The innovation networks of blackberries

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ABSTRACT

Objective: Map the innovation networks of blackberry producers in the Los Reyes Michoacán region, as well as to identify the degree of centrality, density and intermediation of the network and some options for improvement.

Design/methodology/approach: Visits and interviews were made to the main collection centers Sunbell, El Cerrito, SPR and Driscoll, to the personnel of Trusts Established in Relation to Agriculture of the Western Region, the Zamora Agency. For the baseline survey, a universe of 50 producers was considered, including partners and main clients; then, all the red was relieved with the "snowball" technique.

Results: 39% of the producers are also dedicated to the production and marketing of avocado. Most of the production (92%) is destined for export. The main collection centers for export are Sunbelle, Splendor and Driscoll. El Molinito and Moradely account for 70% of the total national market.

Agrofertilizadores de Michoacán Agromich, Fertimich, Bucosa and Agrupe concentrate 70% of the inputs sold to producers. The company Procal stands out in the supply and service management network.

Limitations on study/implications: It is a study focused on the Los Reyes region, which could be extended to other regions, crops, and expand the number of actors involved in the study.

Findings/conclusions: The relationships between different actors centralization, inputs-outputs, and intermediation indicators take higher values, which shows the role of producers and key companies (Ere03 and OP01) as source, collector, and articulator actors. It is important to promote high productivity and profitable technologies for innovation.

Keywords: Blackberries, Networks, Innovation, region, snowball.

Citation: Infante-Jiménez, Z. T., Ortega-Jiménez, P., Coutiño-Puchuli, A. E. (2023). The innovation networks of blackberries. *Agro Productividad*. https://doi.org/10.32854/agrop.v16i1.2389

Academic Editors: Jorge Cadena Iñiguez and Libia Iris Trejo Téllez

Received: September 29, 2022.
Accepted: January 08, 2023.
Published on-line: February 22, 2023.

Agro Productividad, 16(1). January. 2023. pp: 45-57.

INTRODUCTION

World consumption of berries has been growing over the last decade. Several studies anticipate a strong demand for strawberries, blueberries, raspberries, and blackberries, following the trend of recent years. This is expected to remain if these fruits continue to be considered a delicacy by certain consumers who are willing to pay higher prices than those paid for traditional fruits.

Image by Ulrike Leone at Pixabay

International markets require quality and safety certificate; the fruit must be produced through appropriate agricultural practices, free of diseases and quarantine pests as defined by receiving countries; the containers must be clean with open perforations and complete labeling; producers must adhere to the instructions for use of pesticides observed in the Quality Certification Standards determined by the imports-exports agency. In addition, all varieties must prove good flavor, color, and size.

International trends point to the development of new commercial strategies aimed at consolidating external markets, exploiting the increased demand and consumption of berries in developed countries. The world's main producing countries are the United States, Russia, Poland, Turkey, Holland, Germany, former Yugoslavia, and Canada. The largest exporters are Spain, United States, Belgium, and Canada, which account for 60% of the total value. They are followed by Mexico, France, Chile, and Poland, with an aggregated share of 17%. Mexico contributes about 344,000 tons of berries, only 7.3%, so there is a great opportunity to grow considering the comparative advantages of some regions.

It is estimated that the world production of blackberries and hybrids is around 60,000 tons, and most of is frozen (75%). In Mexico, most blackberries used in the agro-industry are frozen, using the *Individual Quick Frozen* (IQF) system. This allows to use the product by piece or in blocks.

The state of Michoacán contributed 96% of blackberries and 27% of raspberries, most of which was produced in the valley of Los Reyes. Mexico is the leading supplier of berries to the United States (USA), contributing 40% of the volume and value of total imports in average, followed by Chile with 16%, Canada with 13%, Netherlands with 12%, and France with 5%.

The USA remains the main export market for Mexico's production. Exports grow in an annual average of 12%. The purpose is to take advantage of the scarcity of berries in the U.S. Market considering the following:

- There is a variety with a longer shelf life (Tupi variety).
- An existing unsatisfied demand
- There is a shortage of production in the USA during the winter season.
- Mexico holds a favorable geographical position compared to other producing countries.
- Mexico has climate advantages as a berry producer. In other words, the production and export in the region of Los Reyes happens precisely when there is no production in the United States; it is harvested from October to April and exported from November to March.

Mainly one crop of one variety predominates in the valley of Los Reyes; it is the blackberry *Tupi*, which replaced the *Brazos* variety approximately 5 years ago. Other varieties that are better adapted to regional conditions have also been developed. This is carried out with a wide entrepreneurial vision by all producers and actors in the network. For this reason, there is a significant input network and collection centers within the municipality.

The main change driver originates from the broker's end, which puts pressure on the Collection Centers to obtain fruit with longer shelf life and acceptable to consumer tastes. Collection Centers establishes the fruit's specifications for arrival in their warehouses (cold rooms). These specifications can only be achieved through proper crop management and technical screening. The supervising technician is accredited by the *Comité Estatal de Sanidad Vegetal* (State Committee on Plant Health).

Producers are aware of the need to innovate and adopt new technologies to achieve greater competitiveness. Some of the most recently implemented and widely used production technologies are macro tunnels, irrigation systems, and safety practices. They put increasing pressure to managing resources in a sustainable way. The blackberry is highly profitable as it is a perennial crop. It has the greatest investment cost, as observed in its cultivation process and healthy growth measures. A reasonable harvest is obtained from the first cultivation year and during the following years. Proper management implies pruning, fertilizing, and ensuring the crop's healthy development, especially during the flowering and harvesting seasons.

The sanitary factor of crop management is the most widely observed parameter. This is because producers must meet special requirements to grow fruits for export.

A good harvest depends to a large extent on the strength and nutrition of the plant, so fertilization is the second most important activity (the first is harvesting) in terms cost of cultivation. Harvesting is the most critical and rigorous stage. Women harvesters must comply with sanitation and safety measures, and the containers they use must be thoroughly clean.

The area of study is similar to that covered by PROCAL, including their partners and customers. It covers six municipalities in Michoacán, mainly involved in the production of blackberries. The municipalities are Los Reyes, Tocumbo, Periban, Tancítaro, Cotija, and Uruapan.

This study will help the Blackberry Networks in Los Reyes become more efficient through organizational and technical innovation related to production and commercialization. The study will carry out the following actions: identify the relationship between actors and their links within the network; observe the behavior of the network and individual nodes; evaluate the performance of actors to obtain a group perspective from the network; acknowledge the characteristics of the network: characterization, density, and centrality; design scenarios to improve the network's performance and competitiveness; develop schemes for a harmonious participation of stakeholders; develop all stakeholders' actions under innovation and mutual benefit schemes that lead to improved competitiveness and congruent use of financial, technological, commercial, administrative, and organizational instruments for producers.

INNOVATION

Innovation is originated from ideas and proposals conceived and expressed by people. It takes the form of plans and projects, and it is people who put innovative projects into practice. Innovation represents any change based on knowledge that generates wealth; the goal of any innovative process is the generation of wealth (Muñoz *et al.*, 2007). Any type of

innovation-oriented change must be based on knowledge and supported by information and data. The goal of any innovative process is economic and social welfare. Innovation Capacity is the ability of a company to integrate tangible and intangible resources to achieve a specific result.

Joseph A. Schumpeter (1883-1950), an Austrian economist of the twentieth century, introduced the process of business innovation as a central element in economic analysis. He conceptualized innovation as the production of different things, or the same things through different methods (Schumpeter, 1968).

For Schumpeter, quoted by Montoya (2004), change emerges from the system (endogenous process). His proposal for economic development introduced the concept of innovation as a cause of development and the innovative entrepreneur as an enabler of the innovation process. Schumpeter (1978) considers the production process as a combination of productive forces, which in turn are composed of material forces. These are the so-called factors of production such as labor, land, and capital, which add to other intangible forces such as technical facts and social organization.

For Schumpeter (1978), technological innovation is the fundamental force that moves capitalist production and the source of its constant transformation. Innovation is understood as an invention that is introduced into the market. For Schumpeter, radical innovations account for social transformation as they are capable of provoking revolutionary changes and decisive turns for the society and the economy. By radical innovation he means the introduction of new consumer goods into markets; the emergence of new production and transportation methods; the opening of new markets; the generation of new sources of raw materials; organizational and managerial changes in companies.

Schumpeter (1996) sees entrepreneurs as people who have the capacity and initiative to propose and implement new production means; they are people, with or without a business, who can generate and manage radical innovations within or outside organizations. The 21st century is characterized by a rapid innovation of technologies, processes, and products. Emerging innovations change the way goods and services are produced, traded, exchanged, and consumed.

Innovations are disseminated through individuals within a social system; the communication pattern across these individuals makes up a social network (Valente, 1999). Context is an essential reference, interaction is a key strategy, and ethics guarantee the sustainability and evolution of any innovative venture.

Drucker (1985) defines innovation as a systematic analysis that transforms changes into business opportunities. He lists the possible sources of innovation as follows: Surprises, inconsistencies, process needs, industry and market changes, demographic or population changes, trends or changes in consumer perception, and new knowledge.

The actors who generate innovations are found in both the public and private sectors. The public sector in Latin America is mainly represented by universities and innovation research centers. The actors involved in innovation are not only those who innovate but also those who acquire innovations. The private business sector is a fundamental recipient of innovations as well as labor unions. However, labor unions are passive recipients while the private sector has decision power (Sutz, 2002).

Innovation is recognized as the key process for the economic growth of companies, regions, and countries (Grossman and Helpman, 1994). Innovation can occur while developing new products, processes, services, or business models in the agroindustrial sector. Innovation processes in rural areas have received little attention compared to urban-industrial contexts.

Through the theory of diffusion of innovations, Rogers (1962) explains how, why, and at what speed new ideas and technologies move across cultures. For Rogers, ideas, practices, or objects perceived by individuals as new constitute the main innovation elements.

According to the most relevant researchers on the subject, some of the most important concepts of innovation are as follows: Schumpeter (1978) sees innovation from an evolutionary perspective; he refers to product innovation, which includes raw material, process evolution, and new market structures. Freeman (1995) describes innovation as the process of integrating existing technology and inventions to create or improve a product, process, or system; it represents the consolidation of a new and economically improved product, process, or system.

There is a difference between invention and innovation, but they are frequently used as synonyms. An invention is any human creation that allows the transformation of matter or energy for its use, whereas innovation is aimed at a market under a business approach detecting opportunities and organizational capabilities to generate new products, processes, or services. On the other hand, technological innovation is a process that combines a market opportunity with a need and/or a technological invention.

Innovation is vital to sustain and move businesses forward. It is a very complex process, and it needs effective innovation management to create radical change and generate adaptations to lengthen the life of a business. The most accepted definition of innovation today is the one offered by the OECD (2018). It describes innovation as a new or improved product or process (or a combination thereof) that differs significantly from the unit's previous products or processes and has been made available to potential users (product) or put into use by the unit (process).

According to the OECD (2005), four types of innovation can be distinguished:

1. Product innovation: it is a good or service that is new or significantly improved with respect to its features or uses. This includes improvements in components, materials and technical specifications, software, ease of use, and other functional characteristics.
2. Process innovation: it is the implementation of a new or significantly improved method of production or distribution. This includes changes in technique, equipment, or software.
3. Marketing innovation: it is the implementation of a new marketing method that involves significant changes in product design or packaging, placement, promotion, or price.
4. Organizational innovation: a new organizational method in business practice, site organization, or in the company's external relationships.

Desouza (2009) describes the innovation process in the following 5 stages:

a) Generation and mobilization of ideas. The generation of new ideas must be spurred by creativity and by the pressure coming from competitors. The mobilization of ideas among different agents is essential in this process and facilitates their development.
b) Review and selection of ideas. This stage consists of considering only the ideas with the greatest potential for generating value as well as economic and social growth.
c) Experimentation. Experimentation tests the feasibility of ideas in a given environment and helps confirm that an invention or idea effectively solves a problem.
d) Commercialization. It allows innovation to be taken to a larger scale and to expand and deploy new products, services, or organizational methods in a particular market.
e) Diffusion and implementation. This stage is the innovation's final approval and the implementation of the necessary structures and resources for its production, maintenance, and diffusion.

These stages do not necessarily appear in this order. Each stage involves different actors who contribute to the generation of new products, services, marketing methods, and organizational processes based on their knowledge, resources, and experience.

Innovation Life Cycle

According to OECD (2018), the main activities of innovation are research and development, knowledge transfer within the company, and innovative marketing and commercialization. The linear approach to the research and development process starts with research, then it proceeds to development, where assimilation, transfer, and protection can be integrated to finally reach innovation.

Innovation is a systemic, interactive, multidisciplinary, and multi-authored process. Among innovation authors are public institutions, such as universities and research and development centers, the State, society, social media, and companies.

A smart innovator first validates whether the market will accept his/her product, understands how to make it reach future customers, and develops it at low cost, seeking market-oriented improvements over time.

The study of innovation networks allows for understanding information flows between producers, companies, and institutions as well as identifying factors related to the existence of such relationships in favor of decision making.

MATERIALS AND METHODS

A few visits and interviews were made to the main collection centers to learn about the situation of the most important stakeholders (Sunbell, El Cerrito, SPR, and Driscoll). We also interviewed Banco de México - FIRA personnel from the Western Regional Office and the Zamora Agency. Producers United for Quality were also interviewed. A universe of 50 producers was considered for the baseline survey, including partners and main clients; then, the entire network was surveyed using the "snowball" technique.

RESULTS AND DISCUSSION

The population analyzed was mostly adults of 46.4 years of age in average: a minimum of 23 years, and a maximum of 68 years of age. They had high-school education level in average (12.6 years) and work experience in the sector between 1 and 18 years, averaging 7.4 years. The gender composition was mostly men (89%) and only 11% women.

All producers grow the Tupi, but only one has an innovative variety. On the other hand, 39% of producers have another crop or activity (avocado), so the average area for blackberry per farmer is 6.7 ha, with an average total area of 12.6 ha and a high coefficient of variation. All producers have a small land tenure. They all consider their production a good market opportunity because:

- They adopt better technologies to increase production.
- The lease of land to grow blackberries represents a constant.
- Cultivation in new areas (Jalisco and Colima) is a trend.

Most of the production (92%) is destined for export, and only 8% is for the domestic market. The latter represents the "rejection", *i.e.*, produce that did not meet the quality standards established by collectors-traders and is mainly destined for regional markets. As for the main collection centers for export, only three of them —*Sunbelle*, *Splendor*, and *Driscoll*— concentrate all produce in approximately 80% of the population of study. Two of the main collection centers that sell to the domestic market —*El Molinito* and *Moradely*— account for 70% of it all.

As for the perception of production problems, farmers mention five main issues in order of importance: the cost of inputs, the cost of labor, low prices, road quality, pests and diseases.

They also perceive five problems regarding access to formal credit through bank and non-bank financial institutions in order of importance: high-value collateral required, complex procedures, low profitability of the activity, high interest rates, and lack of information on the procedures involved.

Because the production network is highly developed in the area, we found all kinds of local providers of inputs, equipment, and machinery for the development of the crop and harvest, financial services, as well as technical, fiscal, economic-financial, and marketing advisory.

Five companies concentrate 70% of the inputs sold to producers: Agrofertilizantes de Michoacán holds 29.4%, followed by Agromich with 11.8% and Fertimich, Bucosa and Agrupe with 8.8% each. According to data provided by the surveyed producers, the average profit per hectare is $78,000.00. However, the most efficient producers achieve a profit of approximately $250,000.00 per hectare.

The dynamics of innovation

The highest rate of innovation adoption is seen in Tocumbo with 81%, followed closely by Los Reyes with 73%. Producers in the city of Peribán have a lower level of adoption. An average innovation adoption rate (INAI) of 71% is estimated according to the information

provided by the producers interviewed. This situation can be explained by the following facts: In Peribán, blackberries are produced together with avocado and peach. The adoption of this crop and the categories or activities included in the calculation of the INAI has been slower. So, 50% of the producers interviewed were above the general INAI average of 76.5%, and six producers remained within that average. We also identified two producers with a high percentage of technological innovation and the group with the most lagging producers.

Three categories present the greatest lag and therefore need appropriate attention. These categories serve as the basis for establishing the Innovation Strategy to improve the INAI.

Organization: There is a perceived need for producers to rearrange their purchase systems and access new, safer inputs to generate scale economies and lower costs for goods and services.

Seedling reproduction and genetic management: This was the second most problematic category as perceived by producers. Currently ALL growers have the Tupi variety established. Only one of them has also a new variety: the Sliping Bioner.

Plantation establishment and management: Blackberry growers in Michoacán, especially in the valley of Los Reyes, are aware of their international competitors. They know that establishing a healthy, vigorous crop and a properly managed orchard is essential to remain in the market.

For producers to obtain a code, they must accept the supervision of technicians authorized by the Collection Center, who are also authorized and certified by the State Committee on Plant Health (CSV).

A good harvest depends to a large extent on the plant's strength and nutrition. Fertilization is then second place (the first is harvesting) in terms of cultivation cost with 17.7%.

Harvest is the most critical and rigorous stage. For this reason, women harvesters must show up with their nails trimmed, groomed, their hair tied back and secured with a

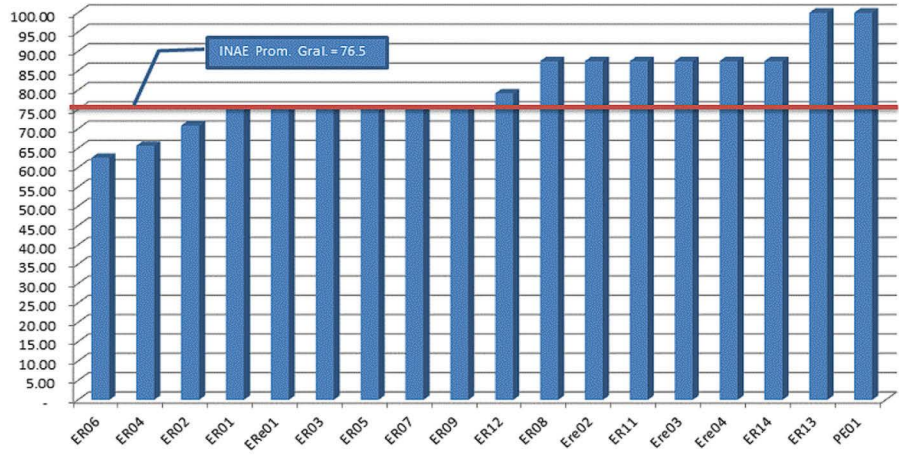

Figure 1. Categories of producers and levels of innovation.

cap. The containers must be completely clean. All boxes (clamshells and container boxes) together with the code are supplied by the company that holds the sales commitment.

Blackberry growers are aware of the need to manage resources in a sustainable way as Good Practices are supervised by CSV-authorized technicians.

There is a defined area in each farm for workers to prepare and ingest their food in isolation from the crop; the toilet must be clean and always have clean water for personal hygiene. The preparation of the products to be applied is also isolated from the crop, and empty containers are immediately collected; they are first confined and then removed from the farm.

The sanitary aspect of crop management is the parameter with the highest level of adoption. This makes sense considering the requirements or specifications that the producer must meet to supply fruit for export.

A letter of intent to sell the fruit to the packing house or Collection Center is signed. This grants a CODE or identification number (ID) for each land property. This data label is attached to each of the plastic boxes (220-gram clamshells) and to the cardboard box containing ten of them.

This code allows traceability in case of problems at any stage of the collection process, during transportation to the destination, or even at the distribution point.

The Task Force (EGI) establishes goals for producers participating in the exhibition to adopt technological innovations that will increase their competitiveness.

Some activities within the categories need to be developed for producers to adopt.

Training, demonstrations, and result evaluation events will be carried out to promote such activities. Adopting new varieties, hiring technical assistance services, and generating the use of macro-tunnels are practices that need the most promotion.

Innovation network

We obtained elements through producer surveys for mapping 16 types of networks, which are shown in the Table 1. The combination of three additional networks was mapped out to better understand the network.

We obtained measures of density, centrality (inputs and outputs), centralization, and intermediation in addition to each network's map (Table 2).

As displayed in the maps and indicators, all networks show the following:

- The number of relationships between actors (density) is low.
- With a diffuse structure,
- no network dominance or predominance (centralization) is shown.
- for input and output indicators or for the intermediation level of each low actor, but it shows a trend for some actors according to the network.

These values were due to the number of producers surveyed as well as the type of response provided. However, the types of producers and the roles they play in each network are identified in each of the mappings.

Table 1. Classification of Actors for Network Analysis.

Code	Actor
ERLT	Leading technology producer
ER	Typical producer
ERe	Referred producer
PI	Supplier of inputs
PE	Machinery and equipment supplier
PG	Genetics supplier
PSP	Professional service provider
IE	Teaching and research institution
PF	Financial services provider
IG	Government institution
CI	Intermediary customer
CA	Staff at collection center, commercial, or agroindustrial
OR	Trade organization
OP	Producer organization
FAM	Family
EP	Own experiment
AoC	Friend or Godfather
RoB	Journals or newsletters
CAP	Training courses
INET	Internet
	Other (specify)

Density is very low in the communication network. There are actors with low inputs and outputs, and there is a small group was with a collector producer (ERELT04), who is known as a technological leader.

The relationships in the communication learning network are low, but a group is clearly identified where a referred producer (Ere05) is seen as a source and articulating actor.

Three small groups stand out in the financing network. It shows collector actors where only one is a financial intermediary, and the other is a marketer-collector.

There are two main collectors in the marketing networks for both the domestic and export markets: El Molinito for domestic and *Sunbelle* for export, the latter being also an important source of financing for producers.

We identified a significant participation of a main input provider in the input supply network (PI01). It is a fertilizer company called *Agro-fertilizers of Michoacán*. The company *Agromich* appears with less importance for other types of inputs.

The producer referred to as Ere03 appears in the innovation network with a significant number of entries. It acts as a source and articulating actor and is referred to by a significant number of producers as the innovator.

The company *Procal* stands out in the inputs and services management network, acting as a conglomerating part in the organization.

Table 2. Types of Networks.

	Types of networks		Density	Centrality		Centralization (Intermediation)		
				Input	Output	Rate	Main Actor	Value
1	Social	Who you talk to	4.50%	9.19	1.5	0.67	Ere03	5
2		Who you learn from	3.23%	1.66	8.32	0	-	0
3		Conflict						
4	Funding	Working capital credit	6.32%	1.66	8.79	0	-	0
5		Investment credit						
6		Joint investments in equipment, facilities, and infrastructure	2.77%	3.09	7.85	0	-	0
7	Marketing	With Quality	5.23%	1.44	34.72	0	-	0
8		No Quality	3.62%	2.64	20.79	0	-	0
9		Consolidated sale						
10	Provision	Who do you buy main inputs from? (Fertilizers)	7.62%	1.22	38	0	-	0
11		Who do you buy secondary inputs from?	4.92%	1.66	9.92	0	-	0
12		Who do you buy tertiary inputs from?						
13		With whom do you buy on a consolidated basis?						
14	Various	Innovative	7.14%	1.55	33	2.08	Ere03	8
15		Joint management	8.19%	1.23	30.55	0.65	Ere03	2
16		Belongs to an organization	8.82%	1.95	48.43	0	-	0
17	Combination	Communication + learning	3.66%	1.53	2.83	0.62	Ere03	10
18		Communication + learning + innov.	3.94%	2.24	10.38	1.4	Ere03	27
19		Communication + learning + lnnov. + management	4.53%	1.94	7.74	1	Ere03	22

The communication, learning, innovation, and management networks were mapped together for a better understanding of the network and actors. This resulted in 3 mappings:

- The first one grouped the communication network together with the learning network.
- The second mapping covered the communication, the learning, and the innovation networks.
- The third mapping included the communication, the learning, the innovation, and the management networks.

The relationships between different actors become more evident and clearer in these 3 mappings. The centralization, inputs-outputs, and intermediation indicators take higher values, which shows the role of producers and key companies (Ere03 and OP01) as source, collector, and articulator actors.

It is also observed that these 4 aspects of the network (communication, learning, innovation, and management) have several communities; one of them hosts the largest number of people and is intercommunicated.

The first part described the network, its members, and the importance of the activity at the regional, state, national and global levels. Then we learned about the relevant characteristics of actors in the network through different tools. These characteristics were considered as important factors in intervention strategies.

Additionally, the activity and innovation dynamics were known, and their status or baseline was established. Also, the roles of different actors were made visible through network mappings and indicators. We therefore suggest strengthening the capacities of PROCAL's staff so they can plan their businesses, increase their membership, their organization, and their market development. We also propose the development of adequate credit schemes, input procurement, risk management, marketing, manufacturing, and technology transfer services. It is important to promote high productivity and profitability technologies for innovation categories such as: Plantation establishment and management, breeding and genetics of new varieties.

CONCLUSION

Our multi-criteria selection indicates the feasibility of supply schemes in their technical, economic, and social aspects as they prompt the producers' interests. Then, the development of the producers' organizational and integration capacities through companies is recommended.

Third, but no less important, is the alternative of developing, transferring, and adopting high productivity and profitability technologies. The network's current situation (baseline) in its different aspects was established; then the interactions of those involved were recorded, and their problems and solutions were defined. This enables a timely follow-up and a clear glimpse to document the degree of development. It also allows us to take preventive and corrective measures and to redirect our strategies if necessary.

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