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Structural analysis of nontraditional Andean fruit chains: the case of the Inca berry agri-food network in Ecuador

CARLOS MORENO-MIRANDA [1,2*], MARÍA FERNANDA PAREDES[2], NATALY SOLÍS[2], RAÚL MORENO[3], DANIELE RAMA [4]

[1]*Agricultural Economics and Rural Policy Group, Wageningen University and Research, Wageningen, The Netherlands*

[2] *Facultad de Ciencia e Ingeniería en Alimentos, Campus Huachi, Universidad Técnica de Ambato, Ambato, Ecuador*

[3]*Facultat de Farmacia y Ciencias de la Alimentación, Campus Diagonal, Universitat de Barcelona, Barcelona, España*

[4]*Alta Scuola di Management ed Economia Agro-Alimentare, Campus Cremona. Università Cattolica del Sacro Cuore, Cremona, Italia*

**Correspondence details:* carlos.morenomiranda@wur.nl

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Abstract: The diversification of agri-food chains has a fundamental role in the economic development of Latin American countries. In Ecuador, the exports of nontraditional crops reached USD4.33 million in 2016. This analysis focused on the Inca berry chain, which is in the Interandean zone and represents a relevant economic expansion. Therefore, the aim was to understand the dynamics across the stages and flows, considering socio-productive and economic aspects, export determinants and policy implications, for which a systematic methodology was used. This study concluded that the diversification of marketing channels, strengthening of associative structures and implementation of agricultural policies are needed to improve performance.

Keywords: Inca berry, dimensioning, performance, associative structures

Introduction

The significant growth of nontraditional agricultural exports has been one of the outstanding characteristics of Latin American agriculture since 2000. The nontraditional export crops in question are primarily high-value products, important examples of which include flowers, fruits, vegetables, and organic crops (Carter *et al*., 1995). The exportation of these crops has increased to meet higher demand in industrialized countries, reflecting growing concerns of consumers about the effects of food on health and the possible harmful

effects of chemical inputs and foods with high-fat contents. In addition, in the mid-2010s, most Latin American governments implemented policies promoting nontraditional export crops often with the support of the Inter-American Development Bank (IDB) and other international organizations-with the objective of generating foreign trade and creating new sources of employment and income for the rural poor (IDB, 2018).

The impact of nontraditional agriculture has been significant for many Latin American countries in several aspects. In addition to generating foreign trade, the exporters of nontraditional crops gain access to market demand based on the quality and availability of their products at specific times during the year when supply is insufficient, and prices are the highest. The particular characteristics of these crops, such as their perishability and the concentration of production in accordance with specific cycles, made it necessary to implement numerous innovations in production technology, organization, and coordination as well as to implement intensive training for rural workers (Hallam *et al*., 2017).

The diversification of agri-food chains plays a fundamental role in economic growth and development, especially for countries endowed with natural resources (Marsden *et al*., 1996; Whitaker *et al*., 1990). Successful cases often take advantage of the so-called knowledge of natural resources, which is a unique combination of factor endowment and technological capabilities in a given natural environment aimed at establishing successful export industries. The examination of cases of agri-food chains for nontraditional products such as cut flowers (in Colombia and Ecuador) and blueberries (in Chile and Argentina) has shown how the process of "self-discovery" these pioneers have experienced has generated opportunities aimed at improving the standard of living of prominent actors (Iizuka and Gebreeyesus, 2017).

In the case of Ecuador, the export of nontraditional crops increased from less than USD 3.0 million in 2010 to more than USD 4.3 million in 2016, contributing to diversifying the country's exports, which had mostly consisted of petroleum and several "traditional" agricultural products, the most significant of which were bananas, cacao, and coffee. The most significant nontraditional crops are flowers (primarily roses), which yielded USD 700 million in exports (16.5% of nontraditional total exports); broccoli, which yielded USD 60 million in exports (1.3% of nontraditional total exports); and fruits (primarily mangos, passion fruit, lemons, pineapples, Inca berries and melons), which yielded USD 280 million in exports (6.5% of total exports) (OEC, 2017).

In 2016, nearly 100,000 rural workers were permanently employed in nontraditional agricultural and agroindustrial work and were involved in activities such as ground and air transportation and the manufacture and sale of agricultural inputs, equipment, and packing containers. Nontraditional export crops are mainly cultivated in the highland region (flowers and broccoli) and the coastal region (tropical fruits), where they have largely replaced extensive ranching, and, in some cases, crops intended for the domestic market, such as potatoes, rice, and wheat, which require significantly less labor. The producers are generally large- and medium-sized companies; only the cultivation of passionfruit is dominated by small producers (Central Bank of Ecuador, 2018).

The nontraditional fruit and vegetable chains represent an opportunity for the expansion of producers' agri-food chain positions. This case study is focused on the Inca berry food chain, which is located in the Interandean zone of Ecuador and is characterized by the expansion of production units (MAGAP, 2014) along the Ecuadorian Interandean zone and its potential for exporting. Considering this situation, a study of market competition, social intervention, production structure and other crucial determinants is relevant.

Taking into consideration the aspects, the aim of this research was to comprehend the agri-food chain of the Inca berry by acquiring knowledge of the primary and support activities, stage structures and agent interventions. To fulfill this objective, the determinants related to social variables, economic performance, production dimensioning, dynamics, determinants of exports, and policy implications were considered.

Materials and Methods

This case study took place in the central zone of Ecuador, which is formed by the provinces of Chimborazo, Cotopaxi, and Tungurahua, where the temperature is between 17 and 28ºC and the mean altitude is 3650 m a.s.l. The estimated total area is approximately 59,900 km².

To understand the Inca berry agri-food chain, a systemic methodology was applied that involves socio-economic and production aspects, export determinants and policy implications, highlighting the most important mechanisms of the agri-food chain of Inca berry, as explained below:

1- Mapping of the agri-food chain. The value chain scheme developed by (Hawkes and Ruel, 2006) was applied to determine the groups of actors and relevant activities and identify the flows of minor and major importance.

2- Recognition of the actors in the stages of the Inca berry value chain. For this purpose, information from the last census (2015) conducted by the Ministry of Agriculture (MAG) was used. Likewise, for the analysis of companies involved in the value chain, the company registry submitted by the Ministry of Industries and Productivity (MIPRO) was utilized.

3- Description of the sample size. The sample size for the organizations involved in the production stage was estimated using a variable that identifies the number of producers registered by the MAG within the area of interest (the central zone). For this purpose, the formula developed by (Sukhatme, 1957) was utilized. Once the formula was applied, the sample of producers was composed of 41 producers from Cotopaxi, 53 producers from Tungurahua and 45 producers from Chimborazo. The analysis of the postproduction stage utilized a registry published by the MIPRO that includes companies in the area of interest linked to the Inca berry chain.

4- Analysis of the agri-food chain. For this purpose, interviews and surveys validated by Cronbach's alpha were conducted; these surveys included production and socio-economic aspects, export determinants and policy implications, reflecting the dynamics of the Inca berry food chain.

5- Analysis of the dimensions of the agri-food chain. The horizontal and vertical dimensions of the Inca berry agri-food chain were identified for this purpose, and the measuring outline published by (Gereffi and Fernandez-Stark, 2016) was utilized.

Results and discussion

Mapping of the Inca berry agri-food chain

The results of the mapping process show the participating actors in detail, as well as the different activities that they carry out within the chain in the same way; the level of importance of the flows of resources and information is highlighted (Figure 1).

Figure 1 shows the Inca berry agri-food chain, where the starting point consists of support activities that are performed by agents such as companies from the private and

public sector; these agents are mainly responsible for supplying inputs for intensive or extensive production. In addition, cooperative savings institutions and state banking entities are responsible for financing the diversity of productive activities in the next stage (production and postproduction).

The next stage analyzed was the production stage; this phase includes individual agricultural producers and private agricultural associations. These actors start the process with high-value flows (of Inca berry raw material) that are managed by intermediaries, district commercialization centers and markets, private processors and startups. Likewise, the actors responsible for transforming the raw material into goods with high added value and actors in charge of marketing these consumer goods manage highly important channel flows.

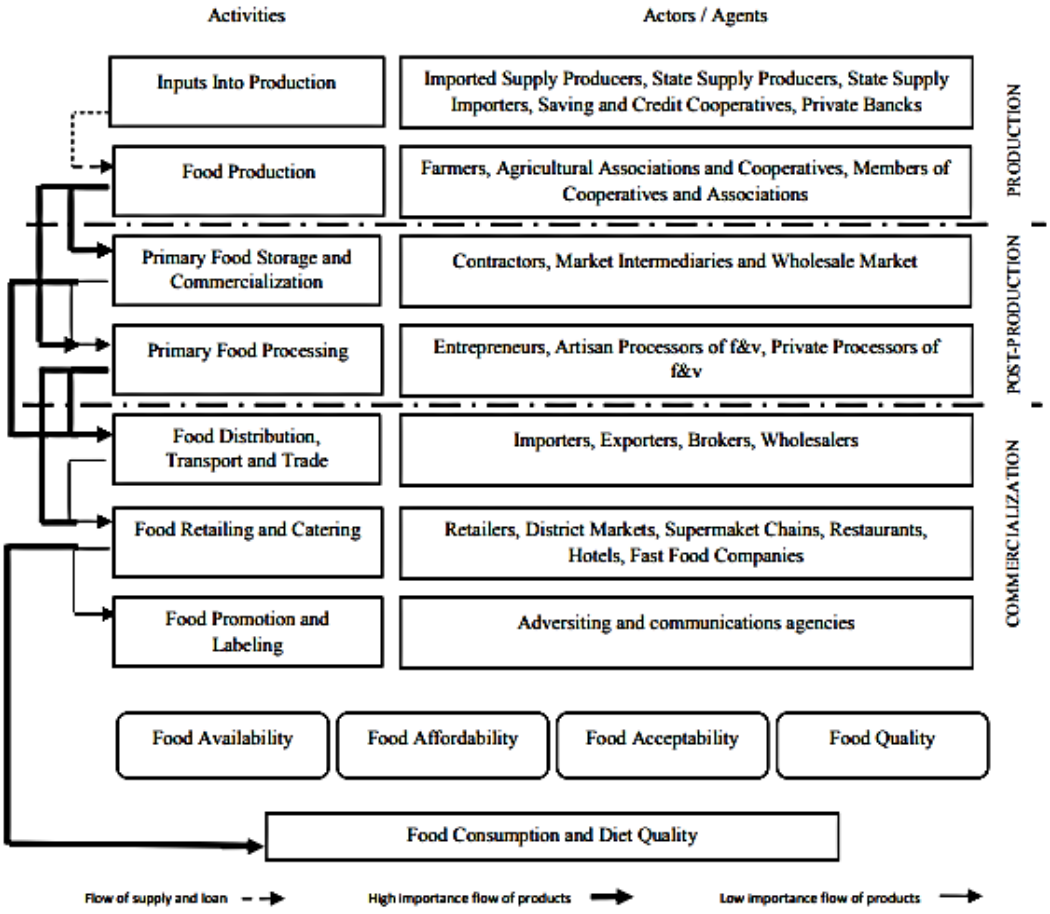

Figure 1 - Agents and flows identified in the Inca berry agri-food chain.

Finally, the less important flows are reflected in the scarce participation of Inca berry goods in international markets, highlighting a notable weakness of this value chain and the need for the prompt intervention of the public and private sectors to reverse the situation and improve the contribution of the Inca berry to the national GDP.

Recognition of the actors of the stages of the Inca berry agri-food chain

The weather conditions, territorial characteristics and population dynamics of the Interandean zone in Ecuador qualify it as the agricultural collection center of the country, but this zone also constitutes an important commercial and business node in Ecuador. Information generated by the MAG (Table 1) indicates that Inca berry production in the central zone is carried out by 0.95% of the producers of vegetables and fruits. The province with the largest Inca berry production area, in the central zone, is Tungurahua.

According to (INEC and SENPLADES, 2015), the cultivation of nontraditional fruits, such as blackberries, Inca berries, strawberries, babacos and tree tomatoes, constitutes an alternative production with considerable growth potential; the presence of these fruits is important for peasant family farming because the cultivation of these fruits complements activities such as pollination and bee breeding and improves the diet of the producing families.

Table 1 - Number of Inca berry producers and area of Inca berry production by province.

QUANTITY	PROVINCE		
	COTOPAXI	TUNGURAHUA	CHIMBORAZO
Agricultural producers	183,530	170,220	248,130
Fruit and vegetable producers	44,010	36,660	69,152
Inca berry producers identified by the MAG	129	189	153
Acreage by hectares of Inca berry production identified by the MAG	259.69	329.09	274.52

Source: MAG, 2016

Table 2 - Type of firms, number of firms by category, number of fruit processing firms and number of Inca berry processing firms in the central zone.

		PROVINCE		
		COTOPAXI	TUNGURAHUA	CHIMBORAZO
TYPE OF FIRM	Microenterprises	1397	3194	1658
	Small businesses	84	357	99
	Medium-sized enterprises	16	61	16
	Large firms	5	18	5
TOTAL NUMBER OF FRUIT AND VEGETABLE PROCESSING FIRMS		54	176	82
TOTAL NUMBER OF INCA BERRY PROCESSING FIRMS		15	27	10

Source: SENPLADES, 2017

Information generated by the SENPLADES (Table 2) indicates that 7112 firms are involved in the manufacturing industry in the zone mentioned; 52.53 % are in the Tungurahua province, 25.73% are in Chimborazo, and 21.73 are in Cotopaxi. Likewise,

4.51% of the firms process fruits and vegetables, and 0.75% transform Inca berry into goods with added value.

Agrarian structure of the Inca berry agri-food chain

There is a permanent division between business agriculture and peasant family farming, and there are significant differences between the two. Business agriculture uses 80% of the land for 15% of the agricultural production units, uses 63% of the water for irrigation and is characterized by the extensive use of agrochemicals and energy for agro-exports. Peasant family farms represent 84.5% of the agricultural production units with a concentration of 20% of the land; they use 37% of the water for irrigation and are mainly dedicated to production for the satisfaction of basic needs.

More than 64% of the production of Inca berries is carried out by small producers, and there has been a considerable increase in the shipments made by peasant exporters. Inca berries are considered to be short-cycle crops, which do not represent even 50% of the demand for water for irrigation. Additionally, this crop group employs 38% of the economically active population (EAP) and, in 2016, it represented 24.3% of the total GDP (OECD/FAO, 2017).

Policy Implications. In the legal framework of the National Constitution of 2008, the National Plan of Good Living 2013-2017, and the Law of Food Sovereignty (LORSA), small producers are considered to be priority subjects of public policy and privileges are granted to peasant farming over agriculture exports. This framework includes redistributive public policies that allow farmers to access productive assets as well as give farmers the right to access water and food (Houck, 1991). The LORSA, in turn, defines 8 fundamental laws for rural development that must be considered: the Land Law, Law of Agro-Biodiversity and Seeds, Law of Communes, Law of Territories, Law of Agrarian Development, Law of Agribusiness and Rural Employment, Law of Animal and Plant Health, and Law of Access of the Peasants and Indigenous to the Public Credit.

Pre-production

The first important contribution is provided by the national government, which has prioritized the strengthening of peasant family farming through the development of economies of rural solidarity, redistribution and access to productive assets, technological innovation and the expansion of production capabilities. In this sense, the governmental entities responsible for supplying inputs and training programs participate to a significant degree. On the other hand, governmental academic institutions whose contribution focuses on improving production performance, plant improvement, and processing technology participate as well as private suppliers of packaging materials, machinery, additives, technology and consultancy for technical and market aspects.

Production

Socio-economic Factors. The producers in this phase are between 29 and 52 years old; most are men (58%), and their education level is secondary (39%) and higher (27%). Of these producers, 37% are cooperative partners and 30% are members of associations. Fifty-eight percentage of the producers mentioned that the main source of financing is based on their own economic resources, and 38% of them mentioned that is based on debt.

The interviews showed that educated farmers seek the ability to make reliable purchases, are serious about payment fulfillment, and seek to sell their products at good prices. The education and academic preparation of these farmers allows them to effectively negotiate with buyers and to be receptive to new technologies in production to offer larger volumes and better quality products.

Production Factors. For producers, the main reason to cultivate Inca berries is the constant and growing national and international demand. Currently, it is possible to observe fruits in local markets that until a few decades ago were unknown and rarely marketed. The international market is of great interest to those who are involved in the production of Inca berries due to their high acceptability, mainly by European consumers. Another factor that has encouraged the cultivation of Inca berries is the extreme fragmentation of the market of traditional products, which have generated losses for their producers. Regarding the aspect of land ownership, 42% of the producers own land, and 31% of them work in partnerships. Of the survey respondents, 55% own more than 3 ha, and the cultivation area for Inca berries is between 0.1 and 1.5 ha, on average. In addition, 56% cultivate the berries in open fields.

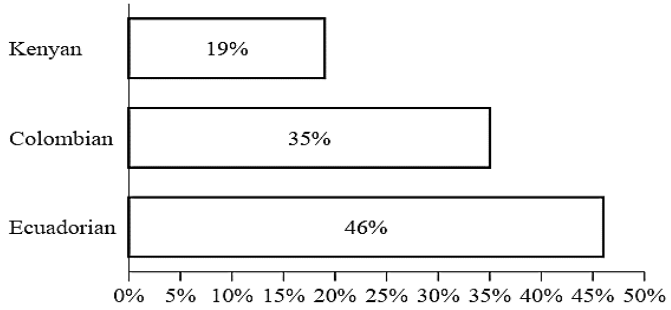

Figure 2 - Inca berry genotypes grown in Ecuador.

Figure 2 shows that the Colombian and Kenyan genotypes are not highly used in Inca berry crops in Ecuador, because they frequently have phytopathological problems (Dunn, Harper and Lynn, 2015); the Ecuadorian genotype is the most used in the Inca berry productive chain. According to Brito, who was quoted by Altamirano M. (2010), in Ecuador, there are approximately 20 varieties of Inca berries. The color is the main factor of differentiation, but size is also an aspect used to distinguish these varieties. Likewise, it is mentioned that there is a yellow variety that can adapt to climatic and agronomic conditions.

In Ecuador, there is a lack of knowledge about the different varieties of Inca berries. The genus *Physalis* includes approximately 100 herbaceous and perennial species whose fruits are formed inside a chalice. The National Institute of Agricultural Research (INIAP, 2016) reports that no genetic improvement of any Inca berry ecotype has been reported in the last 5 years. According to Fischer *et al*., 2014, Rodriguez and Bueno stated that the global leader of Inca berry production is Colombia, which mostly cultivates its own variety (2n = 32) (Fischer *et al*., 2014).

Based on information in Figure 3 and comparing the yields reported by Altamirano (2010) and Fischer *et al*., 2014, who mentioned that the Inca berry yields in Ecuador are approximately 12.9 ton/ha and that the Colombian mean yield is approximately 14.5 ton/ha, it is concluded that the yields are similar. Notably, 35% of Inca berry farmers utilize post-harvest mechanisms to reduce losses during the transport of raw material (Rubiano Pinto, 2013).

Altamirano (2010) mentioned that the Inca berry yield varies depending on the cultivation and management system used. In the open field, yields range between 6 and 15 ton/ha, while for systems using a greenhouse, the yields are between 15 and 25 ton/ha (Tobasura and Ospina, 2010).

Throughput Factors. The analysis was based on gross profit and showed that farmers obtain USD 11,500.00/year (±150 USD/year). Likewise, farmers obtain net income of USD 6,600.00/ha/year (±50 USD/year). Notably, (Orjuela Castro, Castañeda Calderón and Calderon, 2016) reported that the gross profit obtained by Colombian Inca berry farmers

was between 10% and 12% during 2014, while the MAG (2016) reported 18% for Ecuadorian Inca berry farmers.

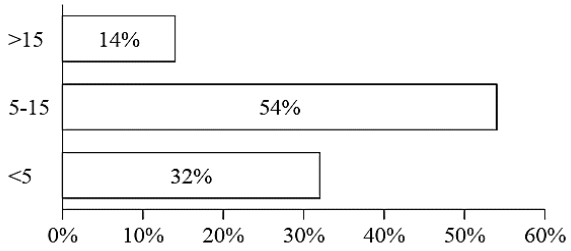

Figure 3 - Productive yield (tn/ha) of the Inca berry agri-food chain.

According to Altamirano (2010), the cultivation of Inca berries is profitable, and the establishment of internal and external marketers of fresh and processed fruits has generated greater dynamism and quantities in the supply and demand of the product. Currently, the cost of producing one ha of Inca berries is approximately USD 6000.00. A yield of 13000 kg/ha/year and a price of USD 1.00/kg would generate a gross income of USD 13,000.00/year; subtracting the production cost would result in a gross profit of USD 7000.00/year, which results in a contribution margin of USD 0.46/kg (Altamirano, 2010).

Postproduction: processing firms

The Ecuadorian MIPRO registered 56 companies participating in the Inca berry agri-food chain in the central zone. Of these companies, 53.73% operate in Tungurahua, 24.64% operate in Cotopaxi and 21.63% operate in Chimborazo-Pastaza. Likewise, 40.1% are firms focused on processing and practices that add value, while 60.9% combine the processing activity with the exploration of new international markets. Another relevant fact is that 81.1% of the firms process Inca berries in canned, dried and ready-to-eat products, while the remaining percentage of companies predominantly process other fruits and vegetables. Finally, it was found that 69.2% of the firms operate in the domestic market and that only 10.4% are pure exporters of Inca berries, for which the main markets are the United States and the European Union.

Economic Factors. Of the total number of companies analyzed, 98.43% are small and medium-sized enterprises (SMEs), and 1.57% are large firms. With regard to the association factor, 58% of the firms are members of associations. In addition, 49% finance their operation with their own resources and debt, and 25% use the stock exchange as an alternative to seek financing.

Logistic Factors. It was detected that 39% of the firms have their own transport to move the finished product, while 48% outsource the transport service through acclimated van cooperatives. Likewise, 89% of the firms do not possess Inca berry production units. In addition, 48% of the firms' suppliers are middlemen, and 52% are full-time farmers.
Finally, only 42% of the companies use contracts to guarantee the purchase of raw materials from producers, and 65% request credit time during the acquisition of raw materials.

One of the specific visions of the industry regarding the Inca berry is to promote the development of this crop to improve the income and living conditions of farmers in the depressed areas of Ecuador. This sector states that currently, fresh and processed fruit is exported to the Netherlands, Germany, Canada, the United States and Europe. The survey respondents also claim that the commercialization format used for Inca berries should be changed to compare them to a line of mini-tomatoes. Similarly, the respondents state that through PRO ECUADOR (the Institute for Export and Investment Promotion), they have

engaged in conversations with the representatives of gastronomic schools with the purpose of making known the culinary and nutritional benefits of Inca berries.

According to data obtained from Corpei, one of the main countries to which the product is exported is Germany (35%), followed by the Netherlands, which receives 17% of Ecuadorian exports. The product is also exported to Russia, the United Kingdom, and Spain (Brito Madrid, 2015).

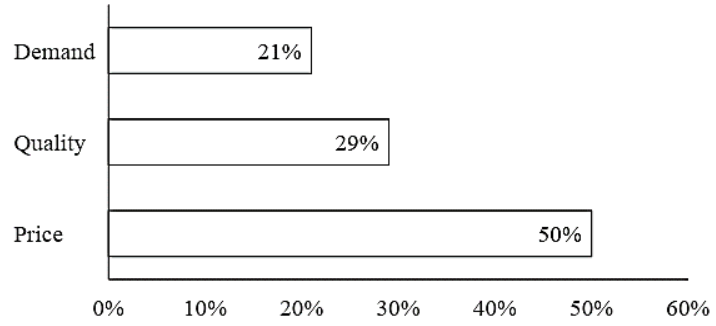

Figure 4 - Decisive factors of Inca berry purchasing decisions made by processors.

Figure 4 indicates that for Inca berry processing firms, the price of the transactions in the market for supplies is the decisive factor during the acquisition of Inca berries, and the survey respondents also indicate that the physical aspects of Inca berries that are most appreciated are the yellow hue, hardness and consistency, as well as physical damage to the skin and size. Low quality will cause 49% of the Inca berry processing firms not to purchase. It was also found that 40% of the companies sell fresh and canned Inca berries, with 64% of the products sold in the national market and 36% sold overseas.

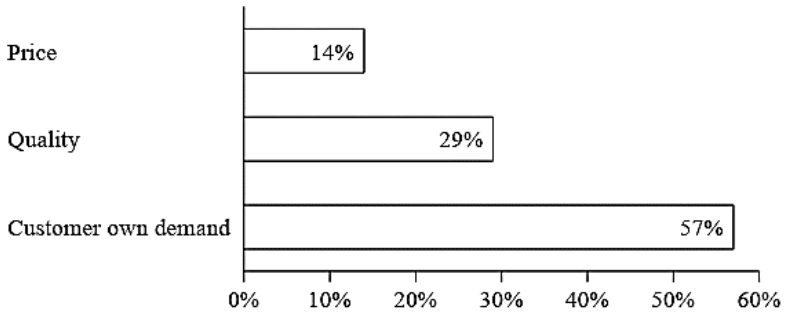

Figure 5 - Decisive factors of Inca berry purchasing decisions made by customers.

According to Figure 5, 57% of the processing firms indicate that the customer's request is a determinant in the merchandising of Inca berry goods. The survey respondents also mention that there is a significant trend of customers searching for Inca berry products with a high added value and those that are innovative, such as juices, jams, desserts, snacks, and functional products (Figure 6).

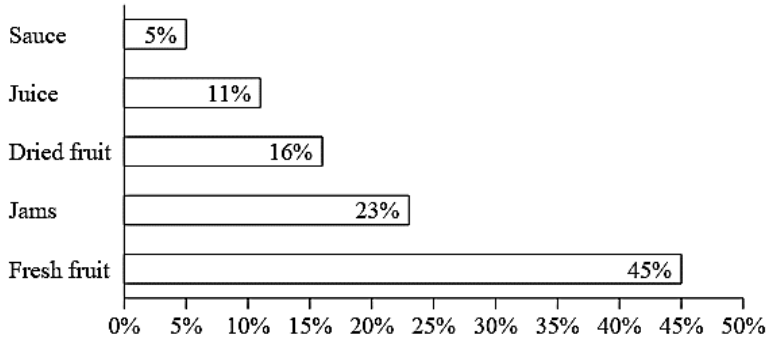

Figure 6 - Consumer preferences for Inca berry-based products

Notably, Inca berries have moved from the neighborhood markets to the shelves of large supermarket chains in the last 7 years in Ecuador. The presence of the Inca berry is increasingly noticeable due to the demand generated by consumers at the national and international levels.

Postproduction: distributors

The distributors registered by the MIPRO have been classified as either medium (capital that ranges between 5 and 10 million dollars) or large companies (capital that ranges between 70 and 100 million dollars). Likewise, these distributors have mainly been set up as corporations to expand their points of sale throughout the country using their chains of minimarkets, supermarkets, and hypermarkets.

Notably, each distributor has developed a strategy of participation that is very different from its competitors (Thrupp, 1995). Likewise, the market segments are differentiated according to the philosophy that the distributors apply in their expansion mechanisms. A relevant aspect that must be changed is that these corporations have established market barriers preventing the entry of foreign retail chains.

The aforementioned distributors have some characteristics in common: they include Inca berry goods in their product offerings, they do not directly produce or alter Inca berries, they work directly with processing firms or producer associations and they always request credit during negotiations that are controlled by the government authority.

Economic Factors. With respect to those who market products made from Inca berries, the collected information indicates that 65% of the companies are SMEs, while 35% are large companies. On the other hand, 53% of the marketers specialize in the distribution of goods and services. In terms of financing, 65% of the distributors rely on their own sources and loans, while 35% use the stock exchange to involve investment partners. In the analysis of the people employed in this sector by gender, 58% are women, and the remaining 42% are men.

Operative Factors. This group of actors engages in economic activities related to the sale of food, beverages and tobacco (50.5%); other retail trade activities (23.3%), clothing, footwear and leather goods (10.9%); pharmaceutical and medicinal products, cosmetics and toiletries (4.7%); books, newspapers and stationery (3.2%); and household electrical appliances, furniture and lighting equipment (3.0%).

Regarding the transfer of goods, it was identified that 80% of the distributors own a fleet of trucks, while 35% outsource the transport service through truck cooperatives. On the other hand, the distributors do not participate in the chain by producing or altering Inca berries, and the acquisition of Inca berries is managed by producers and processors.

In relation to the decisive factor in the pricing of Inca berries, the distributors ensure that the price of products made from Inca berries depends on the strategy they have established to expand their product portfolio of new trends (ready-to-eat foods, foods low

in calories, and practical foods). Similarly, the price set for the final consumer depends on the profit margins established.

According to (MAGAP, 2014), the domestic market prefers Inca berries without their chalice. The aroma, roundness, color, and general appearance are the most attractive characteristics for Ecuadorian consumers, and the price in the domestic market ranges between US D1.5 and 3.00 per kilogram of fruit.

Figure 7 shows the Herfindahl-Hirschman Index (HHI) of the retail sector in Ecuador from 2008 to 2016 based on information gathered from the Ecuadoran Superintendent of Market Power Control.

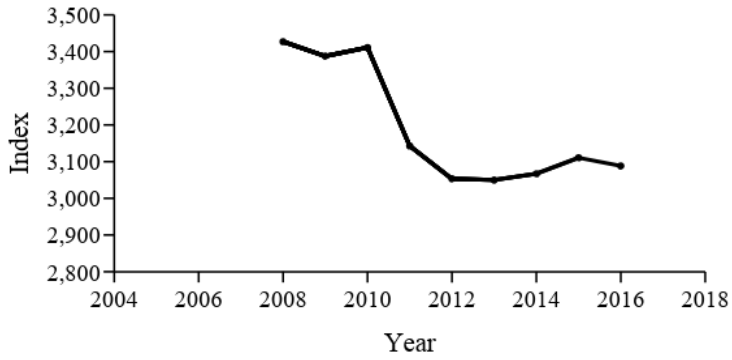

Figure 7 - HHI of the retail sector in Ecuador

It is known that an HHI of less than 1,500 indicates a low level of market concentration; if the HHI is between 1,500 and 2,500, the market is fairly concentrated, and if the HHI is greater than 2,500, it is considered a highly concentrated market (Blandon, Henson and Cranfield, 2008). Figure 7 shows that the HHI of the Ecuadorian retail market has values higher than 2,500 in all the years analyzed. Consequently, based on the above explanation, due to its structure, the supermarket sector in Ecuador is highly concentrated (Rivadeneira, 2016).

Foreign trade and policies

According to interviews with representatives of the Ministry of Foreign Affairs, currently, the economy of Ecuador is under the dollarization scheme and sustained economic growth is pursued. In this context, important actions have been taken to open new markets. It is also important to mention that the COMEX, a forum created for the coordination of foreign trade and investment policies in Ecuador, has a mission to maintain a constant link between the public and private sectors to jointly establish guidelines for the short, medium and long term that boost the country's trade relations with foreign markets. COMEX was created within the framework of the law on foreign trade and investments that was enacted in 2011 and promotes policies to increase foreign trade in Ecuador through the establishment of an institutional framework and a coordination scheme at the country level, which allows for the adequate use of human, technical and economic resources in the task of selling the image of Ecuador abroad. Likewise, this organization supports the efficient development of activities to promote and diversify exports and attract foreign direct investment to the country's productive sectors (Egan *et al*., 1992; Stanley, 1994).

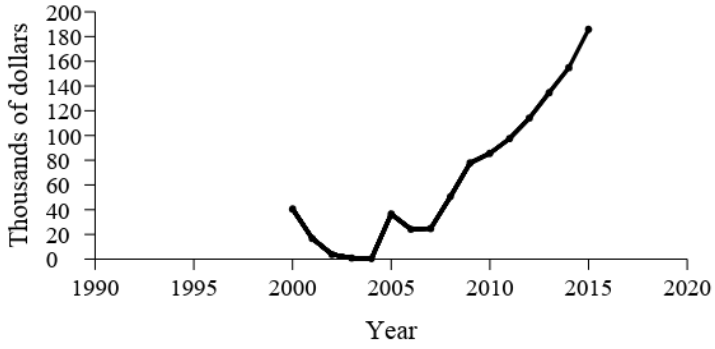

Figure 8 - Exports of Ecuadorian Inca berries from 2000 to 2015.

According to data collected by the Central Bank of Ecuador, Inca berry exports from the year 2000 to the present show a variable trend with fluctuations in volume. The average annual growth rate for Ecuadorian Inca berry exports is 13%. In recent years, the price per kilogram of fresh fruit has significantly increased, reaching values that exceed USD 4.00/kg. Figure 8 shows the trend for Ecuadorian Inca berry exports in free on board (FOB) values up to 2015.

Challenges for exporters

The fruit destined for export must go through a rigorous review of size and relevant sensory aspects, such as color and overall appearance; normally, more than 40% of fresh fruit is discarded. In 2010, the export of fresh Ecuadorian Inca berries to the United States was permitted by the APHIS/USDA (Mosquera *et al*., 2017). This fruit is not subject to any tariffs thanks to the protection of the Andean Trade Preference Act. On the other hand, the European Union requires the presentation of a Good Agricultural Practices (GAP) certificate for Ecuadorian Inca berries. The main competitors for Ecuadorian fresh Inca berries are Colombia, Zimbabwe, Kenya, and Peru. Colombia is the world leader in Inca berry exports, which are valued at USD 15 million/year (Altamirano, 2010).

Dimensioning of the agri-food chain

Research on the dimensions of agri-food chains has generated significant interest because it has unveiled both indirect and unobserved linkages among economies. A relatively new stream of research examines the contribution of the dimensions of food chains to total production and the length of the related production processes. This approach delves deeper into the anatomy of value chains and is expected to address a wider scope of scholarly and policy-relevant questions. The graphical component of the dimensioning shown in Figure 9 and Figure 10 concerning the Inca berry agri-food chain points to the following structure:

Horizontal Dimensions. The horizontal dimensions show the actors that fulfill the same objective within each horizontal level of the agri-food chain. Figure 9 shows that the horizontal dimensioning of the Inca berry agri-food chain includes 6 well-defined levels. The initial level (Level 1) is responsible for the provision of supplies that are indispensable for the functioning of the whole food chain; these are mainly seeds, seedlings, agricultural inputs, machinery, packaging and transport materials, fuel, training (technology transfer), consulting, and loans, among others.

The next level is production (Level 2), which receives more than 60% of the inputs of Level 1 and is responsible for the generation of the raw material, Inca berries. The socio-economic success of this agri-food chain depends on its actors because its associative

structures have weaknesses requiring a public-private intervention to be able to provide a market orientation with the vision to take advantage of market opportunities at the national and international levels (Lasprilla, 2011).

Level 3 serves as an intermediary between the production and processing stages, and organizations in this level are responsible for the primary storage of the product from the production stage. The objective of these organizations is to transfer the raw material to the transformation level. According to data obtained from the Central Bank of Ecuador (2016), 36% of production is channeled through this stage. Level 4 includes organizations that are responsible for transforming the raw material into value-added goods, among which the main products are canned fruits, dried fruits, concentrates, jellies, juices, nectar, desserts, candies, and ice cream. In the last decade, the biotechnological and nutraceutical industry of Ecuador has been transforming Inca berry into ingredients for drugs, nutraceuticals and food supplements (Hinojosa Rojas and Ipiales Pupiales, 2015; Scott, 2013).

The actors in Level 5 are responsible for the wholesale distribution of fresh Inca berries and/or transformed products to local or international markets; these actors state that the Inca berry is not their main distribution product, but they are aware of the potential for the medium and long term. Likewise, PRO ECUADOR is a key actor in the distribution stage because it is the public entity responsible for advising and monitoring everything related to exports, imports and foreign trade. Finally, the actors involved in Level 6 are responsible for retail distribution, food services, and hotels. They have direct connections with consumers and have access to updated information on trends as well as the needs and requirements of consumers (Central Bank of Ecuador, 2016).

Vertical Dimensions. The vertical dimensions show the degree of fragmentation and the distribution of bargaining power at each vertical level of the agri-food chain. The vertical dimensioning classifies in wide levels groups that are formed of hundreds or thousands of participants, where the bargaining power of each actor and the degree of differentiation in the product are minimal. This dimensioning also includes narrow levels, which are formed by a few actors or agents whose bargaining power and degree of differentiation are high. In Figure 10, which shows the Inca berry agri-food chain, Level 1 consists of suppliers of inputs for the production of raw material, and the structure of this level is wide due to the small number of participants, such as private companies, public companies, public advisory institutions, credit cooperatives and banks (private or public).

Level 2 is composed of farmers, producers, associations and agricultural cooperatives, and its main characteristic is a high level of fragmentation (wide structure). The level of product differentiation is minimal, and the bargaining power of its actors is also reduced. The agents in this level balance their economic performance by complementing their agricultural activities with the exploitation of small animal species. According to Espinoza and Monteros (2016), the corporate agri-food regime puts peasant agricultural production units at a disadvantage compared to other actors due to the low levels of competitiveness generated by the prices of imported raw materials. Similarly, peasant units also do not usually benefit from new opportunities for export products with high value due to a lack of capital, production technology, and economies of scale (Espinoza and Monteros, 2016).

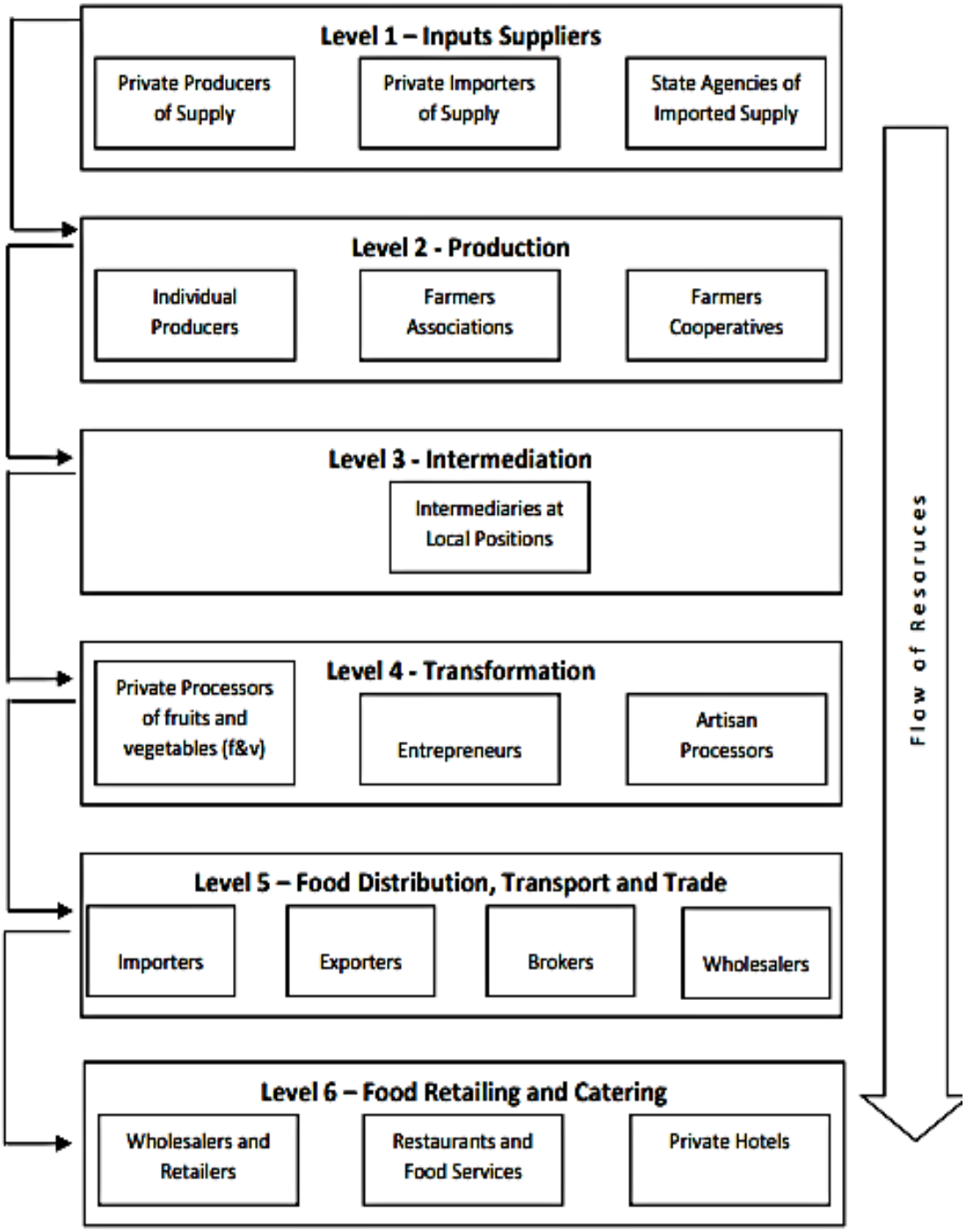

Figure 9 - Horizontal dimensions of the Inca berry agri-food chain

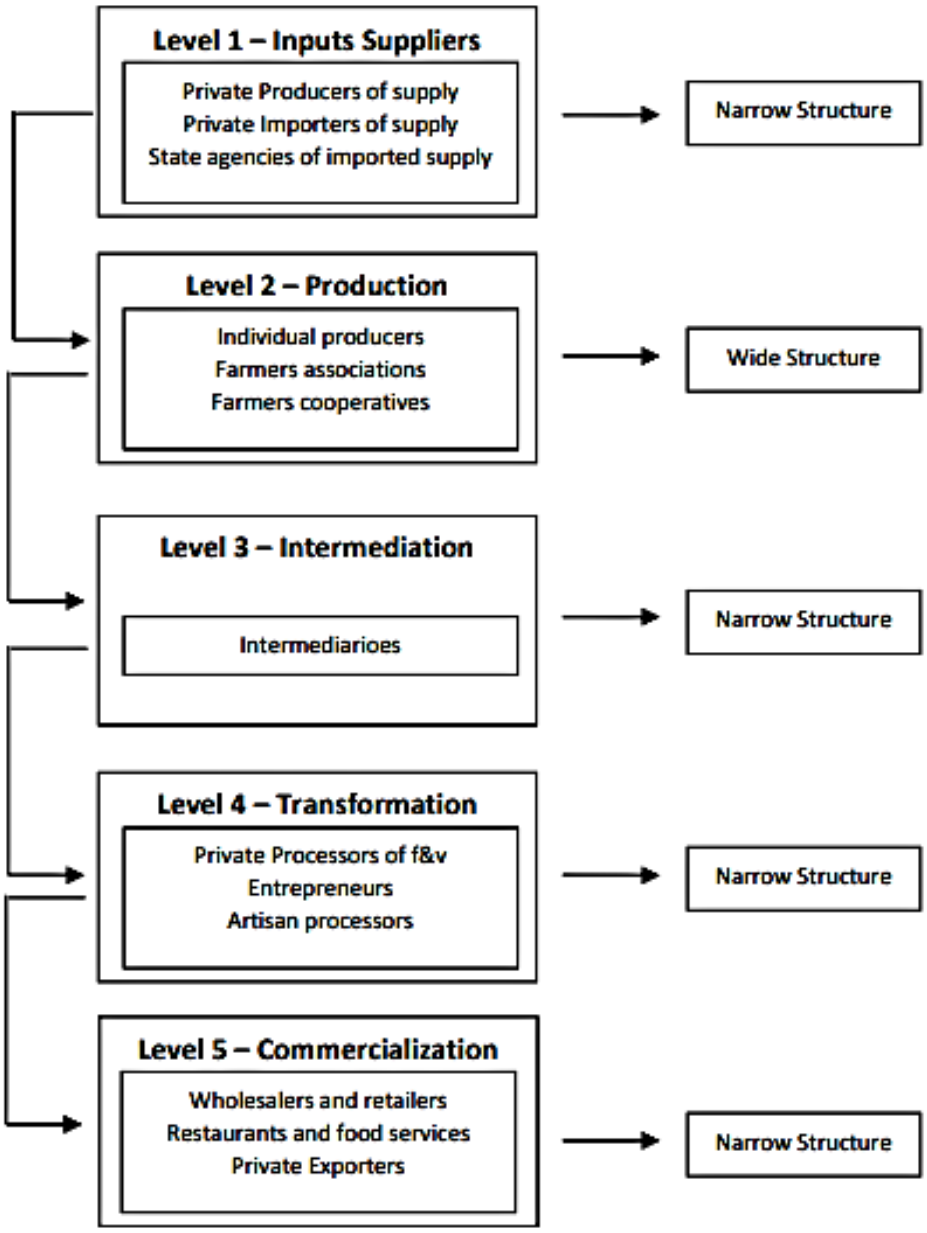

Figure 10 - Vertical dimensions of the Inca berry agri-food chain.

In Level 3, organizations act as intermediaries of the raw material generated in the production stage. This level is not very fragmented. The bargaining power of the organizations operating in this level is greater than that of the producers. These organizations have a short-term advantage because they are able to channel large volumes of raw material to downstream levels in a short period of time, while the greatest long-term disadvantage is the vertical coordination that has been created between producers and processors (Jaffee, 1993).

Level 4 brings together private processors, artisans, and entrepreneurs. This level is characterized by a narrow structure with few Inca berry processors. The bargaining power of these organizations is relatively higher than that of upstream levels, and their greatest advantage is the degree of differentiation in the value-added products. It is important to

emphasize that the nutritional value assigned to Inca berries by the food industry is complemented with nutraceutical and pharmacological applications generated by the biotechnology industry of Ecuador.

Finally, Level 5 groups together wholesalers, retailers, restaurants, food services and exporters and is characterized by a narrow structure (few actors). This level stands out due to the high bargaining power of its actors compared to that of the rest of the actors in the upstream stages. Its main advantage is that these organizations have direct connections with consumers, through which they have the ability to identify trends as well as consumer preferences and needs.

Conclusions

Nontraditional fruits, such as blackberries, Inca berries, strawberries, babaco and tree tomatoes, constitute a production alternative that has potential for Ecuador because they can improve the welfare of the producing families. In relation to the agrarian structure of the Inca berry agri-food chain, more than 64% of the production of Inca berries is carried out by small producers. Likewise, the Inca berries are short-cycle crops, which do not use even 50% of the demand of water for irrigation and employ 38% of the EAP. In the legal framework, the National Constitution of 2008, the National Plan of Good Living 2013-2017, and LORSA consider the small producers of Inca berry to be priority subjects of public policy. This framework includes redistributive public policies that provide farmers access to productive assets as well as the right to access water and food.

In the pre-production stage, the main actor is the national government, which has established as a priority the strengthening of peasant family farming so that state companies significantly intervene by providing inputs and technical training through extension programs. Likewise, governmental academic entities intervene to ensure efficiency at the production level through agronomic and plant breeding schemes and alternative processing schemes.

The production stage includes producers that are between 29 and 52 years old, and few of them are members of associations or cooperatives. This study showed that educated farmers seek the ability to make reliable purchases, are serious about payment fulfillment, seek to sell their products at good prices and engage in successful negotiations to deliver considerable volumes of Inca berries. Likewise, most of these organizations own more than 3 ha of land, and they apply cultivation techniques to capture national and international market opportunities to avoid the fragmentation of the traditional product market. The establishment of internal and external marketers of fresh and processed Inca berries has generated a greater dynamism by doing it profitably. Currently, the cost of producing one ha of Inca berries is approximately USD 6000.00, and its contribution margin is approximately USD 0.46/kg.

The postproduction stage has been divided into two parts. Forty-two companies were identified as processors, and most are in Tungurahua, most likely because Tungurahua is quite commercial. In addition, 60.9% of these organizations are processors and/or exporters. On the other hand, it was found that more than 40% of these organizations are small companies, and only 0.41% are large firms. Likewise, more than 50% are members of associations due to the creation of ANFAB, which is the largest association of food processors in Ecuador. Another important aspect is that the survey respondents indicate that the Netherlands, Germany, Canada, and the United States are the main exporting markets. From the marketing point of view, a clear strategy of commercializing Inca berries abroad to expand international markets could be a change in format by comparing them to mini-tomatoes.

The distributors have been classified as medium and large companies, which are mainly set up as corporations. These organizations have different philosophies and use different participation strategies to become leaders in their market segments, allowing them to establish market barriers in Ecuador. Notably, the people employed in this sector are mostly women. With respect to price determinants, these companies note that the prices they pay to suppliers depends exclusively on their own expansion strategies, while the price charged to the final consumer depends on the margins established by the board of directors. The survey respondents also state that the price in the domestic market for fresh Inca berries ranges between USD 1.5 and 3.00 per kilogram of fruit. The HHI of the Ecuadorian retail market has been higher than 2,500 in the last 8 years; therefore, the supermarket sector in Ecuador is highly concentrated. Regarding foreign trade, Inca berry exports from the year 2000 to the present show a growing trend with fluctuations and a growth rate of 13%. Similarly, the price per kilogram of fresh fruit has significantly increased and exceeds USD 4.00/kg. Finally, the main competitors for Ecuadorian fresh Inca berries are Colombia, Zimbabwe, Kenya and Peru; therefore, Ecuador has created COMEX, a forum for the coordination of foreign trade and investment policies to promote policies that encourage foreign trade in Ecuador through the establishment of an institutional framework that will allow for the adequate use of human, technical and economic resources to sell the image of Ecuador abroad.

Finally, the information obtained from identifying the vertical and horizontal dimensions indicates that the Inca berry agri-food chain needs to coordinate the commercialization channels to open new market opportunities and to encourage farmers to expand Inca berry production units and processing firms to increase their variety of Inca berry goods. Likewise, the governmental authorities should intervene by controlling the amount of product on shelves and oligopolies at the distribution level, developing production training programs and motivating associations and cooperatives to better develop their market orientation.

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