

Experience of good practices

Regularities of innovation management in agricultural cooperatives of Artemisa, Cuba



Regularidades de la gestión de la innovación en cooperativas agropecuarias de Artemisa, Cuba

Regularidades da gestão da inovação em cooperativas agropecuárias de Artemisa, Cuba

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ABSTRACT

Innovation management has been addressed by various authors, who refer to its evolution toward different approaches, viewing it as a systematic process in which new ideas are generated and transformed into new products, services, processes, or models that create added value and competitive advantages. The challenges facing the Cuban agricultural sector are diverse; shortages of technological equipment and other resources limit development and prevent the sector from achieving a satisfactory level of food sovereignty. This research diagnoses the current state of innovation management in agricultural cooperatives in the province of Artemisa to identify their potential, limitations, and barriers, thereby guiding efforts to improve them. Theoretical methods

(analysis and synthesis, induction-deduction) and empirical methods (surveys, semi-structured interviews, and literature review) were employed. As a result of the literature review, eleven models and tools were identified, grouped into four approaches, none of which integrates cooperative governance with the internal management of innovation. The empirical results reveal occasional, process-centered innovation, supported by peer learning and leading producers, but limited by a lack of resources, funding, training, and coordination with actors in the agricultural knowledge and innovation system, as well as by cultural barriers such as low motivation and the individual appropriation of ideas. The findings are discussed in light of recent studies, contributing to the refinement of innovation management within the cooperative context of Artemisa.

Keywords: innovation; innovation management; agricultural cooperatives.

RESUMEN

La gestión de la innovación ha sido abordada por diversos autores, que hacen referencia a su evolución hacia diferentes enfoques, al abordarla como un proceso sistemático en el cual se generan nuevas ideas que se transforman en nuevos productos, servicios, procesos o modelos, que generan valor agregado y ventajas competitivas. Los desafíos para el sector agropecuario cubano son diversos, las insuficiencias en el equipamiento tecnológico y demás recursos, limitan el desarrollo para alcanzar un nivel satisfactorio de soberanía alimentaria. En la presente investigación se diagnostica el estado actual de la gestión de la innovación en las cooperativas agropecuarias de la provincia de Artemisa, para identificar sus potencialidades, limitaciones y barreras que permitan orientar su perfeccionamiento. Se emplearon métodos teóricos (análisis y síntesis, inducción-deducción) y empíricos (encuestas, entrevistas semiestructuradas y revisión documental). Como resultado del análisis bibliográfico identificó once modelos y herramientas agrupados en cuatro enfoques, ninguno de los cuales integra la gobernanza cooperativa con la gestión interna de la innovación. Los resultados empíricos revelan una innovación ocasional, centrada en el proceso, sostenida por el aprendizaje entre pares y por productores líderes, pero limitada por la falta de recursos, financiamiento, capacitación y articulación con los actores del sistema de conocimiento e innovación agrícola, y por barreras culturales como la baja motivación y la apropiación individual de las ideas. Los hallazgos se discuten frente a estudios recientes lo que contribuye al perfeccionamiento de la gestión de la innovación en el contexto cooperativo de Artemisa.

Palabras clave: innovación; gestión de la innovación; cooperativas agropecuarias.

RESUMO

A gestão da inovação tem sido abordada por diversos autores, que se referem à sua evolução para diferentes abordagens, enfocando-a como um processo sistemático no qual novas ideias são geradas e transformadas em novos produtos, serviços, processos ou modelos, que geram valor agregado e vantagens competitivas. Os desafios para o setor agropecuário cubano são diversos; as insuficiências no equipamento tecnológico e demais recursos limitam o desenvolvimento para alcançar um nível satisfatório de soberania alimentar. A presente pesquisa diagnostica o estado atual da gestão da inovação nas cooperativas agropecuárias da província de Artemisa, para identificar suas potencialidades, limitações e barreiras que permitam orientar seu aperfeiçoamento. Foram empregados métodos teóricos (análise e síntese, indução-dedução) e empíricos (questionários, entrevistas semiestruturadas e revisão documental). Como resultado da análise bibliográfica, identificaram-se onze modelos e ferramentas agrupados em quatro abordagens, nenhum dos quais integra a governança cooperativa com a gestão interna da inovação. Os resultados empíricos revelam uma inovação ocasional, centrada no processo, sustentada pela aprendizagem entre pares e por produtores líderes, mas limitada pela falta de recursos, financiamento, capacitação e articulação com os atores do Sistema de Conhecimento e Inovação Agrícola, e por barreiras culturais como a baixa motivação e a apropriação individual das ideias. Os achados são discutidos à luz de estudos recentes, o que contribui para o aperfeiçoamento da gestão da inovação no contexto cooperativo de Artemisa.

Palavras-chave: inovação; gestão da inovação; cooperativas agropecuárias.

INTRODUCTION

Agricultural cooperatives play an essential role in the development of Cuba's national economy. In recent years, measures have been implemented in the agricultural sector to boost food production, within a complex context where the intensification of the blockade poses challenges -including limited access to inputs, financing, and a lack of technological equipment, among others- that hinder their development.

Technology and innovation are key factors for the development of cooperatives and agriculture in general. Proper management of these processes can contribute significantly to improving productivity and strengthening agricultural farmers' associations. Likewise, the management of technological innovation in community-based agriculture is essential for improving productivity, sustainability, and local development (Monge García et al., 2025).

Thus, sustainable innovation is no longer understood merely as the incorporation of technology, but rather as a process of organizational, commercial, and territorial reconfiguration that strengthens the viability of rural economies (Álvarez Pincay & Ezcurra Zavaleta, 2026).

Innovation in cooperatives is a topic of great interest, as these organizations must adapt to a competitive and changing environment without abandoning their socioeconomic essence or the values and principles that characterize their management. Innovation in cooperatives must involve members in decision-making and promote democracy and participation for the development of cooperatives, as well as adopt sustainable practices that minimize their environmental impact. Therefore, it is a multidimensional process that encompasses economic, organizational, social, technological, and environmental aspects.

According to Álvarez Pincay & Ezcurra Zavaleta (2026), the academic discussion on rural development has evolved from approaches focused exclusively on productivity toward perspectives that integrate economic sustainability, social cohesion, and environmental protection. In this evolution, agricultural cooperatives have been recognized as structures capable of articulating productive and social interests in contexts where family farms, imperfect markets, and scale constraints predominate, and it is emphasized that innovation in cooperative production systems is a determining factor in improving the economic performance of rural agricultural units.

As part of the process of updating the Cuban economic model, far-reaching transformations are taking place in all sectors of the economy and all areas of society. In this regard, special emphasis has been placed on linking science, technological innovation with agro-industrial integration, the development of agri-food production, new management models, and more effective relationships between economic actors and the government -all of which promote development through more agile mechanisms and aim to increase the production of a wide range of high-quality products (Díaz-Canel Bermúdez & Delgado Fernández, 2021).

The Guidelines for the Economic and Social Policy of the Party and the Revolution for 2021-2026 outlined the main areas of focus for the five-year period, with the aim of channeling the priorities of the economy and the transformation of the Cuban Economic Model.

The guidelines comprising this plan prioritize: strengthening the management of economic actors, especially socialist state-owned enterprises as the main drivers of the economy; making progress in resolving the economy's structural problems, particularly by developing food production and marketing with an emphasis on the agricultural sector; achieving a greater share of renewable sources in the energy mix; increasing exports and effectively substituting imports; reviving and developing tourism; and promoting foreign direct investment and prioritizing the application of science, technology, and innovation in all spheres of society, particularly in productive activities.

Among the main problems hindering the effective fulfillment of the agricultural sector's mission are: low productivity across various production methods; limited application of scientific findings and innovation in production and service activities; and insufficient material and financial resources, among others.

In this regard, innovation management is a strategic element for consolidating food production at the local level, drawing on the potential of each territory and building upon the food sovereignty and nutritional education program. Improving this management in Cuban agricultural cooperatives requires a tool that, through a systemic approach, coordinates all actors involved in the process, integrating knowledge management actions according to their characteristics and specificities.

The general objective of this research is to diagnose the current state of innovation management in agricultural cooperatives in the province of Artemisa, in order to identify their potential, limitations, and barriers, thereby guiding efforts to improve it.

MATERIALS AND METHODS

To achieve the proposed objective, this research employs a set of theoretical and empirical methods; the materialist dialectical method enabled a systemic study of the innovation management process, providing an understanding of the main relationships within this process and the patterns observed in agricultural cooperatives through analysis and synthesis, supported by induction and deduction in determining generalities and patterns of the innovation process in the agricultural sector, following the logic explained below:

Literature review: the theoretical and methodological foundations related to the innovation management process were analyzed based on definitions provided by various authors, which made it possible to identify the essential elements of this management and its patterns in agricultural cooperatives in the province of Artemisa. The search strategy included academic databases (Scopus, Web of Science, SciELO, Redalyc), using keywords such as: "innovation management," "agricultural cooperatives," "AKIS," "innovation models," "rural extension," "participatory innovation," "Cuba," "agricultural cooperatives," and "innovation management." The search period spanned from 2015 to 2026, prioritizing publications from the last five years.

Diagnosis of the innovation process in agricultural cooperatives in the province of Artemisa: The methodology proposed by Ramos Crespo (2018) was used, beginning with the definition of the objectives and scope of the analysis, the identification of information needs, and the definition of primary and secondary information sources. These steps enabled the characterization of the agricultural cooperatives in the province, the identification of patterns in the innovation management process, and the identification of the main strengths and weaknesses.

Interviews: Seventeen interviews were conducted with executives from the Ministry of Agriculture, officials from the provincial and municipal agriculture offices, the National Association of Small Farmers (ANAP), and the Ministry of Science, Technology, and Environment (CITMA). Qualitative analysis of the interviews was performed using an open and axial coding procedure. In the first phase, 100% of the interviews were transcribed verbatim, and a cursory reading was conducted to identify units of meaning. Subsequently, open coding was performed, assigning descriptive codes to each relevant segment, which were then grouped into emerging categories through axial coding. A total of 47 units of meaning were identified, grouped into six categories: internal governance (12 mentions), access to technology (11), training (9), inter-institutional coordination (7), culture of innovation (5), and financial resources (3). Theoretical saturation was reached in interview number 14, as no new categories emerged. The results were cross-checked against meeting minutes and documentary records to ensure the triangulation of sources.

For the survey, a non-probabilistic purposive sampling method was used, selecting 62 cooperatives that met the following criteria: having been established for more than 10 years and having at least one active innovation project. Given the non-probabilistic and purposive nature of the sampling, the results obtained are descriptive and exploratory in scope for the province of Artemisa and are not statistically generalizable to the entire population of Cuban agricultural cooperatives. However, the

patterns identified can be analytically transferred to other contexts with similar structural characteristics.

The instruments (survey and interview guide) were validated by five experts in innovation management and agriculture, who assessed them as suitable for use. The results obtained from the surveys were processed using descriptive statistical techniques. The results were analyzed using the Statistical Package for the Social Sciences (SPSS).

RESULTS AND DISCUSSION

Results of the literature review

The literature review revealed that the concept of innovation has evolved from Schumpeter's seminal views -centered on the innovative entrepreneur and creative destruction- toward systemic, open, and collaborative approaches (Chesbrough, 2003; Freeman, 1987; Lundvall, 1992), to its current conceptualization as a multidimensional process encompassing product, process, organizational, and marketing innovations (OECD & Eurostat, 2018). In the agricultural sector, this general framework is embodied in Agricultural Knowledge and Innovation Systems (AKIS), which move beyond the linear transfer model by recognizing the multidirectional interaction among farmers, extension workers, researchers, and institutions (Cordovés Torres Gómez de Cádiz et al., 2017). However, the specialized literature emphasizes that, in agricultural cooperatives, innovation management faces specific challenges stemming from their democratic governance, their dual role as both members and service users, and the tension between business efficiency and collective participation (García Pérez et al., 2024). Based on this theoretical overview, the main definitions and approaches that constitute the research's conceptual framework are systematized, serving as a reference point for comparing the empirical findings of the assessment in Artemisa Province.

Based on the theoretical, methodological, and normative frameworks analyzed¹, the authors view innovation management in agricultural cooperatives as a systemic and continuous process of planning, organization, and control that integrates farmers' empirical knowledge with formal

¹ For the purposes of this research, the main theoretical, methodological, and regulatory references consulted in the categories analyzed are as follows: *Management*: López Solís et al. (2019), Rodríguez Sánchez (2020); *Innovation*: Cirera and Maloney (2017), Torres Cala et al. (2018), Myjak (2023); *Innovation Management*: OECD and Eurostat (2018), Cordovés Torres Gómez de Cádiz et al. (2020), Bouschery et al. (2023); *Agricultural Cooperatives*: Pavó Acosta (2019), Acosta Morales (2020), García Pérez et al. (2024), Council of State (2023), Martínez and Fontrodona (2025).

technology transfer, aimed at resolving production problems, ensuring environmental sustainability, and achieving food sovereignty -a process that requires a horizontal and collaborative model based on cooperative principles and values.

In this regard, the challenges facing the Cuban agricultural cooperative sector are diverse, stemming from shortages in technological equipment and other resources necessary to achieve a satisfactory level of food sovereignty by increasing domestic food production, which would make it possible to reduce food imports and, in turn, increase exports. For this reason, given the characteristics and particularities of agricultural cooperatives, improving the innovation process requires a tool that, through a systemic approach, brings together all the actors involved in this process, integrating their actions into the development of their management. Innovation management is not an isolated act but a systemic managerial process that requires aligning resources, knowledge, and organizational culture.

With this in mind, the research identified and compared a set of innovation management models and tools applicable to the agricultural and cooperative sectors (Figure 1), which serves as the basis for the analysis of the empirical diagnosis. The following is a summary of the common aspects and limitations shared by these models.

All models agree on the need to conduct a diagnosis of the innovation management process as a starting point; most recognize the importance of coordination among the various actors involved in the innovation process (government, academia, producers, support institutions); the need to define and develop the capacities of individuals involved in the innovation process is identified; the most robust models use a systems approach that integrates the different components and their interrelationships.

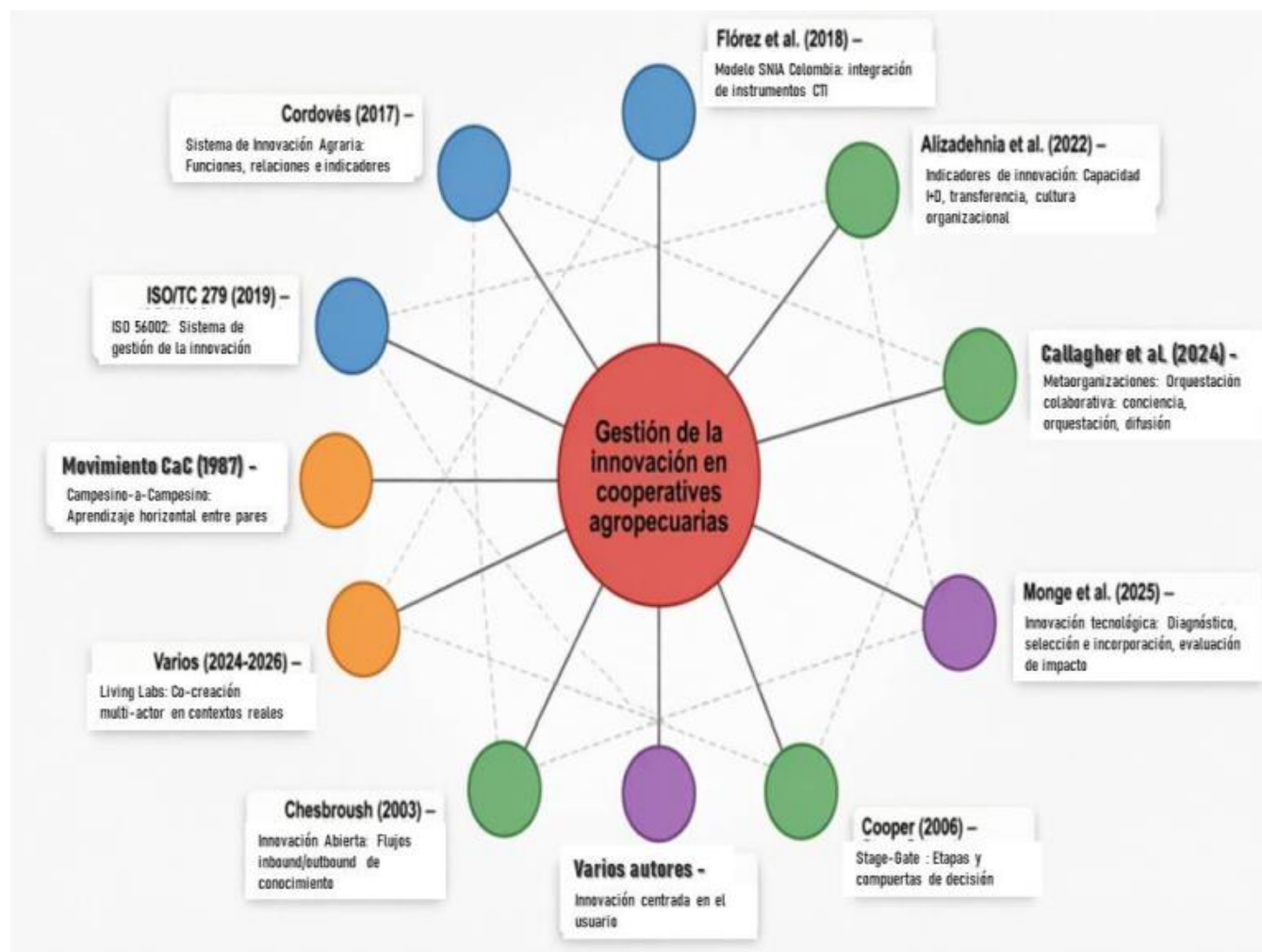


Figure 1. Innovation management models applicable to agricultural cooperatives

Source: Own elaboration using NetDraw 2.181 software

Among the main limitations is that the models do not take into account the specific characteristics of cooperative governance (democracy, participation, dual member-user status) in the design of innovation processes; many models maintain a linear conception of the innovation process (demand-invention-generalization), without sufficiently incorporating feedback loops and iterative learning; they do not adequately integrate innovation management with the cooperative's administrative cycle of planning, organization, direction, and control; although some mention sustainability, they do not develop specific mechanisms to integrate criteria related to responsible innovation, agroecology, gender, youth, and climate resilience; and they do not offer specific tools tailored to the context of Cuban agricultural cooperatives, which have limited resources and unique conditions.

Other authors have identified specific limitations -from the perspective of innovation management- that affect Cuban agricultural cooperatives. Cordovés Torres Gómez de Cádiz et al. (2020) identified the following: insufficient training, a lack of an innovation culture, a lack of knowledge regarding credit applications, distribution difficulties, undefined relationships between academia and the cooperative sector, insufficient financing, a lack of mechanisms for determining demand, and the absence of communication strategies for the widespread adoption of innovations. For their part, Torres Cala et al. (2018) pointed out patterns that limit the innovation process in the Cuban forestry sector, which are also applicable to agricultural cooperatives: a disconnect among key actors, shortcomings in the institutional framework, a concentration of research in subsectors that contribute less to the gross domestic product, and the lack of a dedicated science, technology, and innovation policy.

Results of the diagnosis

The province of Artemisa has a population of 512,602 inhabitants, distributed across 11 municipalities, 66 People's Councils, and 622 localities. To meet the planned demand, it needs to harvest an average of 879.9 ha per month and produce 7,073.7 metric tons of total products, of which 294.7 ha are for root crops (3,536.8 metric tons), 235.8 ha for vegetables (2,357.9 metric tons), 314 ha for grains (471.6 metric tons), and 35.4 ha for fruits (707.4 metric tons).

The total agricultural area amounts to 36,437.84 ha, of which 32,964.33 ha are arable, including 18,820 ha of permanent crops; the area available for planting allows for a crop rotation of 1.2 times. In addition to its commitment to meeting the population's demand, the province contributes to supplying produce to meet the demand of the country's capital.

To ensure these figures, the following structure is in place: 13 state-owned enterprises with 60 UEBs (Basic Business Units), in addition to 174 agricultural cooperatives: 38 UBPCs (Basic Cooperative Production Units), 30 CPAs (Agricultural Production Cooperatives), and 106 CCSs (Credit and Service Cooperatives), with a total of 17,742 members. Of these, 12 UBPCs, 6 CPAs, and 4 CCSs are affiliated with the Sugar Company, and 466 individual producers are affiliated with the various structures. Key production lines include: root crops (cassava, plantain, taro, sweet potato), vegetables, grains, beef, milk, small livestock, pigs, coffee, urban, suburban, and family farming, animal feed production, medicinal plants, fruit trees, forestry, and sugarcane.

During the research process, 17 interviews were conducted with officials from the agriculture delegations, CITMA and ANAP, with the aim of understanding the current status of the innovation management process in the province's agricultural cooperatives.

Based on the results, it was determined that this process is managed through a work system that facilitates the coordination of tasks with the factors that interact with the cooperatives and their members, but it is not carried out systematically.

These production units should have representatives to address science and technology, food quality and safety, the National Association of Innovators and Rationalizers movement, the Science and Technology Forum, and the farmer-to-farmer initiative; however, not all of them have such a representative. Development programs outline the planning of actions for the year and include those related to science, technology, and innovation, which are evident in the movements of model farms, agroecological farms, science champions, farmer leaders, and young entrepreneurs, as well as in collaborative projects and projects of the Cuban Association of Agricultural and Forestry Technicians, and in the partnership with the university through the involvement of agronomy students during their fieldwork placements.

Depending on their capabilities, farmers occasionally develop innovations in processes and products. The lack of specialists at the municipal level to provide guidance and oversight for these efforts hinders the effective functioning of the technical teams within the cooperatives. Among the main difficulties affecting the efficient development of this process are also noted: the lack of training for leaders and members; the lack of foresight and limited application of the results of science, technology, and innovation in production and service activities; and the lack of a systematic approach in the analyses presented to the cooperative's assembly regarding the monitoring of innovation management.

The surveys were administered to members of 62 agricultural cooperatives selected as a sample, including 16 CPAs, 34 CCSs, and 12 UBPCs, all of which have been in operation for more than 10 years. Based on their corporate purpose, 51 (82%) are involved in mixed crops and livestock, 6 (10%) in coffee, 4 (6%) in sugarcane production, and 1 (2%) in honey and fruit production.

The main production problems faced by the province's agricultural cooperatives are related to: a lack of inputs, poor seed quality, soil fertility, limited resources, climate change, water scarcity, low agricultural yields, and the efficiency of processes aimed at changing producers' mindsets.

It was evident that assembly meetings are held periodically, but there is a lack of systematic follow-up on proposed solutions to the production- y problems that arise. Regarding the innovation management process within the cooperative, the survey revealed that 96% innovate only occasionally, while interviews with managers confirmed that this is due to the lack of a continuous work system; only 3% believe that innovation never occurs. Ninety-two percent (57) stated that one of the members is responsible for seeking out and implementing new ideas to improve processes or products, which are put into practice according to the possibilities and conditions of their farm.

With regard to innovative technologies, 82% (51) learn to use them through their own trials, and 17% (11) through guidance from another farmer. This demonstrates the empowerment of empirical knowledge (farmer-to-farmer), but reflects a weakness in formal technology transfer from research centers. Over the past three years, some process innovations have been implemented in these cooperatives; 95% (59) report that these generally involve the use of organic fertilizer, bio-inputs, bio-products, biostimulants, biopesticides, bio-insecticides, bio-antibiotics, and others.

The results also show that 92% (57) of the members of these cooperatives consider their level of access to innovative technologies to be very limited, while 8% (5) consider it to be moderate. Information on new agricultural practices is obtained through exchanges at forums, fairs, and workshops (52%, or 32 respondents) and from other farmers (44%, or 27 respondents). 100% of respondents believe that their cooperative needs to improve its management of innovation, as well as promote training in areas related to science and innovation -which is sometimes provided, according to 69% (43) of respondents.

As the main barriers to innovation in cooperatives, 98% (62) cite a lack of financial resources and a lack of technological training, while 2% (1) cite resistance to change

Based on the results obtained from the survey of producers, the following strengths and weaknesses were identified in the innovation management process of agricultural cooperatives:

Strengths

1. The regular holding of cooperative assemblies.
2. Information on new practices is generally obtained through exchanges at forums, fairs, workshops, and events.

Weaknesses

1. Innovation in the cooperative's products or processes occurs only occasionally.
2. Over the past three years, only a few innovations have been implemented, including those related to organic fertilizer, bio-inputs, bio-products, biostimulants, biopesticides, bio-insecticides, and bio-antibiotics, among others.
3. New ideas for improving the cooperative's results are implemented by some members independently.
4. Improvements in the cooperative's processes or products, following the implementation of innovations, are insufficient.
5. Access to innovative technologies remains limited.
6. Producers learn to use innovative technologies through their own trials.
7. The cooperative's efforts to promote training in science and innovation are sporadic.
8. The main barriers to innovation management are a lack of financial resources and a lack of training.
9. 94% (58) of the producers surveyed rate their cooperative as generally prepared to implement an innovation management model.

Key strengths, limitations, and barriers in the innovation management process in agricultural cooperatives in the province of Artemisa

Potential

- The actions outlined in the government's program objectives to increase national food production and manage science and innovation.
- The General Law on Science, Technology, and Innovation.
- The organization of forums, events, and trade fairs for producers to exchange ideas.
- The experience of leading producers.
- Identification of new ideas based on needs and opportunities.
- Appropriate selection of innovations to be tested in field trials.
- Follow-up on potential solutions to production problems raised by producers.

Limitations

- Lack of resources and funding.
- Limited access to innovative technologies.
- Low soil fertility.
- Market uncertainty.
- Insufficient training for cooperative members in science, technology, and innovation.
- Insufficient coordination and collaboration with stakeholders who interact with agricultural cooperatives to foster the innovation process.
- Insufficient use of innovation in the cooperative's products or processes.

Barriers

- Lack of motivation and an innovative culture among producers.
- Resistance to change.
- New ideas are implemented independently by a single cooperative member (which indicates a lack of collective ownership and teamwork).

The empirical analysis in Artemisa Province reveals that innovation management in agricultural cooperatives is a predominantly empirical, occasional (96%), and individual-based process, which contrasts with the systemic and collaborative approaches that predominate in the contemporary literature reviewed. By comparing these findings with the theoretical frameworks analyzed, we were able to identify essential elements of this process, which are summarized below.

One of the key findings is that 92% of respondents report that new ideas are sought out and implemented by a single member of the cooperative, and 94% rate their readiness to manage innovation as "fair." This result indicates a departure from the principles of democratic governance and collective participation that define the essence of cooperatives (Martínez & Fontrodona, 2025). While authors such as Callagher et al. (2024) conceptualize cooperatives as "meta-organizations" capable of orchestrating collaborative solutions, at Artemisa innovation is not institutionalized within the assembly or the administrative cycle but rather depends on the isolated initiative of "leading producers." This corroborates the tension between business efficiency and collective participation highlighted by García Pérez et al. (2024), demonstrating that, without a management model that integrates innovation into the cooperative's governing bodies, tacit knowledge does not transform into collective intellectual capital.

The data show that 95% of recent innovations focus on bio-inputs and organic fertilizers, and that 82% of producers learn to use new technologies through their own trials or exchanges with other farmers. This behavior aligns with the principles of sustainable innovation and rural development proposed by Álvarez Pincay and Ezcurra Zavaleta (2026), in which territorial and environmental reconfiguration takes precedence over the mere acquisition of machinery. However, this also exposes the weakness of the agricultural knowledge and innovation system in the region. Unlike Open Innovation models (Chesbrough, 2003) or the formal technology management procedures (Monge García et al., 2025) -which assume structured R&D flows from academia to the field- the Farmer-to-Farmer Extension model predominates, in the Artemisa cooperatives. While this model is resilient and adaptive, its predominance reflects a structural flaw in formal technology transfer mechanisms -a historical problem in the Cuban context already noted by Cordovés Torres Gómez de Cádiz et al. (2020) and Torres Cala et al. (2018).

Traditionally, the literature on innovation management in capitalist firms identifies "resistance to change" as the main organizational barrier. However, in the Artemisa cooperatives, 98% of respondents identify a lack of financial resources and a lack of training as the fundamental obstacles, while only 2% mention resistance to change. This demonstrates that the limitations are not primarily attitudinal but rather relate to *absorption capacities* (Alizadehnia et al., 2022) and access to technologies (limited for 92%). The lack of municipal specialists (evident in the interviews) and the disconnect with research centers prevent cooperatives from transitioning from a defensive model (innovating to survive a lack of inputs) to a proactive and entrepreneurial model.

The literature review showed that models such as the Stage-Gate model (Cooper, 2006) or the ISO 56002 standard assume corporate structures with R&D departments and defined budgets. Artemisa's reality confirms the theoretical limitation identified in figure 1: these models are too rigid for cooperative contexts with limited resources. Innovation in these cooperatives does not follow a linear process; rather, it is iterative, based on local experimentation, and strongly influenced by market uncertainty and soil fertility.

In summary, innovation management in Artemisa's agricultural cooperatives is characterized as an empirical, ad hoc process that is highly dependent on knowledge exchange among farmers. Although there is a clear willingness to adopt agroecological practices and bio-inputs, the process lacks systematicity, planning, and a systemic managerial approach. The main barriers identified are a lack of financial resources, insufficient technological training, and weak coordination between knowledge-

generation centers and the cooperatives. This limits the transition from a defensive model to a proactive and entrepreneurial one, as proposed by García Pérez et al. (2024) and Martínez and Fontrodona (2025) regarding the need for the cooperative model to evolve. There is a clear need to implement management tools that bring together local stakeholders, promote formal technology transfer, and strengthen the capacities of cooperative members, thereby ensuring sustainable innovation that contributes to food sovereignty. As future lines of research, it is recommended to delve deeper into the design and validation of an innovation management model adapted to the specific characteristics of the Cuban cooperative context.

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Conflict of interest

Authors declare that they have no conflicts of interest.

Authors' contribution

Odeiky Calzada Hernández and Odalys Labrador Machín designed the study, analyzed the data, and drafted the manuscript.

Odeiky Calzada Hernández and Yerenis Torres Cala were involved in data collection, analysis, and interpretation.

Odeiky Calzada Hernández and Odalys Labrador Machín reviewed the writing of the manuscript and approve the version finally submitted.



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