



Characterization of the Supply and Value Chains of the Colombian Potato Agribusiness Sector

Caracterización de la cadena de abastecimiento y cadena de valor del sector agroindustrial de la papa en Colombia

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Contents

- [1. Introduction](#)
- [2. Theoretical Framework](#)
- [3. Methodology](#)
- [4. Results](#)
- [5. Conclusions](#)
- [Acknowledgements](#)
- [References](#)

ABSTRACT:

The present paper characterizes the supply and value chains of the potato agribusiness sector at the world level, emphasizing the Colombian case. Based on previous agribusiness chain characterization works, the methodology describes the economic, social and environmental features of the chains in question, in order to facilitate the decision-making process. The most important agent of the studied chains was found to be the producer, who operates the production stage, which, in turn, takes place during the upstream phase. However, this is the weakest stage of the chain, and the one that absorbs all the uncertainty of its operation.

Keywords: supply chain, value chain, potatoes, agribusiness

RESUMEN:

Este artículo caracteriza las cadenas de abastecimiento y valor del sector agroindustrial de la papa en un contexto mundial, con énfasis en el caso colombiano. Basada en trabajos previos de caracterización de cadenas agroindustriales, la metodología describe los rasgos económicos, sociales y ambientales de las cadenas en estudio, para facilitar sus procesos de toma de decisión. Se encontró que el agente clave de estas cadenas es el productor, quien opera el eslabón de producción de la papa, lo cual, a su vez, tiene lugar durante la fase upstream. Sin embargo, este eslabón es el más débil de la cadena, y el que absorbe la incertidumbre de su operación.

Palabras clave: cadena de abastecimiento, cadena de valor, papa, agroindustria

1. Introduction

Within the framework provided by CONPES document 3527 of 2008 (National Productivity and Competitiveness Policy), low levels of innovation in production systems are mainly evident through scarce research and adoption of new technologies. In part, this is so because of cultural resistance to said adoption, particularly on the part of small producers, which adds up to a series of factors that result in low productivity and competitiveness of

the chain in its upstream phase (Barrero, 2012).

As part of the general agribusiness program of Colombia, potato constitutes a key staple for the country and the world, because of its elevated and increasing demand. This particular chain presents several problems regarding its productivity, sustainability and competitiveness. In Colombia this sector has been significantly affected by free trade agreements, guild weaknesses and the price of supplies, on which this crop is heavily dependent. This, in turn, negatively affects the welfare of a significant number of rural families who live directly on potato production, especially in the departments of Boyacá, Cundinamarca and Nariño. These people have long been looking for a solution to this adverse situation, partly through agreements with the State, which are aimed at the establishment of favorable policies for the sector.

According to COLCIENCIAS (2005), three strategies have been proposed to improve the productive efficiency of this crop, namely chain articulation, cost reduction, and the strengthening of the primary sector through applied research on biotechnology and conventional plant breeding techniques.

The research priorities of the potato agribusiness chain have to do with soil and water integrated management, economic and environmental assessment of farming practices, environmental impact on the ecosystems where the crop is grown, and application of plant breeding techniques (Ministerio de Ciencia y Tecnología, 2012).

The aforementioned considerations indicate both the need and the opportunity to add value to this agribusiness chain. In this sense, the National Agenda for Science, Technology and Agricultural Innovation (Agenda Nacional de Ciencia, Tecnología e Innovación Agropecuaria – ANCTIA), which instructs on the application of new technologies for the development of agriculture, provided the basic guidelines for the development of the present project. Thus, its main objective was "to characterize the supply and value chains of the potato agribusiness in Colombia" (Bonilla et al., 2009, p.17), which is aligned with the series of Colombian agribusiness chain characterization studies that set the course of action for the current methodological framework.

2. Theoretical Framework

The Supply Chain (SC) concept has been explained as "a multi-agent organization that seeks to meet the demands of the final customer by effectively coordinating its information, product and financial resource flows, which link the supplier to the customer's customer" (García-Cáceres et al., 2013). As to other definitions, the supply chain has been assumed to "cover all activities related to the flow and transformation of goods, from the raw material stage to the end user one, as well as the related information flows" (Ballou, 2004). Just as well, it has been regarded as "a set of three or more entities that are directly related according to descending and ascending flows of products, services, financial resources and information, from the primary production source to the final customer" (Mentzer, 2001, cited in Ballou, 2007).

The Value Chain (VC) concept was developed by Michael Porter in 1986, who stated that it "provides a way to classify the processes of a company in two groups, namely primary and support processes". Within the group of primary processes, we can find logistics, operations and marketing. For their part, support processes include administration and technology, human resource and procurement management. In this way, value is added as each process becomes more productive.

The VC can be understood as a network of alliances between independent companies, aimed at creating strategies that benefit all members, thus allowing the whole group to manage the flow of goods and services.

In the context of agri-food chains, the notion of "strategic alliances" implies that the association is planned in advance by a group of people collectively undertaking activities that they cannot perform individually. The result is a "competitive intelligence", which collects and shares information that cannot be accessed independently" (Holmund and Futon, 2009).

Some key organizational considerations to build a successful VC include information flow

management, performance evaluation, the establishment of common goals, the existence of tangible benefits for all members involved, and the creation of trust and cooperative work relationships (Holmund and Futon, 2009).

Porter defines the value chain as "the sum of the benefits perceived by the customers, minus the costs they incur in order to acquire and use a product or service" (Porter, 1998). In the current work, the VC is assumed to be the set of actions, functions or techniques that add value to a product.

3. Methodology

According to previous works on the cocoa (García-Cáceres et al., 2014), coffee (García-Cáceres and Olaya, 2006) and oil palm (García-Cáceres et al., 2013) agribusiness chains, the current characterization methodology comprised the following steps:

3.1. Development steps

Step 1. Assessing the national and global production of the potato SC: a search was conducted in secondary information sources such as FEDEPAPA (Federación Nacional de Cultivadores de Papa, which stands for "National Federation of Potato Growers"), FAO (Food and Agriculture Organization) and TRADE MAP.

Step 2. Identifying the Colombian agents of the SC, according to data provided by the National Ministry of Agriculture, which are, in turn, mainly obtained from FEDEPAPA.

Step 3. Description of the local SC, based on primary and secondary information. This was done in order to include the views of potato growers, provided that the production step is considered to be the backbone of the chain.

Step 4. Description of the global supply chain, mainly based on secondary information sources, but not neglecting the data provided by the producers.

Step 5. Diagnosis and conclusions about the SC.

At this step, surveys were conducted to obtain information from primary sources, which in the present case corresponded to potato growers of the departments of Boyacá and Cundinamarca. For such purpose, the reference background was provided by the work of Willersinn et al. (2015), who studied the quantity and quality of food losses along the Swiss potato SC, by means of a stepwise investigation. Quantitative data were obtained from field trials; structured interviews with wholesalers, processors and retailers; and consumer surveys in combination with a 30-day long study. This led to evaluating both fresh potato production and processed potato losses. Secondary information sources include documents, journals and websites, which facilitated the technological, institutional (law and business policy) and economic characterization of the studied supply and value chains.

4. Results

4.1. Steps 1 and 4

Global market

Potato is considered to be one of the most important staples of the world, due to its nutritional value and high starch content. The China is the largest producer worldwide, with a >90-million-tons yearly harvest, followed by India, Rusia, Ucrania and the USA (see Table 1).

Table 1
Major worldwide potato producers

Country	Yearly tons
China	99,065,724

India	43,770,000
Federación de Rusia	31,107,797
Ucrania	21,750,290
The United States of America	19,990,950

Source: Adapted from Trademap

Table 2 shows the largest potato importers of the world: Belgium, with 2,001,183 tons, followed by the Netherlands, Spain, Italy, Germany and the United States.

Table 2
Major potato importers around the world during 2016

Importers	Imported amount (yearly tons)
Belgium	2.001.183
The Netherlands	1.788.643
Spain	728.936
Italy	636.686
Germany	592.485
United States of America	511.311
Portugal	442.216

Source: Adapted from Trademap

China ranks first among harvested areas, and is also one of the major importers (see Table 3).

Table 3
Major potato harvested areas

Position	Country	Ha
1	China	5,812,865
2	India	2,130,000
3	Federación de Rusia	2,030,858
4	Ucrania	1,311,600
5	United States of America	407,810

Source: Adapted from Trademap

The continents with the largest worldwide production are Asia (190,516,292 tons), Europe (117,555,648 tons), and America (42,592,735 tons) (see Table 4):

Table 4
Worldwide potato production

Region	Tons
World	376,826,9679
Asia	190,516,292
Europe	117,555,648
America	42,592,735
Africa	24,501,902

Oceania

1,660,390

Source: Adapted from FAO

The Netherlands, France and Germany are potato exporters, while The Netherlands and Germany are also large worldwide producers (see Table 5).

Table 5
Potato exports during

Country	Millions of US\$
Netherlands	\$805,356
France	\$603,406
Germany	\$349,234
Canada	\$227,849
China	\$226,453
Belgium	\$210,198
United States of America	\$204,423
Egypt	\$162,009
United Kingdom	\$148,755
Spain	\$136,229

Source: Adapted from Trademap

Domestic market

On average, potato production represents 32% of the Colombian transitory crop yield. This is, in fact, one of the products of greater consumption in this country, especially in high Andean regions, where it constitutes the basic staple due to its easiness of access and relatively low price (Rojas & Durán, 2011). The potato market in Colombia is considered to be inefficient due to its high levels of intermediation, low or zero value added, absence of quality standards, permanent price fluctuation due to the difficulty to maintain a steady supply, dispersion of producers and consumers, storage difficulties and poor promotion of the product. The market is, for the most part, oriented to direct fresh consumption, while a minimum percentage of the total national production is industrially processed (Fedepapa, 2014).

According to the National Agricultural Survey (Encuesta Nacional Agropecuaria – ENA), carried out by the DANE (2016), out of 3,034,023 tons harvested in Colombia in 2016, 90% came from the departments of Cundinamarca, Boyacá and Nariño (see Table 6).

Table 6
Major potato harvested areas

Department	Harvested Area(Ha)	Production (Tons)	Yield (Tons/Ha)
Cundinamarca	58,082	1,207,193	20.7
Boyacá	45,620	886,597	19.4
Nariño	38,304	684,981	17.9
Antioquia	5,575	109,285	19.6
Cauca	5,159	70,983	13.8
Norte de Santander	2,986	27,362	9.2

Santander	2,628	39,166	14.9
Tolima	1,807	11,669	6.5
Valle del Cauca	291	1,969	6.8
Caldas	102	711	6.9
Risaralda	39	106	2.8
Total	160,593	3,034,023	138.3

Source: Adapted from DANE

Table 7 shows a positive percent index of yield variation across harvested areas in Colombia, indicating a cyclic behavior with a negative trend from 2012 to 2014.

Table 7
Yield variation across potato cultivated areas in Colombia

YEAR	YIELD (Ton/Ha)
2008	18.8
2009	19
2010	19.1
2011	20.6
2012	21.4
2013	20.9
2014	20.4

Source: Adapted from Ministerio de Agricultura y Desarrollo Rural

The cities with higher prices per kilogram of potato are Medellín, Sincelejo and Manizales. Due to logistic costs, other Colombian cities maintain lower and less changeable prices (Trujillo et al., 2013).

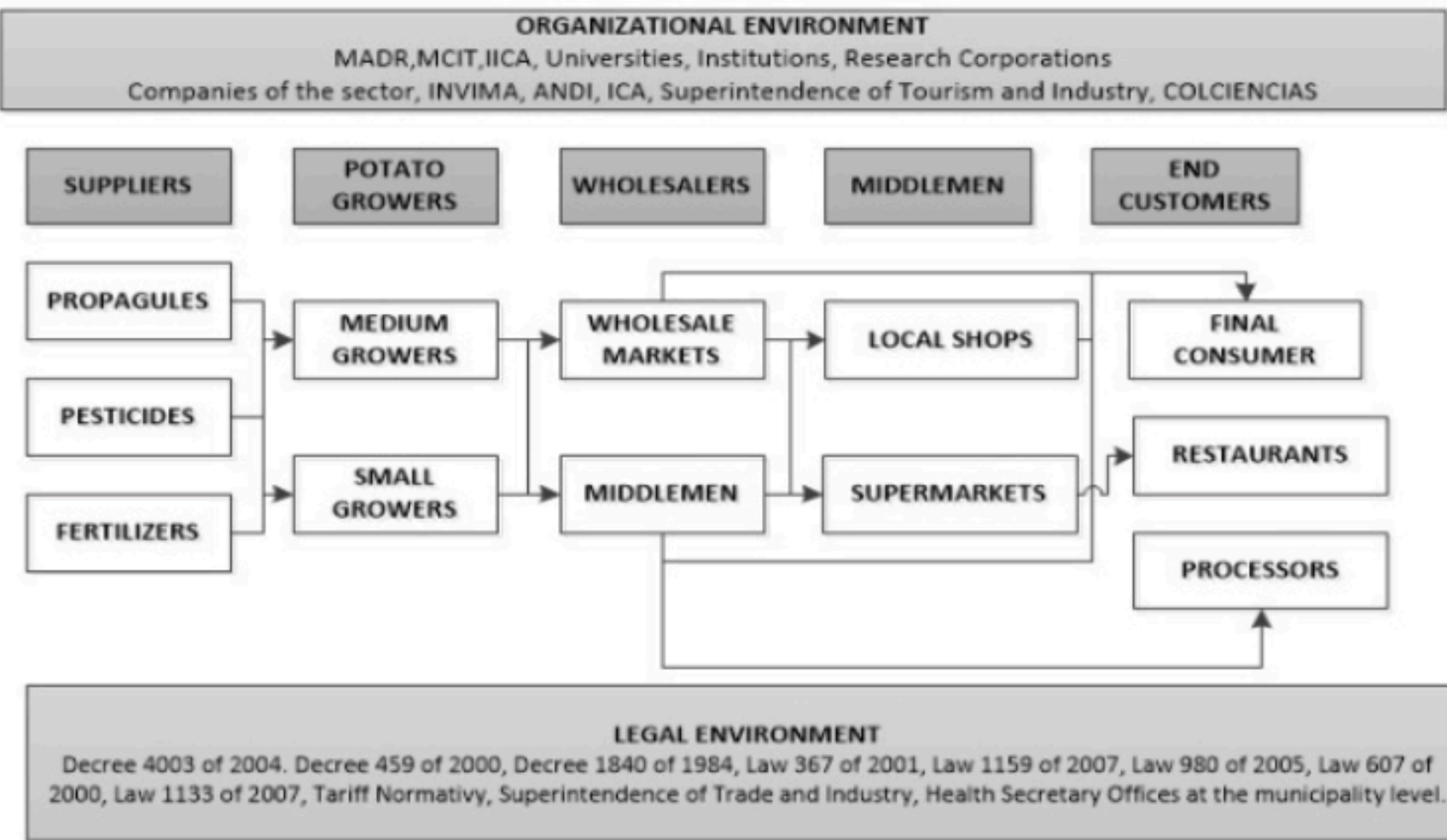
4.2. Steps 2 and 3

SC agents in Colombia and description of the local potato SC

The stages identified for the Colombian potato SC are the following: Provision of supplies, potato production, wholesales, retailing, and purchase by the end customer.

These stages are also related to each other, in such a way that these interactions make the product reach the end customer. Figure 1 shows the mentioned stages, interactions and stage components:

Figure 1
Potato supply chain



Source: The authors (2016), based on data provided by the Colombian Ministry of Agriculture (*Ministerio de Agricultura de Colombia*) <http://www.minagricultura.gov.co>. Accessed February 15, 2015.

Below is a detailed description of Figure 1:

Supplies

The first stage of the SC corresponds to the provision of propagules, fertilizers and pesticides, the latter being intended to control general plague problems, as is the case of chafer grubs, among others. Supply quality must be certified by the Food and Drugs Surveillance Institute (Instituto para la Vigilancia de Medicamentos y Alimentos - INVIMA). These products must be developed in certified laboratories, thus visibly exhibiting the dates of fabrication and expiration. This stage helps assuring that the final product fulfills all the necessary conditions when it enters the market.

Components of the "supplies" stage

The elements involved in this stage mainly have to do with the products offered by suppliers, each of which is presented below:

Potato propagules

The recommendations of FEDEPAPA (2015) with respect to propagules indicate that they should be very healthy (thus free of pests and diseases) and uniformly sized (medium to large), since they offer better resistance to drought. The propagules should ideally produce multiple sprouts, which allows better stem establishment, uniform emergence of the crop and high yield potential. The following aspects should be considered:

- The propagules should not have bruises, black spots or any external or internal lesion.
- They must be purchased from a reputable supplier with proven track record.
- Propagule viability constitutes a fundamental factor which, under optimum sowing conditions, allows the vegetative development of the plant.
- The propagules must have a germination point that allows the plant to sprout and develop properly.

Table 8 specifies the offer of potato propagules by FEDEPAPA in April of 2016.

Table 8. Available potato propagules in April 2014

Variety	Number of bags	Category	Harvest date
Rubí	45	Certified	August
Ciacol Capiro	2901	Certified	November
Ica Unica	198	Certified	November
Pastusa Suprema	2193	Certified	November

Source: Adapted from Fedepapa

Fertilizers

It is recommended to apply a fertilization plan based on soil analysis results, nutritional requirements by variety and expected yields. It is advisable to apply soluble sources supplemented with properly composted organic fertilizers to contribute to soil moisture retention. Just as well, foliar fertilization with potassium and micronutrients is advisable. When plants show water deficiency symptoms or frost damage, foliar applications with sugar are recommended (Fedepapa., 2015).

Agents

The agents involved in this stage are:

- ❖ FEDEPAPA: Supplier of propagules and phytosanitary management services
- ❖ Fertilizer and pesticide producing laboratories
- ❖ INVIMA: responsible for issuing sanitary registers.

Potatoes types grown in Colombia

The classification of potatoes in the market is carried out according to the following characteristics: Color; skin texture, number of eyes, tuber form, outbreak characteristics and harvest, among others.

As to its nutritional value, potato contains three parts of water to one part of starch, carbohydrates, proteins, and lipids. Protein, fiber and vitamin contents are low. The tuber is cholesterol free, contains no sodium, is a good source of vitamins C and B6, and provides dietary fiber.

The potato types that best respond to market requirements are Tocarreña and Pastusa, due to versatility of consumption. For its part, yellow diploid potato (locally known as papa criolla) is sometimes precooked and frozen to be exported.

Production

The second stage is mainly operated by the producers, who are mostly small and some medium scale ones. Potato production in the country is led by Cundinamarca and Boyacá, with a sustained production over the last four years.

Potato is a transitory crop, yielding two yearly harvests. In Colombia, its commercial production is carried out between 2,000 and 3,000 m asl. Although the areas of optimal production in terms of the quality and quantity of the product are located between 2,500 and 3,000 m asl, there are two areas of marginal production. This is so because of limiting factors that correspond to pests and diseases in the case of mild climates (between 1,500 and 2,000 m asl), and to frost in high altitudes ranging from 3,500 to 4,000 m asl. Ninety percent of potato commercial production takes place on sloping land, while 10% is done on flat, mechanizable soils (CEVIPAPA, 2015, p.2).

This stage must ensure the following functions:

- Guaranteeing the delivery of the harvest on the established dates
- Producing high quality potato

- Establishing coordination with suppliers and wholesalers
- Setting the selling price.

Components of the production stage

As the center of the SC, this stage determines its entire dynamics. It is conditioned by the price, amount, variety and quality of the product.

Potato producers can be classified in three groups: small, medium and large (Table 9).

Table 9
Classification of potato producers

Type of producers	Description
Small	This category is considered to represent 95% of potato growers, who carry out their activity in extensions smaller than three ha.
Medium	These farmers make up 7.2% of all potato growers in the country. The activity takes place in extensions larger than 3 ha and smaller than 10 ha.
Large	Representing 1.3% of the country's producers, they cultivate >10 ha land plots.

Source: Adapted from DANE

Most potato growers are small farmers who practice contour plowing. When the slope is lower than 25%, mechanical traction is used for plowing. In steeper areas, the soil is tilled either manually with a hoe, or resorting to oxen, for which a moldboard plow is used (García-Cáceres et al., 2014).

The sowing is done before the beginning of the rainy season, in order to take advantage of rainwater for the germination and development of the crop. The propagules that are most often used are selected from crops growing in the same farm where the planting is going to take place, or in neighboring localities of higher altitude. The task of covering and fertilizing the propagules is done manually with a hoe. General use equipment such as back sprayers or tractors are employed for the maintenance of the crop. In general, the sprayers are not calibrated; "[they] use only one type of nozzle for all products, and no protection garment" (Ministerio de Agricultura y Desarrollo Rural, 2005a, p. 36).

Agents

The agents that intervene at this stage are:

- ❖ Producers from different departments around the country.
- ❖ Farmers, who prepare the land for the planting.
- ❖ Several worker categories, who are in charge of soil fertilization, fumigation, harvest, tuber classification and packing, and trading the product with the wholesalers.

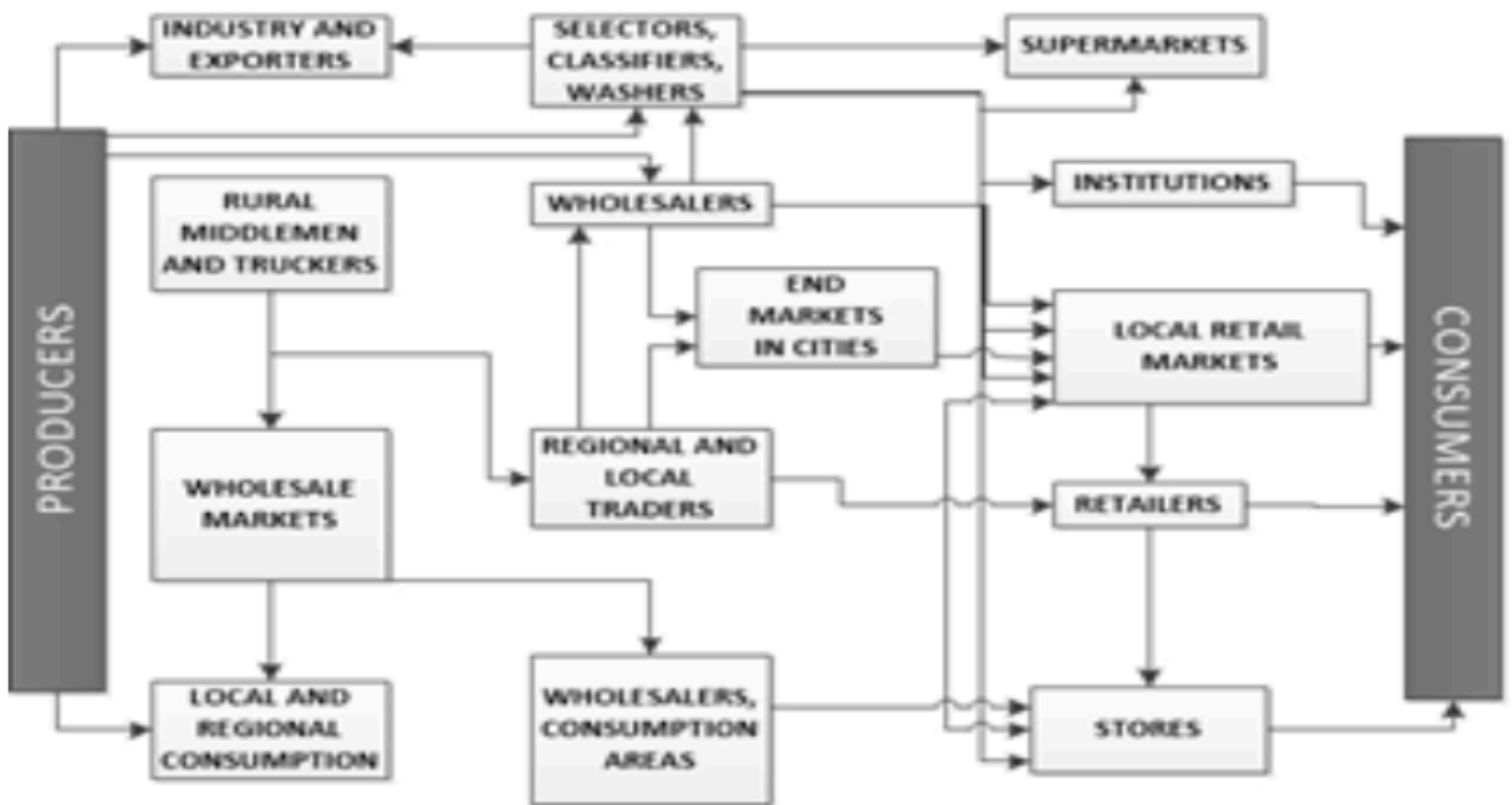
In most cases, the family group is in charge of these tasks, wherein child labor is quite common.

Wholesales

The third stage corresponds to wholesales. Figure 2 illustrates the structure of the Colombian potato market, according to Fedepapa.

The main task at this stage is to distribute the product in large amounts at the national or international levels. Wholesalers usually have direct contact with the producers, in order to avoid an increase in the marketing costs, which is common when there are intermediaries.

Figure 2
Potato marketing structure



Source: The authors

Agents

- ❖ The agents of this stage correspond to wholesale markets and intermediaries.

Intermediaries

Intermediaries are responsible for negotiating with the producers. As marketers, they run potato warehouses and sell the product in small places such as intermediate cities, but usually not in wholesale markets. These intermediaries can be identified as middlemen.

Retailers

Retailers are those who buy the product from wholesalers to supply their businesses and reach the end customer. Retailers sell at a higher price than wholesalers because they take greater risks, since they do not receive a completely fresh product and must handle higher logistic costs.

Their functions include:

- Delivering a good quality product.
- Defining the selling price to the final consumer.
- Articulating with wholesalers and intermediaries and, of course, with the final customer.

Agents

- ❖ Superstores, which are actually retailers.
- ❖ Small grocery stores
- ❖ Neighborhood stores
- ❖ Potato street vendors, who announce the product in popular neighborhoods.
- ❖ Wholesalers.

This stage is characteristically featured by retailers, who maintain a direct relationship with the end customer. They buy the product in local markets and sell it at a higher price, by pounds, kilos and arrobas.

The end customers' stage

The fifth and final stage takes the product to the end customers, who are the majority of the Colombian population, including some small and medium processing industries that obtain

by-products such as homemade potato fries.

Agents

❖ Food shops

They are those who purchase raw or partially processed potato, as is the case of French fries. They correspond to ordinary and specialized restaurants, roasted chicken stops, and shopping centers.

❖ Processors

These include "large, medium and small companies that elaborate a properly packed, ready-to-eat product" (García-Cáceres et al., 2013). Processors correspond to companies like "Yupi" and "Frito-lay", among others.

❖ Housewives

This agent is the one that most frequently purchases the product (three to four times a week), mainly for family consumption purposes.

❖ Restaurants

Depending on the size of the market and the type of customer they serve, restaurants purchase the product in neighborhood stores or wholesale markets.

Value chain of the potato agribusiness sector in Colombia

In order to characterize the VC of the potato agribusiness sector in Colombia, the two largest producers at the national level, namely the departments of Cundinamarca and Boyacá, were analyzed in detail. In order to determine the agents of this agribusiness chain, a primary information survey was conducted with producers and other key agents, priorly identified based on secondary data. The information was collected from the two largest potato producing municipalities of each of the studied departments (as identified by the DANE). The survey instrument in question is presented in Appendix A.

The results of the surveys are broken down by municipality. The number of respondents followed the distribution detailed below:

Tabla 10

Distribution of the surveyed farmers by rural divisions (veredas) of the two studied municipalities.

YEAR	YIELD (Ton/Ha)
Puente Boyacá	212
Montoya	91
Matanegra	79
Ventaquemada total	382
Bosavita	200
Chinquirá	40
Soatama	133
Villapinzón total	373

Source: The authors

Potato production constitutes the first stage of the SC (upstream phase) and the basis for its operation. In order to estimate the value added by the farmers at this stage, a survey was conducted, containing 14 questions. This instrument was applied by visiting the farms of 755 potato producers of the municipalities of Ventaquemada (Cundinamarca) and Villapinzón (Boyacá). The choice of the two studied municipalities and their rural divisions (*veredas*) was not random, since they both contribute the largest potato production in their respective departments. The rural divisions were chosen according to productivity data provided by the mayoralties at the time of the arrival of the research team to the municipality.

Table 11 presents the sequence of cropping activities performed by the potato growers of the departments of Boyacá and Cundinamarca, together with the economic percentage represented by each stage.

Table 11
Indicators

Stage	Activity	Description	Economic percentage
Production	Selection of propagules for sowing	Pastusa	17.9%
		Diacol Capiro (R12)	
		Tocarreña	
		Criolla	
		Other	
	Land tilling	Plow	34.9%
	Propagule sowing	Labor	26.0%
Fertilizers	Pest control	21.2%	
Harvest	Labor	Harvesting potatoes from the soil	43.1%
	Potato selection	Selection of potatoes for sale	45.0%
	Transportation	Transport to local towns	11.9%

Prepared by the authors. 2016

As it can be observed in Table 11, the harvest conveys the most significant losses for potato growers, because of the selection process, which is highly labor consuming. This stage includes product transportation to cities like Tunja or Bogota, which also implies an elevated cost for the farmer.

Propagule selection is an important decision that strongly affects the cost of the production stage, since it determines the pests that are likely to attack the crop. The production stage contributes the largest value added to the SC and VC

Social, Economic and Environmental Indicators

Following methodology by Porter (1998), the key indicators and possible impacts of the upstream phase of the Colombian potato VC were identified. The indicators in question were developed with the aid and participation of the community, specifically potato growing leaders. This is also intended to facilitate a more active participation of the individuals in the association processes involved in their relations with governmental institutions, all of which facilitates their decision - making processes. The indicators proposed are detailed below:

Table 12
Indicators

Type	Indicator	Impacts
Economic	Production and loss of investment (percentage)	Decreased life quality of potato growers
		Loss of land
		Cessation of potato production
	Sales	Debts with suppliers
		Inability to pay loans
	Social	Technical assistance level
Lack of pest management knowledge		
Scarce crop modernization		
Demand for the product		Loss of customers
		Decrease in new product development
Environmental		Hydric resource contamination level
	Soil exploitation level	Loss of soil
		Erosion

Source: The authors

These indicators should be regularly measured by potato growers in their rural division and municipal associations, in order to administrate continuous value improvement within the SC (Carrillo et al., 2002).

The measuring specifics of each of the proposed indicators, as well as their corresponding targets, goals and formulas are presented in Table 13.

Table 13
Management standards of the indicators

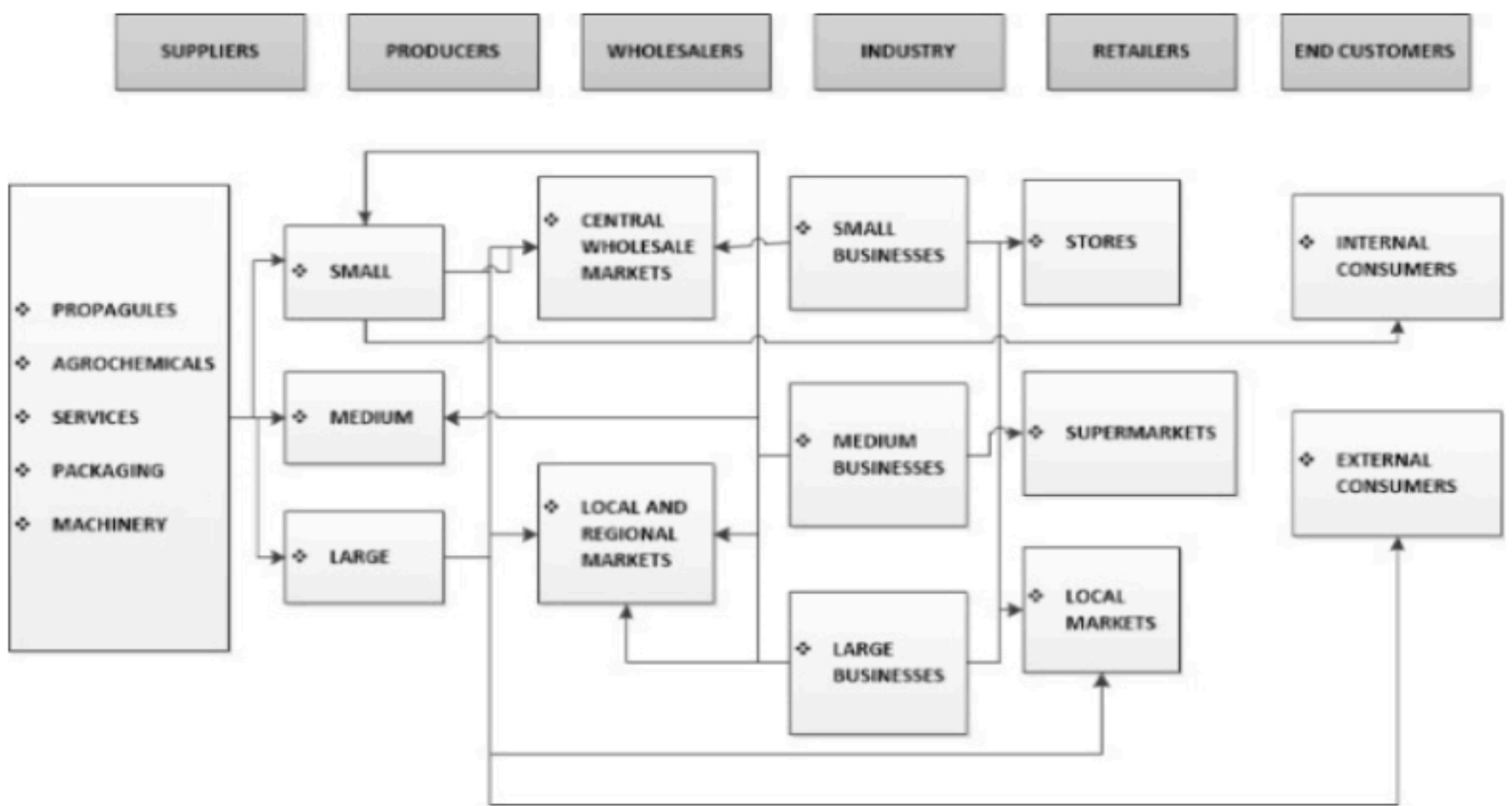
Indicator	Type	Target	Frequency	Danger	Precaution	Goal	Formula
Production and loss of investment (percentage)	Economic	Reducing production losses in order to ensure continuity of cropping activity	Six monthly	90%	85%	95%	Total investment / Total loss (percentage)

Sales	Economic	Gradually increasing sales in order to reduce unnecessary debts	Six monthly	80%	85%	90%	Debt value / Net profit
Technical assistance level	Social	Achieving greater presence of specialists in potato cultivation	Six monthly	80%	85%	90%	Number of potato growers / Delivered technical assistance
Demand for the product	Social	Increasing domestic potato demand by businesses	Six monthly	80%	85%	90%	Total production / Demand for the product (percentage)
Hydric resource contamination level	Environmental	Reducing environmental impact on water resources.	Annual	50%	40%	70%	% of contamination / Permitted levels
Soil exploitation level	Environmental	Reducing soil erosion and ensuring its useful life through training on land use	Annual	60%	40%	80%	% of soil erosion / Possibilities of soil recovery

Prepared by the authors

The value chain constructed from the collected information is summarized in Figure 3.

Figure 3
Value chain

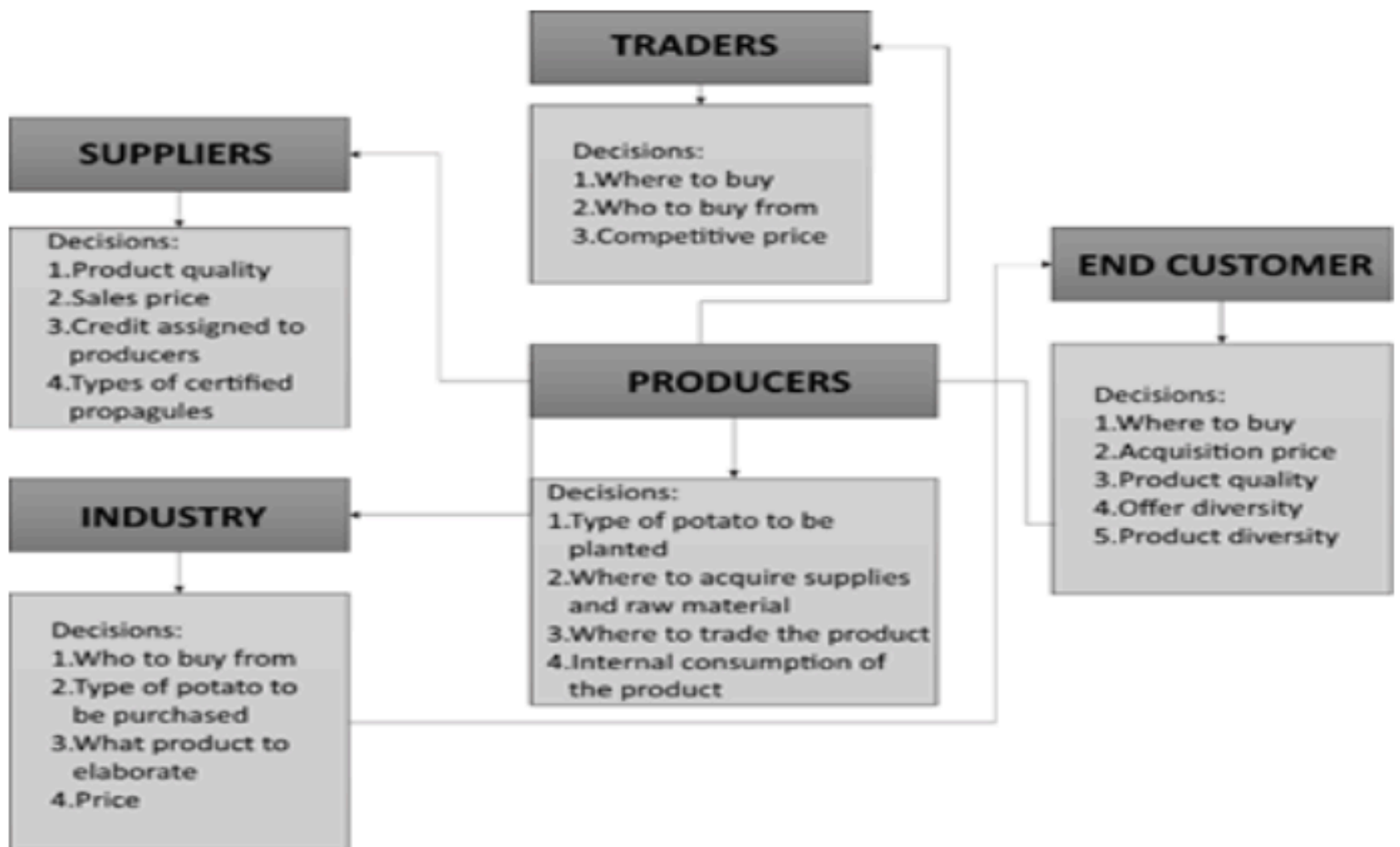


Prepared by the authors

Based on the above, Figure 4 illustrates the relation between the other two stages, in the framework provided by Carrillo et al. (2002).

Figure 4

Connections between the stages of the value chain.



Prepared by the authors. 2016

The decision on the type and amount of potato that is to be planted exerts a significant influence on the other stages. This has to do, on the one hand, with the connection between the offer of a particular potato type, its sales price and the availability of its propagules. On

the other hand, there is a considerable influence on plant health, because not all potato varieties are prone to the same diseases, nor they require the same supplies.

Potato growers have large crop losses, not only due to lack of modernization of their crops, but also to weather conditions. In spite of this, potato production in the country corresponds to the needs of the people. However, if the planting conditions and the training of the farmers to face agroecological variations and pests that attack the crop can be improved, domestic production might increase, which, in turn, would level the field to export the product.

4.4. Discussion (Step 5)

The obtained primary and secondary information allowed demonstrating the existence of added value on the part of suppliers of inputs and raw materials, which are sold in local towns. This is so because producers prefer to pay a slightly higher price to avoid having to travel long distances to source raw materials and supplies, which could imply higher costs. This also shows the difficulties involved in the upstream phase when it comes to establishing community partnerships that allow obtaining better prices for volume purchases when intermediation is reduced.

Potato cultivation in Colombia is labor intensive and scarcely modernized. The profits are marginal and dependent on associated costs which, in turn, hinge on technological level, land fertility and location, and potato variety. In this sense, there are areas in which cultivation is very difficult to sustain due to the elevated risk posed by frost and the large number of natural enemies of the crop.

The variable "client" is perhaps the one that exerts the most influence on the VC, because the entire production process is aimed at customer satisfaction. The specifics of potato demand (which, in turn, are aligned to a particular type of consumer) determine the variety to be planted. For example, the chip industry, which requires a durable tuber that neither blackens when fried nor has an elevated sugar content, usually resorts to varieties like ICA Única. However, it has become clear that this type of potato is not regularly planted, probably because this industry looks for specialized bulk suppliers with whom they establish medium and long term contracts. Traditional producers usually aim at mainstream markets, and thus sow those potato types that are easy to trade, as is the case of varieties Pastusa, DIACOL Capiro (R12) and Tocarreña, which are preferred by end customers such as restaurants, housewives, neighborhood stores and both wholesale and retail markets.

As shown in the survey (Appendix B), one of the factors that determine potato cultivation losses are weather problems such as changing temperatures and frost. Willersinn et al. (2016) studied the economic impact of environmental factors in Swiss potato crops. These authors state that losses can be reduced by changing consumption and product fermentation practices. In Switzerland, these losses are 8 to 42 times higher than in the rest of the world.

5. Conclusions

The present study involved the use of primary and secondary information sources. The primary source corresponded to a survey applied in the municipalities of Ventaquemada and Villapinzón, which belong to the departments of Boyacá and Cundinamarca, respectively. This article presents new research perspectives addressing the solution of the problems of the sector. In this regard, the lack of decision-making support mechanisms for potato growers was observed. Just as well, the difficulty to establish adequate partnership limits the access to supplies and the development of sustainable production alternatives. Finally, it is worthwhile noting that the deficient modernization, support mechanisms and definition of the specific roles of the agents involved at each stage also affect the potato growing activity.

A research perspective is to find the contrast between methodologies to characterize supply chain (Lambert & Enz., 2016), (Salazar et al., 2012) and (García & Ospina., 2017). Also, to characterize other Agricole commodities supply chains.

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[Index]

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