EVALUATING ECOLOGICAL SUSTAINABILITY IN «LA MARGARITA» FARM FROM HOLGUÍN TOWN

EVALUACIÓN DE SOSTENIBILIDAD ECOLÓGICA CON INDICADORES EN LA FINCA «LA MARGARITA» DEL MUNICIPIO HOLGUÍN

Niurlys Rodríguez González. rniurlys@gmail.com. University of Holguin, Cuba
ORCID: https://orcid.org/0000-0002-5950-1796
Mamna Victoria Daley Poyato. daleymamn24@gmail.com. University of Holguin, Cuba ORCID: https://orcid.org/0000-0002-6049- 2129
Alexander Salgado Verdecia. asalgadov@uho.edu.cu. University of Holguin, Cuba
ORCID: https://orcid.org/0000-0002-2702-6097

Receiving date: February 9th, 2025

Acceptance date: March 30, 2025

ABSTRACT

This study assesses the ecological sustainability in «La Margarita» farm in Holguin municipality by using the French method IDEA, version 4 (Indicators in agricultural exploitations) in Cuba. Semi-structured interviews were applied, and the work is supported by empirical and statistical research methods. The analysis conducted of the sustainability dimension, provides elements for extension and research actions that contribute empowering sustainability from Agroecology. Indicators evaluated highlight a predominance of sustainability, mostly as a sample of the existing potential of the farm; however, continued research with socioeconomic indicators for further deepening is evident.

KEYWORDS: agroecosystems; sustainable development; alternative agriculture

RESUMEN

Se realizó una investigación en la finca docente–experimental «La Margarita» en el municipio Holguín para evaluar la sostenibilidad ecológica a través del método francés IDEA versión 4 (Indicadores en explotaciones agrícolas) en

Cuba. Se aplicaron entrevistas semiestructuradas, y el trabajo se apoyó en los métodos empíricos y estadísticos de investigación. El análisis de las dimensiones de la sostenibilidad, aporta elementos para acciones extensionistas y de investigación que contribuyen al empoderamiento de la sostenibilidad desde la Agroecología. Los indicadores evaluados destacan un predominio de la sostenibilidad, en su mayoría como muestra del potencial existente en la finca; sin embargo, se evidencia la necesidad de una continuidad investigativa con indicadores socioeconómicos para mayor profundización.

PALABRAS CLAVE: agroecosistemas; desarrollo sostenible; agricultura alternativa

INTRODUCTION

Sustainable agroecosystems based on agroecological foundations must be supported by ecological principles and involve a systemic change, not just the use of agroecological practices (Nicholls & Altieri, 2019). Agroecology is a means to achieve the objectives of sustainable development (Pérez et al., 2021), but unfortunately, it is often confused with other forms of alternative agriculture (natural, biodynamic, organic, ecological agriculture, permaculture) that emerged in the 1960s. It cannot be viewed merely as a set of practices harmonious with nature, but as designed agricultural systems that are sustainable in the long term.

For the agroecological adoption on farms, it is important that there is a decision by the farmer to acquire knowledge and skills to overcome the gap between the implementation time and the obtaining of quantifiable benefits. Therefore, it is a great challenge for farms adopting agroecology. It is significant the impact of the implemented agroecological practices on sustainability.

Cortés et al. (2023) highlight the agroecology value due to its contributions to agriculture stability and resilience. However, achievements in the dimensions of sustainable agricultural development are only possible if attitudes that prioritize consumerism are radically abandoned and it is considered balance as a system.

Pinedo-Taco et al. (2021) state that there are more than 20 sustainability assessment methodologies, which involve multi-criteria and can be applied to plots and production systems. Sustainability assessment is complex and requires comprehensive measurement using contextualized methods that demand dedication, time, resources, and defining the objectives to be met in the agroecosystems (Cuervo-Osorio et al., 2020).

Sustainability assessment through indicators constitutes an opportunity to understand the progress achieved in agricultural production systems. There are methodologies that allow the evaluation of the ecological, economic, and social dimensions; among them, IDEA (Indicateurs de Durabilité des Exploitations Agricoles - Indicators for Assessing Farm Sustainability) and its indicators, it is a relevant method for research and pedagogical purposes (Zahm et al., 2024). This method has been implemented in 20 countries and it is a strength that it has been contextualized for the first time in Cuba by the Center for Studies on Arid Agroecosystems (CEAAR). This work is pioneering in the IDEA indicator uses.

The teaching-experimental farm «La Margarita» has been a setting for research conducted by students, scientists, and extensionists of the territory; however, the contribution of the agroecological practices implemented on this site to sustainable development is not known.

The absence of timely evaluations leads to a lack of knowledge about whether the practices contribute to sustainable agriculture or not; which has implications for the producer's economy, society, and the environment. Therefore, it was determined the following objective: to evaluate sustainability using ecological indicators of the IDEA-4 method on «La Margarita» farm in Holguin municipality.

DEVELOPMENT

The teaching-experimental farm «La Margarita» in Holguin municipality is located in the Agrarian System «Urban Area-San Rafael». It borders with Jose de La Luz y Caballero University Campus buildings to the northeast, with the

highway from Holguin to Mayari to the north, and with the city's encirclement to the southeast, from Holguin-Mayari highway to Las Tunas main road.

It has an area of 3.44 hectares, the workforce is family-based, it is composed by four members with an average age of 36 years and a university education level. Agriculture is the main economic activity; also, experimentation activities for teaching and extension purposes are developed, serving as references in the province.

The research allowed the study of indicators proposed by the IDEA method, version 4 which were contextualized to the farm conditions. It was evaluated the sustainability ecological dimension through a semi-structured interview and scientific observation as the main associated method. There were also used following research methods:

Analysis-synthesis: in the references searching on the teaching-experimental farm background.

Historical-logical: in the characteristics searching and logics of synergies in the selected study context.

Systemic structural-functional: in the analysis of how the structural and functional elements involved in the farm behave.

Hypothetical-deductive: in the precision of the research study objectives due to its exploratory nature with the IDEA method.

Statistical: descriptive statistics for information processing.

Evaluating sustainability through indicators of the IDEA-4 method constitutes an opportunity to identify the progress in agricultural production systems, especially where Agroecology is practiced.

These studies allow determining the contribution of agroecological practices to the developing sustainable agroecosystems and they are based on indicators of the ecological, economic, and social dimensions.

Behavior of indicators on «La Margarita» farm ecological dimension

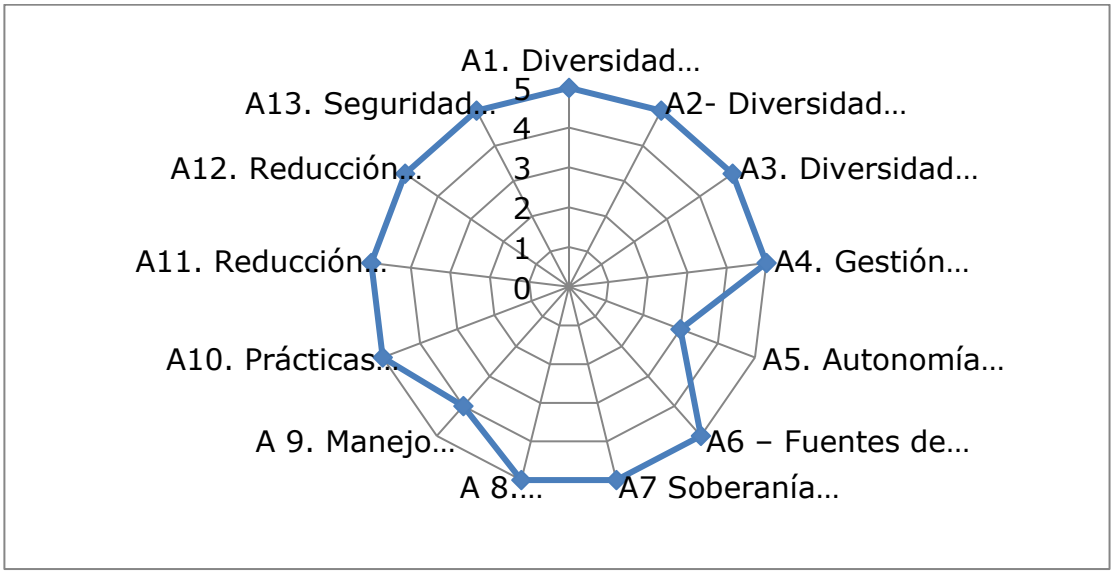

Figure 1: Behavior of ecological indicators

As can be seen, only one indicator did not achieve the maximum score (energy autonomy and materials). Among the reasons explaining the behavior of the indicators are:

A1. Diversity and distribution of cultivated productive species

It has high diversity and distribution of species: forestry (29), root vegetables and plantains (21), grains (3), fruit trees (32), ornamental plants (52), pastures (2).

A2. Genetic diversity

Genetic diversity is high in terms of varieties and cultivates of different species of agricultural interest. It has 19 mango varieties, 10 of guava, 16 of plantains, 2 of sweet potato, and 5 cassava cultivates. The animal species come from the crossbreeding of Creole and improved breeds; it has 8 bovine, 2 equines, 16 sheep, 3 pigs, and 43 poultry. These results are achieved due to the producer awareness and management, proactivity being very important for the farms´ developing sustainable (Rodríguez, 2023).

A3. Temporal distribution of crops

The strategy of intercropping tree crops and crops of more than three years on the farm has benefits; for example, trees and perennial crops integration in the agricultural landscape promotes biological diversity. Crop association is a widely used agroecological practice, some examples are: Plantain-coffee, Avocado-citrus, Guava-Cassava-Cucumber, Fruit Plantain-Natural pastures, Corn-Pumpkin, Coconut-Mulberry-Citrus, and Mango-Pastures. This is a potential that favorably influences the other elements interacting in the agroecosystems (Costa-Pereira et al., 2024).

A4. Management of pollinators and auxiliary crops

Insecticides have not been used in agroecological areas or on animal herds in recent years to protect biodiversity. Regarding the existence of flowering plants in the agricultural plots, there are ornamentals, repellents, and trees; also, there is a beehive and diverse flowering plants, including: tithonia, coconut, sweet potato, white romerillo, royal palm, squash, flowery pine nut, and fruit-bearing eucalyptus.

A5. Autonomy of energy and materials

This is the indicator with the lowest value (3 out of 5) due to total dependence on the national electricity grid. However, regarding infrastructure materials, the producer builds and repairs his agricultural tools and has a specific warehouse for storing agricultural products. It is common the farm seed production for at least one species and in different varieties.

The farm is sustainable because it does not depend on any external food for the animals, which is a favorable element. The producer is an innovator of multi-action equipment and has seed conservation infrastructure, an aspect that enables local development (Benítez et al., 2020).

A6. Fertilization sources

Chemical fertilizers are not used; on the farm, access to more than two organic fertilizers is available and they are used. Bovine manure obtained

within the area is sed as an alternative source. There is a perspective to introduce biofertilizers, such as effective microorganisms and worm humus.

A7. Sovereignty in water use

The existence of two wells with water availability year-round is a strength. These supply sources are within the farm and are destined for human and animal consumption, and crop irrigation.

A8. Optimization of water use

The most irrigated crops are: squash, fruit plantain, plantain, guava, tomato, sweet potato, and cucumber. In the case of papaya, cassava, fruit trees, and some root vegetables, they are irrigated every seven days. Installing an irrigation system is a demand for the farm.

A9. Management to favor soil fertilization

This indicator did not reach the maximum score (4 points out of 5) due to the absence or few areas under fallow (less than 30% of the useful agricultural surface). Being a factor that favors fertilization, it could be considered to leave some areas covered with grasses, which will depend on the availability and possibility to be assessed by the producer.

It is positive that on the farm, pesticides are not used and anti-erosive measures are implemented with live and dead barriers to avoid losing the soil (Palau, 2019), as well as drainage ditches. There are fertilized an average of 1.3 hectares, corresponding to 30%, during the year. It is carried out localized fertilization with organic fertilizer every campaign or when labor is available. Crop residues are not burned; they are incorporated into the soil as organic matter.

A10. Adoption of agroecological practices

Agroecological practices has been increasing over the years. Among the main practices developed are:

- ✓ Ancestral technique uses for soil farm, moon phases, and seed conservation techniques.

- ✓ Organic fertilizer uses, composting, and biofertilizers instead of synthetic chemical products to nourish crops.
- ✓ Soil protection with live and dead barriers, crop rotation, localized fertilization.
- ✓ Crop rotation to prevent erosion, control pests and diseases, and improve soil fertility naturally.
- ✓ Integrated pest management that reduces dependence on chemical pesticides.
- ✓ Environment protection and natural habitats (e.g., nests).
- ✓ Biodiversity conservation of plant and animal species.
- ✓ Food quality improvement by not using agrochemicals, ensuring no harm to human health.

Agroecology guarantees long-term sustainability on the farm and climate change resilience; however, the producer mentions facing resource scarcity, which has been counter by applying agroecological knowledge and alternatives. Agricultural extension can greatly influence promoting the acceptance of sustainable practices by producers and raising awareness to adopt sustainable activities that protect the environment and natural resources (DE OCA, 2024).

A11. Reduction of phytosanitary and veterinary products

It is significant the producer management with local alternatives, favoring less dependence on conventional products (Vázquez et al., 2019). Chemical pesticide uses has been minimized on the farm. Alternatives for insect pest control have been adopted, including the botanical extract uses, such as: tobacco solution, neem, pimpinilla, and ash. There are only used antiparasitic with green medicine and tithonia and leucaena due to their potentiality in the case of veterinary product treatments.

A12. Reduction of the impact on air quality

There are developed agricultural practices that emit particles on the farm, especially when using the tractor for land preparation, and due to the presence of animals (cattle, sheep, equines, and poultry). Also, there is management of non-ruminant organic waste, leaving it in the open air, given the raising of pigs.

The existence of fruit trees and other species, grouped forming a semi-forest area, is positive.

A13. Security in the availability of means of production

There is a supply of manual work tools, some innovated by the farmer. External dependence on seeds is minimal and it is managed, if necessary, with relatives and friends. The infrastructure existence for the storage and/or processing of agricultural products to reduce the risk of losses is a farm potential. Production covers 50% of the family's self-consumption, with the remainder being sold through the cooperative to which the producer belongs. There is an available labor force skilled in the work, and there is no dependency on external water or feed for the livestock.

This demonstrates sustainability in these elements, which are key to the farm's development. The available workforce is proficient in performing all necessary tasks.

Actions to promote the farm ecological sustainability

- ✓ Increase the amount of hives through the progressive installation of an apiary to improve pollination.
- ✓ Implementation of alternatives for energy generation, such as biogas.
- ✓ Maintenance and increment agroecology in the production system design.
- ✓ Promote food processing and the organic and natural biofertilizer uses.

- ✓ Efficient water usage through the implementation of drip irrigation systems, rainwater harvesting, and water conservation techniques to optimize usage and reduce losses.

- ✓ Implement agroforestry to a greater extent to increase biodiversity, improve soil quality, and provide habitats for wildlife.

The analysis of ecological sustainability performance using contextualized indicators from the IDEA-4 Method confirmed that «La Margarita» farm adopts a solid approach, based on the sustainability of agricultural activities.

CONCLUSIONS

The farm has potential for sustainability, such as: optimized water use, implementation of localized irrigation, sources of fertilizers for soil fertility improvement, and an innovative approach to mechanization through the design of implements using local resources. The evaluated indicators highlight that the ecological purposes and methods used positively benefit the social sphere, enabling satisfactory economic growth, as it is stated by the interviewed producer. Therefore, it is necessary the indicators´ contextualization for socio-economic monitoring.

BIBLIOGRAPHIC REFERENCES

Benítez Odio, M., Martínez Robaina, A., Herrera Gallo, M., Páez Fernández, P. L., & del Busto Concepción, A. (2020). Estrategia para implementar la gestión del conocimiento en el Sistema de Innovación Agropecuario Local. *Cooperativismo y Desarrollo*, *8*(1), 45-56. http://scielo.sld.cu/scielo.php?pid=S2310-340X2020000100045&script=sci_arttext

Cortés, J., Vieli, L., & Ibarra, J. T. (2023). Family farming systems: An index-based approach to the drivers of agroecological principles in the southern Andes. *Ecological Indicators*, *154*, 110640. https://www.sciencedirect.com/science/article/pii/S1470160X23007823

Costa-Pereira, I., Aguiar, A. A., Delgado, F., & Costa, C. A. (2024). A Methodological Framework for Assessing the Agroecological Performance of Farms in Portugal: Integrating TAPE and ACT Approaches. *Sustainability*, *16*(10), 3955. https://www.mdpi.com/2071-1050/16/10/3955

Cuervo-Osorio, V. D., Ruiz-Rosado, O., Vargas-Villamil, L. M., García-Pérez, E., Gallardo-López, F., & Díaz-Rivera, P. (2020). MARCOS METODOLÓGICOS PARA LA EVALUACIÓN DE LA SUSTENTABILIDAD AGRÍCOLA EN CUENCAS HIDROGRÁFICAS: UNA REVISIÓN. *Tropical and Subtropical Agroecosystems*, *23*, 28. https://www.academia.edu/download/107630527/3118-13587-2-PB.pdf

DE FINCAS, E. R. (2021). DE LA AGROECOLOGÍA. https://www.researchgate.net/profile/Luis-Vazquez-50/publication/359936102_Ruta_de_la_Agroecologia_para_la_transformacion_de_fincas_en_resilientes_ante_el_cambio_climatico/links/62578e3aa279ec5dd7f4e4af/Ruta-de-la-Agroecologia-para-la-transformacion-de-fincas-en-resilientes-ante-el-cambio-climatico.pdf

DE OCA, E. R. M. (2024). Extensionismo como aporte al desarrollo rural, perspectiva de los profesionistas. http://riaa.uaem.mx/handle/20.500.12055/4755

Fonseca-Carreño, N. E., Salamanca-Merchan, J. D., & Vega-Baquero, Z. Y. (2019). La agricultura familiar agroecológica, una estrategia de desarrollo rural incluyente. Una revisión. *Temas agrarios*, *24*(2), 96-107. https://revistas.unicordoba.edu.co/index.php/temasagrarios/article/view/1356

González, N. R., Fuentes, Z. R., Betancourt, T. L., & Sánchez, O. I. F. (2022). Diagnóstico participativo y jerarquización de acciones para impulsar la producción agroecológica en Gibara, Holguín. Revista de Gestión del Conocimiento y el Desarrollo Local, 9(2), cu-id. https://revistas.unah.edu.cu/index.php/RGCDL/article/view/1765

Nicholls, C. I., & Altieri, M. A. (2019). Bases agroecológicas para la adaptación de la agricultura al cambio climático. *Cuadernos de Investigación UNED*, *11*(1), 55-61. https://www.scielo.sa.cr/scielo.php?script=sci_arttext&pid=S1659-42662019000100055

Olalde, M. O. (2007). Sostenibilidad ecológica. *Revista de la Cátedra Unesco sobre desarrollo sostenible enero*, *39*. https://www.ehu.eus/cdsea/web/wp-content/uploads/2016/12/Revista1.pdf#page=41

Palau, M. (2019). Partimos de la soberanía alimentaria para llegar a la agroecología. *Biodiversidad, sustento y culturas*, *101*(3), 5-10.

Pérez Consuegra, N., & Caballero Grande, R. (2021). *Agroecología en Cuba–Iniciativas y evidencias innovadoras escalables*. Food & Agriculture Org. https://books.google.com/books?hl=es&lr=&id=cctGEAAAQBAJ&oi=fnd&pg=PP2&ots=iNM8MkU3GH&sig=Qw-AmPSvVTqIEEvpSzBju-HE-Mo

Pérez, D. M., Pimentel, K. R., Díaz, E. A., & López, M. S. D. (2021). Evaluación de la sustentabilidad de agroecosistemas en la zona de Sumidero, provincia de Pinar del Río, Cuba. *Ecovida: Revista científica sobre diversidad biológica y su gestión integrada*, *11*(1), 70-84. https://dialnet.unirioja.es/servlet/articulo?codigo=9439074

Pinedo-Taco, R. E., Borjas-Ventura, R. R., Alvarado-Huamán, L., Castro-Cepero, V. P., & Julca-Otiniano, A. M. (2021). Sustainability of agricultural production systems: A systematic review of the methodologies used for their evaluation. *Tropical and Subtropical Agroecosystems*, *24*(1).

Rodríguez, N (2023). Estrategia de extensión agraria como contribución a la sostenibilidad de fincas en usufructo en Báguanos, Holguín. (Tesis a opción de grado científico de Dr. Ciencias Agrícolas, Universidad Agraria de La Habana).

Vázquez, L. L., Castellanos, A., & Leiva, V. (2019). Transición agroecológica y resiliencia socioecológica a sequías en Cuba. *Celia Boletín Científico*, *3*, 1-43. https://www.researchgate.net/profile/Luis-Vazquez-50/publication/339339131_Transicion_agroecologica_y_resiliencia_socioecologica_a_sequias_en_Cuba/links/5fdf9a7f299bf140882f7c99/Transicion-agroecologica-y-resiliencia-socioecologica-a-sequias-en-Cuba.pdf

Zahm, F., Ugaglia, A. A., Barbier, J. M., Carayon, D., Del'homme, B., Gafsi, M., ... & Rodrigues, I. (2024). Assessing farm sustainability: the IDEA4 method, a conceptual framework combining dimensions and properties of sustainability. *Cahiers Agricultures*, *33*, 10. https://www.cahiersagricultures.fr/en/articles/cagri/full_html/2024/01/cagri230151/cagri230151.html