South American Publishing

SAP Environmental Research and Ecotoxicity. 2024; 3:120
doi: 10.56294/ere2024120

ORIGINAL

Green innovation analysis for cocoa farmers in the municipality of Roberto Payán

Análisis de la innovación verde para los cultivadores de cacao en el municipio de Roberto Payán

Sergio Oleider Angulo Rincón[1], Claudia Magali Solarte Solarte[1]

[1]Universidad CESMAG, Administración de Empresas. San Juan de Pasto, Colombia.

Cite as
Angulo Rincón SO, Solarte Solarte CM. Green innovation analysis for cocoa farmers in the municipality of Roberto Payán. SAP Environmental Research and Ecotoxicity. 2024; 3:120. https://doi.org/10.56294/ere2024120

Publication History
Submitted: 23-05-2023
Revised: 02-10-2023
Accepted: 06-01-2024
Published: 07-01-2024

ABSTRACT

The municipality of Roberto Payán has a promising agricultural sector for cocoa cultivation, supported by favourable natural conditions and a great potential for the adoption of sustainable agricultural practices. Through the application of green innovations, such as agroforestry, the use of organic fertilisers and the integration of clean technologies, it is possible to ensure not only higher productivity, but also environmental protection and the creation of a more resilient and competitive agricultural system. The project focuses on green innovation applied to cocoa harvesters in the municipality of Roberto Payán, with the aim of improving both productivity and environmental sustainability in the region. This municipality has vast hectares of land suitable for large-scale cocoa production, which offers a unique opportunity to transform the agricultural sector. The research seeks to identify the problems and opportunities related to cocoa cultivation, proposing alternative solutions that reduce the environmental impact and increase the quality of the product. The paradigm is positivist by other authors called quantitative and uses data collection and analysis to answer research questions and test previously established hypotheses and relies on numerical measurement, counting and often on the use of statistics to accurately establish, measure and evaluate the quality of the product use of statistics to accurately establish patterns of behaviour in a population.

Approach: the research approach is quantitative because surveys will be conducted in order to collect and analyse numerical data. The research on cocoa farmers has an empirical analytical method because the causes and effects of the problem will be studied and alternative solutions will be given. The current research is descriptive in that it will provide information on the characteristics of the population under study during the year 2024. 30 cocoa producers will be randomly selected, including both family members and some from the village of Loma Linda, as the only data to which we have access for the study.30 cocoa producers will be selected, including both family members and some from the Loma Linda village.

Data collection techniques: Primary sources: A survey will be applied to cocoa farmers in the Loma Linda village (Roberto Payán). Books and degree works of the universities of the city of Pasto will be consulted.Tertiary sources: Web pages, blogs, digital books and digital articles will be consulted. The work shows that the municipality of Roberto Payán has a great potential to develop large-scale cocoa cultivation, taking advantage of the favourable geographical and climatic conditions of the region. The implementation of sustainable agricultural practices, such as agroforestry, the use of organic fertilisers and crop diversification, will not only improve cocoa productivity and quality, but will also contribute to environmental preservation and long-term sustainability.

Keywords: Green Innovation; Cocoa; Producers.

RESUMEN

El municipio de Roberto Payán cuenta con un sector agrícola prometedor para el cultivo de cacao, respaldado por condiciones naturales favorables y un gran potencial para la adopción de prácticas agrícolas sostenibles. A través de la aplicación de innovaciones verdes, como la agroforestería, el uso de fertilizantes orgánicos y la integración de tecnologías limpias, se puede garantizar no solo una mayor productividad, sino también la protección del medio ambiente y la creación de un sistema agrícola más resiliente y competitivo. El proyecto está centrado en la innovación verde aplicada a los recolectores de cacao en el municipio de Roberto Payán, con el objetivo de mejorar tanto la productividad como la sostenibilidad ambiental de la región. Este municipio cuenta con vastas hectáreas de tierras aptas para la producción de cacao a gran escala, lo que ofrece una oportunidad única para transformar el sector agrícola.

© 2024; The Authors. This Open access article is distributed under the Creative Commons Attribution 4.0 license (https://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

La investigación busca identificar las problemáticas y oportunidades relacionadas con el cultivo del cacao, proponiendo alternativas de solución que reduzcan el impacto ambiental y aumenten la calidad del producto. El paradigma es positivista por otros autores denominado cuantitativo utiliza la recolección y el análisis de datos para contestar preguntas de investigación y probar hipótesis establecidas previamente y confía en la medición numérica, el conteo y frecuentemente en el uso de estadísticas para establecer con exactitud, patrones de comportamiento en una población.

Enfoque: el enfoque de la investigación es cuantitativo debido a que se llevará a cabo encuestas con el fin de recolectar y analizar datos numéricos. La investigación de los cultivadores de cacao tiene un método empírico analítico por que se estudiaran las causas y los efectos de la problemática y se dará alternativas de solución. La investigación en curso es descriptiva ya que se dará conocer las características de la población objeto de estudio durante el año 2024.

Se seleccionarán aleatoriamente 30 productores de cacao, incluyendo tanto a familiares como a algunos de la vereda de Loma Linda, como los únicos datos a los que se tiene acceso para el estudio. Se elegirán 30 productores de cacao, incluyendo tanto a familiares como a algunos de la vereda de Loma Linda.

Técnicas de recolección de la información: Fuentes primarias: Se aplicará una encuesta a los cultivadores de Cacao de la vereda Loma Linda (Roberto Payán Se consultará en libros, trabajos de grado de las universidades de la ciudad de Pasto Fuentes terciarias: Se consultará en páginas web, blogs, libros digitales, artículos digitales. El trabajo cuenta que el municipio de Roberto Payán posee un gran potencial para desarrollar el cultivo de cacao a gran escala, aprovechando las condiciones geográficas y climáticas favorables de la región. La implementación de prácticas agrícolas sostenibles, como la agroforestería, el uso de fertilizantes orgánicos y la diversificación de cultivos, no solo mejorará la productividad y la calidad del cacao, sino que también contribuirá a la preservación del medio ambiente y la sostenibilidad a largo plazo.

Palabras clave: Innovación Verde; Cacao; Productores.

INTRODUCTION

Cocoa, Theobroma cacao, is one of the most traditional products of Meso-America. Cocoa has been present in American culture since pre-Columbian times. It originated in the Amazon and was consumed by the Toltecs, Aztecs, and Incas. At the beginning of the 17th century, the Spanish conquistadors introduced cocoa to Europe, from where it began to be widely consumed.

The project focuses on green innovation among cocoa collectors in Roberto Payán. It also seeks to analyze the problems and opportunities for improvement in environmental care, proposing alternative solutions so that growers can use them and make their products more productive and of high quality. The municipality has large hectares of land for large-scale cocoa production.

The research will focus on green innovation for the cultivation of cocoa, where the aim is to change chemical fertilizers for natural fertilizers, reduce water and air pollution in the spraying process, use renewable energies such as those provided by the sun and wind, as well as the creation and development of green awareness through the generation of cocoa production as a profitable and environmentally sustainable business, to encourage the development of a green economy and the production of cocoa as a profitable and ecologically sustainable business.

Environmentally sustainable business to encourage cocoa harvesters to use green innovations to boost their crops. According to FAO data, Colombia ranked tenth among the world's leading cocoa producers in 2018. Colombian production hovered around 52 743 tonnes placing it just behind nations such as the Dominican Republic, Peru, and Ecuador. However, it is still far from the production volumes of African countries such as the Ivory Coast, Ghana, Nigeria, and Cameroon.[1]

Over time, cocoa production in Colombia has fluctuated. From the 1960s to the early 1990s, it experienced steady growth, increasing from around 15 000 tonnes to almost 60 000 tonnes. However, in the mid-1990s, it fell to less than 35 000 tonnes by 2002. Since then, it has shown an upward trend, reaching a peak of nearly 60 500 tonnes in 2017, although this value hardly represents a recovery from the production peaks of the early 1990s.[1,2,3,4,5]

Regarding the regional distribution of cocoa production in Colombia, the primary department is Santander. Its production has risen since 2011, reaching more than 25 000 tonnes in 2019, representing 42 % of the national total. It is followed by Antioquia and Arauca, with figures between 4500 and 5300 tonnes, respectively. Huila and Tolima produce between 4100 and 4500 tonnes, while Nariño is close to 3400. Cundinamarca and Meta produce around 2200 tons, and Cesar and Norte de Santander reach 1500 tons. The rest of the departments contribute around 6000 tonnes, representing 10 % of the total.[1,6,7,8,9,10]

In terms of area planted with cocoa, Santander also leads, with growth from 2010, when it covered 46 500 hectares, to 2018, when it reached 56 500 hectares (32 % of the national total). Antioquia followed it with 14 800 hectares in 2018, and Nariño and Arauca approached 14 000 hectares. Norte de Santander and Huila have figures close to 12 000 hectares, while Tolima exceeds 11 300 hectares. The rest of the departments do not exceed 6700 hectares. Growth is notable in Cundinamarca, where the figure doubled between 2010 and 2018. However, it still does not reach 5,000 hectares, and Arauca, Meta, and Nariño increased the area planted by about 50 % in the same period.[1,11,12,13,14]

The cocoa sector is estimated to grow by 3 % by 2021, reaching a crop area of 193 953 hectares and a production of 65 174 tonnes.

Between 2015 and 2020, the area under cocoa cultivation in Colombia experienced an increase of 13 %, while production saw an increase of 15 %. In 2020, production experienced an increase of 3676 tonnes, representing an increase of 6 %, marking a historic milestone for the country. This increase in production in 2020 is attributed to two main factors: firstly, favorable weather conditions throughout the year contributed positively to the flowering of the trees; secondly, cocoa prices in the last two years have been above $7500 per kilogram, which has allowed producers to have economic resources to fertilize their crops.[15,16,17,18,19,20]

Cocoa growers in the municipality of Roberto Payán have several problems in making this product a commercial power in the region, as it is an area that is forgotten in the territory of Colombia; with all that, cocoa producers are faced with not having highly qualified work tools such as the great technologies in the agricultural sector, well, in Colombia, farmers not only cocoa but in general suffer from the use of technologies that facilitate their work and generate growth to their productivity. Technology is fundamental to this field to make the productivity of products more efficient. As long as the farmers do not have highly qualified tools, the economy of the farming sector will remain the same.[21,22,23]

It can also be observed that the cocoa producers of Roberto Payán, besides not having technology, do not have adequate inputs for this product. While they find one input that serves for the cultivation of cocoa in the region, there are more than 10 inputs that serve to produce illicit crops.

However, illicit crops have become a trigger at the national level, as they are the source of drug trafficking networks, corruption, crime, etc. As a result, crops such as cocoa are not feasible in this area, as they do not generate the same.

The cultivation of illicit crops, such as coca leaf, is currently a strong force in the municipality of Roberto Payán, as its inhabitants are economically dependent on it. This is a cause for concern, as most of the villages in the municipality are opting to grow this crop to support themselves economically and provide for themselves, as it has become the primary source of economic income for their families.[24,25,26]

Cocoa, better known in the territory as chocolate, was rich in the land in its beginnings because the ancestors planted it a lot, and it was one of the traditional fruits of the municipality of Roberto Payán. However, as time went by, this practice was lost, and it can be said that few people planted it, and there are only a few houses where trees of this fruit can be seen.

How does green innovation contribute to the growth and development of cocoa farmers in the municipality of Roberto Payán?

Objective

To carry out an analysis of green innovation for cocoa farmers in the municipality of Roberto Payán.

METHOD

Other authors call the positivist paradigm quantitative. It uses data collection and analysis to answer research questions and test previously established hypotheses. It relies on numerical measurement, counting, and often statistics to establish patterns of behavior in a population accurately.

It is based on a deductive approach, moving from the general to the particular. From extensive knowledge of generality, the bounded behavior of an individual particularity can be deduced. It is based on modeling that defines how everything is done, transforming it into a more rigid approach framed in a certain way of doing things.

It is based on the probabilistic induction of logical positivism because it emphasizes the proven or verified experience of the senses.

The research on green innovation in cocoa producers belongs to the positivist paradigm because it uses data collection and analysis through surveys, where numerical measurement is made, to tabulate and interpret the information obtained.

Approach

"Quantitative research consists of collecting and analyzing numerical data. This method is ideal for identifying trends and averages, making predictions, testing relationships, and obtaining general results from large populations".

The research approach is quantitative because surveys will be conducted to collect and analyze numerical data.

Method

The method is empirical-analytical, in which studies use numerical or statistical data to answer specific cause-effects.

The research on cocoa farmers uses an empirical-analytical method because it studies the causes and effects of the problem and provides alternative solutions.

Type of Research

Descriptive research focuses on identifying the characteristics of the population being studied. This methodology focuses more on the 'what' rather than the 'why' of the research subject.

The current research is descriptive in that it will provide insight into the characteristics of the population under study in 2024.

Population and sample

Population

An estimate of the population will be made through direct observation in an area affected by the presence of illicit groups and the absence of formal records in databases. Thirty cocoa producers will be randomly selected, including family members and some from the village of Loma Linda, as the only data available for the study.

Sample

As this is an environment where illicit groups and the lack of formal records make it difficult to access reliable data, a convenience sampling method will be used to estimate the population. Thirty cocoa producers will be chosen, including both family members and some from the Loma Linda village, which, according to a study:

Convenience sampling is a non-probabilistic and non-random sampling technique used to create samples according to ease of access, availability of people to be part of the sample, availability of the researcher chooses members only based on their accessibility, the availability of people to be part of the sample in a given time interval, or any other practical specification of a particular item.

The researcher chooses members only because of their proximity and does not consider whether they really represent a representative sample of the whole population. This technique makes it easier to observe habits, opinions, and views. Researchers use sampling techniques in situations where large populations need to be assessed since it is almost impossible to test an entire population.

Convenience sampling is the most commonly used sampling technique, as it is extremely quick, simple, and inexpensive, and members are usually accessible to participate in the sample.

This technique is used when no criteria are considered for a person to be part of the sample. Each element of the population can be a participant and is eligible to be part of the sample. These participants are usually dependent on proximity to the researcher.

Data collection techniques

Primary sources: a survey will be conducted on the cocoa growers of Loma Linda village (Roberto Payán).

Secondary sources: books and degree work from the universities of Pasto will be consulted.

Tertiary sources: web pages, blogs, digital books, and digital articles will be consulted.

RESULTS

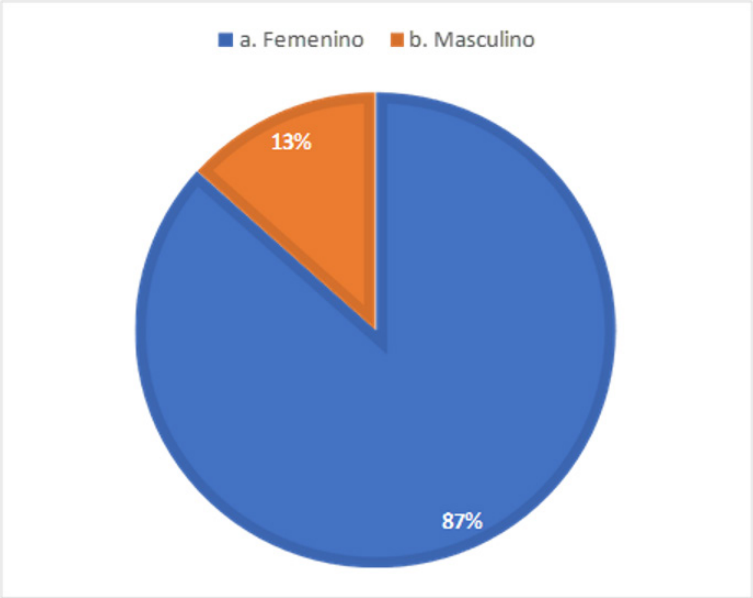

Figure 1. Gender

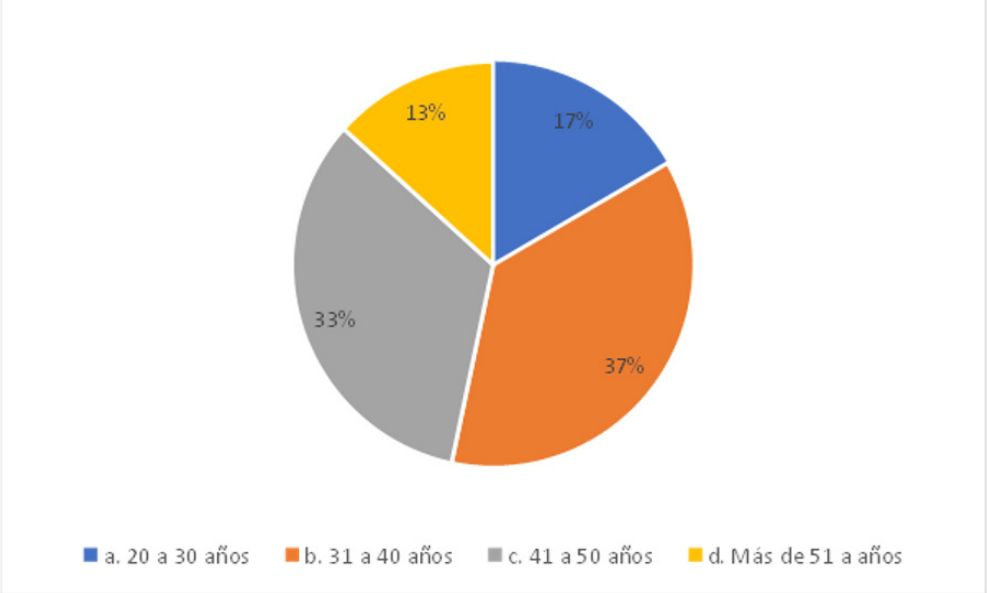

Figure 2. Age

Diagnosis based on green innovation in cocoa harvesters in the village of Loma Linda in the municipality of Roberto Payán.

The results of the surveys are presented below:

The figure shows the gender distribution of cocoa farmers, showing that 87 % are men, while the remaining 13 % are women. This notable difference reflects the male predominance in the region's agricultural activity, where men are the ones who are mostly involved in cocoa cultivation. Women, on the other hand, tend to be involved in other activities, such as domestic work.

The figure above shows that 37 % of the growers are between 31 and 40 years old, being the largest group. This suggests that most of those involved are in the middle of their productive stage. On the other hand, 33 % are in the 41-50 age range, indicating that middle-aged adults also play an important role in this activity.

17 % are underrepresented young people aged 20-30, reflecting low participation of the younger generation. On the other hand, 13 % are older than 51, representing the least numerous group, probably due to the physical demands of the crop. Thus, most cocoa farmers (70 %) are between 31 and 50. In contrast, younger and older cocoa farmers participate to a lesser extent, which could indicate challenges for generational renewal and the long-term sustainability of the crop.

Fifty percent of the growers earn the legal minimum wage, indicating that half are at the bottom of the wage scale. This group faces significant economic constraints.

Meanwhile, 27 % receive less than one minimum wage, which is evidence that a considerable group of farmers are below the minimum income standard, possibly reflecting low levels of productivity or profitability in their crops.

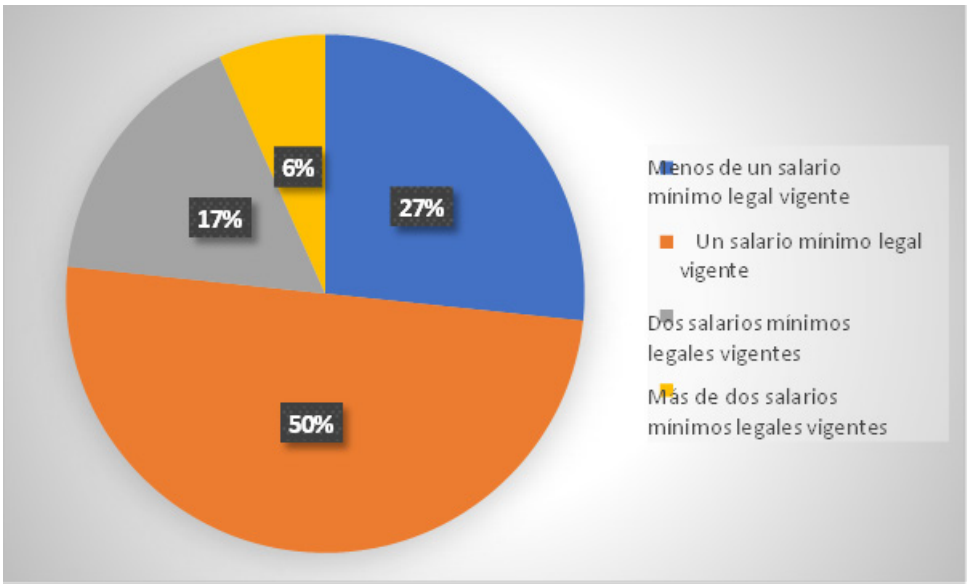

Figure 3. Monthly income

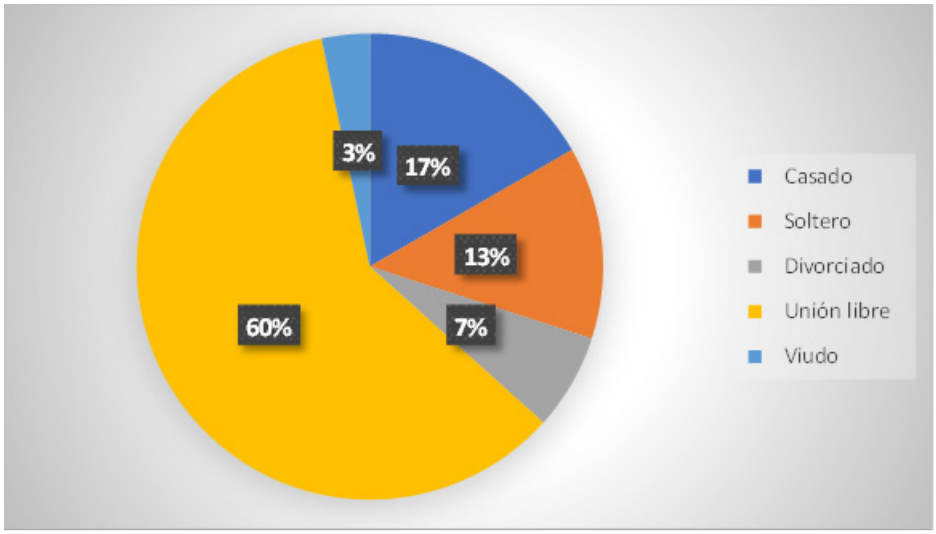

Figure 4. Marital status

17 % earn two minimum wages, representing an economic improvement compared to the previous groups, although they remain a minority. This group could be better positioned due to factors such as access to better technologies or markets. However, 6 % of growers, the smallest group, earn more than two minimum wages.

This analysis shows an unequal income structure in the cocoa sector, where most farmers are at the lower end of the wage scale.

This could suggest the need for policies or programs that encourage higher productivity, access to better markets, and financial support for smallholders.

It is worth noting that the highest-paid farmers are people who not only have an income from the crop but also have other jobs or are collaborators of the state (teachers, social leaders, individual jobs) to depend on a single income and the stat.

According to the figure 4, 60 % of respondents live in a consensual union, which could indicate a change in social norms or preferences concerning traditional marriage. This trend may be due to greater social acceptance of unions without legal formalization, economic difficulties, or a greater search for flexibility in couple relationships.

Some 20 % of respondents still opt for formal marriage, which shows that it is still an important option, although not the most common in this sample. This could be related to cultural, religious, or legal factors.

A significant percentage of respondents (17 %) are single, which may reflect a desire for independence or a postponement of forming a partner due to professional or personal goals.

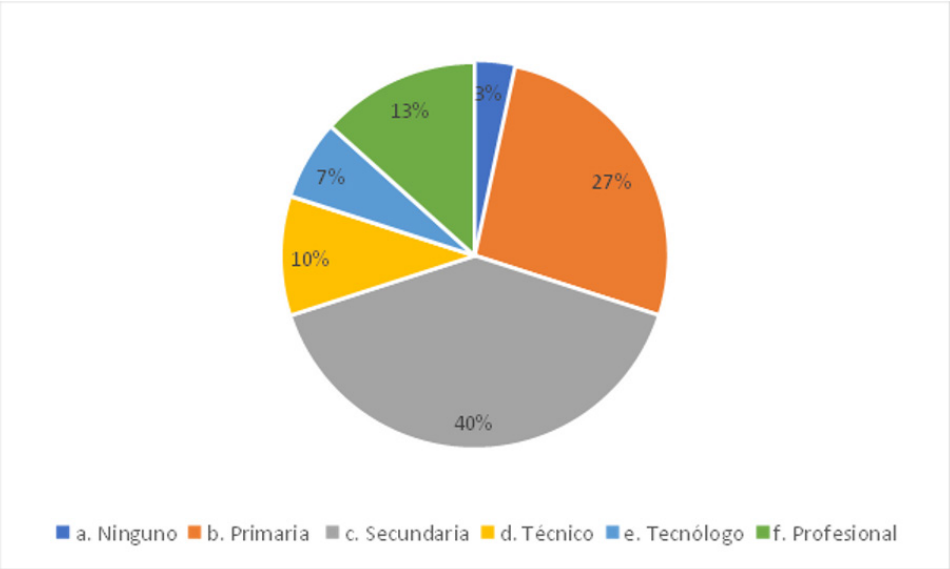

Figure 5. Level of study

The survey shows that 40 % of cocoa farmers have secondary education, the highest proportion. This indicates that many of the farmers have attained a medium level of education, which could influence their technical knowledge and skills in cultivation. However, 27 % of the growers completed primary education, showing that a significant part of the population has a basic level of education.

After that, 13 % of the growers have professional studies, which represents a smaller group but with a more advanced academic background. This could imply greater access to specialized knowledge in agriculture or crop management. Meanwhile, 10 % have attained technical studies. This group has training oriented towards practical skills, which could be useful in implementing improvements in the production processes of cocoa cultivation.

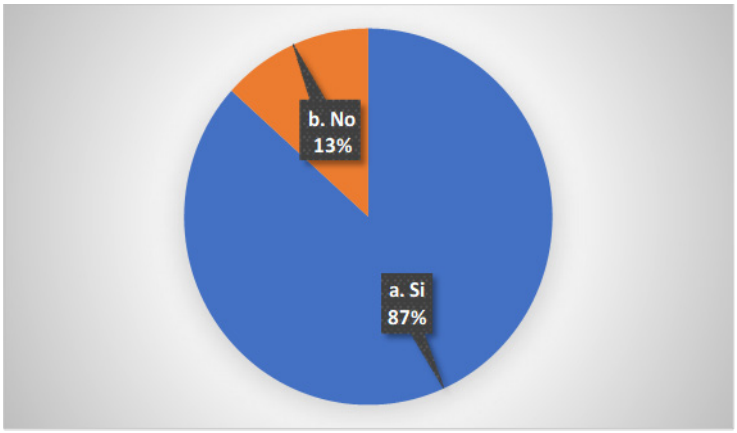

Figure 6. Delivers its production to a raw material collection centre

Finally, 7 % of the farmers have technologist studies, an intermediate level between technician and professional, which could give them an advantage in using more advanced technologies and production methods. Only 3 % of the farmers have no formal

education at all. This group is the smallest, suggesting that most cocoa farmers have at least some formal education.

This analysis reflects the diversity of educational levels among cocoa farmers. The majority have a predominantly middle level of education, but there is a significant presence of people with higher education who could help drive improvements in the industry.

The figure shows that 87 % of respondents indicate that they do deliver their production to a collection center. This is a majority percentage, suggesting that most producers prefer to centralize the delivery of their cocoa to collection centers. This may be due to logistical facilities, trade agreements, or the possibility of accessing larger markets.

Only 13 % of producers do not use collection centers to deliver their production. This minority group may be marketing directly or using other distribution mechanisms, which could suggest greater autonomy or a different approach to selling their cocoa.

This analysis suggests that collection centers are critical for most producers, facilitating market access and providing an efficient avenue for marketing cocoa.

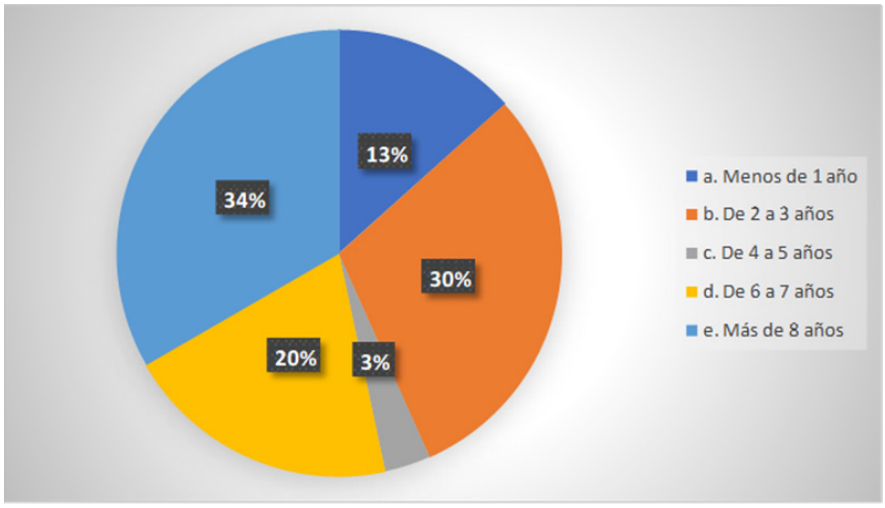

Figure 7. Years as a cocoa farmer

34 % of the farmers have been growing cocoa for more than 8 years. This group represents the largest proportion, which indicates that a significant part of the farmers have extensive experience in the sector, which can positively influence their knowledge and cultivation practices. On the other hand, 30 % of the respondents have been growing cocoa for 2-3 years. This sizeable group suggests many relatively new producers, possibly driving the sector's growth.

However, 20 % of growers have grown cocoa for 6-7 years. This group is also significant and reflects a mix of intermediate experiences that may be at a stage of consolidation as growers. Meanwhile, 13 % of the farmers have less than 1 year of cocoa growing, indicating that this percentage corresponds to new entrants starting to establish themselves.

Finally, 3 % of the respondents have been growing cocoa for 4-5 years, the least represented group. This suggests that fewer producers are in this time frame.

This analysis shows a combination of established experience and the entry of new growers, which may contribute to the long-term sustainability of the cocoa sector

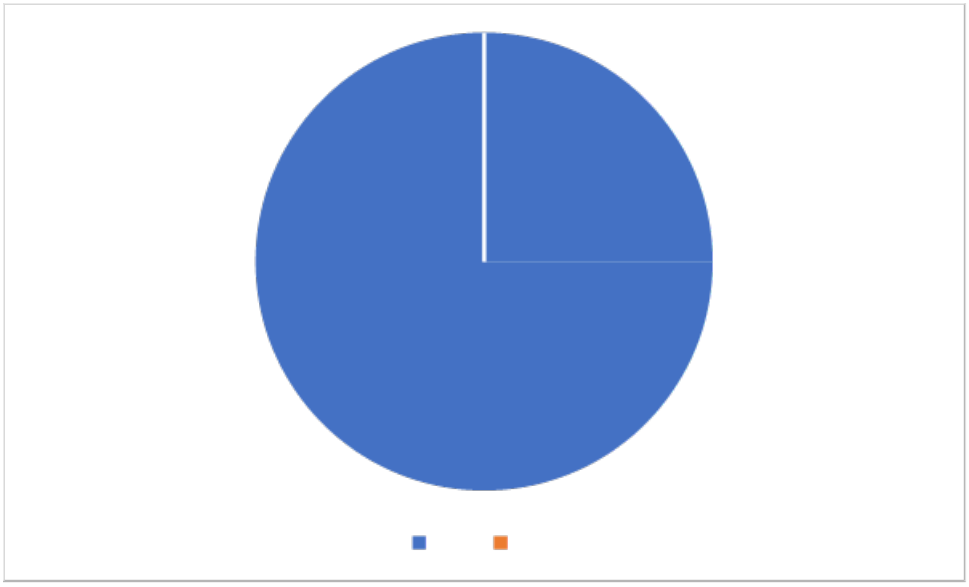

Figure 8. Owns its own cocoa crop

100 % of the participants answered 'yes', suggesting that growers are not working on rented land, under third-party contracts, or on other people's land.

This result highlights farmers' autonomy and complete control over their farming activity, which may influence their decision-making, management practices, and profitability of the cocoa business. This suggests a high degree of farmer independence, which could translate into a greater commitment to product quality and an ability to implement improvements in their farming. In addition, total land ownership indicates stability and rootedness in cocoa farming.

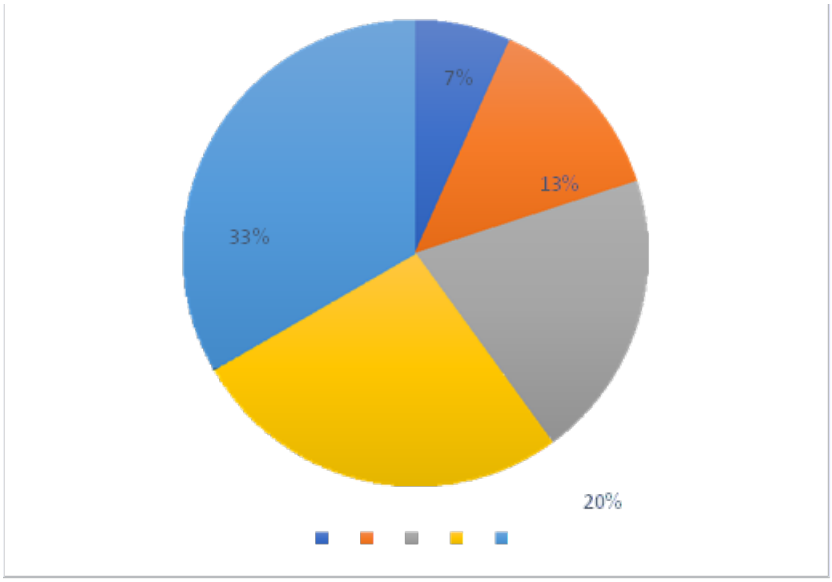

Figure 9. Hectares owned

The figure shows that 33 % is the largest category, indicating that most respondents or cocoa farmers own only one hectare. This could suggest that many smallholder farmers are involved in cocoa cultivation. 27 % show that many farmers have more space to cultivate (2 hectares), which could be related to increased investment and resources.

On the other hand, 20 % of farmers have 3 hectares. Although the percentage has decreased, it is still a considerable portion representing farmers with a moderate capacity to grow cocoa. However, 13 % own 4 hectares. This group is noticeably smaller, which could indicate that as the area under cultivation increases, the number of farmers is decreasing. This could reflect barriers such as costs, access to land, or the management of larger crops.

Finally, 7 % is the most minor proportion, suggesting that few farmers own 5 hectares of land. This could indicate that cocoa cultivation over larger areas is less common, possibly due to economic or market constraints.

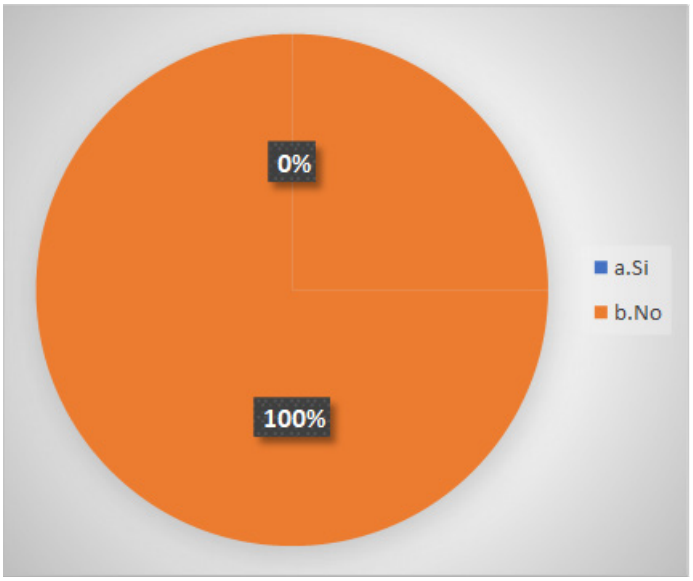

Figure 10. Produces under a quality standard and/or certificate, nationally and internationally

The 100 % of respondents not producing under quality standards or certifications indicate a lack of alignment with modern market trends, where sustainability and quality are increasingly valued. Cocoa producers in Roberto Payán should consider implementing standards and certifications, which could open new doors and improve their economic situation.

https://doi.org/10.56294/ere2024120

This is because the population is unaware of any standards that could benefit them.

.

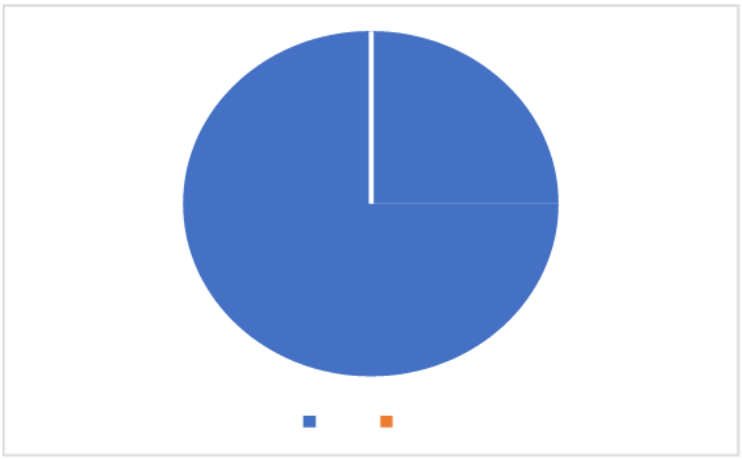

Figure 11. Changes in the environment such as climatic factors and soil quality positively influence cocoa cultivation and harvesting

100 % of the respondents agree that environmental factors, such as climatic changes and soil quality, positively influence cocoa cultivation and harvesting. This means that everyone recognizes that the natural environment plays a fundamental role in the successful production of cocoa. This is crucial, as it reflects a widespread understanding of the importance of optimal environmental conditions for maximizing productivity and quality in cocoa cultivation.

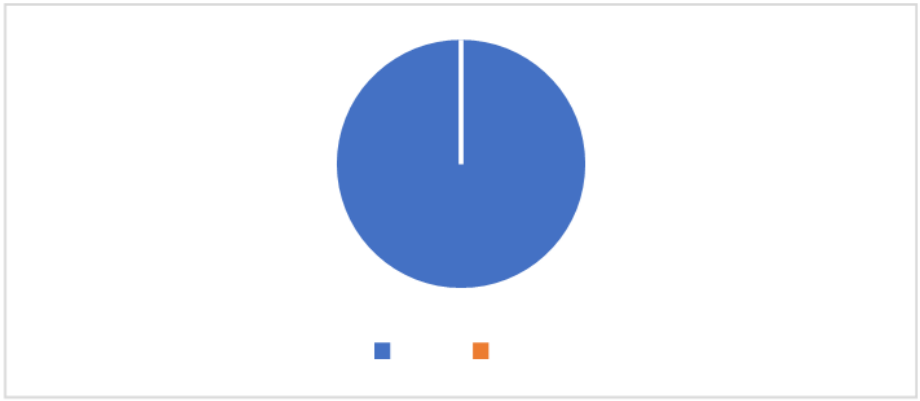

Figure 12. The quality of the environment: climate, temperature, humidity, soil fertility is suitable for producing cacao

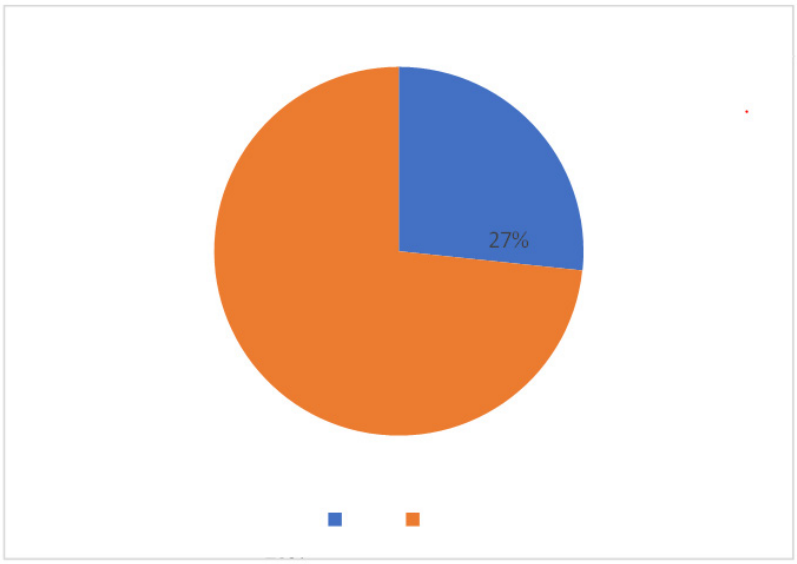

Figure 13. Has received technical advice and innovation from government agencies for cocoa production

The figure indicates that 100 % of the respondents consider the quality of the environment, including factors such as climate,

temperature, humidity, and soil fertility, to be suitable for cocoa production. Not a single respondent expressed the opposite.

This result suggests that cocoa farmers perceive the current environmental conditions as favorable for the crop, a positive indicator of productivity and sustainability of production in the areas analyzed.

73 % of cocoa producers report not receiving technical advice and innovation from state agencies. This high percentage suggests that most producers have access to institutional support to improve their production. This could imply an exemplary implementation of state agricultural support programs in the region, aiming to improve cocoa quality, increase productivity, or introduce new technologies or cultivation practices. Twenty-seven percent of respondents have received technical advice or innovation from state agencies. Although a minority, this percentage is not negligible, indicating that many producers may be working without technical support. 67 % of the respondents stated that they have not received technical advice and innovation from non-governmental agencies for cocoa production. On the other hand, 33 % have received accessory support because they attended a course given by the SENA, where they were given guidance on how to grow cocoa and supported by giving seeds for the cultivation of cocoa.

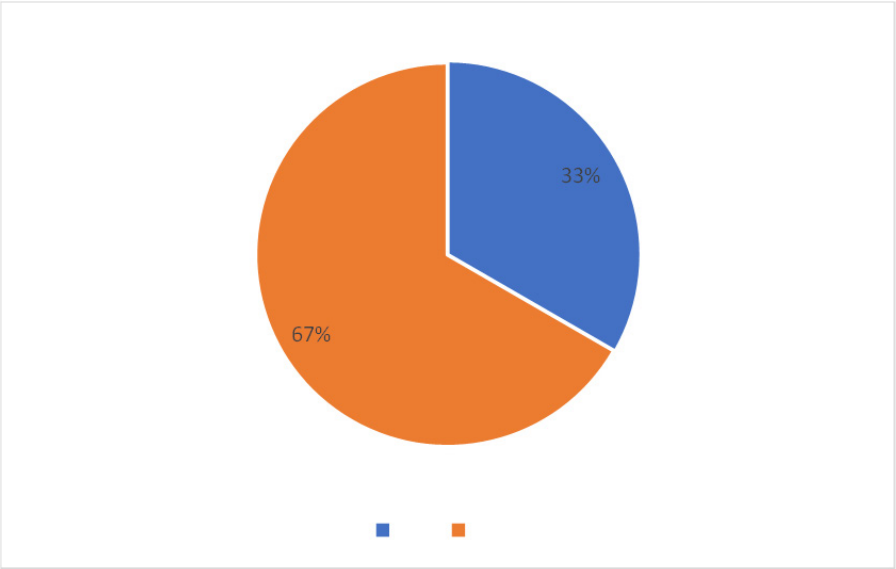

Figure 14. Has received technical advice and innovation (seeds for cultivation) from non-governmental organisations for cocoa production

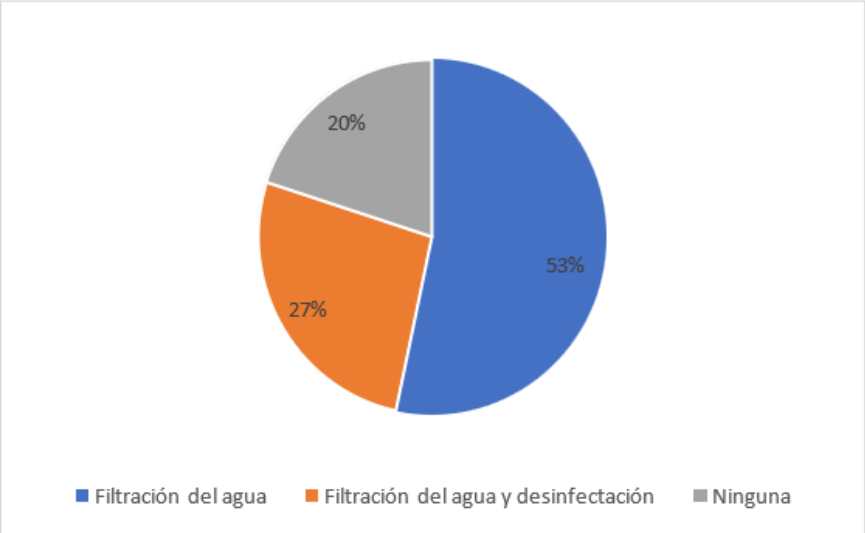

Figure 15. How wastewater is treated in cocoa cultivation

The high proportion of 'no' indicates an opportunity to improve the scope of support programs to promote greater adoption of innovative techniques and resources to improve the productivity and sustainability of cocoa cultivation. The majority of respondents 53 % indicated that wastewater from cocoa cultivation is treated by a filtration process. This suggests that filtration is the main method used to manage wastewater on these plantations. The fact that more than half of the respondents use filtration suggests that there is an awareness of the need to treat wastewater in cocoa farming, although this process could be improved by adding disinfection.

https://doi.org/10.56294/ere2024120

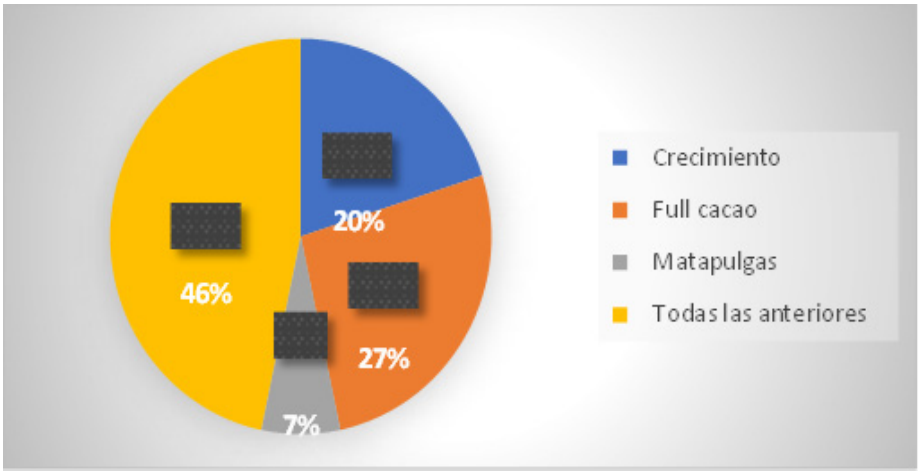

Figure 16. Type of fertiliser used for cocoa growing

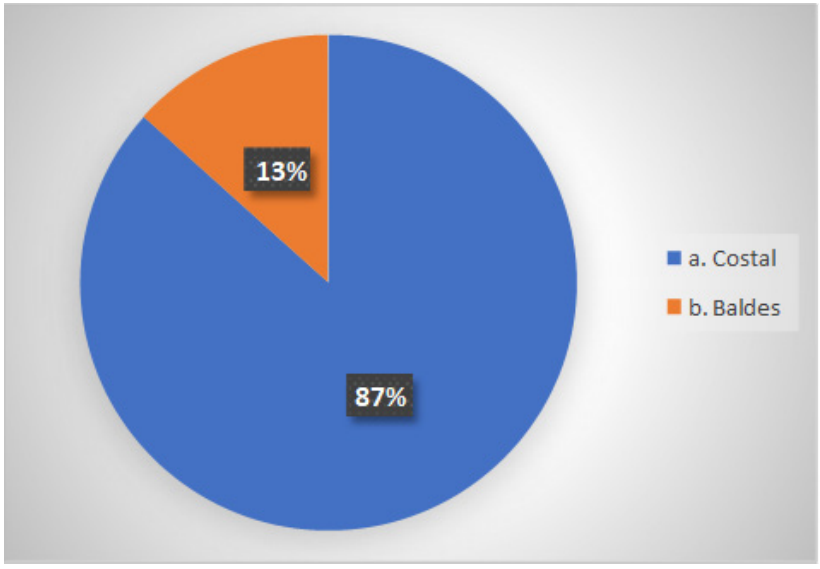

Figure 17. Types of packaging used to sell cocoa

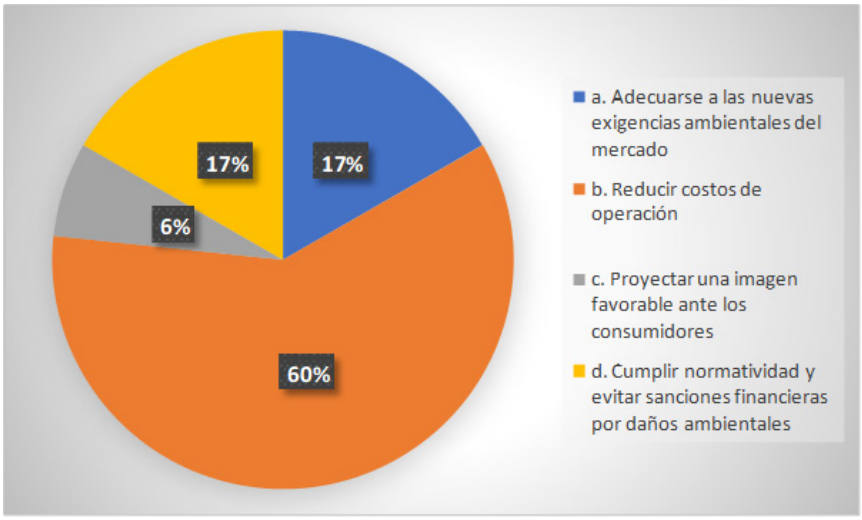

Figure 18. Reasons for implementing green practices in cocoa growing

46 % of respondents use various fertilizers, suggesting that almost half of respondents do not limit themselves to a single type of fertilizer, but prefer to combine different options to obtain better results.

This trend may indicate greater awareness of the need to balance nutrients and control pests at the same time. This variation could be related to the need to ensure both the healthy growth healthy crop growth and protection against pests and improving the quality of the cocoa.

https://doi.org/10.56294/ere2024120

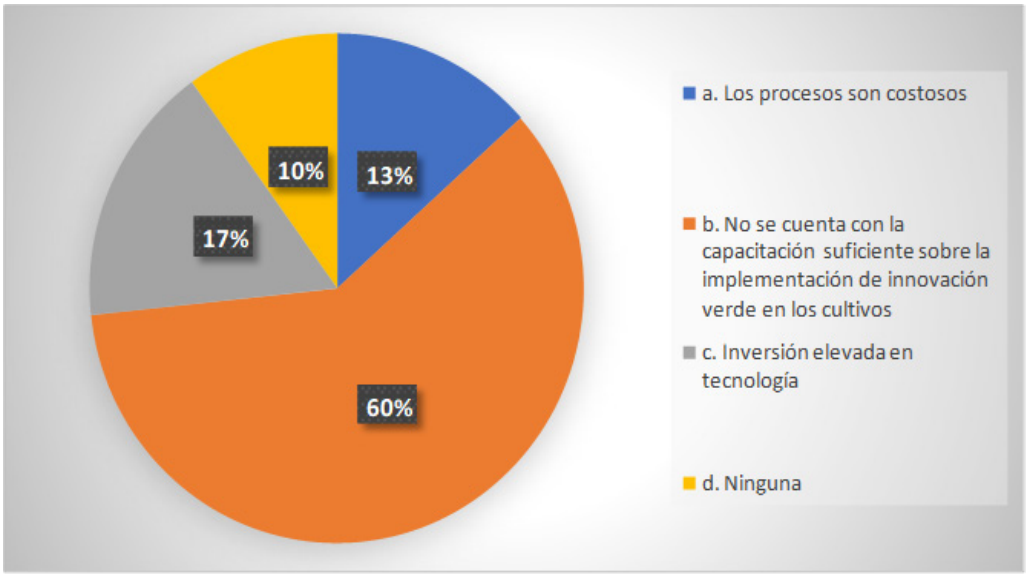

Figure 19. Difficulties in implementing green practices

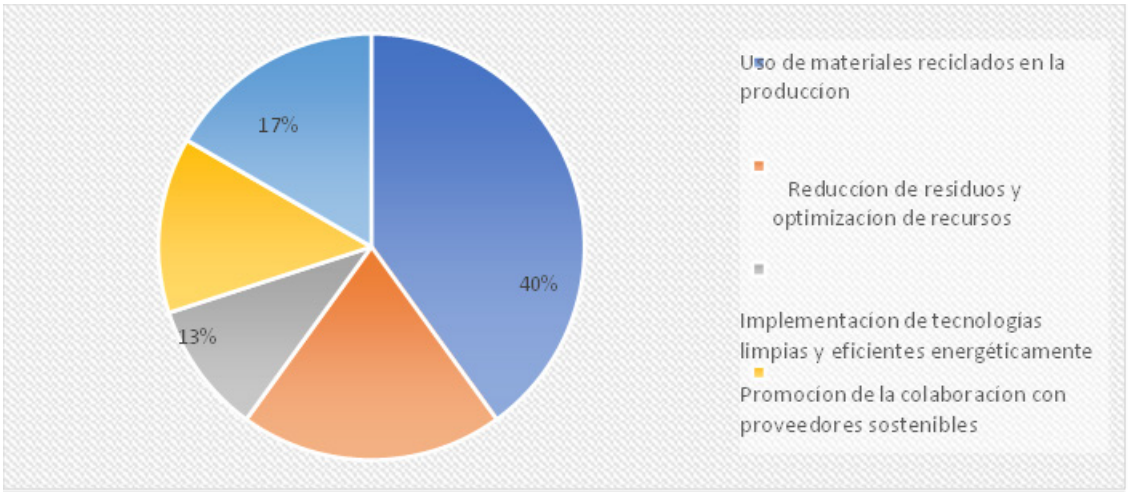

Figure 20. Measures you implement on your farm to reduce your environmental impact

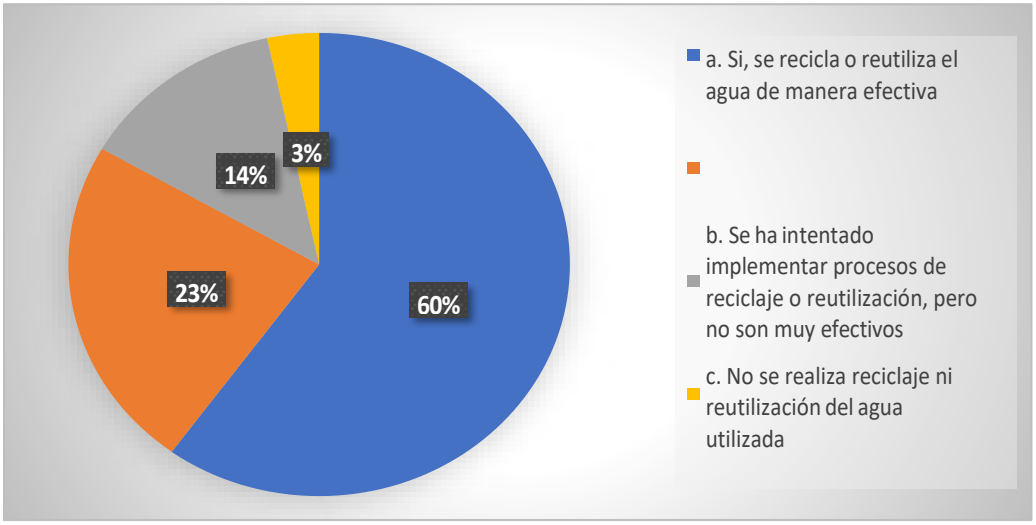

Figure 21. Management of technology or processes that allow for recycling or reuse of water used in their operations

87 % of cocoa producers opt for sacks as their primary packaging. This may be due to several reasons. Sacks tend to be cheaper and widely available, which makes them accessible to most producers. They also make loading the cocoa easier, as they are less labor-intensive to transport in rural areas

The predominant use of sacks reflects a clear trend toward a more traditional, economical, and efficient packaging method for

cocoa producers. Although buckets offer advantages in terms of reusability, their low adoption suggests that they do not fit most respondents' logistical or economic needs.

60 % of respondents consider the main reason for implementing green practices in cocoa farming to be reducing operating costs. This suggests that most farmers see green practices as an efficient way to make their processes more economical in the long run by optimizing the use of resources such as water, energy, or fertilizers or by improving production efficiency.

The analysis of this survey shows that most cocoa farmers are mainly motivated by the operating cost savings that can be derived from green practices. 60 % of respondents cited lack of adequate training as the main obstacle to green practices, suggesting a strong need for training programs. Growers lack access to necessary information on sustainable agricultural practices. These include techniques such as agroforestry, crop rotation, and shade crops, which are essential to conserving soils and increasing biodiversity

The 40 % of cocoa producers choosing to reuse materials to mitigate environmental impact is a positive indicator of environmental awareness in the sector. This practice can include the reuse of agricultural materials, such as tree pruning residues, cocoa shells, or compost, which helps to reduce waste and improve the sustainability of operations.

60 % of respondents indicate that more than half of the producers have effectively implemented processes to recycle or reuse water, which could be driven by the need to conserve resources and reduce costs in areas where water may be scarce or costly.

Most producers (60 %) have established effective processes for recycling or reusing water, suggesting that there is awareness and commitment to the responsible use of this resource.

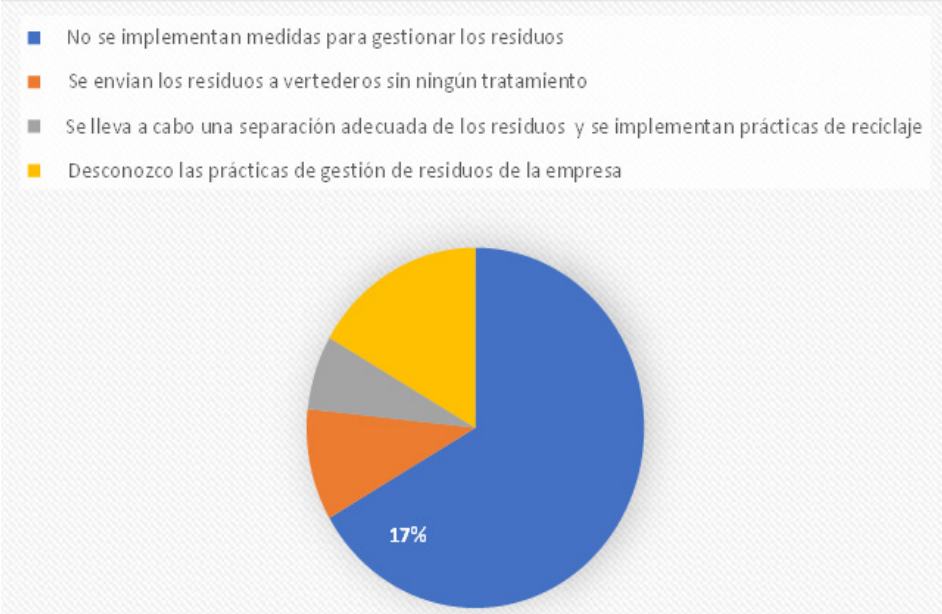

Figure 22. Management of waste generated in the production process

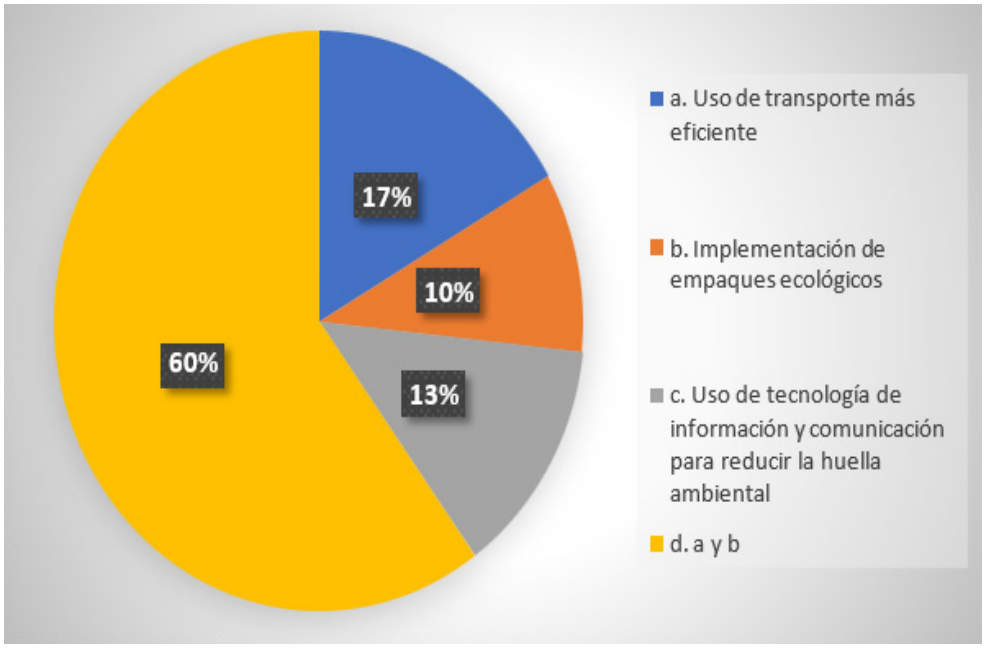

Figure 23. In which area do you think distribution and marketing processes should be improved from a green innovation perspective?

60 % of respondents indicate that no measures are implemented to manage waste in the cocoa production process.

This could reflect a lack of awareness or resources to establish sustainable waste management practices. This high percentage suggests that farmers in the area are not yet trained to take action to reduce or properly manage waste.

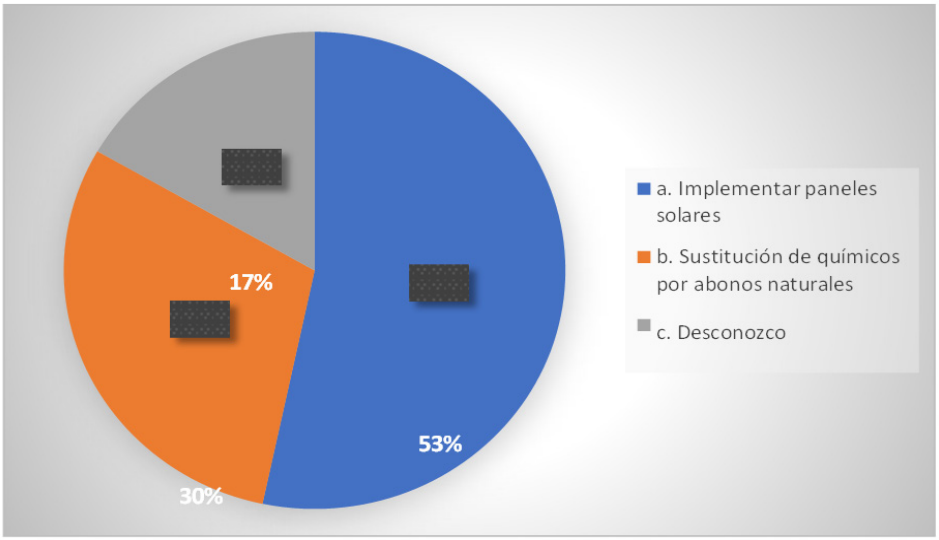

Figure 24. Measures you would take to improve energy efficiency in the production and marketing processes of cocoa farming

The analysis of the survey results shows that 60 % of respondents identify two key areas that need improvement in distribution and marketing processes from a green innovation perspective: the use of efficient transport and the implementation of eco-friendly packaging.

1. The use of efficient transport is fundamental because the region only has the river for transport. Getting their product out of the area is expensive, so they opt to sell it at an economical price. With the connectivity of land transport, they can get the product and have higher profits, which would motivate the farmers.
2. Implementation of ecological packaging. Encourage research into sustainable materials and support the design of modular or removable packaging that facilitates recycling.

53 % of respondents choose to implement solar panels as one of the most effective measures to improve energy efficiency. This reflects an apparent inclination towards using renewable energy in agriculture, which reduces energy costs in the long term and minimizes the carbon footprint. The installation of solar panels allows the generation of clean and stable energy, reducing dependence on conventional sources, which are often more costly and polluting. This measure is not only seen as an economically viable option but also as a strategy to align with global trends towards sustainability.

The survey also shows that a majority of producers are interested in concrete and technologically advanced measures, such as solar panels, while a significant number are already open to more sustainable practices, such as the use of natural fertilizers.

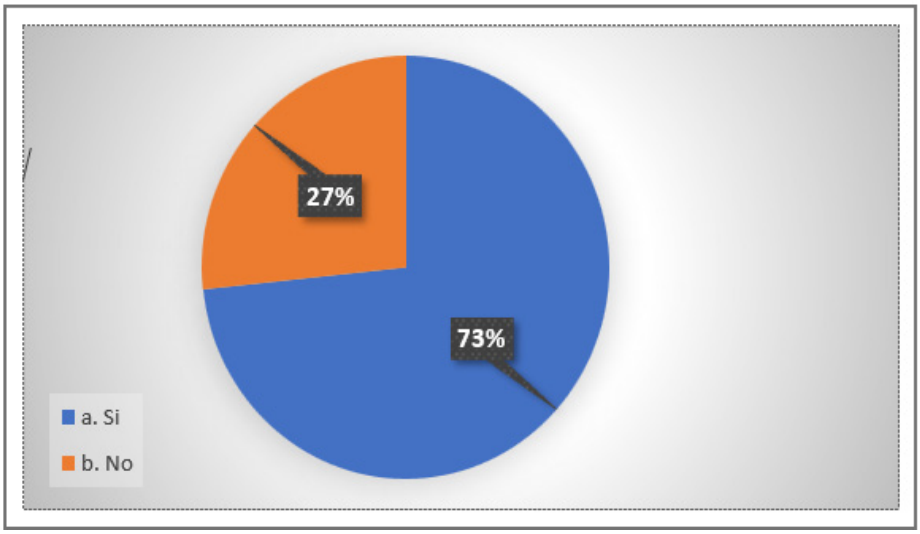

Figure 25. Would you be willing to invest in the implementation of green practices on your crop in the long term

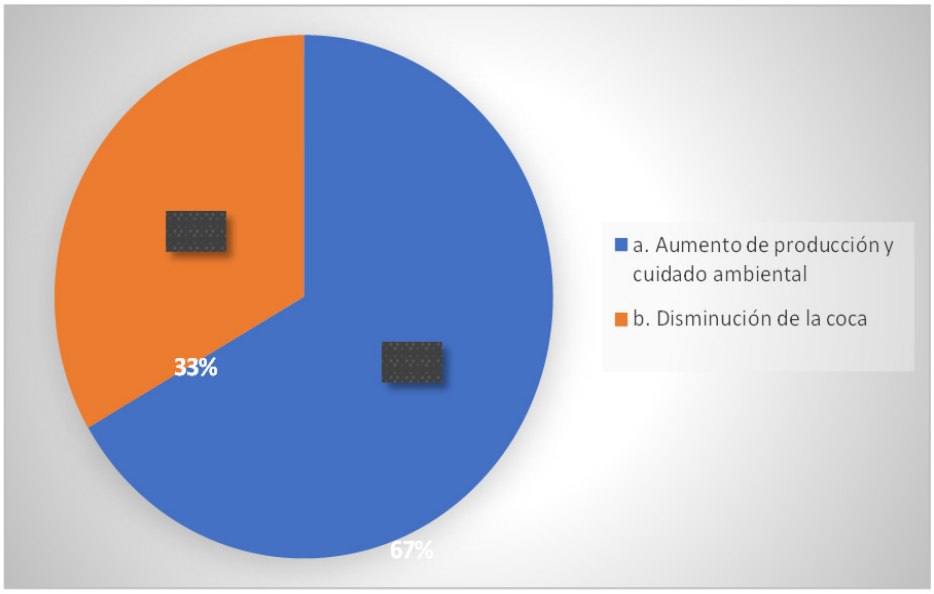

Figure 26. How do you think green innovation could benefit cocoa production in the municipality of Roberto Payán

73 % of respondents expressed that they would be willing to invest in green practices long-term, reflecting a broad interest and openness towards sustainability in agricultural production. This result suggests that farmers are not only aware of the environmental impact of their activities but also see green practices as a viable and beneficial long-term investment.

This indicates that the agricultural sector is willing to evolve and improve its relationship with the environment.

Matriz MEFE para los cultivadores de cacao			
Factores	**Valor**	**Calificación**	**Valor ponderado**
Oportunidades			
Apoyo gubernamental	0,08	3	0,24
Clima favorable	0,07	4	0,28
Proyectos de desarrollo rural	0,9	4	0,36
Promoción del cacao regional	0,12	3	0,36
Acceso a mercados internacionales	0,08	4	0,32
Crecimiento de la demanda	0,10	3	0,30
Total	**0,54**	**21**	**1,86**
Amenazas			
Conflictos armados	0,08	2	0,16
Sustitución de cultivos	0,10	1	0,10
Falta de innovación	0,09	2	0,18
Falta de infraestructura vial	0,12	2	0,24
Competencia global	0,07	1	0,07
Total	**0,46**	**8**	**0,75**
TOTAL, GENERAL	**1**		**2,61**

Figure 27. External Factors Evaluation Matrix MEFE

Many respondents believe that green innovation can optimize farming methods, using sustainable practices that improve yields and protect the environment. Green innovation would benefit producers in terms of income and foster greater community cohesion by allowing them to collaborate on sustainable farming practices. This could lead to the creation of support networks and the improvement of local infrastructure.

The majority of respondents perceive that green innovation would not only benefit cocoa production by increasing yields and product value but would also positively impact the community and the environment. This highlights the need to encourage policies and programs that support the transition to more sustainable agricultural practices in the region.

External Factors Evaluation Matrix MEFE

An audit of the external environment is carried out to identify threats and opportunities for cocoa farming. The following steps were followed:

- A list of success factors was drawn up, considering first the opportunities and then the threats.
- Each external factor was assigned a weight between 0,0 and 1,0, taking into account the level of impact that this variable generates on cocoa farmers, taking care that the sum of all the weights assigned to the factors added up to 1,0.
- Each of the external factors received a score between 1 and 4, where 4 = major opportunity, 3 = minor opportunity, 2 = minor threat, and 1 = major threat.
- The value is multiplied by the rating for each factor to determine the weighted score.
- As a last step, the total score was obtained by adding the weighted score.

It can be analyzed that the MEFE matrix of the cocoa crops in the village of Loma Linda de Roberto Nariño has 11 external factors, of which six belong to the opportunities and 5 to the threats, where they obtained the following scores:

Opportunities (Total: 1,86)

Governmental support (0,08; score 3; weighted value 0,24)

The existence of government support indicates that some policies and programs could facilitate cocoa production and marketing. The moderate rating suggests that, although there is support, it may not be sufficient or fully exploited.

Favourable climate (0,07; score 4; weighted value 0,28)

A conducive climate is critical for cocoa cultivation. This high score highlights the importance of this factor in ensuring successful and high-quality harvests.

Rural development projects (0,09; score 4; weighted value 0,36)

Ongoing projects are an excellent opportunity to improve infrastructure and production capacities. The high score suggests that these projects are well-received and effectively implemented.

Promotion of regional cocoa (0,12; score 3; weighted value 0,36)

Promoting regional products can increase the visibility and demand for local cocoa. This is essential for building a strong brand and differentiation in the market.

Access to international markets (0,08; score 4; weighted value 0,32)

Accessing international markets represents a great opportunity to increase sales and recognition of quality cocoa. A high score suggests that this access is quite effective.

Growth in demand (0,10; score 3; weighted value 0,30)

Growing market demand for cocoa is a positive indicator. However, the moderate rating suggests that growers must be prepared to meet this demand continuously.

Threats (Total: 0,75)

Armed conflict (0,08; rating 2; weighted value 0,16)

The presence of armed conflict can destabilize communities and affect production. This moderate rating indicates that it is a risk that should be considered.

Crop substitution (0,10; score 1; weighted value 0,10)

Crop substitution is a significant threat that can divert farmers' attention and resources to other, more profitable products. The low score underlines the urgency of addressing this problem.

Lack of innovation (0,09; score 2; weighted value 0,18)

Lack of innovation may limit the competitiveness of growers. This threat highlights the need to adopt new technologies and farming methods.

Lack of road infrastructure (0,12, rating 2, weighted value 0,24)

Deficiencies in road infrastructure hinder access to markets and the distribution of products. This threat needs immediate attention.

Global competition (0,07; score 1; weighted value 0,07)

Competition in the global market is a minor but relevant challenge. The low score suggests that competition may be manageable if local competitive advantages are strengthened.

Overall Total (Opportunities and Threats): 2,61

The overall total of 2,61 indicates a positive balance, as opportunities (1,86) significantly outweigh threats (0,75). This suggests that, although challenges exist, cocoa farmers can exploit many more possibilities.

Internal factors assessment matrix MEFI

An internal environment audit is carried out to identify the strengths and weaknesses of cocoa farming. The following steps were taken:

- A list of key internal factors was drawn up.
- A weight between 0,0 and 1,0 was assigned to each factor. The total of all weights should add up to 1,0.
- A score between 1 and 4 was established for each, where one major weakness, two major weakness, 3 = minor strength, and 4 = major strength.
- The value was then multiplied by the rating for each factor to determine the weighted score.
- Finally, to obtain the total score for the cocoa crops, the weighted score was summed up as follows.

Matriz MEFI para los cultivadores de cacao			
Factores	**Valor**	**Calificación**	**Valor ponderado**
Fortalezas			
Disponibilidad de terreno para cultivar cacao	0,15	4	0,60
Empoderamiento comunitario	0,10	3	0,30
Suelos fértiles	0,12	4	0,48
Diversidad de especies de cacao	0,10	3	0,30
Total	0,47	14	1,68
Debilidades			
Dificultad para acceder a los mercados regionales y nacionales	0,10	1	0,20
Falta de capacitación en producción y comercialización	0,12	1	0,12
Desvalorización del cacao	0,15	2	0,30
Enfermedades y plagas al cultivo	0,08	2	0,16
Acceso a recursos financieros	0,08	2	0,16
Total	0,53	8	0,94
Total, general	**1**		**2,62**

Figure 28. Internal factors assessment matrix MEFI

https://doi.org/10.56294/ere2024120

It can be analyzed that the MEFI matrix of the cocoa crops of the village of Loma Linda de Roberto Nariño has nine internal factors, of which four belong to the strengths and 5 to weaknesses where they obtained the following qualifications:

Strengths

Availability of land to cultivate cocoa (Value: 0,15, Rating: 4, Weighted value: 0,60)

Analysis: a rating of 4 indicates that the land is highly favorable for cocoa cultivation, which is critical for the crop's success.

Implication: this strength should be capitalized to maximize cocoa production and quality.

Community empowerment (Value: 0,10, Rating: 3, Weighted value: 0,30)

Analysis: empowered communities tend to collaborate better, which can create cooperatives or associations that strengthen the cocoa value chain.

Fertile soils (Value: 0,12, Rating: 4, Weighted value: 0,48)

Analysis: fertile soils are an excellent advantage for optimal plant growth.

Implication: investing in agricultural practices that maintain soil fertility will be key.

Cocoa diversity (Value: 0,10, Rating: 3, Weighted value: 0,30)

Analysis: The diversity of cocoa varieties can provide competitive advantages and adaptation to different markets.

Implication: Promoting this diversity can help people cope with pests and diseases. Obtaining an overall score of 1,68

Weaknesses

Market access (Value: 0,10, Rating: 1, Weighted value: 0,20)

Analysis: a score of 1 indicates minimal market access, a critical weakness.

Implication: strategies such as partnerships or marketing networks should be sought to improve connection to markets.

Lack of training (Value: 0,12, Rating: 1, Weighted value: 0,12)

Analysis: this weakness suggests that producers may not have the necessary skills to maximize production and quality.

Implication: investing in training programs to improve farming and management skills is critical.

Devaluation of cocoa (Value: 0,15, Rating: 2, Weighted value: 0,30)

Analysis: devaluation indicates a significant problem affecting the profitability of the crop.

Implication: marketing and product differentiation strategies are needed to address this situation.

Diseases and pests to the crop (Value: 0,08, Rating: 2, Weighted value: 0,16)

Analysis: this weakness represents a risk to production, although it is being moderately managed.

Implication: implementing integrated pest and disease management is crucial for crop protection.

Financial access (Value: 0,08, Rating: 2, Weighted value: 0,16)

Analysis: limited financial access may restrict investments needed to improve production.

Implication: to ensure financial viability, seeking alternative financing and support programs is essential.

Having an overall score of 0,94 on weaknesses.

The organization's overall score of 2,62 on the MEFI matrix indicates a balanced position, with significant strengths that can be leveraged and weaknesses that need attention.

Overall recommendations

Strengthening Opportunities: to increase the production of high-quality cocoa, the strengths of the region, especially the fertile land and soils, should be fully utilized.

Improve Market Access: implement strategies to improve market access, such as establishing relationships with cooperatives and distributors.

Training and Education: invest in training programs to address skills shortages and improve production.

Differentiation Strategies: develop products that differentiate themselves in the market to counteract the devaluation of cocoa.

Integrated Pest Management: implement sustainable practices to manage diseases and pests, ensuring crop health.

SWOT Matrix

The SWOT analysis is carried out to study the company's external and internal factors, facilitate decision-making, provide a frame of reference when selecting strategies, and review the company's position.

Threats and opportunities are represented by the external conditions of the company that can influence it negatively or positively; opportunities are external conditions that could affect the company positively, and threats are external conditions or actions of other subjects that could affect it negatively. Types of green product and process innovation that can be implemented with cocoa pickers in the Loma Linda village (ROBERTO PAYAN).

	(F) FORTALEZAS 1. Disponibilidad terrenal para cultivar cacao 2. Empoderamiento comunitario 3. Suelos fértiles 4. Diversidad de cacaos	**(D) DEBILIDADES** 1 Acceso al mercado 2 Falta de capacitación 3 Desvalorización del cacao 4 Enfermedades y plagas al cultivo 5 Acceso financiero
(O) OPORTUNIDADES 1 Apoyo gubernamental 2 Proyectos de desarrollo rural 3 Promoción del cacao regional 4 Acceso a mercados internacionales 5 Crecimiento de la demanda 6 Clima favorable	Estrategias (FO) Contactar con entidades como el ministerio de agricultura, desarrollo rural y el SENA para acceder a programas de asistencia técnica y capacitación sobre el cultivo de cacao (F1, O1). aprovechar el proyecto minagricultora que busca la renovación de 6.500 hectáreas de cacao con su inversión de 12.000 millones (F2, O2). Mostrar en redes sociales como TikTok, Facebook y Instagram el proceso sano de la cultivación de cacao de la región de Roberto Payan (F3, O3).	Estrategias (FA) Cultivar los terrenos disponibles para que grupos armados no se apoderen de las tierras (F1, A1). Realizar campañas agricultoras de cacao con ayudas de institución del SENA, lograr una motivación a la comunidad (F2, A2). Presentar con ayuda del consejo comunitario un proyecto vial a Colombia transforma donde demostremos los venefícios que se lograrías si se tiene una conectividad vial en la regio (F3.A3). Implementar la selección del tipo de cacao y ejecutar un secado artificial para agilizar el secado del cacao (F4, A4).
	Crear una asociación para tener una amplia producción y poder hacer importación sacando provecho a las variedades de cacao (F4, o4).	
(A) AMENAZAS 1 Conflictos armados 2 Sustitución de cultivos 3 Carecimiento de infraestructura vial 4 Falta de innovación 5 Competencia global	Estrategia (DO) Acceder a los programas que ofrece la federación de Fedecacao, para mejorar las técnicas de cultivos para aumentar la calidad del cacao y la comercialización (D1, O1). Capacitación: Proporcionar formación en buenas prácticas agrícolas, manejo de plagas, optimización de la cosecha y post-cosecha (D2, O2). Innovar en la presentación como empaques ecológicos generando una imagen regional y un valor agregado al producto (D3, O3). Utilizar variedades de cacao que sean resistentes a enfermedades y plagas. También realizar control Biológico al cultivo (D4, O4).	Estrategia (DA) Implementar diálogos con cabecillas de grupos armados para minimizar el riego y abrir el acceso al mercado de cacao (D1, A1). Implementar la diversidad de otros cultivos dentro del cacao (D2, A2). Por la falta vial de la rigió se optará por tener convenios con empresas de transporte terrestre de Barbacoas (D3, A3). Técnicas como utilizar productos biológicos basados en bacterias o hongos para el control de plagas o enfermedades, diferenciándonos de la competencia (D4, A4). Acceder a financiamientos con entidades como el banco agrario para invertir y ser competente (D5, A5).

Figure 29. SWOT matrix of weaknesses, opportunities, strengths, and threats

Procesos	Detalles
Producción	Integrar el cultivo de cacao con otros productos como plátano o frutas que se den en el territorio con el fin de mejorar la biodiversidad, cuidar el suelo y generar sombra. También se abonará las plantas con abono orgánico como el compost para reducir la utilización de fumigas con químicos que dañen el medio ambiente.
Distribución	Buscar convenios con las empresas transportadoras que mejor servicio brinde con el objetivo de lograr una distribución del cacao a mercados más rentables como el de Tumaco.
Marketing y ventas	Una plataforma de comercio electrónico que permita a los agricultores vender y promocionar el cacao. directamente a consumidores y mercados internacionales, eliminando intermediarios y aumentando sus ingresos. Además, la plataforma puede incluir funcionalidades como reseñas de productos, historias de los agricultores y certificaciones de calidad, lo que genera confianza en los consumidores. Esta estrategia no solo fomenta un comercio más ético y sostenible, sino que también permite a los agricultores diversificar sus mercados y alcanzar audiencias globales, contribuyendo así a la estabilidad económica de la comunidad.
Sistema de información y comunicación	Crear una base de datos para tener acceso a los cultivadores para informarles de capacitaciones o proyectos para los cultivos de cacao. Además, el sistema puede incorporar canales de comunicación, como boletines informativos, mensajes de texto y plataformas en línea, para asegurar que la información llegue de manera rápida y efectiva. Esto no solo empodera a los agricultores al mantenerlos informados, sino que también fomenta una comunidad más unida y colaborativa.
Proceso de negocio	Asociarse con empresas o entidades que permitan al cultivador interactuar directamente a consumidores y mercados internacionales, eliminando intermediarios y aumentando sus ingresos. Al eliminar intermediarios, los cultivadores no solo pueden obtener precios más justos por su producto, sino que también tienen la oportunidad de construir relaciones más sólidas con sus compradores.

Figure 30. Types of green product and process innovations that can be implemented with cocoa collectors in the Loma Linda village (ROBERTO PAYAN)

Compost will also be produced for cocoa cultivation, contributing to crop sustainability and improved productivity. Here are some of the main objectives:

Improve soil fertility

Nutrient supply: compost is rich in essential nutrients (nitrogen, phosphorus, potassium) that favor the growth of cocoa plants.

Increased organic matter: improves soil structure, increasing water and nutrient retention capacity.

Environmental Sustainability

Waste Recycling: uses organic waste (crop residues, kitchen waste, manure) that might otherwise become waste, contributing to the circular economy.

Reduction of Synthetic Chemicals: decreases reliance on chemical fertilizers, reducing the risk of soil and water contamination.

Increased Productivity

Improved Growth and Yield: a more fertile and healthy soil can produce more vigorous plant growth and higher fruit production.

Pest and disease control

Improved Soil Health: healthy soil can be less susceptible to pests and diseases, reducing the need for pesticides.

Reduced Erosion

Improved Water Retention: soil rich in organic matter has a better capacity to retain water, which helps prevent erosion and improves drought resistance.

Local Economy

Cost Savings: farmers can reduce fertilizer costs and improve crop profitability by producing compost locally.

Environmental Education and Awareness

Promoting Sustainable Practices: encouraging the use of compost can help farmers better understand the importance of sustainability in agriculture.

It is a practice that improves the health and productivity of the cocoa crop and contributes to environmental sustainability and the well-being of farming communities.

Composting

Compost is an organic fertiliser obtained by decomposing plant and animal waste or residues into a homogeneous mass with a lumpy structure rich in humus and microorganisms. This process is aerobic, so it is enhanced in the presence of air since the decomposition is done by microorganisms such as bacteria and fungi.[2]

Materials

Source: https://repository.agrosavia.co/bitstream/handle/20.500.12324/1195/Ver_Documento_1195.pdf?sequence=1&isAllowed=y

Figure 31. Materials

It is very simple to manufacture; all that is needed are materials found on cocoa farms, such as soil, vegetable waste (banana, corn, beans, cocoa shells, kitchen waste, and others), animal manure (cattle manure, chicken manure, and others), lime or ash, water, black plastic #5 gauge.

Use of organic fertilizer

After obtaining the organic fertilizer, it is recommended that it be used in plantations cultivated within the cocoa agroforestry system to increase the soil's humus content and water retention capacity, improve its structural stability, facilitate the soil's work, stimulate its biological activity, and supply most of the nutrients necessary for the plant's development.[3]

Source: https://repository.agrosavia.co/bitstream/handle/20.500.12324/1195/Ver_Documen to_1195.pdf?sequence=1&isAllowed=y

Figure 32. Use of organic fertilizer

Action plan with strategies to implement green innovation for cocoa farmers in Roberto Payán.

Estrategias	Descripción de las estrategias	Objetivo de la estrategia	Responsable	Tiempo Promedio	I
Crear una asociación de cultivadores de cacao en la vereda Loma Linda	La creación de una asociación fortalece el tejido social y promueve la colaboración entre los miembros de la comunidad. Además, puede generar proyectos de bienestar social, como la construcción de infraestructuras, servicios de salud, educación, y capacitación técnica. La asociación puede promover prácticas agrícolas sostenibles y amigables con el medio ambiente, como la agroforestería (cultivo combinado con árboles) y el uso responsable de productos químicos. Esto no solo mejora la calidad del cacao, sino que también protege el entorno natural y contribuye al cambio climático. Una asociación bien organizada permite a los pequeños productores unirse para negociar precios más justos y acceder a mercados nacionales e internacionales. El cacao de Roberto Payán podría ser valorado por su calidad y características especiales, lo que permitiría a los cultivadores obtener mejores ingresos. La asociación puede establecer vínculos con empresas procesadoras de cacao, cooperativas de comercialización o incluso con marcas de chocolate de alta gama, lo que facilitaría la venta del cacao a mejores precios.	Fortalecer a la comunidad cacaotera de la región	Cultivador	2 meses	As cor leg
Producción sostenible	Ampliación de cultivos o sembrar nuevas hectáreas en terrenos disponibles y aptos para cultivar cacao en grandes cantidades, ya que puede llevar a un **incremento en los ingresos** totales de los agricultores, por lo tanto, tienen más cacao para vender. A medida que la producción se incrementa, también se incrementa la	Aumentar la producción, cuidando el medio ambiente y reducción de costos.	Asociación y cultivador	De 6 meses a 1 año.	Nú hec se

	capacidad de venta, lo que se traduce en mayores ganancias. Se realizará en cada cultivo un respectivo semillero con el objetivo de tener una agricultura sostenible, evitar la compra de semillas teniendo disminución en costos al contrario se podía generar un ingreso vendiendo semillas de cacao a otros cultivadores. Fomentar la implementación de **sistemas agroforestales** donde el cacao se cultiva bajo sombra de árboles nativos o frutales. Este enfoque no solo ayuda a la protección del suelo contra la erosión, sino que también puede mejorar la biodiversidad, proteger las fuentes de agua y aumentar los ingresos por la venta de productos adicionales como frutas (caimitos, caña, naranja, aguacate y otras frutas que se dan en la región), o productos y maderas como (plátano y cedro), esto puede complementar los ingresos de los cacaoteros y reducir los riesgos económicos derivados de la dependencia de un solo cultivo. El u**so de fertilizantes orgánicos** y **abonos verdes** (como compost o estiércol), que mejoran la estructura del suelo y la retención de nutrientes, y son más amigables con el medio ambiente que los fertilizantes químicos. Además, el uso de residuos agrícolas y materia orgánica local para producir abonos puede reducir los costos de insumos. Teniendo en cuenta el desperdicio de las cascaras de plátano, cacao y de otros productos se llevará a cabo su utilización para crear abonos para los cultivos, cabe resaltar que el uso de este tipo de abonos ayuda al control de plagas y enfermedades. Para lograr estas estrategias se realizará una solicitud al SENA para que dicte				

	capacitaciones y formación técnica donde se lograra que los cultivadores sepan cómo desarrollar todo el proceso desde la siembra, cultivo, cosecha, postcosecha hasta la venta del producto.				
Comercialización	**Marketing en redes sociales**: Aprovechar las redes sociales (como **Instagram**, **Facebook** o **TikTok**) para contar historias sobre el cacao de Roberto Payán, destacando las prácticas sostenibles y el trabajo de los agricultores. Este tipo de marketing,	Dar a conocer el cacao de la región con el objetivo de obtener un posicionamiento en el mercado.	Cultivador - Asociación	2 meses	% inc ve

	Para los cultivadores y procesadores, esta transformación representa una oportunidad para diversificar sus ingresos, mejorar la competitividad y acceder a mercados más amplios, tanto locales como internacionales.				

Figure 33. Action plan with strategies to implement green innovation in cocoa farmers in Roberto Payán

CONCLUSIONS

The project for the cocoa sector in Roberto Payán demonstrates a holistic approach that takes advantage of the region's internal resources and capacities and the opportunities and support available from the national context. The success of this project will depend, to a large extent, on collaboration between local producers, government institutions, and non-governmental organizations.

By integrating technical training, institutional support, investment in infrastructure, and effective promotion in national markets, cocoa production in Roberto Payán will be boosted, facing threats with resilience and taking advantage of opportunities efficiently. This approach will not only improve the competitiveness of cocoa in the region. However, it will also contribute to local communities' economic and social development, ensuring a long-term positive and sustainable impact.

The new cocoa sector strategies for the Roberto Payán region represent a holistic vision that seeks to transform internal weaknesses and external threats into opportunities for the sector's sustainable and competitive development. By improving agricultural practices, optimizing cocoa quality, implementing packaging innovations, and diversifying crops, regional producers can increase their yields, access new markets, and improve their economic well-being.

At the same time, addressing security, infrastructure, and pest control threats through adaptive strategies, such as dialogues with local stakeholders, transport agreements, and biological control, will ensure that cocoa production is profitable but also resilient and sustainable. Access to finance and collaboration with government and private entities will be key to implementing these strategies and ensuring that cocoa from Roberto Payán is recognized nationally and internationally for its quality and sustainability.

It is recommended that cocoa producers form a legal association in the solidarity economy modality. The main contribution of the members will be their work in the crop, which is key to improving the production of high-quality cocoa and obtaining good yields. Through this association, technical assistance should be requested from Fedecacao to optimize and strengthen the crops and access credit from the Agrarian Bank to secure the necessary resources to restart production correctly.

Implementing organic fertilizers and green manure, such as composting, is a crucial strategy for agricultural sustainability. It improves soil health and water quality and contributes to a more resilient agricultural system that is less dependent on chemical inputs that negatively affect the environment.

Innovation in cocoa production and processing, along with taking advantage of opportunities for certification, fair trade, and differentiation in high-value-added markets, can be key to improving their income and competitiveness in the global marketplace. Implementing sustainable agricultural practices, investing in processing technology, and diversifying cocoa products will allow them to access premium markets and ensure the long-term sustainability of their crops and communities.

Creating a cocoa producers' association in Roberto Payán represents a transformative opportunity beyond improving agricultural productivity. Such an association would strengthen the social fabric, enable the implementation of sustainable agricultural practices, and open the door for producers to access broader markets and fairer negotiations. In addition, through crop diversification, additional income generation, and access to finance and infrastructure, cocoa farmers in the region will achieve greater economic stability and resilience to the risks associated with agriculture.

By adopting a holistic approach that combines collective work, environmental sustainability, cocoa quality improvement, and technical training, the Roberto Payán association can become a model of success that not only improves cocoa competitiveness but also promotes the region's social, economic, and environmental well-being. With the support of local authorities, educational institutions, and companies in the sector, this project can transform agriculture in the region, improving the living conditions of producers and positioning cocoa from Roberto Payán as a benchmark of quality and sustainability in the global market.

FINANCING

None.

CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Sergio Oleider Angulo Rincón, Claudia Magali Solarte Solarte.
Data curation: Sergio Oleider Angulo Rincón, Claudia Magali Solarte Solarte.
Formal analysis: Sergio Oleider Angulo Rincón, Claudia Magali Solarte Solarte.
Drafting - original draft: Sergio Oleider Angulo Rincón, Claudia Magali Solarte Solarte.
Writing - proofreading and editing: Sergio Oleider Angulo Rincón, Claudia Magali Solarte Solarte.

BIBLIOGRAPHIC REFERENCES

1. Cooperación Económica y Desarrollo (SECO). Diagnóstico de la Cadena de cacao en Colombia, con énfasis en CFA orgánico y sostenible. 2019 https://www.colombiamascompetitiva.com/wp-content/uploads/2021/09/CC_Guia-diagnostico-de-la-cadena-de-cacao-140721.pdf

2. Morales M. Después de obtener el abono orgánico se recomienda emplearlo en plantaciones. 2018 https://repository.agrosavia.co/bitstream/handle/20.500.12324/1195/Ver_Documento_1195.pdf?sequence=1&isAllowed=y

3. Morales M. Es un abono orgánico que se obtiene por descomposición de residuos o desechos. 2018 https://repository.agrosavia.co/bitstream/handle/20.500.12324/1195/Ver_Documento_1195.pdf?sequence=1&isAllowed=y

4. Mortis S, Rosas R, Chaires E. Paradigma de Investigación Cuantitativa. Instituto Tecnológico de Sonora; http://biblioteca.itson.mx/oa/educacion/oa3/paradigmas_investigacion_cuantitativa/index.htm

5. Moreno JA. El proceso del beneficio en la poscosecha del grano de cacao. 2021. https://repository.unimilitar.edu.co/server/api/core/bitstreams/d91ece23-c537-4f3a-a021-5ea37753ea6b/content

6. Minagricultura. Cadena de cacao. 2021. https://sioc.minagricultura.gov.co/Cacao/Documentos/2021-03-31%20Cifras%20Sectoriales.pdf

7. Miñarro M. Innovación tecnológica, organización del trabajo y sostenibilidad ambiental: ¿es el teletrabajo una forma de empleo verde? Estud Financ Rev Trab Segur Soc. 2021;(454):5-16. https://repositori.uji.es/xmlui/handle/10234/192859

8. Organisation for Economic Co-operation and Development (OECD). Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation. 2018. https://www.oecd-ilibrary.org/docserver/9789264304604-en.pdf

9. Osorio M, Rodríguez L, Sierra R, Terán W. Curvas de respuesta fotosintética a la luz en plantas de cacao (Theobroma cacao L.) aclimatadas a luz solar plena en Cundinamarca. Bot Sci. 2023;101(2):435-48. https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2007-42982023000200435&lang=es

10. Organización de las Naciones Unidas (ONU). La Agenda para el Desarrollo Sostenible. 2021 https://www.un.org/sustainabledevelopment/es/development-agenda/

11. Procolombia. El cacao en Colombia está presente en sus departamentos. 2020. https://www.colombiatrade.com.co/noticias/el-cacao-en-colombia-esta-presente-en-sus-departamentos

12. Roa M. Los mayores exportadores e importadores de chocolate del mundo. Statista; 2021. https://es.statista.com/grafico/25259/principales-exportadores-e-importadores-de-chocolate-y-alimentos-que-contienen-cacao/

13. Rovira S, Patiño J, Shaper M. Eco-innovación y producción verde: una revisión de las políticas de América Latina y el Caribe. CEPAL; 2017. https://repositorio.cepal.org/bitstream/handle/11362/40968/1/S1700072_es.pdf

14. Sáenz S, Helfgott S. Los profesionales del agro en la difusión de innovaciones agrícolas sustentables en la región oriental de Colombia. 2009. https://ciencia.lasalle.edu.co/eq/vol1/iss11/4/

15. Serrano J, Bikfalvi A, Llach J, Arbeláez J, García J. Orientaciones, dinámicas y motivaciones para la obtención del producto innovador verde. Rev CEA. 2022;8(17):e2138. https://revistas.itm.edu.co/index.php/revista-cea/article/view/2138

16. Sistema agroalimentario. Teoría del sistema agroalimentario. 2021. https://elenjambresinreina.eu/sites/default/files/2017-06/teoriasa.pdf

17. Agrosavia. Innovación Agropecuaria (SNIA - Ley 1876 de 2017), se crearon las entidades prestadoras de servicios de extensión agropecuarios (EPSAGROS). 2020 https://www.colombiamascompetitiva.com/wp-content/uploads/2021/09/CC_Guia-diagnostico-de-la-cadena-de-cacao-140721.pdf

18. Ar IM. El impacto de la innovación de productos ecológicos en el desempeño y la competitividad de las empresas Capacidad: el papel moderador de la preocupación ambiental gerencial. Procedia - Social and Behavioral Sciences. 2012;62:854-64. doi:10.1016/j.sbspro.2012.09.144

19. Colombia turismo. Reseña histórica del municipio Roberto Payán. http://www.colombiaturismoweb.com/DEPARTAMENTOS/NARINO/MUNICIPIOS/ROBERTO%20PAYAN/ROBERTO%20PAYAN.htm

20. Daza Cacao. Historia del cacao en Colombia. Federación Nacional de Cacaoteros y Universidad Industrial de Santander; 2023. http://www.dazacacao.com/blog/historia-del-cacao-en-colombia/

21. Driessen P, Hillebrand B. Innovación verde: innovaciones que consisten en procesos nuevos o modificados, prácticas, sistemas y productos que benefician al medio ambiente. 2002 http://portal.amelica.org/ameli/jatsRepo/134/1342338002/html/index.html#redalyc_1342338002_ref33

22. Escrucería JH, Gil OL, Velasco R. El municipio de Roberto Payán. 2006 https://www.cctumaco.org/images/Archivos/censo_ROBERTO_PAYAN.pdf

23. García M. Coca, guerrilla y sociedad civil en el Guaviare: regulación de conflictos y otros controles. file:///C:/Users/LENOVO/Downloads/colombiaint29.1995.02.pdf

24. IMMAP. Roberto Payán. 2023. https://colombia.immap.org/evaluacion-necesidades-narino-2022/roberto-payan /

25. Congreso de Colombia. Ley 1562 de 2012. Por la cual se modifica el sistema de riesgos laborales y se dictan otras disposiciones en materia de salud ocupacional. 2012 https://steel.net.co/ley-1562-de-2012/

26. Congreso de Colombia. Ley 2163 de 2021. Por medio del cual se aprueba el "Convenio Internacional del Cacao", adoptado en Ginebra el 25 de junio de 2010. 2021 https://vlex.com.co/vid/ley-2163-2021-medio-879132786