Cultivos Tropicales, Vol. 45, No. 4, October-December 2024, e-ISSN: 1819-4087, p-ISSN: 0258-5936, https://ediciones.inca.edu.cu

Cu-ID: https://cu-id.com/2177/v33n4e15

Original article

Adoption of Ecomic® and Quitomax® technology on four Mayabeque farms

Adopción de la tecnología Ecomic® y Quitomax® en cuatro fincas de Mayabeque

Ilén Miranda Mora[1]*, Luis Roberto Fundora Sánchez[1], Gloria Marta Martín Alonso[1], Clara María Trujillo Rodríguez[2], Joanna Gazmuri Roldán[1], Ramón Rivera Espinosa[1]

[1]Instituto Nacional de Ciencias Agrícolas (INCA), carretera San José-Tapaste, km 3½, Gaveta Postal 1, San José de las Lajas, Mayabeque, Cuba. CP 32 700

[2]Universidad Agraria de La Habana "Fructuoso Rodríguez Pérez", carretera a Tapaste y Autopista Nacional, San José de las Lajas, Mayabeque, Cuba. CP 32 700

ABSTRACT: The combined employment of the bioproducts EcoMic® and QuitoMax® are very effective to increase the agricultural yields, however, its adoption under production conditions is even very limited. It is in and of itself that it was carried out this work to evaluate the adoption of the technology of the combined handling of EcoMic® and QuitoMax® in four rural properties of the county Mayabeque. The evaluations were developed in areas of production of the farms "La Chivería", "El Mulato", "San Miguel" and "Santa Catalina", beginning with the initial characterization of the farm, trainings in the use and handling of the bioproductos and the establishment of permanent areas with the employment of this technology in crops sequences. The results showed that the combined employment of the bioproducts caused a positive effect in the yields of the crops sequences in the four valued farms. In addition, the forms of adoption of the technology will depend on the general conditions of each farm and the knowledge of each producer. For the success of the innovation stocks, it is required the accompaniment and consultantship to the producers.

Key words: innovation, bioproducts, agricultural extension, management.

RESUMEN: El empleo combinado de los bioproductos EcoMic® y QuitoMax® es muy efectivo para incrementar los rendimientos agrícolas, sin embargo, su adopción en condiciones de producción resulta aún muy limitada. Es por ello que se realizó este trabajo para evaluar la adopción de la tecnología del manejo combinado del EcoMic® y el QuitoMax® en cuatro fincas de la provincia Mayabeque. Las evaluaciones se desarrollaron en las áreas de producción de las fincas "La Chivería", "El Mulato", "San Miguel" y "Santa Catalina", comenzando con la caracterización inicial de las fincas, capacitaciones en el uso y manejo de los bioproductos y el establecimiento de áreas permanentes con el empleo de esta tecnología en secuencias de cultivos. Los resultados mostraron que el empleo conjunto de los bioproductos provocó un efecto positivo en los rendimientos de las secuencias de cultivos en las cuatro fincas evaluadas. Además, las formas de adopción de la tecnología van a depender de las condiciones generales de cada finca y los conocimientos de cada productor. Para el éxito de las acciones de innovación, se requiere el acompañamiento y la asesoría a los productores.

Palabras clave: innovación, productos biológicos, extensión agrícola, manejo.

*Author for correspondence. ilenmiranda45@gmail.com

Received: 24/12/2023

Accepted: 17/05/2024

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

Authors' contribution: Conceptualization- Ilén Miranda. Research- Ilén Miranda, Gloria Martín, Luis Roberto Fundora, Ramón Rivera. **Methodology-** Ilén Miranda, Luis Roberto Fundora, Gloria Martín, Clara María Trujillo, Joanna Gazmuri. **Supervision-** Gloria Martín, Clara María Trujillo. **Initial draft writing-** Ilén Miranda, Luis Roberto Fundora. **Final writing and editing-** Ilén Miranda, Luis Roberto Fundora, Gloria Martín, Clara María Trujillo. **Data curation-** Ilén Miranda, Gloria Martín, Clara María Trujillo.

INTRODUCTION

In recent years, the process of agricultural expansion has generated the need to create mechanisms to promote technological advances in the farming sector. Encouraging and supporting producers' means betting on the sustained development of the rural milieu in its economic, social and environmental aspects. It is proposed that the environment for its promotion and development requires the common good, technology and user communities (1).

In this sense, Cuban agricultural production, today more than ever, needs to increase yields and raise the nutritional content of crops, mainly with domestic inputs that contribute to the reduction of imported agrochemicals. For this reason, since the 1990s, intensive research has been carried out in the search for bioproducts from natural raw materials, which has led to the current existence of about 21 products catalogued as biofertilizers and biostimulants (2, 3).

Among these catalogued products, QuitoMax® is a deacetylated derivative of chitin and an important structural polysaccharide of the cell walls of fungi, the cuticle of insects and the exoskeletons of crustaceans; the latter being the source for obtaining it for practical purposes in agriculture (4). Another of the most common bioproducts used in these agricultural practices is EcoMic®, derived from Arbuscular Mycorrhizal Fungi (AMF), which are obligatory symbiont organisms associated with the roots of higher plants, and whose main advantage is that they increase the exploration capacity of the soil, the absorption of mineral nutrients and, consequently, the growth and development of plants (5).

There are several interested authors who recognize the value of the use of bioproducts and the close relationship between the arduous work of innovation for scientific and research knowledge and social development. Others promote the use of bioproducts to contribute to food and crop production in all seasons (6, 7).

For these reasons, these bioproducts have been combined and adopted as part of agricultural production technologies in peasant farms to increase yields of different crops. It is suggested that the generation and adoption of new technologies should be carried out in parallel with the producer, taking into consideration his own idiosyncrasy, culture, interests and the agroecological and economic conditions in which he develops (8). Innovation is a factor of change in all sectors of the economy, society and daily life (9). It is now recognized as a strategic priority of great importance in meeting the challenges facing agriculture. It is considered necessary because of its contribution to reducing costs, increasing productivity, the possibility of substituting imports and increasing export capacity.

Given the current context of Cuban agriculture, where the use of fertilizers and chemical pesticides imported at high prices is being minimized, it is of great importance to have products of natural origin, non-toxic, obtained from national raw materials, through methodologies that reduce production costs and can increase yields in the same cultivable area (10). That is why the objective of the research was to evaluate the adoption of the combined management technology of EcoMic® and QuitoMax® in four farms in Mayabeque province.

El proceso de expansión agrícola ha generado en los últimos años la necesidad de crear mecanismos que potencien avances tecnológicos en el sector campesino. Fomentar y dar apoyo a los productores significa apostar por un desarrollo sostenido del medio rural en su vertiente económica, social y medioambiental. Se plantea que el entorno para su fomento y desarrollo requiere del bien común, la tecnología y comunidades de usuarios (1).

MATERIALS AND METHODS

Characterization of the study scenario

The present research was developed during the years 2017 to 2023, in Mayabeque province. The case study included the farms "El Mulato", "La Chivería", "San Miguel" and "Santa Catalina", whose social purpose is the production of viands, grains, vegetables and are dedicated to facilitate food supply to improve the country's economy. These farms were selected for their high levels of biodiversity, for implementing agroecological techniques, and for their easy access and open willingness of producers to participate in the research.

Since 2017, the National Institute of Agricultural Sciences (INCA) has carried out different extension and training actions to the farms under study that respond to the project "Establishment of a system for EcoMic® use of mycorrhizal biofertilizer and other bioproducts in food production", which have achieved productive, economic, social and environmental results in the peasant cooperative sector, where producers occupy an important, integral and leading role in the agrarian development of the municipality in all aspects of peasant life.

That is why the work methodology used was the Participatory Action Research (PAR) (11) to interpret the process of the producers in the search for solutions to their problems based on innovations. For this reason, we began with the individual characterization of each farm, to diagnose its current situation, as well as the degree of knowledge of the producers about soil fertility, the use and management of biofertilizers and local sources of nutrients, through the empirical method of semi-structured interviews with the producers. In addition, it was reflected in the interviews which were the main limiting factors of production in the farmers' opinion.

Training

PRA seeks the real needs of the community through joint work between producers and extensionists, starting with planning, defining approaches, systematizing experiences and developing social transformations. Therefore, different types of training were implemented on the farms using awareness-raising and group work techniques, based on a two-way dialogue on the use and management of bioproducts, the production of green manure seeds and their management, as well as other alternatives for supplying nutrients to crops.

The impact degree of the training on farmers' knowledge and the acceptance level of the proposed management was assessed through the application of surveys, the evaluation of the frequency of each response offered and monitoring at the entity level. The number of farmers who take ownership of the proposed integrated nutrient management system was identified with respect to farmers who receive the training but do not use it.

Permanent areas

An area dedicated to short-cycle crops was selected as a permanent area within each farm to evaluate the effect of the combined use of EcoMic® and QuitoMax® technology on agricultural yields. As a permanent area, it was assumed that the treatments under study were always maintained in the same area during the entire crop sequence (2017-2023). Each sequence depended on farm conditions and grower preferences.

In all cases, two treatments were evaluated: one the production control, which included all the management traditionally carried out by the producers to the crop and the other consisted of this same traditional management plus the joint application of EcoMic® by seed coating at planting and the application of QuitoMax® sprayed with 50 mL ha^{-1} at the time of crop growth and pre-flowering, according to the manufacturer's instructions. A quasi-experimental model was used because the treatments were located in each of the farms in non-randomized strips, considering five samples in each strip as replicates.

Crops evaluated in each farm are presented in Table 1. For all crops in each sequence evaluated, the agricultural yield was estimated.

After testing the homogeneity of variance between treatments, two by two, for each crop and farm, the equality hypothesis of the means of the yields of each crop between treatments was verified. With this information, the confidence intervals were calculated using the following formula:

$$IC = \mathrm{X} \pm t\alpha(2)(n-1)S/\sqrt{n}$$

Where: CI = confidence interval, $\bar{X}$ = arithmetic mean, S=standard deviation. n = number of observations, t = Student's t-statistic of the hypothesis test, α=0.05 for a confidence level of 95 %.

End-of-season surveys for each crop

At the end of each crop cycle (harvest), an end-of-season survey was applied to the producers participating in the production process. The agronomic results obtained and the level of satisfaction with the adoption of the new technology were evaluated. In this way, we followed up on the particularities that the applications of these bioproducts presented in each crop, their level of acceptance and difficulties with their use.

In this sense, five questions were formulated. Question one was developed with the objective of finding out if differences were observed with the combined use of EcoMic® and QuitoMax® with respect to the control in terms of: yield, number of flowers/fruits, plant growth, leaf area and if no difference was observed.

In order to investigate the difficulties of using some of the bioproducts evaluated, question two was asked. In the case of question three, it made it possible to determine whether the actors involved in the innovation process feel that their way of thinking and doing agriculture has changed after experimenting with the bioproducts.

A proactive assessment was made, taking into account present actions that also have repercussions for the future. With respect to the use of innovation, the skills of producers as innovators in the face of environmental events were conceived. Questions four and five, referring to how and when the bioproducts will be used again. Using statistical tools: analysis of absolute and relative frequency distribution for each variable reported in the surveys, the producers identified the factors limiting production.

Table 1. Crop sequences in each farm analyzed as a case study

El Mulato	La Chivería	Santa Catalina	San Miguel
Corn	Bean	Bean	Bean
Bean	Pepper	Corn	Cassava /canavalia
Cassava	Cassava	Sweet potato	Corn
Bean	Garlic	Corn	Sweet potato
Corn	Corn	Bean	Canavalia
Cucumber	Bean	Corn	Garlic
Bean	Tomato	Barbecho	Corn
Corn	Corn	Bean	Sweet potato
Tomato	Bean	Corn	Bean
Bean	Garlic	Canavalia	Sweet potato
Corn	Canavalia	Pumpkin	
Bean	Tomato		
	Bean		

Source: Own elaboration with research data

RESULTS AND DISCUSSION

Characterization of the study scenario

The characterization of the four farms was carried out through initial surveys of the producers, which were based on visits and participant observation. The main characteristics of these farms are presented in Table 2.

The soil type (12) and irrigation method used on the farms is shown in Table 3.

Figure 1 shows the main characteristics found in the farms related to soil fertility management and plant nutrition.

The main characteristics of the farms were as follows:

- 75 % of the interviewees previously used biofertilizers, only in the Santa Catalina farm it was not used due to lack of knowledge and because the acquisition of the same was not within reach.
- 100 % of the farmers used mineral fertilizers on their farms because they saw it as an alternative to increase their production.
- Regarding training on the use of bioproducts, 75 % of the producers said that they had access to them on some occasions, although not systematically. Only on the Santa Catalina farm did they not receive training until the beginning of the project.
- On the other hand, 100 % of those surveyed stated that organic fertilizers are widely used, although they are not applied in adequate quantities and are produced in very low percentages, while 75 % stated that green fertilizers are little used; only La Chivería farm makes use of them.
- In the meetings with the producers, it was found that soil analysis is very little used, only 50 % do it, such is the case of El Mulato and La Chivería farms.

The study carried out on the farms allowed grouping those with homogeneous conditions, to know their limitations and the possibility of adopting technological changes. In this sense, the characterization of the productive systems is an important stage in the research (13). It consists of determining a set of variables that distinguish a particular area or production unit and make it different from others. In these agricultural production systems it is of great importance to determine the characteristics of the soil before putting it into exploitation (14).

It can be said that the benefits of the combined use of bioproducts are not used in the farms, not only because the availability is low, but also because they require an integral training that had not been carried out. In this sense, a study was conducted on agricultural production in terms of food

Table 2. Characteristics of the farms under study

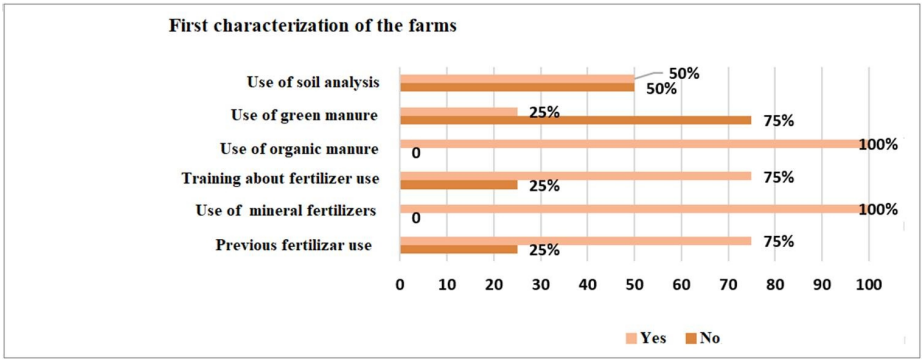
Farms	Productive Form to which they belong	Location	Area (ha)
La Chivería	CCS Paco Cabrera	Zaragoza, San José de las Lajas, Mayabeque	6
El Mulato	CCS Orlando Cuellar	Tapaste, San José de las Lajas, Mayabeque	14
San Miguel	CCS Niceto Pérez	Tumba Cuatro, Jaruco, Mayabeque	3
Santa Catalina	CCS Santa Elena	Los Palos, Nueva Paz, Mayabeque	26.8

Source: Own elaboration with research data

Table 3. Soil types and irrigation methods used on the farms

Farms	Type of soil	Irrigation method
La Chivería	Fersialitic Reddish Brown	Diesel and irrigation
El Mulato	Red Ferrallitic Leachate	Diesel and spraying
San Miguel	Carbonated sialitic brown	Without irrigation
Santa Catalina	Red Ferrallitic Leachate	Electric and spraying

Source: Own elaboration with research data



Source: Prepared by the author with research data

Figure 1. Results of the initial surveys applied to producers

sovereignty and nutritional education. It was agreed with the criterion that before developing any research, the first thing to do is to carry out a study of the available patrimony (15). These diagnoses are carried out with the objective of identifying the potentialities and restrictions in the agrarian systems, through teamwork, group discussion and the use of participatory techniques. Their purpose is to train and sensitize producers in order to transform their actions in an equitable manner. Therefore, the role of the extensionist is relevant as a mediator of the cognitive process that allows raising the quality of life of the actors and increasing their agricultural yields.

The behavior of the factors limiting production is shown in Figure 2.

- It was observed that 75 % of the respondents do not perceive soil fertility as a limiting factor, while for the Santa Catalina farm it is an obstacle.
- 100 % of those surveyed stated that soil type and stoniness are not limiting factors.
- Only 25 % said that seed quality and weed control were not a problem for agricultural production.
- Seventy-five percent of the farmers see agricultural machinery, lack of fertilizers and manure, and labor as limiting factors.
- Fifty percent of the farmers see irrigation, pests and diseases, and incentives to produce and market as obstacles to agricultural production.

This comprehensive assessment made clear the need to intensify training and other innovation actions with farmers to promote the integrated use of bioproducts. The production and use of organic fertilizers, the use of soil analysis and the maintenance of soil fertility, achieved greater efficiency, sustainable yields and economic and social impact.

When comparing the research with other studies, the existence of limiting factors for production was observed. This author identified the deficit of agricultural implements, machinery, soil preparation and seed quality. In contrast to this research, the restrictive variables do not coincide, since they vary depending on the functional diversity of the agrarian systems. Thus, there is agreement on the criterion that it is necessary to identify the strengths and weaknesses of the environment where the new technology will be put into practice (16).

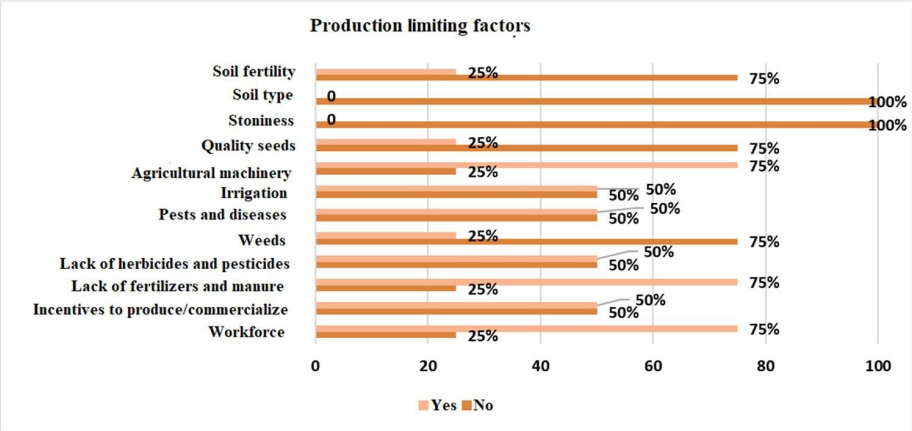
Based on this diagnosis, in line with the research of the System of actions for the production of viands for food sovereignty and nutritional education (17), the analysis of natural, material and infrastructure resources, economic, productive and social resources was deepened, identifying potentialities and restrictions through team work, group discussion and brainstorming, in order to train and sensitize producers with practical methods on the management of bioproducts.

Training

During the period from 2017 to 2023, 25 training actions were carried out, 21 individual, within the farms and 4 in cooperative workshops about the combined use of these bioproducts and their integration with local sources of nutrients. Since the PRA methodology was assumed, the producers of the farms under study were involved and the results were socialized in the cooperative production units to which each of the farms belonged. Throughout the research process, the producers had broad participation in decision-making, bidirectional dialogue, learning from action and social transformation.

In all the activities carried out, leaflets were distributed on how to use EcoMic® and QuitoMax® according to the crops. These trainings were carried out with the objective of stimulating, incorporating and recognizing the contribution and capacity of producers to increase production, productivity and agricultural diversity in favor of the environment and the country's food security and sovereignty.

The actions were carried out to facilitate the development of peasant farms that introduced, developed, experimented with and disseminated appropriate technologies. This innovation process supported and strengthened integral and sustainable production systems that not only contributed to a greater supply, diversity, quantity and



Source: Prepared by the author with research data

Figure 2. Production limiting factors

quality of food, but also to improving the income and well-being of the peasant family. These activities not only sought to increase the knowledge of the actors involved in production, but also to maintain active communication, exchange and acquisition of new knowledge in two ways: to the researchers and to the producers.

In the results of this study, similarities can be found with other research conducted, where it is stated that without change there is no sustainable progress. Organizational change necessarily involves the transformation of the attitudes of the people who make up the organization. It is a complex process, as it is influenced by acquired sociocultural traditions. Training is undoubtedly a great weapon in the transformation of attitudes. It influences people's mentality, the development of their actions and the implementation of the correlated knowledge between researcher - producer - extensionist (18).

Furthermore, it is agreed with other authors that the success of a technology or of a process of technological change does not depend so much on its specific goodness, but on the willingness and implementation capacity of those in charge of putting it into practice. It is precisely the social groups and the relationships established among them that are the scenarios where the processes of change materialize and decide their success (19).

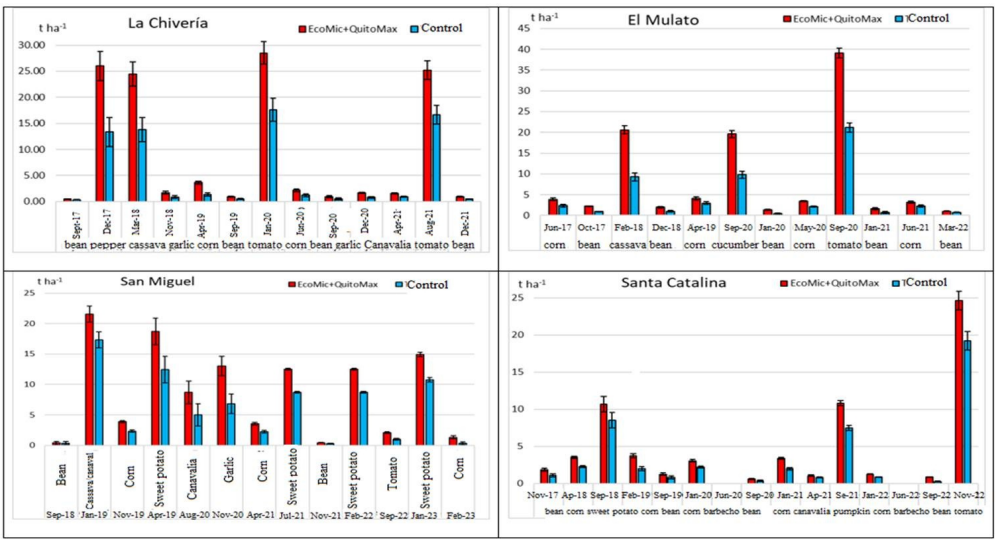
At the same time, it is certified that training should be systematic and objective, in accordance with scientific and technological advances, using participatory methods, opening spaces for reflection, exchange of experiences and knowledge. At the same time, it should take into account the agricultural and environmental characteristics of the locality, without ignoring the leading role of the producers as actors in the agricultural process and food sustainability, and thus achieve an improvement in their living conditions and those of the population in general (20).

Permanent areas

When analyzing the yields of the different crops in the permanent areas studied (Figure 3), it was observed that the treatments where the bioproducts were applied in all cases were higher than those of the production control, which showed that the use of EcoMic® by seed coating and the application of QuitoMax® by foliar spraying had a positive effect on this indicator. This result could be due to the fact that QuitoMax® exerted an antimicrobial activity against some filamentous fungi, yeasts and viruses that affect the active principles of the plant by its active ingredient (chitosan). For its part, the product Ecomic® must have intervened in the transport of several elements from the soil to the host plant, especially in the absorption of water (21).

This established symbiotic relationship benefited the fungi with the supply of carbon sources from the plant, within which specific mycorrhizal signals are induced that influence root development. The establishment of the fungus could facilitate the flow of photosynthates from the aerial part to the root zone; the AMF uses a part of these photosynthates to produce metabolic energy, and through this pathway ensures its maintenance and development; the other part is mobilized in the form of sugars and lipids from intra- and extra-root fungal mass (21).

Given the effects and importance of the combined use of bioproducts in terms of their use, both in foliar form as well as in imbibition of the seeds in agriculture, it can be said that their application has become almost essential in the phytotechnical management of crops. In such a way that they are not only applied independently, but the combination of their effects has been sought to improve plant growth and increase production (22). Similar results to those obtained in this research have been achieved by other authors, who have used the application of QuitoMax® by imbibing the grains and coating them with EcoMic® plus the subsequent foliar application of QuitoMax® at different times during crop development, which led to an increase in yields (23-26).



Vertical bars: confidence interval of the means with a significance level of 95 %

Figure 3. Yields (t ha^{-1}) obtained in the crop sequences carried out in the four farms under study

End-of-season surveys for each crop

Thirty-five surveys were conducted with the producers of the farms at the end of each campaign (crop) with the objective of knowing the results of the combined use of EcoMic® and QuitoMax®. From the processing of the surveys (Figure 4) the following aspects were derived:

- 65 % of the respondents agreed to reuse the bioproducts in several crops.
- Sixty-five percent of the producers expressed a change in their way of thinking when farming because both the current situation, the scarcity of external inputs, and the feasibility of using these byproducts and their integrated management with local sources of nutrients, demonstrated to them the advantages of using byproducts.
- Only 35% had difficulties in the co-management of byproducts and requested systematic training. These difficulties were related to unforeseen events on the farms, as well as changes in the handling of the byproducts according to the crop and type of soil to be used.
- Seventy-five percent of the producers surveyed expressed having found increases in agricultural yields and profits, which indicates an increase in demand.

In general, the producers rated the level of acceptance of the use of these bioproducts as satisfactory and the training on the combined management of bioproducts and their integration with green manures and other local sources of nutrients, the production of green manure seeds, and soil management and conservation as very favorable.

It is important to emphasize that agricultural production requires an integrated management of bioproducts and local sources of nutrients; without their proper use, they would not be fully effective (5). On the other hand, it became evident that it is necessary for specialists to accompany and advise producers in order to achieve the greatest success in the application of the combined use of EcoMic® and QuitoMax® technology in the dynamic production scenarios of smallholder farms.

The results of the survey applied to the producers at the end of each campaign are in line with what has been expressed by other authors, since, for local development to guarantee food stability to its inhabitants, it requires training and educating individuals from a conception of sustainable development on agroecological bases and with a focus on equity. It enables interactive learning processes, based on the dialogue of knowledge, traditional and scientific knowledge, as well as citizen participation as a distinctive and meritorious element. This makes them active participants and not mere beneficiaries, they mediate on the decisions that affect them and achieve empowerment in their local communities. This systematic follow-up achieved success with the application of technology in productive scenarios (27).

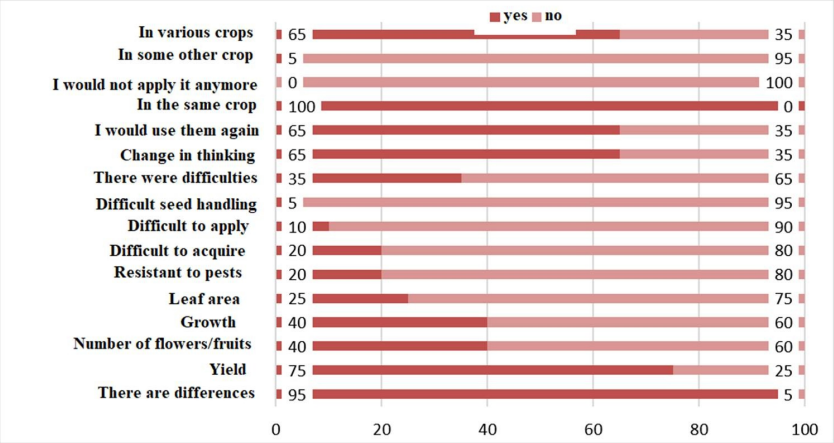
CONCLUSIONS

The adoption of the agricultural technology of the joint use of EcoMic® and QuitoMax® bioproducts constitutes an alternative for obtaining crops that are increasingly more environmentally friendly and have less harmful effects on the environment, contribute to increasing agricultural yields and reduce the use of mineral fertilizers, as well as satisfy the needs of farming families.

It is essential to accompany producers to achieve the greatest benefits from bioproducts under production conditions.

BIBLIOGRAPHY

1. Alfonso S, Socorro M. Adopción de tecnologías en Cooperativas de Producción Agropecuaria. Una visión teórica. Revista de Gestión del Conocimiento y el Desarrollo Local. 25 de septiembre de 2020;7(2):1-18. Disponible en: https://ojs.edicionescervantes.com/index.php/RGCDL/article/view/1297.
2. Núñez M, Reyes Y, Falcón A. Impactos productivos de bioestimulantes cubanos en la agricultura. Ediciones INCA; 2021. Disponible en: https://ediciones.inca.edu.cu/index.php/ediciones/lib.



Source: Prepared by the author with research data

Figure 4. Results of the survey applied to producers at the end of each season

3. Peón A, Díaz LP, Fonseca IG. Metodología para potenciar la formación integral desde la asignatura química orgánica a partir del uso de bioproductos en la agricultura. Revista Mapa [Internet]. 19 de marzo de 2022 [citado 16 de octubre de 2023];6(26). Disponible en: https://www.revistamapa.org/index.php/es/article/view/323.
4. Mederos Y, Ramírez MÁ, Falcón A, Bernabé P, María A. Estabilidad química y actividad biológica del QuitoMax® durante su almacenamiento. Cultivos Tropicales. 2020;41(1). Disponible en: http://scielo.sld.cu/scielo.php?pid=S0258-59362020000100006&script=sci_arttext.
5. Rivera R, Fernández F, Ruiz L, González PJ, Rodríguez Y, Pérez E, et al. 2020. Manejo, integración y beneficios del biofertilizante micorrízico EcoMic® en la producción agrícola. 151 p., Ediciones INCA, San José de las Lajas, Cuba. ISBN: 978-959-7258-05-6. Disponible en: https://ediciones.inca.edu.cu/files/libros/beneficios_del_biofertilizante_micorr%C3%ADzico.pdf.
6. Álvarez UA. Bioproductos cubanos ofrecen resultados en cultivos villaclarenos. Vanguardia, p. 1 - Buscar con Google [Internet]. 2022 [citado 30 de octubre de 2023]. Disponible en: https://www.google.com/search?client=firefox-b-e&q=%C3%81lvarez+Hern%C3%A1ndez%2C+U.+A.+%282022%2C+2+20%29.+Bioproductos+cubanos+ofrecen+resultados+en+cultivos+villaclarenos.+Vanguardia%2C+p.+1.
7. Cruz T. Inversiones para obtener bioproductos en Cuba. [Internet]. 2021 [citado 30 de octubre de 2023]. Disponible en: https://www.google.com/search?q=Cruz+M%C3%A9ndez%2C+T.+%282021%2C+1+26%29.+Inversiones+para+obtener+bioproductos+en+Cuba.+Granma%2C+p.+1.%0D%0A%0D%0A&client=firefox-b-e&sca_esv=577807614&sxsrf=AM9HkKnn_vle2SeBc9UQ-.
8. Sánchez BI, Zegbe Domínguez JA, Rumayor Rodríguez AF. Propuesta para evaluar el proceso de adopción de las innovaciones tecnológicas. Revista mexicana de ciencias agrícolas. septiembre de 2013;4(6):855-68. Disponible en: https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2007-09342013000600003.
9. Hernández Y. Perspectivas o enfoques en la promoción de la innovación agropecuaria local. Importancia de la comunicación en este proceso. Revista Científica Agroecosistemas. 6 de mayo de 2019;7(1):188-95. Disponible en: https://aes.ucf.edu.cu/index.php/aes/article/view/265.
10. Pérez JJR, Enríquez-Acosta EA, Arrebato MAR, Pedroso ATR, Lara-Capistrán L, Montiel LGH. Evaluation of the growth, yield and nutritional quality of pepper fruit with the application of Quitomax®. Ciencia e investigación agraria: revista latinoamericana de ciencias de la agricultura. 2019;46(1):23-9. Disponible en: https://pdfs.semanticscholar.org/683f/c8a0911c89c3918d8cf860880452713ee5b4.pdf.
11. Sablón A, Salguero Z, Vallejo Y. Extensión Agraria. Selección de lecturas. La Habana: Félix Varela; 2011. Disponible en: https://scholar.google.es/scholar?hl=es&as_sdt=0%2C5&q=Sabl%C3%B3n+A%2C+Salguero+Z%2C+Vallejo+Y.+Extensi%C3%B3n+Agraria.+Selecci%C3%B3n+de+lecturas.+La+Habana%3A+F%C3%A9lix+Varela%3B+2011.&btnG=.
12. Hernández A, Pérez A, Bosch D, Speck NC. La clasificación de suelos de Cuba: énfasis en la versión de 2015. Cultivos Tropicales. 31 de marzo de 2019;40(1):a15-e15. Disponible en: https://ediciones.inca.edu.cu/index.php/ediciones/article/view/1504.
13. Rojas R, Alvarado L, Borjas R, Carbonell E, Castro V, Julca A. Caracterización de fincas productoras de café convencional y orgánico en el valle del Alto Mayo, región San Martín, Perú. *Revista de Investigación e Innovación Agropecuaria y de Recursos Naturales*. 2020;7(2):100-111. Disponible en: http://www.scielo.org.bo/scielo.php?script=sci_arttext&pid=S2409-16182020000200013.
14. Carnero G, Hernández-Jiménez A, Bernal-Fundora A, Terry-Alfonso E. Características de los suelos Fersialíticos Rojos Lixiviados de la llanura meridional alta de Pinar del Río. *Cultivos Tropicales*. 2022;43(3). Disponible en: https://ediciones.inca.edu.cu/index.php/ediciones/article/view/1673.
15. Torres CC, González MM, Ramírez JF, Marín LG. Articulación del plan de soberanía alimentaria con las estrategias de desarrollo. Coop. Desarro. 2022;10:129–144. Disponible en: https://coodes.upr.edu.cu/index.php/coodes/article/view/483.
16. Pérez Quintana IA, Sablón Pérez AM. Transferencia de tecnología e innovación en la producción de caña. Revista Gestión del Conocimiento y el Desarrollo Local. 2021;8(1):59-72. Disponible en: https:// www.studocu.com/pe/document/universidad-catolica-santo-toribio-de-mogrovejo/ingenieria-industrial/1426-5694-1-sm/18061791.
17. Ramos ME, del Busto A, Pacheco Y, Monduy L. Sistema de acciones para la producción de viandas en función de la soberanía alimentaria y educación nutricional. Cooperativismo y Desarrollo [Internet]. abril de 2023;11(1). Disponible en: http://scielo.sld.cu/scielo.php?script=sci_abstract&pid=S2310-340X2023000100004&lng=es&nrm=iso&tlng=es.
18. González MC, Tarragó C. Capacitación para el cambio. *ACIMED*. 2008;17(4):0-0. Disponible en: https://www.redalyc.org/articulo.oa?id=31212687002.
19. Conde, R & Cols. 1992. Las políticas de promoción de la ciencia y la tecnología: el caso de la Biotecnología. En: La Biotecnología y sus repercusiones sociales y políticas. Rosalba Casas y otros. UAM-UNAM. México. Disponible en: https://www.google.com/search?client=firefox-b-e&sca_esv=dc4da4efb85aac0a&sxsrf=ACQVn08MPX1Ew8QATmeXMDRWMpu1-oKKkQ:1708004815270&q=Conde,+R+y+Cols.1992:+%E2%80%9CLas+pol%C3%ADticas+de+promoci%C3%B3n+de+la+ciencia+y+la+tecnolog%C3%ADa:+el+caso+de+la+Biotecnolog%C3%ADa%E2%80%9D.+En:+La+Biotecnolog%C3%ADa+y+sus+repercusiones+sociales+y+pol%C3%ADticas.+Rosalba+Casas+y+otros.+UAM-UNAM.+M%C3%A9xico&spell=1&sa=X&ved=2ahUKEwjLmafiva2EAxWJjLAFHUvRCdYQkeECKAB6BAgJEAI.

20. Núñez JR, Rubio ZS, Reyes RM. Capacitación sobre extensión agraria en la cooperativa de producción agropecuaria amistad cuba-nicaragua. Revista de Gestión del Conocimiento y el Desarrollo Local. 21 de diciembre de 2020;7(3):12. Disponible en: https://ojs.edicionescervantes.com/index.php/RGCDL/article/view/1335.
21. Ruiz-LaO D, Nápoles-Vinen S, Mustelier-Ocle MC. Respuesta productiva de la Passiflora incarnata L. Con aplicaciones combinadas de productos biológicos. Revista Transdiciplinaria de Estudios Sociales y Tecnológicos. 1 de septiembre de 2022;2(3):32-41. Disponible en: https://revista.excedinter.com/index.php/rtest/article/view/53.
22. Bécquer CJG, González Cañizares PJ, Ávila Cordoví U, Nápoles Gómez JÁ, Galdo Rodríguez Y, Muir Rodríguez I, et al. Efecto de la inoculación de microorganismos benéficos y Quitomax® en Cenchrus ciliaris L., en condiciones de sequía agrícola. Pastos y Forrajes. marzo de 2019;42(1):39-47. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0864-03942019000100039.
23. Rivera R, García M, Ruiz M, Espinosa A, Simó J, Nápoles MC, et al. INFORME PRIMER SEMESTRE/JUNIO 2016 DEL MEGAPROYECTO. 2016; Disponible en: https://www.researchgate.net/profile/Ramon-Espinosa%203/publication/294582507_Manejo_conjunto_e_impacto_de_biofertilizantes_micorrizicos_y_otros_bioproductos_en_la_produccion_agricola_de_diferentes_cultivos/links/56c26b3408ae2dc3eb884896/Manejo-conjunto-e-impacto-de-biofertilizantes-micorrizicos-y-otros-bioproductos-en-la-produccion-agricola-de-diferentes-cultivos.pdf.
24. González JC, Torres JA, Reyes JJ, González LG, Jiménez M, Boicet T, et al. Respuesta agronómica de dos variedades de maíz blanco (Zeas mays, L.) a la aplicación de QuitoMax, Azofert y Ecomic. Biotecnia. 2018;20(1):3-7. Disponible en: https://www.redalyc.org/pdf/6729/672971085001.pdf.
25. Pérez Y, Rosales PR, Menéndez DC, Falcón A. Aplicación combinada de quitosano y HMA en el rendimiento de maíz. Cultivos Tropicales [Internet]. diciembre de 2019 [citado 1 de febrero de 2023];40(4). Disponible en: http://scielo.sld.cu/scielo.php?script=sci_abstract&pid=S0258-59362019000400006&lng=es&nrm=iso&tlng=pt.
26. Blanco-Valdes Y, Cartaya-Rubio OE, Espina-Nápoles M. Efecto de diferentes formas de aplicación del Quitomax® en el crecimiento del maíz. Agronomía Mesoamericana. 2022;47246-47246. Disponible en: https://www.scielo.sa.cr/pdf/am/v33n3/1659-1321-am-33-03-00017.pdf.
27. González Yuneidys, Abreu Orquídea, Terry Elein, Benítez Bárbara, Calves Eduardo Rosales Pedro, Martínez Yamilka. Monitoreo y la evaluación de los escenarios de innovación agropecuaria local en Mayabeque pp. 254-265. Estudios del Desarrollo Social: Cuba y América Latina RPNS 2346 ISSN 2308-0132 Vol. 9, No. 3, Septiembre-Diciembre, 2021. Disponible en: https://revistas.uh.cu/revflacso/article/view/3980.