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PARTICIPATION OF THE AGRONOMY CAREER IN THE LOCAL DEVELOPMENT OF THE MUNICIPALITY OF TRINIDAD, CUBA


PARTICIPACIÓN DE LA CARRERA DE AGRONOMÍA EN EL DESARROLLO LOCAL DEL MUNICIPIO TRINIDAD, CUBA

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ABSTRACT

Among the main latent difficulties that constitute a current brake on the achievement of the proposed objectives to achieve food sovereignty in the Municipality of Trinidad, Cuba, based on respect and conservation of the environment, the following can be mentioned: poor agrotechnical management, indiscriminate use of agricultural inputs, lack of knowledge of producers and professionals of sustainable production technologies, soil degradation, lack of knowledge of botany and plant improvement of frequently planted crops, poor quality or insufficient availability of the gametic and agamic seeds used, lack of knowledge and violation of current agrarian legislation, agricultural territorial planning outside the real context presented by the municipality, among others. Elements that in one way or another have to do with the insufficient training of professionals and workers in the agricultural sector in the territory. This work proposes a design and implementation of training actions in the agricultural sector of the territory that allow achieving sustainability standards therein, based on joint action between the Municipal University Center of Trinidad and the Municipal Delegation of Agriculture, already exposing the first results of this training, managing to contribute to the territory the first 53 professionals trained in the version of the Diploma in Sustainable Agriculture, another result obtained is that several Agricultural Engineers have graduated, whose Diploma Work Topics have been in charge of solving problems that prevent the development of agriculture at the municipal level, achieving the publication of some of these works in high-impact magazines at an international level, among others, which contribute to increasing work efficiency in the agricultural sector of the territory. thus contributing to the local development of the territory and obtaining recognition of the research and contributions made in the territory at an international level.

Keywords: effectiveness – elevation – strategy – territory – Training

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RESUMEN

Entre las principales dificultades latentes y que constituyen un freno actual para el logro de los objetivos propuestos para alcanzar la soberanía alimentaria del Municipio Trinidad, Cuba, sobre la base del respeto y conservación del medio ambiente, se pueden mencionar las siguientes: deficiente manejo agrotécnico, uso indiscriminado de insumos agrícolas, desconocimiento de los productores y profesionales de las tecnologías de producción sostenible, degradación de los suelos, desconocimiento de la botánica y fitomejoramiento de los cultivos frecuentemente sembrados, mala calidad o insuficiente disponibilidad de las semillas gámicas y agámicas utilizadas, desconocimiento y violación de la legislación agraria vigente, planificación territorial agropecuaria fuera del contexto real que presenta el municipio, entre otros. Elementos que de una u otra forma tienen que ver con la insuficiente capacitación de los profesionales y trabajadores del sector agropecuario en el territorio. El presente trabajo propone un diseño e implementación de acciones de capacitación en el sector agropecuario del territorio que permitan alcanzar estándares de sostenibilidad en el mismo, a partir de una acción conjunta entre el Centro Universitario Municipal de Trinidad y la Delegación Municipal de Agricultura, exponiéndose ya los primeros resultados de esta capacitación, logrando aportar al territorio los primeros 53 profesionales formados en la versión del Diplomado en Agricultura Sostenible, otro resultado, obtenido es que se han graduado varios Ingenieros Agrónomos, cuyos Temas de Trabajo de Diploma han estado en función de resolver problemas que impiden el desarrollo de la agricultura a nivel de municipio, logrando la publicación de algunos de esos trabajos en revista de alto impacto a nivel internacional, entre otros, los cuales contribuyen a la elevación de la eficiencia del trabajo en el sector agropecuario del territorio contribuyendo de esta forma al desarrollo local del territorio y obteniendo un reconocimiento de las investigaciones y los aportes realizados en el territorio a nivel internacional.

Palabras clave: Capacitación – efectividad – elevación – estrategia – territorio

INTRODUCTION

Strategies are general programs of action that carry with them commitments of emphasis and resources to implement a basic mission. They are patterns of objectives, which have been conceived and initiated in such a way as to give the entity a unified direction (Koontz, 1991).

Humanity is at a turning point in its history. It is faced with great disparities between nations and within nations, with worsening poverty, hunger, disease, illiteracy, and with the continuing deterioration of the ecosystems on which our well-being depends. However, by integrating environmental and development concerns and paying more attention, basic needs can be met, living standards for all can be raised, ecosystems can be better protected and managed, and a more secure and prosperous future can be achieved. No single nation can achieve these goals alone, but together we can achieve them in a global partnership for sustainable development” (Cabrera, 2013).

In the Roadmap derived from the World Higher Education Conference held in Barcelona in 2022, it was stated that:

“Higher Education Institutions have three great social missions: to produce knowledge through scientific research, to educate people, in the broad sense of the word, paying special attention to the knowledge and skills necessary for professional life, and to be socially responsible...” (UNESCO, 2022).

Each territory has specific particularities that allow it to move in one direction or another more or less rapidly Maqueiras (2021). Thus, considering planning as the primary basis for development, it is necessary to speak of a new type of planning, called ecological, environmental or strategic, which can be conceived as: “The instrument for planning and programming the use of the territory, productive activities, the management of human settlements and the development of society, in congruence with the natural potential of the land”, sustainable use of natural and human resources, and the protection and quality of the environment. This idea is cemented in the possibility of thinking and creating the future from the knowledge and valuation of the present and its articulation to the past, and should be understood, then, as a public management tool to control, promote and direct contemporary social systems, articulated in their geoeological sustenance base (Valdés & Suárez, 2018).

Trinidad, as a territory populated since pre-Columbian times and with more than half a millennium of existence since its foundation as a village that early reached the category of city, has treasured physical-geographical particularities and its historical and economic evolution, which make it an ideal scenario for the development of tourism as the main support for its development (CAM Trinidad, 2023).

But the transition from an economy that was sustained for centuries by the sugar cane activity to another that requires a vision and therefore a more holistic study and use of all the potential of the territory such as tourism, represents a challenge that its human resources are in the obligation to face because it has identified by the government authorities a bank of problems, where one of the priorities is the satisfaction of the growing food needs of a demographic nucleus in constant expansion, facing for it a series of difficulties within the agricultural infrastructure that it has, to be able to give a solution to the existing problems, many of them are in the obligation to face, One of the priorities is the satisfaction of the growing food needs of a demographic nucleus in constant expansion, facing a series of difficulties within its own agricultural infrastructure, to be able to solve the existing problems, many of these difficulties have been generated by the actions of man himself in his historical desire to provide food to his fellow countrymen (Valdés *et al.*, 2023).

Among the main latent difficulties that constitute a current obstacle to achieving the proposed objectives for territorial food sovereignty based on respect for and conservation of the environment are the following: poor agrotechnical management, indiscriminate use of agricultural inputs, lack of knowledge of producers and professionals of sustainable production technologies, soil degradation, lack of knowledge of botany and phytotechnics of frequently planted crops, poor quality or insufficient availability of gametic and agamic seeds used, ignorance and violation of current agrarian legislation, territorial agricultural planning outside the real context presented by the municipality, among others (Valdés, 2019).

Among the main latent difficulties that constitute a current obstacle to achieving the proposed objectives for territorial food sovereignty based on respect for and conservation of the environment are the following: poor agrotechnical management, indiscriminate use of agricultural inputs, lack of knowledge of producers and professionals of sustainable production technologies, soil degradation, lack of knowledge of botany and

phytotechnics of frequently planted crops, poor quality or insufficient availability of gametic and agamic seeds used, ignorance and violation of current agrarian legislation, territorial agricultural planning outside the real context presented by the municipality, among others (Valdés, 2019).

It is also correct to highlight the critical situation of the coastal strip of Casilda which presents a strong contamination of its waters by human action that has turned this area into a highly dangerous focus emitting diseases that significantly affect the health of the population (PGOU, 2018).

An important part of the aforementioned limitations are the cumulative result of a predominant ideology within the professionals who have directed the productive process and logically of the producers themselves, in the use of a conventional agricultural model, which as has been handled previously, has fallen into complete crisis, not adjusting to the current precepts that move the agricultural development at a global and national level, nor to the elementary desire for the preservation of our own species (Hernández *et al.*, 2023).

The University, the main center in charge of managing the formation, training and permanent improvement of these resources, has to undertake important actions to encourage them to undertake in a productive, rational and scientifically based manner the great tasks that will allow them to creatively integrate the management and protection of their agricultural resources, urban and territorial planning, the efficiency of productive activities in correspondence with the updating of the country's economic model and in general, the environmental sustainability of tourism development, even considering the new forms of management, for which the environmental issue is identified as one of the most important concerns of mankind; The boom that this issue has taken in recent years is related to the intensification of numerous problems at all scales, which affect society in an increasingly harmful way (Law on Food Sovereignty and Nutritional Security, 2022).

It is necessary to promote a change in the productive mentality, through the search for and adoption of sustainable and harmoniously integrated agricultural production techniques that constitute alternatives to traditional models, and achieve an increase in the production of healthy food in the quantities necessary to satisfy the demanding demands of tourism. It is also necessary to disseminate more widely the variety and richness of the tangible and intangible heritage and

promote its proper management and interpretation for its conversion into tourism products that show the richness and diversity of the culture of the municipality and the country (González, 2007).

From training, science and innovation, we continue to contribute to the implementation of Municipal and Provincial Development Strategies, local innovation systems, self-management and sustainability of municipalities, with the participation of Municipal University Centers (CUM) as main actors in knowledge management, with special emphasis on capacity building, which is evident in the increase in actions at the territorial level. There are dozens of local development projects, technologies certified and absorbed by the municipalities. The increase in R&D&I projects that contribute to the development of the territories is notable, including several of international scope (Díaz-Canel, 2022).

This study is aimed at the so-called long-term solutions, and proposes to carry out an investigation on alternatives that can contribute to train, qualify and overcome professionals capable of assuming the challenges of sustainable development in the construction of the economic model to be built in Cuban society, including those incorporated to the non-state management forms. It is also articulated with the Municipal Development Plan, as a strategy to strengthen the municipality and at the same time improve the use and rational exploitation of its agricultural and fishing resources in a results-oriented local management framework.

To design and implement alternatives of formation, training and improvement, in the agricultural sector of the Trinidad municipality, Cuba, from the university and in consonance with the real needs of the territory, in contribution to the theoretical and practical strengthening of local development in the Trinidad Municipality.

MATERIALS AND METHOD

In order to achieve the objectives of this research, several stages were outlined. The first stage consisted of characterizing the agricultural sector of the municipality of Trinidad, Cuba. For the university to be a protagonist in the process of social development, it must integrate from a systemic conception its substantive processes: academic, labor and research and break its walls with genuine extension processes that instruct while educating from latent and felt needs in their different contexts of action and project their activities: Therefore, the

university of the territory will bring together the existing human capital and will do so by taking advantage of its own and external resources, so as to produce the necessary synergy between all stakeholders and interested parties, it is necessary to align strategies, knowledge and priorities of development with human welfare.

Stage 1. Characterization of the agricultural sector in the Municipality of Trinidad, Cuba (CAM Trinidad, 2023; Sánchez, 2023).

The Municipality has a territorial area of 116,747.37 ha and of them 60,703.72 ha are agricultural, including 13,288.2 ha of temporary crops, 14,327.5 ha of permanent crops and 44,976.99 ha of livestock. It also has a non-agricultural area of 44,154.68ha, of which 43,151.22 ha are dedicated to forest plantations. The Idle Land Fund available at the end of 2021 was 1,787.48 ha, a figure that was higher in previous years and has decreased due to the fact that today there are a total of 1,745 tenants in the territory, of which 286 are property owners and usufructuaries by different Resolutions 1459.

The economic base of this Sector in the territory is supported by: Trinidad Agroforestry Company with 4 UEB: UEB Coffee Benefit: Felicidad, Seibabo and La 23, UEB Valle de los Ingenios, UEB Urban Farm, UEB Assurance.

As a result of the low availability of areas with irrigation systems (0.0003 ha), which means that almost all crops are grown in dry land, together with the intense drought that has affected the municipality in recent years, the levels of production and collection of agricultural products, which is why it is necessary to increase the areas under irrigation, since there is potential in terms of supply sources, which can be exploited with appropriate technologies, which could reverse the current results.

Stage 2. Study and adaptation of the research and training objectives of the Agronomy Career of the Municipal University Center of Trinidad in terms of local development.

For the fulfillment of this stage, a transdisciplinary group of the Municipal University Center of Trinidad was created, belonging to the Agronomy career of this center, among which were Agronomists, Foresters, Veterinarians, among others, who together with specialists of the

agricultural system in this municipality, undertook the task of analyzing the Local Development Strategy, They were given the task of analyzing the existing Local Development Strategy in the municipality, and under the care and monitoring of the Municipal Administration Council (CAM), after knowing the 6 strategic lines shown in the strategy, consensus was reached that the strategic line number one, under the title: "Production and food with science", fit perfectly with the intention of the Agronomy Career of the Municipal University Center to contribute to the support of the local development of the municipality, being able as a university to respond to the demands and needs that this line demanded for its execution.

Stage 3. Diagnosis of the agricultural sector of the Municipality of Trinidad.

At this stage the transdisciplinary group created and mentioned above was called with the task of conducting a diagnosis of the agricultural sector of the municipality of Trinidad, in the period between January 2015 and December of that year, covering 100% of the existing productive forms in the sector, and 100% of the agricultural, livestock and forestry territory of the municipality, for this purpose three work teams were created, which would cover the entire territory, To this end, three work teams were created, which would cover the entire territory, gathering the threats, opportunities, weaknesses and strengths that existed in each productive form, and in each component of the agricultural system of the municipality, that is, agriculture, forestry and livestock, then a work table was set up where by analysis and weighting the weaknesses, threats, opportunities and strengths that were common and those that were not were established, establishing a general diagnosis of the sector for this period of time in this municipality.

Stage 4. Establishment of the action plan by the Municipal University Center in order to contribute to local development.

Finally, and bearing in mind the weaknesses and threats found in the diagnosis, most of which were directly or indirectly related to training problems and low application of science and technology, an action plan was created and implemented between 2016 and 2019 to solve these threats and weaknesses, which made it possible to put the potential of the specialists of the

Agronomy Career of the Municipal University Center of Trinidad in terms of training and to solve many of the problems detected, in addition, all the research potential of the career was involved in order to solve some of the problems that appeared in the diagnosis that prevented progress in the aspirations of the territory of a sustainable local development. In 2019, several results of the implementation of the action plan began to be obtained, appearing results that allowed to begin to evaluate the impact that the participation of the Agronomy career had had on local development, that work continues, and the impact is monitored until today.

Ethical Aspects: This work responds to one of the lines of research of the Agronomy Career of the Faculty of Agricultural Sciences of the University of Sancti Spiritus, which in turn is in full consonance with the Local Development Strategy in force in the Municipality of Trinidad, contributes new aspects to knowledge in the still little explored topic of the participation of the different university courses existing in municipal university centers, and specifically the Agronomy course in local development. This work is guaranteed by its tutors and institutions that represent that it does not constitute plagiarism of another presented, both in Cuba and internationally.

RESULTS AND DISCUSSION

Diagnosis of the current situation of the agricultural sector in the Municipality of Trinidad carried out by specialists of the Trinidad Municipal University Center.

The diagnosis was the tool used by the specialists of the Municipal University Center of Trinidad to obtain data that would allow us to know the real situation of the agricultural system of the Trinidad Municipality in the evaluated period, allowing us to know the risks and opportunities that exist in the agricultural sector of the municipality and that directly affect the functioning of this sector.

The strengths, weaknesses, opportunities and threats that the agricultural sector has at the time of introducing a scientific result are framed below.

Strengths

- ★ Existence of the science and innovation system in the province (Trinidad Municipal University Center, Trinidad Plant Health Research Station, Entomophagous and Entomopathogen Production Center, County, Trinidad).
- ★ High number of qualified researchers in the agricultural sector.
- ★ Integrated provincial strategy for science, technology and technological innovation.
- ★ Existence of areas available for agricultural production.
- ★ Beginning of a process of assimilation of scientific-technical results for low-input systems obtained by research centers.
- ★ Existence of various forms of production in the agricultural sector with great productive potential in the Trinidadian territory.
- ★ Existence of permanent sources of food, vegetable and fruit production during all seasons of the year.
- ★ Existence in some of the productive forms of advanced technologies that can promote an increase in the production of vegetables, viands and fruit trees.
- ★ Existence in some of the productive forms of osseous facilities that can be reconditioned for the installation of the necessary technological equipment in the mini-industries.
- ★ Established producers, with a high level of relevance and knowledge in the art of producing vegetables and fruits.
- ★ Proximity of the productive forms to the main population centers and companies of the territory.

Weaknesses

- ★ Insufficient introduction into productive practice of the scientific results of the agricultural research centers.
- ★ Low availability of material and financial resources in the agricultural sector of the territory.
- ★ Lack of continuity of scientific results (scientific results that have been shelved).
- ★ Lack of visibility, will and creativity of many of the cadres that manage the agricultural sector in the

territory in the need to implement new technologies that allow new productive options.

- ★ Deficient contracting process of agricultural productions between the productive forms and the Municipal Collection.
- ★ Delinquent payments for contracted productions between the productive forms and the Municipal Collection.
- ★ Existence of osseous lands in the municipality's land fund.
- ★ Poor conception of the territorial planning of vegetable production.
- ★ Outdated soil fertility studies of the territory.
- ★ The existence in the Municipal Direction of Agriculture of an incomplete and inefficient human resources training strategy.

Opportunities

- ★ The country's need for import substitution.
- ★ Priority in the country towards innovation issues.
- ★ Definition of priority research lines in the country (food production, energy saving, import substitution).
- ★ Interest on the part of the Provincial Assembly of People's Power and the PCC, for innovation issues and introduction of scientific results.
- ★ Sufficient natural resources for the introduction of agricultural results.
- ★ Increased demand for a variety of packaged vegetable products by the sectors: self-employed, tourism, business and population of this municipality.
- ★ Political will of the authorities of the territory to create new productive opportunities in the agricultural sector of the territory, which at the same time, allow an increase in the productions and variety of agricultural products.
- ★ Existence of available labor in the territory to meet the demands of the agricultural sector and to face any new investment in the sector itself.
- ★ Existence of a Municipal University Center that can meet the training demands of the agricultural sector in the territory.

Threats

- ★ The economic and commercial blockade is maintained.
- ★ Unstable international scenario (world crisis).
- ★ Increase in the prices of raw materials and materials on the market.
- ★ Effects of climate change.
- ★ Fluctuation of the labor force in the territory.
- ★ When an analysis and evaluation of the results shown in the diagnosis is made, it is obtained that many of the weaknesses and threats shown by the

agricultural sector in the municipality are directly or indirectly related to problems in the training of its human resources, which limits the achievement of more efficient processes, preventing the desired sustainability of the sector.

- ★ The following is a breakdown of the Action Plan designed to provide a solution to the training problem that has arisen, showing actions for each stage, i.e. initial, diagnosis, intervention and evaluation, but due to the format required for this presentation and in order to save space, only the diagnosis stages will be addressed (Table 1).

Table 1. Action Plan designed to provide a solution to the training problem.

Diagnosis.	Selection of diagnostic tools and techniques to determine the current status of the company.	2015	Research group.	Determination of the starting situation
Ejecution.	Training and research actions to resolve threats and weaknesses detected in the diagnosis.	2016-2019	Research group.	Monitoring of the implementation process.
Evaluation.	Evaluation of the results obtained in the different diagnoses to plan a work strategy.	2019	Research group.	Measurement and comparison of results obtained.
Evaluation.	Evaluation of the impacts on the preparation of the leaders and workers of the companies, the self-employed sector and population centers.	2019	Research group.	Measurement and comparison of results obtained.
Evaluation.	Evaluation of the impacts on the preparation of the teachers - tutors who are part of the study	2019	Research group.	Measurement and comparison of results obtained.
Evaluation.	Assessment of the impacts on the preparation of tutors for master's degrees and diploma work	2019	Research group.	Measurement and comparison of results obtained.
Evaluation	Evaluation of improvements in environmental quality levels in the CUM.	2019	Research group.	Measurement and comparison of results obtained.

Results obtained to date with the implementation of the action plan.

The first results obtained from the implementation of the strategy are as follows:

Completion of a Diploma Course in Sustainable Agriculture: In this Diploma Course, directives and workers of the different productive forms in the agricultural sector

of the territory participated, achieving a graduation of 53 graduates, who with the presentation of their theses proposed solutions to different problems of the agricultural sector of the municipality.

Postgraduate Phytotechnology Course: This course was considered a postgraduate and training course, with the participation of professionals from the agricultural sector, but also workers who did not have a higher level of education, achieving 20 graduates.

Training in basic agronomy topics for the Head of the Training Department of the Enrique Villegas del Algarrobo Agronomy Polytechnic.

A postgraduate course in Techniques and Principles of Management to the managers and workers of the UBP Cigar Factory Juan de Mata Reyes, in 2018 with the graduation of 15 students in the Postgraduate modality and 5 in the Training Course modality.

Advice on agricultural issues to the Local Development Group, as well as participation as methodological advisors in the First Strategic Line of the Local Development Strategy.

Delivery of postgraduate courses on Food Sovereignty to Mayors and main cadres of the Municipal Assembly of People's Power.

The culmination of studies of 10 students in the Agronomy Career, course 2023, in the modality of Regular Course by Meetings, who will defend their Diploma Work in option to the title of Agronomist Engineers in topics that respond to the current needs of the agricultural sector of the territory, propitiating the search for a sovereign and sustainable territory in the feeding of its population.

The generalization of one of the scientific investigations, carried out by students and professors in a company producing bioinputs in Costa Rica, see Annex 1.

The delivery of training courses to Social Fighters in the Socialist Agroecological Training Center Indio Rangel of the sister Bolivarian Republic of Venezuela, on issues related to Agroecology, between 2020 and 2021, achieving the training of more than 600 fighters, which through the

Francisco de Miranda Front, became multipliers of these issues nationwide.

The training of the main cadres of the Francisco de Miranda Front, in the sister Bolivarian Republic of Venezuela on management issues, here was jointly developed a Management Strategy for the Socialist Agroecological Training Center Indio Rangel, which was published in an international indexed magazine, located in the first level of the Ranking, see the list of publications that appeared in these results.

The visibility and recognition of the scientific research undertaken by the Agronomy Career of the Municipal University Center of Trinidad at national and international level has been achieved, an example of this is the achievement of the publication of this strategy in an international journal indexed in the first place of the Ranking. See list of publications appearing in these results.

The visibility and recognition of the scientific research undertaken by the Agronomy Career of the Centro Universitario Municipal de Trinidad has been achieved at national and international level, an example of this is the achievement of the publication of this strategy in an international journal indexed in the first place of the Ranking. See list of publications appearing in these results.

Two professors belonging to the career are currently completing their Master's degree in Agricultural Sciences, attached to the José Martí Pérez University of Sancti Spiritus.

List of publications on agriculture and livestock in the Municipality of Trinidad in first and second level indexed journals (Table 2):

Table 2. List of publications on agriculture and livestock in the Municipality of Trinidad.

Title of publication and journal	Year of the publication
<i>Heterorhabditis bacteriophora</i> effect on coffee berry borer in the Algarrobo locality, Trinidad, Cuba. <i>Centro Agrícola</i>	2016
Strategic model for the Agricultural Production Cooperative 13 de Marzo, Trinidad, Cuba. <i>Revista Científica Agroecosistemas</i>	2018
Preparation of a Manual for the Organization of the Work of the Nucleus of Socialist Agroecological Training "Indio Rangel" (NUFASIR) Bolivarian Republic of Venezuela. <i>International Journal of Science, Technology and Society</i>	2021

(Continue Table 2)

(Continue Table 2)

Accion of planification in The CPA "13 Of March", Trinidad City, Cuba. <i>International Journal of Advanced Technology & Science Research</i>	2021
Legal Status Until 2016 of the Land Fund, Labor, Salary and Performance in the Agricultural Sector of the Trinidad Municipality. <i>International Journal of Science, Technology and Society</i>	2023

As can be seen in the previous table, it has been possible to output some of the results obtained in the scientific research carried out in the Agronomy program of the Municipal University Center of Trinidad, either through undergraduate or postgraduate training actions, an example, of this is the publication made in 2016, in Centro Agrícola Magazine, a magazine that is indexed in top-level databases, and shows the results obtained in a Diploma Work in the control of the main pest that Today it causes damage to the coffee plantations in the Trinidad municipality. All of the above contributes to a vision of continuous training of our professionals, from the connection of our undergraduate students with 112 careers and 64 Higher Technician programs, with study plans increasingly aligned with the 2030 National Development Plan and from a more comprehensive, flexible and diverse postgraduate training (UNESCO, 2024).

The results of the aforementioned research have had a great impact not only at the national level, but also internationally, the above can be corroborated in the request made by the Company Bio Control S.A of Costa Rica (2019), which requested the main author of this work the formal authorization of the results obtained in this research to be used as scientific support in its research work and production of biocontrollers.

Author contributions: CRediT (Contributor Roles Taxonomy)

DVZ = Delvis Valdés-Zayas

GPC = Gretter Polo-Conesa

Conceptualization: DVZ, GPC

Data curation: DVZ, GPC

Formal Analysis: DVZ, GPC

Funding acquisition: DVZ, GPC

Investigation: DVZ, GPC

Methodology: DVZ, GPC

Project administration: DVZ, GPC

Resources: DVZ, GPC

Software: DVZ, GPC

Supervision: DVZ, GPC

Validation: DVZ, GPC

Visualization: DVZ, GPC

Writing – original draft: DVZ, GPC

Writing – review & editing: DVZ, GPC

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