	93,9	Animal husbandry

of commercialization ways and C3- dependence on external inputs.

Ecological dimension (ED). It was measured from six variables, because of the importance that was given in this work to the complexity of designs and to the management of biodiversity in animal husbandry production systems.

Productive biodiversity (DMBPr). It was evaluated from eighteen indicators: types of productive items (Pr_1), diversity of herbaceous and shrub crop species (Pr_2), utilization of temporary crop systems (Pr_3), surface with designs in polycultures (Pr_4), complexity of designs in polycultures (Pr_5), diversity of species in tree crop systems (Pr_6), surface with agroforestry designs (Pr_7), complexity of agroforestry designs (Pr_8), diversity of animals in rearing systems (Pr_9), surface with silvopastoral designs (Pr_{10}), plant complexity of silvopastoral designs (Pr_{11}), system complexity with mixed design (Pr_{12}), surface of complex cropping systems (Pr_{13}), origin of planting material (Pr_{14}), origin of varieties (Pr_{15}), and of the breeding stock of animals (Pr_{16}), origin of breeds (Pr_{17}) and self-sufficiency in feedstuffs for animals (Pr_{18}).

Soil management and conservation (SMC). It was evaluated according to seven indicators: crop rotation system (S_1), crop rotation surface (S_2), diversity of organic biomass sources (S_3), surface with incorporation of organic biomass (S_4), planting surface with minimum tillage or without it (S_5), surface with anti-erosion practices (S_6) and conservation in soil preparation (S_7).

Water management and conservation (WMC). It was evaluated according to five indicators: area under irrigation systems (W_1), irrigation systems (W_2), water supply sources for agricultural use (W_3), drainage management (W_4) and drainage system (W_5).

Sanitary interventions in productive items (MISRPr). It was evaluated based on five indicators: intervention decisions in plant production items (I_1), integration of biological interventions in plant production items (I_2), intervention decisions in animal production items (I_3), integration of biological interventions in animal production items (I4), level of self-sufficiency of inputs for interventions in plant and animal items (I_5).

Design and management of auxiliary biodiversity (DMBAu). It was evaluated through fifteen indicators: surface with lateral living barriers (Au_1), diversity of species in lateral living barriers (Au_2), surface with intercropped living barriers (Au_3), diversity of species in living or intercropped barriers (Au_4), internal ecological corridors (Au_5), diversity of species in internal ecological corridors (Au_6), structural diversity of internal ecological corridors (Au_7), management of seminatural environments (Au_8), structural diversity of the environments (Au_9), management of tree plantations (Au_{10}), structural diversity of tree plantations (Au_{11}), management of perimeter fence (Au_{12}), structural diversity of the perimeter living fence (Au_{13}), tolerance to weeds (Au14) and diversity of animals for labors (Au_{15}).

Status of associated biodiversity elements (ABEs). It was evaluated by considering twelve indicators: incidence of weeds (As_1), diversity of weeds (Au_2), incidence of gall nematodes (Au_3), incidence of harmful organisms on crops (Au_4), diversity of harmful phytophagous organisms (Au_5), diversity of harmful phytopathogenic organisms (Au_6), incidences of harmful organisms on farm animals (Au_7), diversity of parasites in farm animals (Au_8), diversity of diseases in farm animals (Au_9), diversity of pollinators (Au_{10}), diversity of groups of natural regulators (Au_{11}) and population of natural regulators (Au_{12}).

Sociocultural dimension (SCD). The degree of satisfaction of the sociocultural aspects was established through four variables:

1. Satisfaction of basic needs: In its evaluation it comprised three indicators: A1) housing, A2) comfort and A3) services.
2. Acceptability of the production system: It was evaluated through indicator B1), satisfaction.
3. Social integration: It considered indicator C1), relationship with other members of the community.
4. Ecological knowledge and awareness. It was estimated according to indicator D1), ecological knowledge and awareness.

Stage 2. Standardization and weighing of the indicators. To allow the comparison of the farms and facilitate the analysis of the multiple dimensions of sustainability, the indicators were standardized through their transformation, according to a scale of 0 to 4, with 4 being the highest sustainability value and 0 the lowest. All the values, independently from their original unit, were transformed or adjusted to this scale. This allowed to integrate various indicators of a different nature into others that are more synthetic or robust.

For weighing the indicators, the value of the scale was multiplied by a coefficient, according to the relative importance of each variable with regards to sustainability. This coefficient multiplies the value of the variables as well as that of the indicators. This allows the construction of higher level indicators or indices. The weighing was carried out through discussion and consensus among the members of the work group. Likewise, a threshold or minimum value was defined that each dimension or variable had to reach to consider a farm sustainable, equal to or lower than the average value of the scale, that is, 2. In addition, it was considered that none of the three dimensions should have a lower value than the previously-stated one. The weight of each indicator showed its importance in sustainability.

To evaluate the complexity of the design and management of agroecosystems, Vázquez (2013) was used as a reference. This author groups the elements of biodiversity into productive biodiversity, such as introduced biota, which is planned and cultivated or reared for economic purposes; associated biodiversity or organisms that directly influence, positively or negatively, the physiological development and defense of cultivated plants; and auxiliary biodiversity, which comprises non-cultivated vegetation that lives naturally or is introduced, and that is managed to positively influence the rest of the biodiversity.

In turn, these functional components were related to the management that is performed in the production system to carry out the diagnosis through the indicators design and management of the elements of productive biodiversity (DMBPr), soil management and conservation (SMC), water management and conservation (WMA), management of sanitary interventions in productive areas (MISRPr), design and management of auxiliary biodiversity elements (DMBAu) and status of associated biodiversity elements (ABEs).

The biodiversity management coefficient (BMC) of the production system coincides with the index of the ecological dimension and was determined by the expression:

$$BMC=- [DMBPr + SMC + WMC + MISRPr + DMBAu + ABEs]/ 6$$

The obtained value allows to classify the system with regards to the complexity degree reached by the designs and managements of the biodiversity elements (table 2).

The standardization and weighing of the studied indicators and variables were carried out. When weighing the economic dimension (DK), it was considered that the most important indicator, due to the characteristics of the studied productive group (farmers), was food self-sufficiency. In this sense, it was given twice the weight of the rest. It was calculated as the algebraic sum of its components multiplied by their weight or bearing:

Economic dimension (DK):

$$\frac{2\ ((A1 + A2)\ /2) + B + (C1+ C2 + 2C3)\ /4}{4}$$

Ecological dimension (ED). Sixteen indicators were weighed as the most important, and all variables were equally important.

The indicators with the highest weight were: surface of complex crop systems, use of temporary crop systems, crop rotation system, sources of water supply for agricultural use, drainage management, integration of biological interventions in plant productive items, integration of biological interventions in animal productive items, surface with lateral living barriers, surface with intercropped living barriers, internal ecological corridors, management of semi-natural environments, management of tree plantations, tolerance to weeds and diversity of groups of natural regulators (table 3).

The index of the ecological dimension (ED) of the system was calculated through the following expressions:

$$ED = \Sigma\ (DMBPr+SMC+WMC+MISRPr+DMBAu+ABEs)/6.$$

Sociocultural dimension (SCD): In this dimension, the indicators of satisfaction of basic needs were considered as having the highest weight: housing and degree of acceptability of the productive system:

Sociocultural dimension (SCD):

Table 2. Scale used to measure the complexity degree of biodiversity in the farms.

Management of biodiversity	Complexity degree of biodiversity
0,1-1,0	Simplified
1,1-2,0	Little complex
2,1-3,0	Moderately complex
3,1-3,5	Complex
3,6-4,0	Highly complex

Table 3. Variables of the ecological dimension and formulas to calculate them after weighing the indicators.

Variable	Formula
Productive biodiversity (DMBPr)	DMBPr= $\Sigma(2Pr_1+Pr_2+2Pr_3+Pr_4+Pr_5+Pr_6+ Pr_7 +Pr_8+ Pr_9+ Pr_{10}+Pr_{11}+ 3Pr_{12} +Pr_{13}+Pr_{14}+Pr_{15}+ Pr_{16}+ Pr_{17}+2 Pr_{18})/23$.
Soil management and conservation (SMC)	SMC= $\Sigma(2S_1+S_2+S_3+2S_4+S_5+S_6+ S_7/9$
Water management and conservation (WMC)	WMC= $\Sigma(A_1+A_2+2 A_3+ 2A_4+ A_5)/7$
Sanitary interventions in productive items (MISRPr)	MISRPr = $\Sigma(I_1+ 2I_2+ I_3+2I_4+ I_5)/7$
Design and management of auxiliary biodiversity (DMBAu)	DMBAu= $\Sigma(2Au_1+ Au_2+2Au_3+Au_4+3Au_5 +Au_6+ Au_7 +2 Au_8+ Au_9+ 2 Au_{10}+ Au_{11}+ Au_{12} +Au_{13}+2 Au_{14}+ Au_{15})/22$.
Associated biodiversity (ABEs)	ABEs= $\Sigma(As_1+As_2+As_3+As_4+As_5+As_6+ As_7 +As_8+ As_9+ As_{10}+ 2As_{11}+ As_{12})/13$

$$\frac{2\,((2A1 + A2 + 2\,A3)\,/5) + 2\,B + C + D}{6}$$

Finally, with the results of the economic (DK), ecological (ED) and sociocultural (SCD) dimensions, the general sustainability index (ISGen) was calculated according to the previously defined conceptual framework.

General sustainability index (ISGen):

$$\Sigma\ (DK + ED + SCD)\ /3$$

Results and Discussion

In the economic dimension (table 4), in all cases the farmers reported that they had monthly incomes higher than 1 500 pesos. This is over the vital minimum agreed upon in the municipal development strategy of 2016. Several products, susceptible to commercialization, were prioritized to maintain economic stability.

With regards to the surface per family members, only in farm III, it was lower than the established threshold, which contributed to a decrease in the index of food self-sufficiency.

This farm (III) has a high economic risk. It has few marketing channels and high dependence on external inputs, an aspect that coincides with the rest of the studied farms. According to Casimiro (2016a; 2016b), for agroecological family farming (AFF) diversified systems are more resilient (Nicholls and Altieri, 2019; Casimiro-Rodríguez *et al*., 2020), as they subsidize their own fertility and productivity, implement practices of soil conservation and amelioration, as well as polyculture and silvopastoral systems with less dependence on oil and its derivatives. This presents them as systems that contribute to climate change mitigation and adaptation.

In the economic dimension (DK), in all cases the sustainability criteria were met (DK $\geq$ 2), and it was shown that the farmers' purpose was not only the search for profit but also the maintenance of a balance between production and consumption for the subsistence of the family farm.

All the farmers participated in various economic activities outside the farm. From them, monetary flows and significant income for households were obtained; in addition to having family remittances, which is consistent with the new model of rurality. Suset *et al*. (2013) and Miranda-Tortoló *et al*. (2020) highlighted the different aspects of rural transformations and stressed the increasing

Table 4. Analysis of the economic dimension in five farms in the Perico municipality.

Farms	Food self-sufficiency		Net income	Economic risk			Economic dimension
	A_1	A_2	B_1	C_1	C_2	C_3	
I	3	4	4	4	2	2	3,25
II	4	4	4	4	3	2	3,56
III	3	1	4	3	1	2	2,38
IV	4	3	4	3	2	2	3,19
V	4	4	4	3	3	2	3,5

A_1: production diversification, A_2: surface of self-consumption production, B_1: satisfaction of the economic needs of the family group, C_1: diversification for sale, C_2: number of commercialization ways, C_3: dependence on external inputs diversification of rural activities and the importance of non-agricultural jobs and incomes in the livelihood strategies of peasants and agricultural workers.

When the term rurality is used, the aim is to adopt a scheme that is not limited only to agriculture in the rural economy. One of the contributions of the analysis of the new rurality is the questioning of the presumption of many analysts and those in charge of formulating public policies, which states that rural communities are very well integrated into the markets, and that they do not operate exclusively in a subsistence farming logic. The new ruralists reveal that peasants develop multiple activities (pluriactivity and multifunctionality).

Ecological dimension. The ecological dimension (table 5) showed values that placed it, according to the evaluated scale, in the category of moderately complex (farms I, II, III and IV) and little complex (V). These values are similar to those obtained by Miranda-Tortoló *et al.* (2018), who, when evaluating six farms in the same municipality, grouped them in the category of little complex, except for the Cayo Piedra farm (complex), which is nationally and internationally recognized as an agroecological farm; They also refer that the trend to increase complexity is a slow process that requires a great deal of understanding by farmers.

The ecological dimension index (ED) in farm V did not meet the established criterion (1,81), because such indicators as soil management and conservation, sanitary interventions in productive items, and the design and management of the auxiliary biodiversity were below the required value, contrary to what was observed in the other studied systems.

The variable design and management of productive biodiversity was higher than 2, and exceeded the threshold value, although several indicators did not meet the indicated range by themselves. None of the farms have established silvopastoral systems and, therefore, these are not complex. These systems can contribute to climate change mitigation (López-Vigoa *et al*., 2017; Rivera-Herrera *et a*l., 2017; Milera-Rodríguez *et al*., 2019) and have the additional advantage of increasing productivity in the short and long term.

Regarding the agroforestry designs, it was found that they were not very complex in farms I, II and V, because they had less than four integrated species.

Other indicators were also lower than 2: the complexity of the system with mixed design (farm I), the area with polyculture design (farms II and V) and the diversity of animals in breeding systems (farms I and IV).

Funes-Aguilar (2015) states that the integration of crops, livestock and trees is significant, according to agroecological principles, since it strengthens the links among the different biophysical components and provides opportunities for the multifunctionality of the system.

The variable soil management and conservation behaved unfavorably in farm V, since the value obtained is below the threshold value (1,67). This could be due to poor management of the soils dedicated to animal husbandry. Although they carry out crop rotation, incorporate organic biomass, use minimum tillage and anti-erosion practices, the results are not sufficient, which can lead to the degradation of the soil resource. The preponderant function of the soil in the system motivates its conservation and amelioration to have a decisive impact, from the economic, environmental and social point of view (Riverol *et al*., 2001).

In the Cuban context, soil degradation is one of the five main environmental problems. Martinez *et al*. (2017) recognize the use of conservation and improvement practices as important. However, Oropesa-Casanova (2019) in studies conducted

Table 5. Evaluation of the economic dimension per variables.

Farm	DMBPr	SMC	WMC	MISRPr	DMBAu	ABEs	ED	Degree of complexity
I	2,3	2,44	2,29	2,14	1,82	2,77	2,29	Moderately complex (sustainable)
II	2,26	2,56	2,14	2	1,68	2,46	2,14	Moderately complex (sustainable)
III	2,78	3,33	2	2,86	2,14	2,3	2,57	Moderately complex (sustainable)
IV	2,91	3,67	2	2,43	2,95	2,38	2,72	Moderately complex (sustainable)
V	2,04	1,67	2	1,29	1,77	2,08	**1,81**	Little complex (sustainable)

DMBPr: design and management of the productive biodiversity, SMC: soil management and conservation, WMC: water management and conservation, MISRPr: sanitary interventions in productive items, DMBAu: design and management of auxiliary biodiversity, ABEs: associated biodiversity in the Perico municipality observed little use of amendments, bioproducts, organic fertilizers and minimum tillage.

Water management and conservation is carried out in a sustainable manner. However, in farms II and III, irrigation forms that are not very environment-friendly are used.

Regarding the variable sanitary interventions in the productive items for the control of organisms harmful to plants and animals, similar results were found in the farms. In this analysis, farm V obtained a value below the threshold (1,29). In all cases, the level of self-sufficiency of inputs for interventions in plant and animal items had a great influence. In general, good management of health interventions was not achieved, because the systems did not achieve the necessary self-regulation capacity.

With regards to the variable auxiliary biodiversity design and management, farms I, II and V did not meet the established requirements, which may be associated with the scarce presence of lateral living barriers, ecological corridors, tree plantations, as well as their diversity and structure. In addition, they showed few repellent plants and mini-forests, which would provide permanent shade for plants and animals and, in turn, could constitute reservoirs for natural enemies.

Regarding functional biodiversity, associated biodiversity is one of the least visible and worked by farmers. For Nicholls *et al*. (2017) and Altieri (2017) through functional biodiversity an important objective of the conversion process is achieved: the enhancement of the ecological functions of the agroecosystem, which allows farmers to gradually eliminate inputs, by relying on ecological processes and key interactions of the agroecosystem; in addition to increasing food security, conserving and restoring soils, forests and water, as well as their role as carbon sequestrants.

In all cases, the established value was met, although the farmers still do not know all of its functionality.

Sociocultural dimension. Regarding the sociocultural dimension (SCD), all the farms fulfilled the established sustainability indicators (table 6). The variables farmer's satisfaction, degree of social integration, degree of ecological awareness and knowledge, if analyzed particularly, showed values over the permissible threshold (2). This is fundamental, because they constitute the so-called social capital, which sets in motion the natural capital. Those needs that, in spite of not being vital, are highly important because they are related to the social environment of the farmer and his/her insertion in society, constitute the so-called social capital, which comprises the interactions among the individuals that form the community, and between them and the entities (institutions, public and private organisms) that are somehow related to their interests (Dellepiane and Sarandón, 2008). In this case, the aspects that enhance the relations among the members of a community were considered favorable for sustainability.

Evaluation of the general sustainability. The use of indicators allowed to find variability in the three dimensions (economic, ecological and sociocultural). Differences were observed among the values of the different dimensions, as well as in the general sustainability index, which was higher than the threshold value in all the farms (table 7).

When analyzing the sustainability of the systems, only farm V did not fulfill the established requirements, because for considering a farm sus-

Table 7. Economic, ecological and sociocultural dimensions, general sustainability index and classification.

Farm	DK		SCD	ISGEN	Sustainable
I	3,25	2,3	3,8	3,12	Yes
II	3,56	2,1	3,5	3,0	Yes
III	2,62	2,7	3,1	2,81	Yes
IV	3,19	2,7	4	3,3	Yes
V	3,5	1,8	3,8	3,03	No
Average	3,224	2,32	3,64	3,052	
Variation coefficient %	11,56	16,80	9,64	5,86	

DK: economic dimension, ED: ecological dimension, ISGEN: general sustainability index, SCD: sociocultural dimension tainable the value of each dimension must be equal to or lower than the mean value of the scale (2). For this case, it was not fulfilled in the ecological dimension.

Similar results were obtained by Milián-García (2017), who when evaluating a farm in the same municipality reached an acceptable sustainability index, although in this case the farm management satisfied, to a higher extent, the ecological objectives compared with the others.

For further analysis two farms were considered: the one with the best performance (farm II) and the one that did not fulfill the indicators to be sustainable (farm V). For such purpose, a spider web chart was used, which allowed to detect large differences in the sustainability components (fig. 1). In the Mercedita farm (II), the system management was better in almost all the indicators and variables, although the Palo Lindo farm (V) was superior in food self-sufficiency. Several of the analyzed aspects had close values to the ideal ones in the two studied farms.

The external limits represent the ideal sustainability value and the intermediate one, the threshold value.

The three dimensions are between parentheses: economic (K), ecological (E), sociocultural (SC), food self-sufficiency (FS), net monthly income (NMI), economic risk (ER), design and management of productive biodiversity (DMBPr), soil management and conservation (SMC), water management and conservation (WMC), sanitary interventions in productive items (MISRPr), design and management of auxiliary biodiversity (DMBAu), associated biodiversity (ABEs), satisfaction of the basic needs (SBN), acceptability (Accept), social integration (SocIn) and ecological knowledge and awareness (EcAwar).

In the Mercedita farm, all the variables, ecological as well as sociocultural and economic, showed favorable aspects for sustainability. This could be given by the complexity in the farm design and management. In this farm the basic needs were satisfied, without compromising the natural resources for future generations, with solid links in the community from its social integration, ecological knowledge and awareness.

Conclusions

The methodology for the evaluation of sustainability in its multiple dimensions is an important tool at local level. The validation of this proposal allows to find trends in the field of sustainability, establish its causes and propose medium-term solutions.

Recommendations

To apply the methodology used in this research to other productive scenarios in the municipality.

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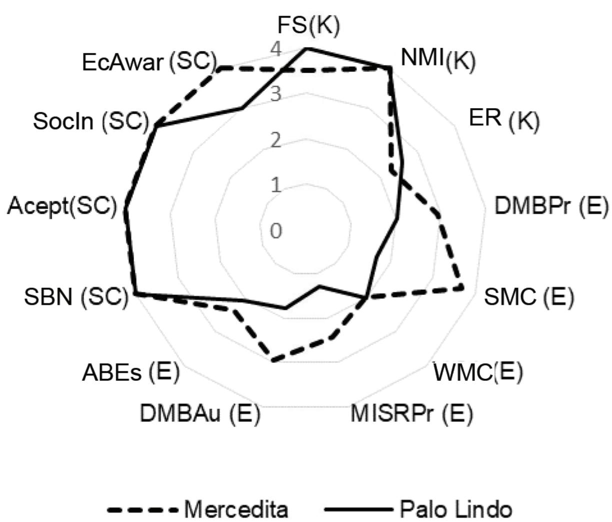

Figure 1. Sustainability indicators in two farms of the Perico municipality .

Local Agricultural Program (PIAL, for its initials in Spanish), as well as the productive entities and farmers to whom the results of this work contribute.

Conflict of interests

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

Authors' contribution

- Katerine-Oropesa-Casanova. Conception, data acquisition, analysis and interpretation, manuscript writing and revision.
- Hilda Beatriz Wencomo-Cárdenas. Research conception and design, manuscript writing and revision.
- Taymer Miranda-Tortoló. Research conception and design, manuscript writing and revision.
- Juan Carlos Lezcano-Fleires. Research conception and design.

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