Cultivos Tropicales, Vol. 45, No. 2, April-June 2024, e-ISSN: 1819-4087, p-ISSN: 0258-5936, https://ediciones.inca.edu.cu

Cu-ID: https://cu-id.com/2050/v45n2e02

Bibliographic review

Experiences of the technological management and innovation in Cuban agriculture

Experiencias de la gestión tecnológica y la innovación en la agricultura cubana

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ABSTRACT: At the global level, innovation systems have been oriented towards regional or local contexts and with flexible perspectives from their practical implementation, interactions between social actors and the role of learning in knowledge management. In the Cuban agricultural sector, there are different models, systems and procedures in order to implement technology management and innovation. On the other hand, the diversity of approaches and productive items in the Cuban context of agricultural sciences, contributes to the plurality of criteria in the approach to this subject, either from the institutional framework or from the execution of projects. The objective of this bibliographic review is to provide a detailed analysis of the main experiences, with special emphasis on the systems that make an outstanding contribution to the performance of local agri-food systems, through the participatory management of innovation.

Keywords: participatory research, pilot farms, rural development strategies, technical aid.

RESUMEN: A nivel mundial, los sistemas de innovación se han orientado hacia los contextos regionales o locales y con perspectivas más flexibles desde su instrumentación práctica, las interacciones entre los actores sociales y el rol del aprendizaje en la gestión del conocimiento. En el sector agropecuario cubano, existen diferentes modelos, sistemas y procedimientos con la finalidad de instrumentar la gestión de tecnología y la innovación. Por otra parte, la diversidad de enfoques y rubros productivos en el contexto cubano de las ciencias agrícolas, contribuye a la pluralidad de criterios en el abordaje de esta temática, ya sea desde la institucionalidad o desde la ejecución de proyectos. El objetivo de esta revisión bibliográfica es brindar un análisis detallado de las principales experiencias, con especial énfasis en los sistemas que realizan una destacada contribución al desempeño de los sistemas agroalimentarios locales, a través de la gestión participativa de la innovación.

Palabras clave: asistencia técnica, estrategias de desarrollo rural, fincas experimentales, investigación participativa.

INTRODUCTION

The theories of innovation systems, defined in the last decades of the 20th century, encompass the set of indicators and variables that contribute to the development of innovation capabilities, from an organization to a locality, a country, sector or region; as well as the elements and relationships that interact in the production, diffusion and use of knowledge (1-3).

At present, the scientific body of knowledge shows that these theories are valued from more flexible and different perspectives in regional or local innovation systems from their operational levels, the peculiarities of their interactions and the role of learning (4-7).

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Received: 02/08/2022

Accepted: 14/10/2022

Conflict of interest: The authors declare that they have no conflict of interest.

Author contributions: Conceptualization- Miguel Socorro Quesada, Teodoro López Betancourt. Research- Deborah González Viera. **Methodology and Supervision-** Miguel Socorro Quesada, Teodoro López Betancourt**. Initial draft writing-** Deborah González Viera. **Writing and final editing and data curation-** Deborah González Viera, Miguel Socorro Quesada, Teodoro López Betancourt.

In the Cuban agricultural sector, both in the conventional agricultural model and in the current agricultural model aimed at sustainability on agroecological bases, the management of technology and innovation assumes the incorporation of scientific-technical results as a basic component to guarantee the country's food security and sustainable development (8-10).

By virtue of this, the degree of adoption of promising innovations by the institutional matrix is manifested in the performance of the cycle of food sustainability in Cuba; with special transcendence in the substitution of imports, in addition to the use of natural and energy resources (11).

Therefore, the objective of this review is to provide a detailed analysis of the different approaches and concrete experiences, in terms of technology and innovation management, which are used by different agricultural science research institutes in Cuba.

DEVELOPMENT

Institutional vision of the management of technology and innovation

It is important to clarify that academic works on innovation in Cuban agriculture use the term Technology and Innovation Management. For the most part, the experiences assume econometric or socioeconomic approaches and are aimed at the development and participatory adoption of technologies (12).

By virtue of this, Cuban authors define the interacting factors that cause the limitations in the development of this academic discipline and conclude that, in the introduction of a new technology, the point of view of the receiver should be considered more than the approach of the sender (13, 14).

In the characterization and diagnosis of the National System of Agricultural Science and Technological Innovation (SINCITA), the Ministry of Agriculture (MINAG) conceptualizes technological innovation in accordance with the definition of the Oslo Manual. In this case, the definition includes the role of innovation in the company's strategy, the internal and external changes that must take place and the need to have an impact on the degree of satisfaction of the demands of the agricultural sector (15, 16).

In this sense, the Agricultural Extension System (AES) of the Minag is the current interface of technological innovation management in Cuban agriculture and a diversified and integrating device to support farmers. PASEA (Franco-Cuban Project to Support the Agricultural Extension System) enhances synergy among the actors in the extension/innovation process and values both the knowledge of scientific research and the empirical knowledge of producers (17).

The phases or PASEA methodology stages include: the systemic diagnosis of the production unit that contributes to the design of an action plan, the joint work to find solutions through interest groups and the connection of activities between organizations through networks of competencies (18,19).

This last phase was not implemented in practice, thus affecting the performance of the AES as an interface entity. Instead, vertical forms of extension are carried out with a strong link between scientific institutions and business groups, in synergy with other approaches supported by agroecology (17,20,21).

Thus, the Farmer to farmer methodology in Cuba has a working system based on agroecology, sustainable agriculture and horizontal communication. Its objective is to facilitate exchange and learning processes with participatory methodologies, where farmers are the protagonists (22,23).

An example of the link between the productive sector and science is the Management System for Science and Technological Innovation in Swine Production (GECIPOR System), which is the tool for managing science and technological innovation in swine production. The GECIPOR system assumes the systemic vision of innovation, with emphasis on closing the science/ technology/innovation cycle in the swine production chain (24-26).

In this sense, the Sugarcane Research and Producer Assistance System is structured under the concept of the "closed cycle", for the generalization of research results through Scientific-Technical Services. Within the validation-extension activities, methodological studies are carried out to provide adequate solutions for sugarcane production (27).

Similarly, actions are carried out to implement the AES of the Tropical Fruit Growing Research Institute. This system uses six different ways to identify the demands of the fruit agroindustry. The identified demands facilitate the design and execution of the different projects, in which results are obtained with scientific-technological recommendations that are introduced into production practice (28).

The livestock sector presents the largest number of scientific works that address the subject of innovation in depth and contextualized to the agricultural environment. Among them, the application of a model to support the decision-making process, which considers the interrelation between business functions and the fundamental activity in livestock companies, stands out (12).

Likewise, other researches define the general procedure of the Extension System of the Institute of Animal Science (SEICA). The methodological contribution of these works consists in the foundation of such extension system. In addition, the conceptual relationship of agricultural extension with the management cycle is described, which includes the functions of Technology and Innovation Management, which is applied in the Cuban university-state livestock enterprise relationship (29-31).

In turn, plant health has in the model of Participatory Phytosanitary Innovation, a platform for learning and innovation, which facilitates the design of programs of local agroecological pest management. The generation, validation and adoption of phytosanitary technologies with the active participation of the researcher, the technician or extensionist and the farmer (32,33) characterize this model.

On the other hand, the infrastructure and mechanisms that make possible the development of 28 Subprograms of Urban, Suburban and Family Agriculture are the basis of agricultural extension, where the municipal urban farm and its structure at the level of the People's Council constitute the core of the extensionist scheme (34).

An interesting tool to make irrigation a sustainable activity is the Irrigation Advisory Service (IAS). Focused on farmers' demands, it is oriented towards water management and irrigation systems for a more rational use of water resources, hence its relevance now (35).

The need for Technology Management and Innovation in rice cultivation is given by the implementation of strategies that allow the reduction of external inputs without affecting yield. In this endeavor, no model is proposed and the precepts of technology management are implemented at the local level, through Agricultural Extension (36-39).

For its part, the Agricultural Engineering Research Institute (IAgric) proposes a procedure with a proactive approach for the Integrated Management of Technology Transfer. Its application is intended to improve the technology transfer and acquisition management capacity of entities involved in technological and environmental improvement processes in companies (40).

Agroecosystem sustainability and participatory technology identification

In Cuba, various methodologies are used to analyze the sustainability of agroecosystems and identify the demands for technological innovations, for the projection of sustainable strategies under local conditions (32, 41-45).

The Methodology for the Development of Plant Biodiversity (MEDEBIVE) makes it possible to analyze agroecosystems under the principles of participatory action research. Its approach is aimed at plant biodiversity and constitutes an enriching complement to the efforts of a transformative vision towards sustainable development (41).

Based on the MEDEBIVE proposal, the Methodological Proposal for the Sustainable Agricultural Development of Agroecosystems (PROMEDAS) integrates different systems analysis tools and includes a set of sustainability indicators and indices that reflect the proximity of agroecosystems to sustainability (41, 42).

The Ecological Framework for the Assessment of Sustainability (ECOFAS) uses the DIA (diversified, integrated and self-sufficient) system approach in the conversion of agricultural systems. Its purpose is to identify local strategies to reduce the limitations or critical points detected in the analysis of agroecosystems and define appropriate strategies for sustainable agricultural production 43).

The working methodology of the Franco-Cuban Project to Support the Agricultural Extension System (PASEA) proposes a set of methodological tools for a generalist, systemic and participatory agricultural extension. Its central purpose is to serve as a liaison device between the different actors involved in the AES and the different forms of organization of agricultural production in Cuba (19).

The agroecological reconversion of agricultural systems into sustainable systems is one of the demands of Cuban agriculture, especially in urban, suburban and family environments. Biofarms system provides a solution to this imperative, since it consists of a process of participatory learning, diagnosis and innovation on biodiversity at the farm level (33, 44).

The Agroecosystem Diversity Index (ADI) is another novel proposal for assessing the sustainability of agroecosystems based on functional and associated diversity, with four sub-indices that define the diversity that cannot be lacking in the agroecosystem (family, local or territorial) to ensure sustainability towards food sovereignty (45).

This index is a tool that promotes diversity for its utilitarian values for human food, animal food, biodiversity to improve the physical, chemical and biological properties of soils, and complementary biodiversity that functions in favor of other forms of life and non-food needs. Therefore, the ADI is an integrative proposal that does not interfere with any of the other existing proposals (45).

Innovation networks between farmers, scientists and local decision-makers

The search for solutions without a systemic approach in the analysis of agroecosystems generates unfavorable consequences for innovation. The systemic vision and the strengthening of innovation underpin the Local Agricultural Innovation Program (PIAL), as a strategy for promoting agrobiodiversity in favor of food security and sovereignty (46).

The genesis of the PIAL has its antecedents in Participatory Plant Breeding (PF), a movement that involves farmers in the participatory selection of seeds and dissemination of agrobiodiversity in economically important crops (47).

The main tools used in PIAL in the agricultural scenario are Local Diagnoses, Agrobiodiversity Fairs, Agricultural Biodiversity Dissemination Centers, Peasant Experimentation, Innovation Festivals and Farmers' Schools (48).

Local diagnoses are the first stage of the FP-PIAL and involve - to varying degrees - researchers with farmers and their families, for the agricultural and social characterization of the community. The questionnaires therefore include demographic, agronomic, phytosanitary and gender aspects. Therefore, with this instrument, relevant information is obtained about the use of seed systems, with special emphasis on farmers' access to the formal system (49).

Agrobiodiversity fairs are proposed as the second phase of the FP-PIAL and their objective is to contribute, through participatory selection, to maintaining and increasing the biodiversity of species and cultivars of crops of economic interest to farmers. Variety gardens or fairs are recognized institutionally for some crops, as is the case of the "National System of Popular Rice Production" (49, 50).

The FP-PIAL project's approach has an impact on the spontaneous emergence of Agricultural Biodiversity Dissemination Centers, based on the work of the Local Agricultural Innovation Centers, where local stakeholders are empowered to disseminate biodiversity (51).

The leading institutions develop Local Agricultural Innovation Centers, which are a system of relations between local, national and international stakeholders, directed by a local facilitating entity, that promote continuous changes in production systems to increase the quantity and quality of economic, environmental and social benefits for the target populations (51).

According to the literature, Agricultural Biodiversity Dissemination Centers are sites (farms or groups of farmers' farms, backyards, backyards) where a high diversity of crops, technologies and cultivars are introduced, experimented, conserved and disseminated at a minimum cost, so that they can be maintained and multiplied in a sustained manner by the participating communities (51).

Among the relevant results of the FP-PIAL is the inventory of 95 Agricultural Biodiversity Dissemination Centers and 10 Local Agricultural Innovation Centers, located in 28 municipalities in 10 Cuban provinces. In this way, a critical mass of farmer experimenters is created in the communities and leaders by species are identified (52).

The farmers themselves, with the objective of acquiring new knowledge, can define Farmer experimentation as a process developed at the farm level. The observation of the operation of new technologies, under practical conditions, is vital in the instruction and training of farmers (53).

The Innovation Festivals are the actions for the sale of cultivars held by the farmers participating in the FP-PIAL project. The commercial outlet for biodiversity and innovation products is carried out with the support of municipal governments, in a space of exchange between farmers and consumers (48).

Farmers' schools, according to the characteristics of the Cuban countryside, comprise a set of workshops that follow the cycle of a crop, a technology or a thematic unit, where peasant experimentation becomes a fundamental structure for discovery, adoption and adaptation to local conditions. Its main role is the collective strengthening of peasant knowledge through scientific knowledge and practical experience (54).

The actions of the FP-PIAL generate new spaces for synergy and integration in the relations between the formal and local systems for managing genetic resources, due to the development of the Local Seed Committees in the Agricultural Biodiversity Dissemination Centers (55).

PIAL goes beyond the centralized model of innovation and technology transfer, where researchers know the priorities of farmers and adopt the technologies designed in the research centers. The adoption of technological innovations, with the participation of farmers as protagonists, makes it possible to rethink the Cuban agricultural innovation system in a new socioeconomic context (47).

Another notable result of the implementation of the FP-PIAL, in terms of innovation, is the increase in the research awareness of participating farmers, which is manifested in the creation and transition of cultivar and seed evaluation groups into technology experimentation networks (56).

The systemic approach lies in a more integrated understanding of the functioning of agricultural systems, where the farmer is at the center of the process of adopting technological innovation. In this regard, the innovation systems linked to agrifood chains are examples that demonstrate decentralized and participatory forms of food innovation, production and marketing (55, 57).

Participatory management of innovation and local agri-food development

The Cuban PASEA and FP-PIAL experiences show that municipal agricultural development is increasingly less responsive to the linear model of innovation, which does not usually take into account the diversity of scenarios and demands of local agricultural systems. These experiences take advantage of systemic approaches to innovation, which is conceived as a social, interactive and systemic process that emphasizes the role of networks, interactions, actors and innovation and is materialized as a fundamental expression of the quality of these interactions (58).

In view of this reality, conceptual renovations in this area suggest that an innovation system is a fabric that articulates various actors that supported by institutions, policies and regulatory systems that allow it, interact with each other to produce, disseminate and use knowledge (59).

The Local Agricultural Innovation System (SIAL), with its background in the lessons and lessons learned from the PIAL in each of its phases. It constitutes a proposal for participatory management of innovation and development at the territorial level, which seeks to strengthen the current innovation system in Cuba, by providing a model that has been built, hand in hand, between people from science and agricultural production, with the purpose of promoting the agrifood and local development of the territories (60).

From a theoretical perspective, the SIAL uses the approach of Local Innovation Systems, which seek to promote policies that encourage the coordinated work of local actors, in order to create capacities and manage knowledge, through learning by doing with its modalities (seed diversity fairs, farmer experimentation, innovation festivals and convivial gatherings) together with popular education (61).

The SIAL articulates new forms of social organization of innovation with a culture of participation, based on principles and good practices, for local agricultural development, in which the Multi-Action Management Platform (MAMP) and the Local Agricultural Innovation Groups (GIAL) are essential components for taking advantage of and enhancing the capacities available in the territories (60).

The Multi-stakeholder Management Platform is the local coordination space, led by municipal governments, which brings together a group of stakeholders with the leading participation of farmers and peasants, while the Local Agricultural Innovation Groups are the direct beneficiaries of innovation, brought together by a common challenge or demand (60).

In summary, the SIAL articulates components (tangible and intangible) and processes for participatory innovation management. It is in response to local demands for agricultural and rural development. It takes advantage of and enhances local capabilities, traditional and scientific knowledge, as well as relevant experiences, to generate sustainable improvements in a contextualized and equitable manner (62).

CONCLUSIONS

- From the institutional point of view, the results of this work show similarities in the use of approaches and principles of Technology and Innovation Management. Likewise, it is difficult for the models, systems and procedures to cover all the ideas or theoretical approaches of their methodological support, especially the most recent ones.
- Among the common points, it can be seen that training and feedback receive special attention, because information and knowledge management is a fundamental component that supports their proposals, although it is not evident at first sight.
- In the Cuban agricultural and livestock environment, most of the successful experiences, by item, lack the identification and characterization of groups of farmers and producers with similar technological needs or domains of recommendations, and this issue is essential in the adoption of technological innovations.
- Finally, the systemic approach constitutes a fundamental aspect of the existing methodologies and tools, which conceive the analysis of the sustainability of agroecosystems together with the participatory identification of the demands for technological innovations in Cuban agriculture.

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