Integrated logistics development in Colombia: A commitment to strengthening the first-mile logistics in isolated territories

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Abstract

Logistics is a discipline whose areas of knowledge can determine the competitiveness of an organization, a territory, or a nation. Since Colombia has an agro-industrial vocation, government institutions and the communities that produce these products must work together to achieve the integral development of this sector. Despite the above, the current context shows that part of this population faces socioeconomic problems, such as a lack of education and opportunities. Specifically, in the case of the Zapatosa's swamp, Cesar, there are other problems associated with poverty, inequality, state neglect, and overexploitation of natural resources. This document presents an integral training program called Easy Logistics, whose purpose is strengthening the first stage of the supply chain in this region, incorporating norms and quality standards associated with the post-harvest phase of the lemon.

Key words: Social logistics, first milestone, SCM, logic frame.

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Introduction

Colombia, being a country privileged by its geographical location, stands out for its agricultural production capacity, which can be developed in most of the national territory. According to Statista's research department, this economic activity represents 7.43% of the composition of the national GDP and around 3 million people depend on it as indicated in the labor market report quoted by Portafolio newspaper, showing its importance for the nation.

In addition to the above, it is evident that the relevance of some products belonging to the fruit sector has increased significantly. Citrus, for example, showed an upward trend in the number of hectares planted and harvested, as well as in tons produced annually from 2017 to 2021. Particularly, according to Garcia *et al.* lemon stands out for its growth in the last 2 years, registering approximately 366,127 tons produced in 2020 according to figures published by the Ministry of Agriculture.

In 2019, according to the characterization of the citrus production chain carried out by the Ministry of Agriculture, these crops are generally located in Santander, Cundinamarca and Valle del Cauca. Other departments such as Risaralda, Quindío and Antioquia have the highest production yields in tons per hectare, however, this pattern is not similar in all regions of the country. This can be seen in the department of Cesar, which ranks 22nd in the Departmental Competitiveness Index and its population faces a series of socioeconomic, logistical and technological problems that limit the development of its agricultural activity.

In the department of Cesar there are some regions of particular interest for the State; this is the case of the ecoregion of the Ciénaga de la Zapatosa, which, according to the departmental government, plays a strategic role for the development of its community. Additionally, being the largest inland wetland in Colombia, it is a protected area by the State since different species of birds and fish include this place as a transitory habitat in their migratory processes.

The Ciénaga's extension ranges between 36,000 ha^2 and 50,000 ha^2 and borders the Momposina depression and a fragment of the Magdalena River. In addition to the above, about five municipalities and more than twenty corregimientos are part of this ecoregion, with an estimated population of 150,000 people according to De la Hoz.

The resident communities of this ecoregion are faced with a series of socioeconomic problems. In the Ciénaga, the same consequences of state neglect and the precariousness in the provision of essential services are evident as detailed by CEPAL when analyzing the current situation of several rural areas nationwide. For example, according to DANE figures, almost half of the department's population did not have access to the Internet during 2019, just as Cruz-Carbonell *et al.* mentions that this occurs in more than 55% of its educational institutions.

Despite these conditions, the region has the potential to improve its agricultural production, since some fruits such as bananas and lemons are marketed to other regions of the country and there is a significant extension of crops within the swamp (3% in both cases). Thanks to this, some projects have begun to be developed in the region to promote the economic and social development of the community. In particular, the BPIN royalties project 2020000100730 executed by the ECORZAP alliance, whose purpose is to strengthen the supply chain through a series of strategies that strengthen six fundamental drivers in the logistics area: institutional and public policy, human capital, information and ICT, infrastructure, logistics processes and organizational structure.

According to CONPES 3982 of 2019, logistics processes require trained technical personnel to increase productivity in the different sectors of the economy. However, according

to the 2020 National Logistics Survey, 14.5% of respondents consider that the lack of relevant and trained human talent is a barrier to carry out their logistics operations. In addition to the above, an analysis conducted cooperatively between the Ministry of Education, FITAC and the IDB in 2017 shows that there is a deficit in the supply of specific programs in this training area in some departments of the country.

Considering the above, the purpose of this document is to present a proposal for strengthening the human capital involved in the logistics chain of the agricultural sector the Ciénaga de la Zapatosa. Mainly, the proposal focuses on the post-harvest stage of the lemon with the objective of increasing the competitiveness of the region through management tools and instruments, as well as educational material to increase the knowledge of producers, transporters, stockpilers and traders about the requirements that the lemon must meet for consumption or processing[1], the regulatory framework that governs this agricultural activity, as well as heuristics to improve inventory management.

The document initially shows the formulation of the project objectives followed by the methodology used for the proposal approach. Additionally, the previous state of the art that supports its development and the results obtained are presented, detailing the structure of the deliverables obtained during the exercise. In the section of discussion a series of limitations and recommendations to be considered for the adequate implementation of the proposal are detailed and finally the conclusions of the document are presented.

Objectives

To design a comprehensive support and training program for logistics management during the post-harvest phase of lime production in the Ciénaga de la Zapatosa, Cesar. The program should characterize the actors in the production chain, identify their socioeconomic limitations, and propose strategies, tools, and training instruments tailored to their needs, incorporating sanitary regulations and technical aspects of traceability, storage, picking, packing, and transportation.

State of the Art

Logistics and transportation are strategic tools for economic development, as they have a direct impact on product competitiveness by improving connectivity within the territory, particularly across the various stages of the supply chain [16]. In this regard, the implementation of good logistics practices and resilient, adaptable supply chains is a key factor in strengthening the agricultural sector and promoting the development of rural communities involved in it.

The COVID-19 pandemic brought about a series of restrictions on access to basic goods and services, significantly affecting agricultural activities in developing countries. In response, technological solutions were implemented to mitigate these impacts. In India, for example, the SEIVR mobile app was developed for real-time monitoring of crop status as part of a farmer support strategy [17]. Similarly, in China, modern marketing methods and greater integration into local markets were promoted, enhancing the resilience of agro-productive systems against the effects of the health crisis [18].

The case of China introduces the concept of short supply chains, which represent an efficient and sustainable alternative, especially in rural territories such as the Ciénaga de la Zapatosa. According to the European Network for Rural Development magazine, these local food systems strengthen and diversify the rural economy by generating employment, retaining wealth in the territory, and reducing the carbon

[1] Colombian Technical Standard 4087 (NTC) establishes the requirements to be met by Tahiti lemons intended for consumption or as raw material for processing.

footprint compared to extended supply chains [19]. This approach is particularly relevant in the Colombian context, where limited infrastructure in isolated regions—as evidenced in the introduction and results of this work—requires logistical solutions that demand fewer resources and promote greater community ownership.

To formulate a proposal that generates a positive impact in the Ciénaga community, it is essential to apply the Logical Framework Approach. According to ECLAC, this is a structured tool that facilitates the conceptualization, design, execution, and evaluation of projects [20]. This methodology allows for the systematic identification and analysis of problems, stakeholders, and possible solutions, promoting a comprehensive understanding of the context and effective planning of the proposed interventions.

Finally, the project design includes the use of educational materials and management tools to encourage autonomous learning in the community, thereby overcoming barriers to information access in areas with limited connectivity. This approach is supported by studies such as one conducted by the University of Turin, which shows that the flipped classroom model—where activities not requiring direct interaction are carried out remotely—improves both academic performance and student perception compared to fully face-to-face methods [21].

Methodology

The methodological structure of this study is organized into two phases. The first phase involves a review focused on analyzing the state of the art and the contextual framework of the Ciénaga de la Zapatosa, considering both logistical and social aspects that affect the agricultural supply chain in this region. The second phase consists of formulating the "Easy Logistics" proposal, structured under the principles of the Logical Framework Approach, which is widely used in planning and evaluating development projects in rural and agro-industrial contexts, as outlined by ECLAC [20].

To support the context analysis, a non-experimental, descriptive research design was applied. This design allows for the examination of phenomena without manipulating variables, based on their direct observation in the environment. According to Hernández-Sampieri, this approach is appropriate for exploratory studies aiming to characterize social or technical dynamics using secondary sources [22]. In this case, information was gathered from official documents, academic literature, and institutional reports focusing on lemon farming in the department of Cesar.

To develop the state of the art, a systematic document review was conducted, focusing on indexed academic sources, technical documents, and reports issued by international organizations (such as ECLAC, OECD, IDB) and Colombian government agencies (such as DNP, Ministry of Agriculture, DANE). This review identified relevant studies on the role of logistics in regional development and the competitiveness of the agro-industrial sector, as well as international experiences in improving human capital in rural areas. The results of this review are integrated into Section 3 of the article, with the corresponding citations.

After completing the contextual diagnosis phase, the proposal was formulated using the Logical Framework Approach, recognized for its usefulness in strategic planning of rural and community development projects [20]. This approach structured the design of the “Easy Logistics” project using three key tools: the problem tree, the objective tree, and the planning matrix, presented in Annexes 1, 2, and 3, respectively.

The proposed program aims to transfer

didactic knowledge in logistics, specifically applied to the post-harvest phase of lemon production, taking into account the region's socio-technical conditions. To properly define the target population, an organizational analysis was carried out, linking findings from the initial diagnosis with the proposed deliverables. The results section outlines these outputs, while the conclusions provide key recommendations for the effective implementation of the program in the Ciénaga de la Zapatosa community.

Results

Identification of the

Taking into account the problems previously identified in the contextual framework and comparing the international standards established for the treatment, packaging, labeling, harvesting and storage of lemons, it was possible to identify that there is a large knowledge gap in the community living in the Ciénaga de la Zapatosa.

In addition, there are certain conditions that hinder logistical operations, such as infrastructure deficiencies, lack of human resource training, communication failures and poor implementation of ICTs for productive operations. As a result, the competitiveness of crops is affected due to cargo damage caused by improper handling. As a result, the department of Cesar's share of agricultural GDP is significantly lower than in other regions of the country.

The above is summarized in the problem tree proposed in Annex 1, which lists the causes (branches) at the bottom, the main problem (stem) in the center, and the consequences observed in the community (leaves) at the top.

Approach to

Once the problems to be mitigated with this improvement proposal have been identified, the objectives that this document seeks to achieve in line with the general objective presented above are presented.

It is important to remember that the general objective of the project is to present a comprehensive training and support program for logistics management in the harvest and post-harvest phases of lemon production. In addition, a series of deliverables should be designed to adapt to the needs of all the actors involved in the production chain of this fruit and, at the same time, incorporate the knowledge presented associated with logistics processes.

Annex 2 shows the objectives tree, where its branches indicate the proposed deliverables of the project, the stem the general objective to be achieved and finally its leaves the expected results with the implementation of "Easy Logistics". The final products are described in a later section of the document together with the final recommendations that will allow an adequate implementation of the project, however, below is a brief description of the actors that this improvement proposal seeks to impact.

Analysis of actors involved in the production chain

In order to delimit the scope of the project, it is necessary to identify and characterize each of the stakeholders or interested parties, since this task allows focusing the proposal according to the needs, limitations and knowledge of the target population. In this case, the following five stakeholders are defined.

Farmers

Farmers of the Ciénaga de la Zapatosa who are engaged in agriculture, who in most cases have not had guidance or education related to logistics, so that the handling of products during the execution of activities related to this area is given empirically, by experience, by tradition and/or by knowledge

and information shared with other peasants and farmers.

Conveyors

People dedicated to transporting fruit from farms and planting areas to storage centers and local markets. Generally, this activity is carried out by logistics companies in the country's large urbanizations; however, in this case, it is the peasants and farmers who carry out this work using, in most cases, pack animals, bicycles or motorcycles. There are also scenarios in which none of these tools are available, so the product is carried directly by the person. In addition, cargo trucks are rarely used, and in many cases they do not meet the minimum quality and suitability requirements for transporting goods.

Stockpilers

Personnel working in facilities dedicated mainly to the reception, storage and preparation of agricultural products (in this case, lemons) from farmers' farms and fields, destined for local markets or other neighboring regions. Citrus is the only product that has a storage center (in the municipality of Astrea), which has limited tools and infrastructure available for the work that is done there.

Local merchants

Personnel working in plazas and facilities dedicated to the commercialization of agricultural products obtained in the region. The people who work in these places, as well as the farmers, do not have technical or specialized knowledge about the handling of these fruits, and in all cases do not have the necessary implements for their disposal and storage.

Government Institutions

Government of Cesar, municipal governments, the CAR del Cesar, ICA, UPRA and other governmental entities that generate, coordinate and control the regulations and norms of the territory, as well as the support programs for each of the previously mentioned actors, and that are largely responsible for promoting an adequate physical, technological, economic, cultural and social environment that allows the development of the region, together with its inhabitants.

Presentation of the

Based on the problems and context previously presented, the following is the structure and description of the improvement proposal to strengthen the logistical management of the lemon in the study territory. This proposal is made taking into account the technological limitations of those involved, as well as the need to guarantee a significant and beneficial root change for the inhabitants of the Ciénaga de la Zapatosa, which implies integrating each of the stakeholders in order to promote a joint and coordinated development. The proposal is also structured and synthesized in the logical framework matrix (see Annex 3).

With this in mind, the proposal consists of generating a comprehensive program to guide and facilitate the logistical management of lemons in the post-harvest phase of the five previously described actors in the Ciénaga de la Zapatosa. This proposal has the following components: offline application, logistics management manual, traceability labels on the fruit packaging (baskets), traceability format in collection centers and a radio program on logistics.

Easy Logistics offline application

It consists of an application called Easy Logistics, which will allow the inhabitants of the Ciénaga de la Zapatosa and each of the actors involved to easily and interactively learn and understand the information related to logistics (initially) focused on the handling of lemons. A quick guide on how to handle, pack, prepare and transport the fruit in the harvest and post-harvest phases, including transfer and disposal in local markets, as well as intermediate procedures in the collection centers, 3. A section of recommendations based on the organoleptic characteristics of the fruit, and 4. A module of frequently

asked questions and contact information for government entities or institutional bodies to provide technical guidance to users.

As it is an offline application, it allows anyone with a technological device such as a cell phone or tablet to use it once the app is downloaded, without the need for internet. In addition, when there is the possibility of connecting to a network, the application will be automatically updated, as well as the information contained in it, in the event of new regulations or new technological developments that are of interest to the user related to logistics.

The functional requirements of the application are: a) To consolidate the technical regulations related to lemon logistics (initially) presented in an easy to understand and concise manner, b) To present in a didactic way a lemon handling guide divided by actors in the supply chain, specifically farmers, transporters, collection centers and local markets, c) Provide recommendations regarding the product based on its particularities derived from its organoleptic properties, and d) Answer frequently asked questions through a section provided for this purpose and provide with information that facilitates contact with technical personnel to help and facilitate the work of users.

It will have information of interest both for farmers and transporters, as well as for collection centers and local markets, so that it will have two modes for viewing the content: 1. by type of user, 2. by type of information.

Management Manual

Its purpose is to instruct in a didactic, timely and easy way on the techniques and practices that each of the actors involved should include during the development of logistics operations in the lemon production chain. The manual is extremely important because of the lack of academic programs focused on logistics in the region and the fact that the practices carried out by the population have been acquired in an empirical or traditional manner. In addition to providing technical information, this tool seeks to maximize the quantity of lemons that reach the final consumer by avoiding the loss of units due to bruises, exposure to inadequate conditions or contact with contaminants that make these fruits unfit for consumption or that are rejected due to their quality by any of the actors interested in processing them.

With this in mind and as with the offline application, a manual will be created for each actor involved as described in section 5.3 (except for the government), with information divided into each phase of the chain: harvest, post-harvest, transport, storage, preparation and disposal in the market for sale to the final consumer. In this way, both the manual and the guide found in the application will have similar information, in accordance with the duty of handling and logistical management of lemons as stipulated in current regulations.

Labels

Considering that it is necessary to have an orderly record of significant information related to the harvest of a product, in order to quickly and efficiently track the existing inventory, as well as to address the various harmful eventualities that may arise, such as pests and diseases in a production lot, inconsistency in the requirements of the lot with respect to what is requested in the order form, among others; this component of the proposal contains the design of labels or tags that should be attached to the packaging where the load of lemon is transported.

Recalling what was explained in the state of the art and making a rigorous implementation of NTC 4087, this label must contain both information about the producer and the content and classification of the product that is deposited in the package. Thus, based on the instruction given to the actors involved, this label is designed with the purpose that

farmers incorporate it in the baskets where the lemons are collected. It is worth mentioning that this information must be completed once the harvest is finished and the package is filled with the determined quantity or weight of fruit of an appropriate size, category and color scale.

Management Formats

The main purpose of this product is to facilitate the management the growers involved in the lemon supply chain. For this purpose, we propose the creation of an automated Microsoft Excel® document that initially allows obtaining the product demand forecast through three statistical models (linear regression, simple exponential smoothing and double exponential smoothing) and at the same time adapting the Silver Meal heuristic to obtain a better inventory management.

It is important to keep in mind that the forecasting tool must be fed with the information gathered in the Ciénaga de la Zapatosa, so that feedback on the models proposed can be obtained and, if necessary, they can be modified.

Radio Program

This component arises from the aforementioned limited technological infrastructure and access to networks, since Internet connectivity is limited in this territory. addition, recalling the initial criticism of the absence of government in territories far from the center of the country and its main cities, this gap must be reduced by ensuring that such information reaches everyone in a concise and timely manner despite the limitations.

It is common to use the radio in rural areas both as a leisure and informative tool, so it is pertinent to create a radio program where the inhabitants of the Ciénaga de la Zapatosa are informed about the logistical news associated with the regulations, strategies and recommendations, along with the attention and response to any concerns that may arise. In addition, it will be possible to name and honor those people who include in their work practices the recommendations, strategies and techniques shared through the various components of the program, which will serve as a motivation and incentive to increase the adoption of these instruments.

Discussion

The "Easy Logistics" program is initially proposed for the handling of lemons; however, it can be scaled to all fruits grown and produced in the swamp, in order to obtain a greater benefit. It seeks to ensure that all people have access, trying to reduce as much as possible the social gaps created by inequity, poverty and lack of opportunities. In addition, it is necessary that the government or the responsible agency promotes, facilitates and supports the dissemination of the program, providing access to the corresponding material such as guides, obtaining the packaging (baskets), obtaining the labels, among others.

Taking into account the work done by Dixon and Zhou mentioned above, it is possible to note the positive impact for farmers of developing new strategies to increase the capacity of the production and distribution chain in this sector. In addition, this ecoregion has the potential to increase its lemon production since it is a permanent crop, which, compared to other regions, does not have a competitive factor that the implementation of the project is intended to develop.

In addition to the above, the combination of different information and communication technologies such as the mobile application together with the radio program and training manuals can increase the participation of the community in this project in parallel with the adoption of knowledge related to the concepts, standards and norms of logistics processes.

Some of the recommendations that will be disseminated in the application are the following: 1) To facilitate the filling out of the traceability label, it is relevant to have color tables or reference fruits that meet the quality requirements demanded by the market, as well as tables containing information about the category and size of the product. 2) Harvesting should be done during the coolest hours of the day. Ideally, it should not be carried out between eleven in the morning and two in the afternoon, due to the high temperatures that occur during this period in the producing regions of the country, which leads to a rapid deterioration in quality and a reduction in the shelf life of the fruit. 3) In the storage centers, if there is no cement floor, or gravel and pallets, some baskets can be used as a base, on which the rest of the baskets can be stacked with the harvested fruit. In addition, if the place does not have walls, polyshade or green mesh can be used as an alternative to keep the fruit away from the animals on the farm.

Finally, it is essential that state and departmental investment in education and infrastructure be significantly increased, as this will have an immediate impact on the well-being of the population, but also on the effectiveness of the strategies and information disseminated.

Conclusions

The Ciénaga de la Zapatosa is a territory where the absence of the state is reflected in the poverty, the precarious infrastructure conditions, the reduced and limited academic offer, as well as in the dynamics and labor practices that take place there taking into account the lack of instruction and orientation. It is necessary to implement projects that articulate the State-Academy-Industry triad.

With this in mind, the proposals generated must be capable of reducing the existing social gaps caused by inequality as much as possible, as well as guaranteeing that the majority of the population has access to them regardless of their educational or economic level.

This is where logistics is an area that can have a significant impact on the population, since it facilitates the achievement of improvements in the well-being and quality of life of the population, reducing inequality gaps and promoting the collective development of local producer communities.

Therefore, government entities and responsible organizations must commit to the nation and develop programs such as "Easy Logistics" that allow the development, progress and growth of the regions, since this not only benefits the inhabitants of these territories, but also increases country's competitiveness in general.

About the article

Author Contribution

- Gabriel Steven Riascos Castro: Conceptualization, methodological development, drafting of the manuscript, and structuring of the Easy Logistics project.
- Lina Marcela Prieto Vega: Critical review of the contextual framework, validation of the methodological approach, and technical editing of the content.
- Juan Carlos Manga Cadena: Academic supervision, bibliographic management, final manuscript revision, and structural adjustments.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest that may have influenced the results or interpretation of the data presented in this article.

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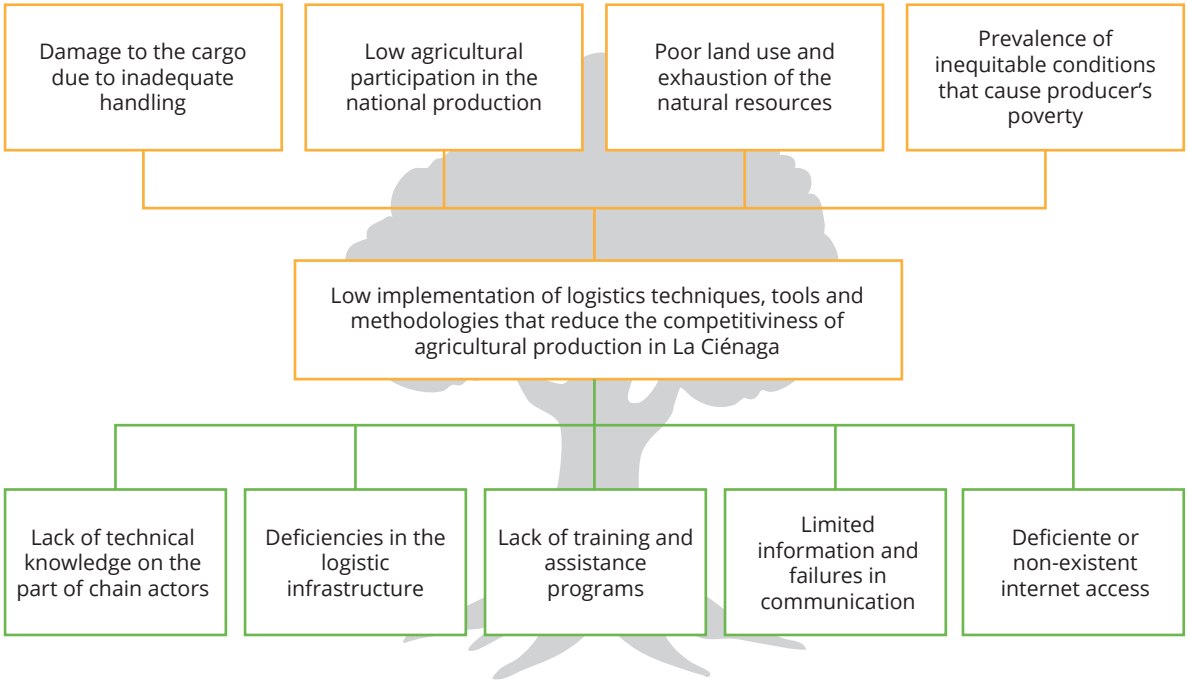
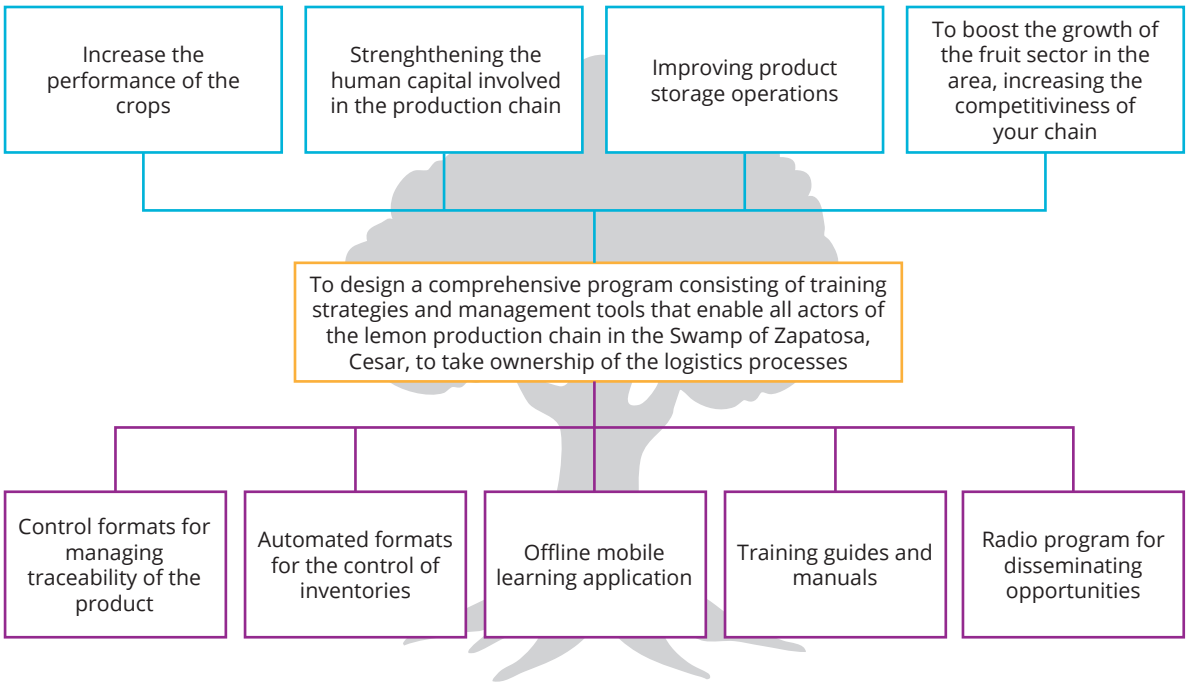
Annexes

Annex 1: Problem tree of the current context in Ciénaga de la Zapatosa.



Annex 2: Tree of objectives expected to be met with the implementation of the "Easy Logistics" program.



Annex 3: Logical framework matrix of the "Easy logistics" program.

NARRATIVE SUMMARY	MEASURABLE INDICATORS	MEANS OF VERIFICATION	ASSUMPTIONS
PURPOSE			
To structure an integral proposal that incorporates the knowledge and techniques associated with the logistic processes in the lemon production chain in the Ciénaga de la Zapatosa.	Program participant satisfaction scale.	Surveys and participatory monitoring.	- The Governor's Office and the municipal governments provide support to the program. - Government entities provide information about the program and promote community participation. - The community is willing to participate in the program and to provide feedback in order to make the pertinent adjustments.
PURPOSE			
Promote the development of the fruit sector in the region by strengthening human capital through the transfer of knowledge on product handling and storage techniques.	- Level of dissemination of the program. - Level of community participation. - Evaluation of the proposal and its components.	- Periodic surveys and reports on dissemination strategies. - Accounting and registration of participants. - Qualification obtained by peer evaluators on the viability and relevance of the project.	- Evaluators are trained and willing to evaluate the proposal. - There is transparency in the published information associated with the dissemination strategies and registration of participants. - Verify that there are no duplicates in the records and that there are no inconsistencies in the information.
RESULTS			
Appropriation of socialized knowledge related to the logistics operations of the productive chain that contributes to improve the living conditions of the actors involved.	- Level of adoption of acquired knowledge. - Reduction of damage caused by improper cargo handling	- Surveys to find out what techniques, knowledge or methodologies have been implemented. - Results obtained in the evaluations applied to the community - Proportion of products damaged or not complying with quality standards	- Participants are willing to conscientiously complete surveys and assessments - No objections to the manipulation of personal data are raised.
ACTIVITIES			
- Design and development of a mobile application called "Easy Logistics". - Design and creation of a manual for the logistic management of lemons. - Creation of traceability labels - Creation of digital formats to facilitate the management of collection centers. - Creation of a radio program to provide timely information focused on product logistics.	- Compliance in the development and operation of the proposed deliverables.	- Level of satisfaction with the mobile application - Evaluation of the physical tools used for training - Audits and evaluations carried out at the collection centers to verify the use of labels on cargo - Radio program tuning statistics	- The competent agencies will facilitate the acquisition of licenses for the use of software tools necessary for the development of deliverables. - No modification or adulteration of the formats or labels used - The governmental entities will provide a space for the formation of strategic alliances that will allow the launching of the radio program.