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AN ASSESSMENT OF EMERGING NETWORKS IN THE FRUIT SECTOR: THE CASE OF INCA BERRY IN ECUADOR

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ABSTRACT

The diversification of agri-food products through emerging chains has a fundamental social and economic role in Ecuador. A substantial amount of research focused only on examining critical factors in terms of agronomic and environmental performance. However, there is a shift in the agri-food chain perspective and study towards more sustainable models of production, logistics trade, and consumption. Aspects such as the socio-economic sustainability, level of collaboration between actors, an adequate chain configuration, and the employment of smart governance mechanisms show the weaknesses where stakeholders can propose enhancements. In this respect, socio-economic and productive factors are consequential and still affecting the progress of these chains. Also, the current growth of market opportunities at the local and international level is a driver to support them by setting sustainable strategies. This study aimed to analyze socio-economic and production aspects to understand the dynamic across the emerging Inca berry (Physalis peruviana) chain located in Ecuador and bring forward potential strategies. Thus, chain vertical and horizontal dimensioning was introduced to contribute with relevant insights. The framework applied accounts with a revision of primary and support activities, and flows of high and low relevance. The investigation clustered pre-production, production, and post-production tiers. Also, it executed the food chain mapping, the identification of chain actors, and application of surveys at the supply chain levels to identify strengths and weaknesses based on specific socio-economic and productive variables. Results stated several viable long-term strategies. Examples of those strategies are the diversification of marketing channels, the intervention of academic institutions to improve efficiency, productivity, and the associations' empowerment. All of them aimed at circular economic models. The main research contribution is the application of the chain configuration to assess the chain performance comprehensively. Based on the results, our recommendation is incorporating new indicators to analyze the environmental and institutional components profoundly.

Key words: Inca berry, dimensioning, performance, associative structures, rural extension

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INTRODUCTION

In the last decade, the growth of exports of crops has been significant in Latin American countries [1]. These exports are mainly fresh products such as flowers, fruits, vegetables, and cereals. The Governments of those countries claim that trade activity has increased because of the growing food demand of developed countries [2,3]. This aspect evidences relevant changes in consumer diets and, therefore, commercial opportunities for Latin America agri-food players [4,5], where institutions such as the Inter-American Development Bank – IDB, play a "pivotal role"[1] in strengthening foreign trade to Latin America [6]. However, medium and long-term adjustments executed by the countries will determine the economic positioning of this sector over time [7,8].

Previous research has pointed out some socio-economic issues of the Latin America fruit and vegetable sector [9]. The consequences of agro-exports growth, the high incidence of informal recruitment of workers [10,11], are examples of such issues [12]. Moreover, as in the case of Ecuador, the persistence of minimal profit margins for farmers [13,14], and the vulnerability of peasant families [15,16,17,18] are concerns evidenced. Researchers claim that food chains who fail to adopt long-term strategies tend to suffer a severe downturn that will impact negatively on social well-being [19,20].

The progress of Ecuadorian agri-food chains can also suffer from market failures and low level of collaboration [21,22]. Such issues are mainly related to the power imposed by large companies in the supply chains [23], the coordination level between actors, and the way of how are distributed the costs and benefits between the supply chain stages [22]. Therefore, the scientific community should consider the aspects mentioned when assessing the performance of fruit and vegetable supply chains [24].

The Inca berry network is an emerging chain located in the Highland region, which is characterized by the expansion of its production units in the last years [25]. This chain employs around 2000 of rural workers who participate in activities such as soil-conditioning, transportation, and transformation of raw material [26]. Also, 98 percent of firms involved are SMEs[2] [27], which look for an opportunity for a superior market positioning. This paper presents an attempt at the integrated evaluation of Inca berry chain into its primary and support activities. Besides, it performed a horizontal and vertical configuration[3] to interpret the implications of potential actors' collaboration.

MATERIALS AND METHODS

The data collection took place in the inter-Andean zone, which is composed of Cotopaxi, Tungurahua, and Chimborazo provinces. Inca berry chain has had attention from different sectors, because of its farming structure, inequality in irrigation water, loss of moors, and instability of market prices. The methodology involved socio-economic,

[1] A pivotal role is to play a central role, and everything related to the topic turns or depends on it.

[2] Small and medium-sized enterprises

[3] The determination of chain levels through the horizontal and vertical dimension.

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production, exporting, and agricultural policies. Also, it highlighted the structures at the horizontal and vertical level, as explained below:

1. Food chain mapping. The scheme employed is the one developed by [28], which determined the groups of actors and relevant activities. Also, this step identified the *flows of less and greater importance*[4] running through the chain.
2. Identification of value chain actors. This phase employed the information from the last census (2015) conducted by the Ministry of Agriculture (MAG). Also, it analyzed the post-production actors by examining the record of SMEs and large companies submitted by the Ministry of Industries and Productivity (MIPRO).
3. Sample size description. The experiment used the continuous variable "number of producers registered by MAG" to estimate the sample size of producers. Also, it applied the Sukhatme formula [29] at the 95% confidence level. The sample of producers looked at 41, 53, and 45 producers from Cotopaxi, Tungurahua, and Chimborazo, respectively.
4. Descriptive analysis. Beforehand, the experimental phase executed a workshop with stakeholders to select performance variables from a predetermined list. The list considered productive and socio-economic factors. Also, it accounted for export and agricultural policy implications. Then, it constructed interviews and surveys validated by Cronbach's alpha index to collect data from the selected locations. The analysis of data used descriptive statistical tools to present the findings.
5. Scanning of the configuration. In this step, the experiment applied the estimating outline published by [30] to identify the horizontal and vertical structure. This tool gave vital insights about the complexity level of the chain under study.

RESULTS AND DISCUSSION

Food chain mapping

The overview started by identifying support and primary activities (Figure 1). Agrocalidad and Iniap performed 60% of operations into the pre-production stage, where most of the supporting activities take place. Public and private financing entities (75%) supported the production and post-production activities through funding programs to SMEs, entrepreneurs, and peasant producers.

[4] Flows of less importance correspond to agri-food material streams. Flows of greater importance correspond to financial, informative, and non-agri-food material streams such as fertilizers and machinery.

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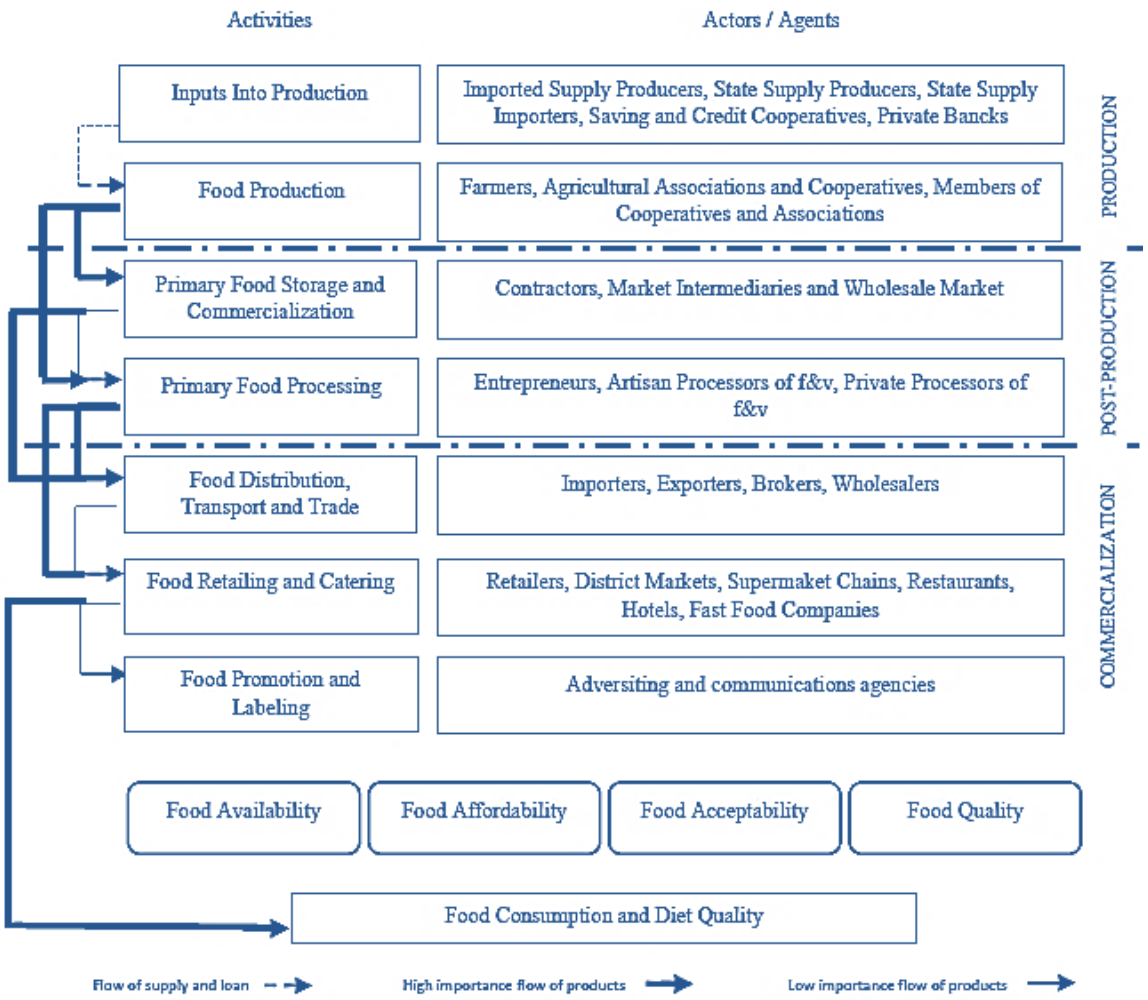

Figure 1: Agents and flows identified in the Inca berry agri-food chain

Furthermore, the chain mapping identified the production stage, which included individual producers, private associations, and farming firms. These actors started with the flows of greater importance (agri-food material) by delivering them at commercialization centers. Examples of those commercialization centers were wholesale outlets located at Ambato and Riobamba cities. Next, it identified private processors and startups, which transformed raw material into goods with high value-added. More than 50% of processed Inca berry belonged to the canning and dried categories. Also, the mapping recognized actors involved in the commercialization stage; such actors were importers, exporters, retailers, and advertising agencies, among others. This general overview will be more detailed in the descriptive analysis section.

Identification of value chain actors

The Ministry of Agriculture of Ecuador (2016) pointed out that 0.95% of fruit and vegetable producers are involved in the Inca berry production stage (Table 1). The province with the largest Inca berry production surface was Tungurahua. On the other

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hand, the Secretariat of Planning and Development (2017) reported that 7112 firms linked with the Inca Berry industrial phase (Table 2). Tungurahua had 52.5 % of firms, Chimborazo accounted with 25.7%, whereas Cotopaxi presented 21.7%.

Descriptive analysis

Pre-production stage

The outcomes stated that Government institutions prioritized strategies such as the development of rural economy, and the redistribution of production supplies like manuals, seeds, fertilizers, irrigation systems, among others. Besides, public agencies were responsible for transferring novel techniques of production such as mulching, crop rotation, and application of vegetation indices for agricultural crop yield prediction. Also, academic institutions such as the Technical University of Ambato and University of the Armed Forces, located in the inter-Andean zone, led programs aimed to improve production performance, plant genetics, and processing technology. The scientific community of those institutions devoted many resources in topics such as the efficiency of land and water use, and food packaging [32, 33, 34].

Production stage

Socio-economic findings. Outcomes stated that producers were between 29 and 52 years old. Most of them were men (58%), the prevalent education level was the secondary (39%), and 27% of respondents finished the bachelor. This academic background situation was not a barrier to negotiate with downward actors. However, farmers always took the risk regarding contract renewal with buyers and fair selling prices each business cycle. Also, 37% of producers were cooperative partners, and 30% were association members, even so, few of them were willing to adopt specific strategies to expand volumes of Inca berry. The last breakthrough was that 58% of producers financed the production through savings, and 38 percent were subject to bank debts (Table 3).

Production findings

Most of the producers (60%) considered the growing demand of Inca berry at the local and international levels as the primary driver to expand crops. However, the results also pointed out that 55% of respondents had more than 3 ha of land, but the Inca berry crops covered only between 0.1 and 0.9 ha on average, while the rest of land is used in conventional crops such as potato, beans, maize, and vegetables. Another driver of Inca berry supply was the high fragmentation of traditional markets such as potato, maize, and onion. However, findings determined a production stage with limited downward coordination, 42% of the producers presented high diversification of crops, and just 31% operated through partnerships. Besides, there was a low density of Colombian and Kenyan Inca berry plantations, 35 and 19 percent, respectively, which confirm the preference by the local genotype (Figure 2). The foreign varieties presented phytopathological vulnerability and lack of adaption to Ecuadorian fields [35,36]. The Ecuadorian genotype was by far the most common variety in production units.

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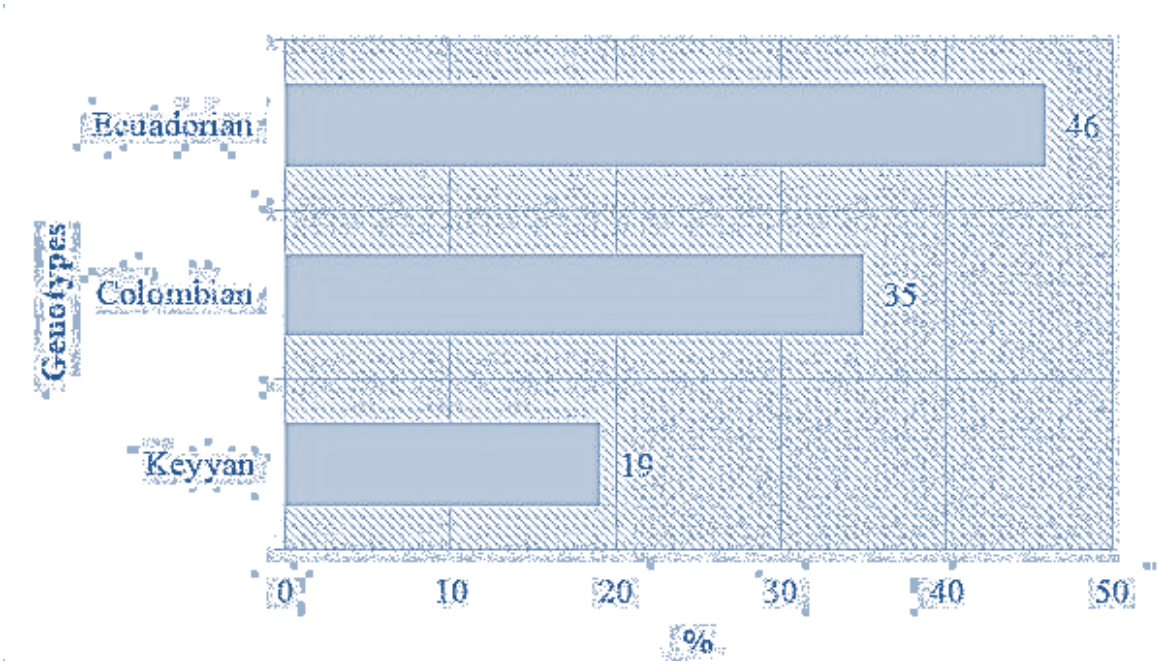

Figure 2: Percentage observed of Inca berry genotypes grown in Ecuador

Observations stated that the knowledge shortcomings of peasant farmers had affected the production stage directly and indirectly. According to Orejuela-Castro *et al.* [37], examples of those shortcomings were sustainable crop management and Inca berry plant breeding. Therefore, the National Plan of Agricultural Support 2013-2017 failed in supporting key aspects of emerging agri-food chains. The design of this policy aimed to enable accessibility to agronomic assets [38]. However, it was necessary to implement a monitoring plan of those policies able to reinforce agricultural systems.

Apart from that, observations elucidated some rates of productivity. By these means, they showed 12.9 t/ha of Inca berry yields on average (Figure 3). The reference was Colombia as the current leader in Inca berry production. The results reported by Córdova and Monteros-Guerrero [39, 40] about Colombian yields stated 14.5 ton/ha. The production systems and infrastructure of both countries were very similar and competitive with each other. However, returns could vary depending on the production method. In open field, yields ranged between 10 and 13 t/ha, whereas greenhouse systems yielded between 15 and 25 t/ha. Therefore, the enhancement of yields needs urgent attention to crop modernization. Further, findings indicated that challenges were at the post-harvest practices where only 35% of producers applied them to reduce losses.

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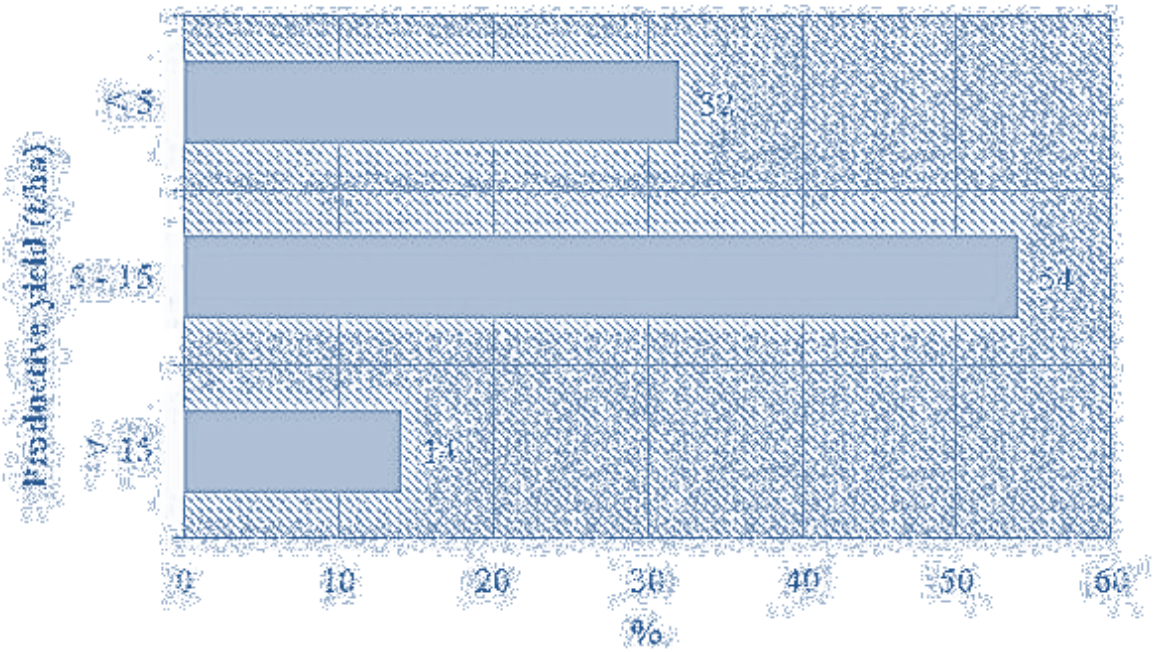

Figure 3: Productive yield (t/ha) determined in the Inca berry agri-food chain

Performance findings. Respondents stated predicted yields under the right weather conditions, around 13000 kg/ha/year (±30 kg/ha/year), the total variable cost is USD 0,54/kg, and the local price is USD 1.0/kg. Observations showed that each hectare would generate a gross income of USD 13,000/year (±50 USD/year) and a net income of USD 7,020/ha/year (±50 USD/year). The contribution margin is around USD 5,980/ha/year (±50 USD/year) or USD 0.46/kg. According to Monteros-Guerrero and PROECUADOR [40, 41], the Ecuadorian Inca berry production was profitable, and its IRR (internal rate of return on investment) ranged between 13 and 25 percent. In addition, PROECUADOR [42] reported an 18 percent of profitability rate at Inca berry production in the Inter-Andean zone. The outcomes reported by PROECUADOR [42] pointed out the Colombian gross profit between USD 5,000/ha/year and 8,000/ha/year during 2014 and 2015.

Post-production stage: processing firms

Economic findings. Outcomes stated that 98.4% were SMEs, and 1.57% were large firms. Also, 40.1% were raw material processors, whereas 60.9% combined the processing with marketing activities. Besides, 69.2% of firms worked with retailers, and only 10.4% were exporting companies. However, respondents made the case that processing companies required support to improve their performance. Such support would be in aiding the diversification of their product portfolio and the possibility of building links with public entities to expand the foreign trade [50]. Besides, 45% of respondents considered supply price as the decisive factor during the purchasing process of Inca berry (Figure 4). The quality criteria were relevant. For instance, buyers demanded fruit quality in terms of size, color, and absence of physical irregularities; otherwise, low quality dropped the chance of negotiation to a 49% probability.

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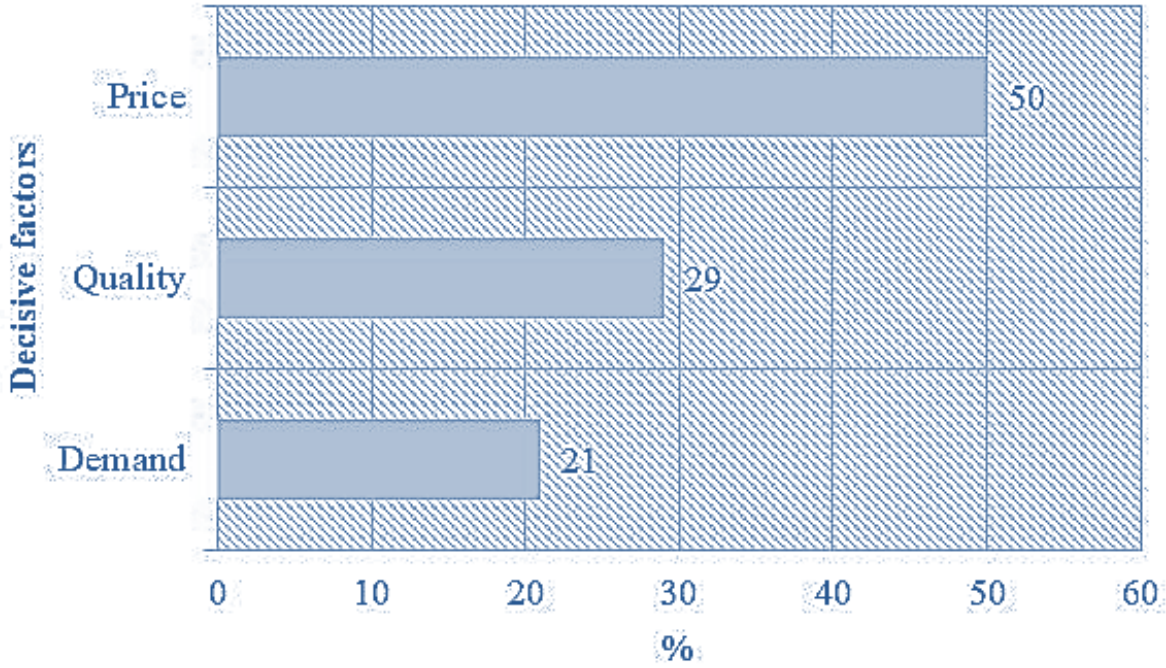

Figure 4: Influencing factors of Inca berry in purchasing process by processors

Logistic findings. Results pointed out that only 39.1 % of firms owned transport facilities, whereas 60.9% outsourced this service through local van and truck cooperatives. Only 40% of the companies did not present difficulties to transport fresh Inca berry. Also, 89% of companies' delegates emphasized the high dependency they had on producers' deliveries; thus, there was not a competition between both stages. Their suppliers were middlemen (48%) and full-time farmers (52%). Despite the challenges faced by the logistics, it was essential to stress the public investment in roads aimed at improving efficiency. Nevertheless, the enhancement of short marketing circuits by following trends in customer preferences (Figure 5), could reach a more sustainable logistic through mechanisms of coordination within the fresh format and from processed versions. The following section explained the performance and role of formal distributors and their impact over the chain performance.

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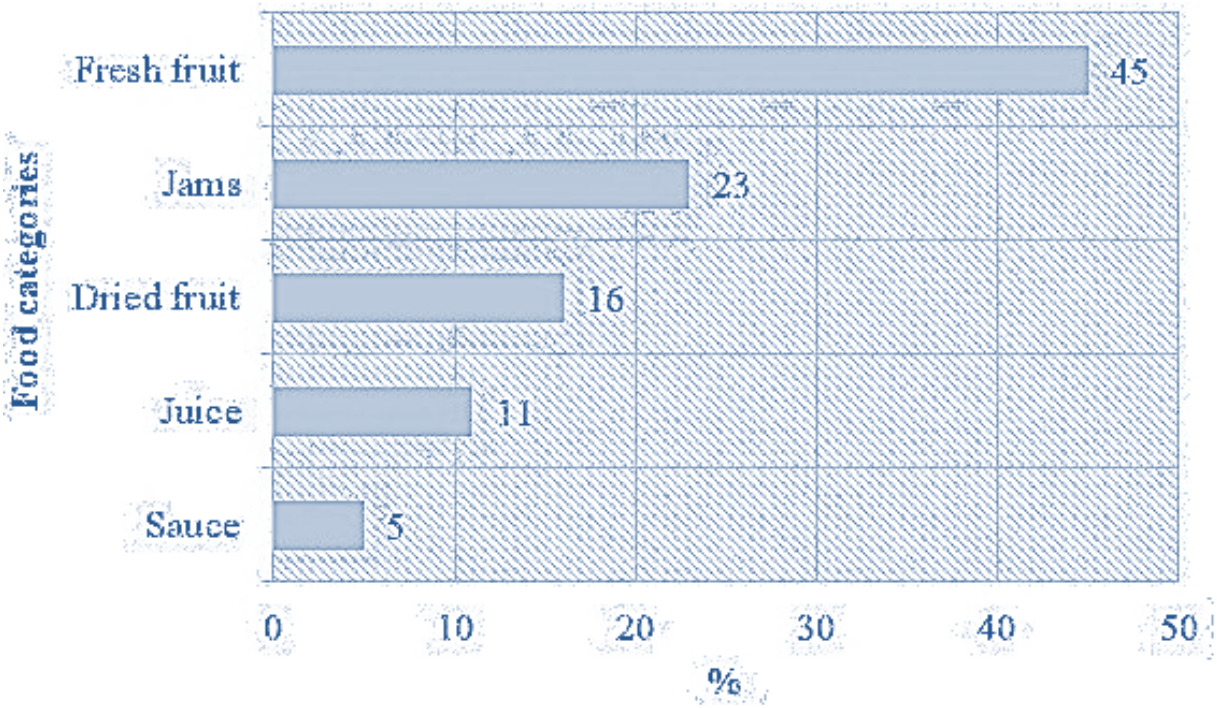

Figure 5: Categories of Inca berry based products preferred by consumers

Post-production: distributors

Economic findings. Outcomes from the Market Power Control Agency - SCPM showed a highly concentrated retailing structure (Figure 7). The HH Index presented values higher than 2,500 during the last 15 years. Also, they stated that corporations managed the food distribution businesses and invested intensively to expand their marketing chains. The power of these actors was imminent. Respondents said that distributors financed activities with capital and bank lending (65%), while 35 percent used the stock exchange to involve new investors. Also, they argued that each distributor set up a differentiation strategy to prevent the entry of foreign retailers and procedures to avoid affectations of final consumer pricing. The price of fresh fruit ranged between USD 2.00 to 3.00/kg, whereas the processed one ranged between USD 6.00 to 9.00/kg. However, the pricing also depended on the profit margins predetermined by the board of directors.

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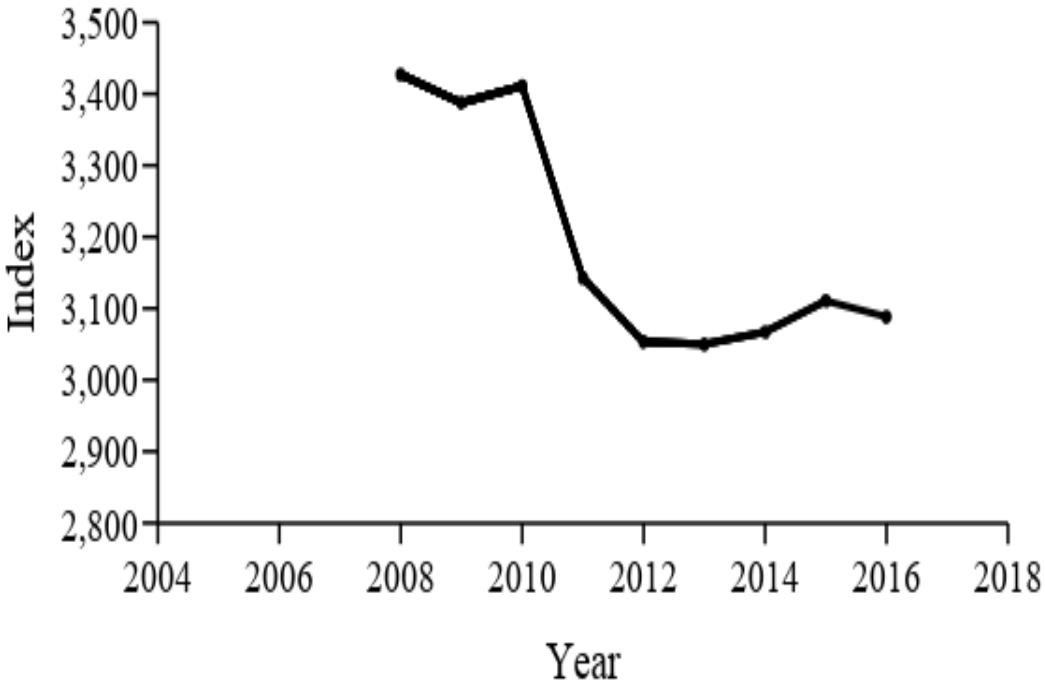

Figure 6: The retailing sector HH Index in Ecuador from 2008 to 2016

Logistic findings

Outcomes stated that 80% of firms owned truck fleet, whereas 20% outsourced this service through regional truck cooperatives. Also, 90% of companies depended on the deliveries of Inca berry products from producers and processors. However, they had the fruit farming intention in long- term perspective. Besides, 78% of their suppliers were SMEs, and 22% were full-time farmers. Interviewees claimed the strict policies they had to negotiate directly with formal firms still present gaps that should be evaluated by experts or must be subject to adjustments since they do not solve power market issues.

Foreign trade

Findings stated that Inca berry exports presented a growing trend of volumes at a rate of 13% per year since 2000. Exporter companies and small and medium enterprises claimed that they faced rigorous revisions because of the international market regulations imposed by the countries of destination, which are mainly from North America and Western Europe [43, 44]. Public authorities supported on Good Agricultural Practices to increase competitiveness and promote exports. However, respondents claimed that 40% of exporters faced losses at some point in the trading process. The main competitors of Ecuador were Colombia, Zimbabwe, Kenya, and Peru [45].

Scanning of the configuration

Horizontal configuration. The initial level was responsible for the provision of inputs. The second one received more than 60% of the contributions from Level 1. Observations pointed out that the success of the Inca berry chain depends on the associative structures.

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Level 3 served as an intermediary between the production and processing stages and channeled off 36% of the production. Level 4 included processors of different size. Level 5 distributed to local or international markets and consumers. Level 6 was responsible for retail delivery, food services, and hotels (Figure 8). They had direct connections with consumers and had access to updated information on consumer trends [42,43,44].

Vertical configuration

Outcomes examined the degree of fragmentation and the distribution of bargaining power. The fragmented level was the second, which is composed of farmers, producers, associations, and agricultural cooperatives, and its bargaining power was constrained. Levels corresponding to input suppliers, processors, intermediaries, and distributors were small structures [45]. Their bargaining power and capability to differentiate goods were higher (Figure 8). These factors were significant when the market competition takes place.

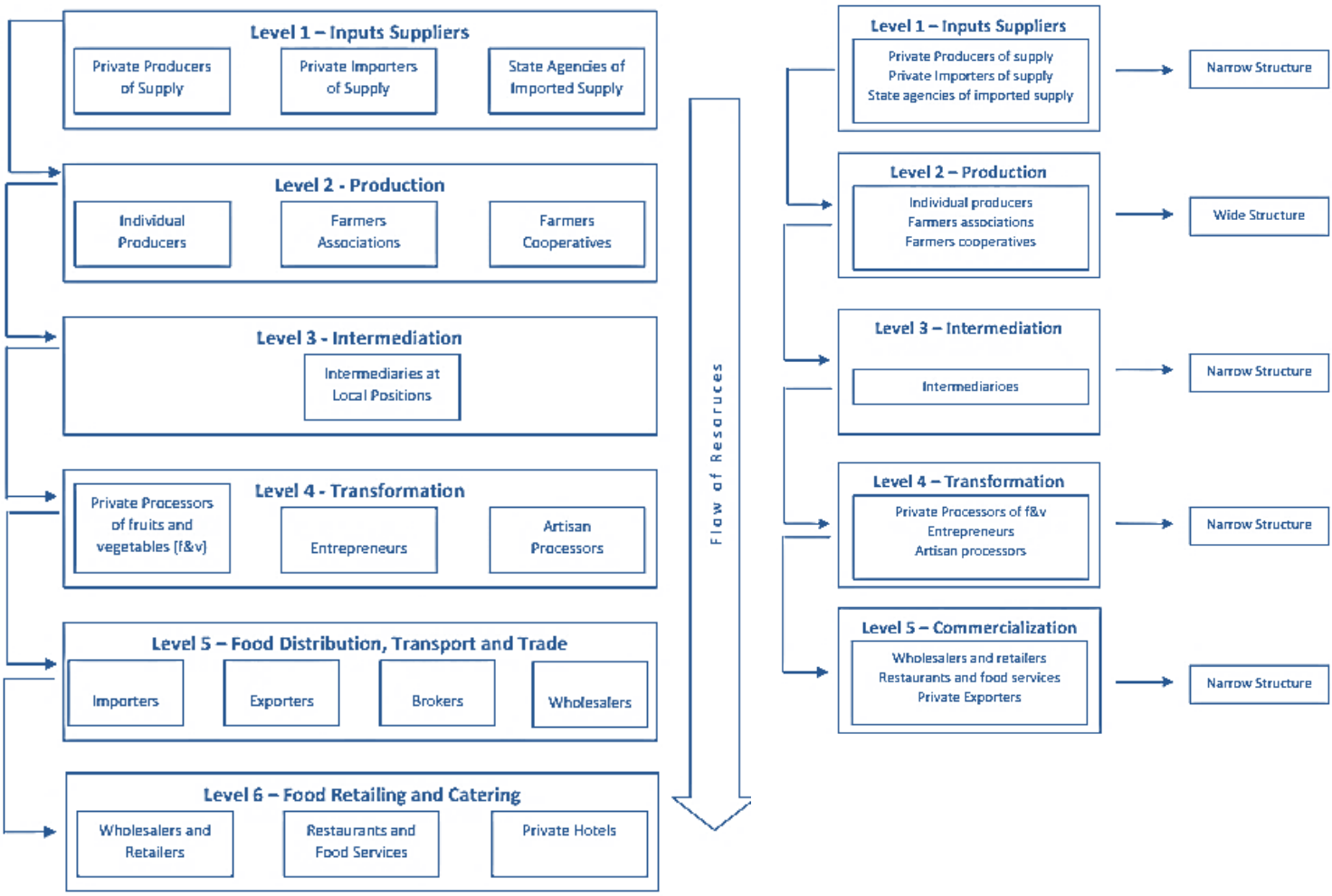

Figure 8: The horizontal and vertical configuration observed of Inca berry chain

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CONCLUSION

The main actors identified are public entities. The priority of these actors was the strengthening of peasant family sustainability. Therefore, the first strategy was to reinforce these entities, which provided technical training and monitoring of Inca berry cultivation through extension programs. The second potential strategy was the stimulation of associativity at the producer level. This strategy could contemplate a market orientation, and so producers will capture a better national and international market positioning. The third strategy pointed to the generation of links with academic institutions to improve performance, efficiency, sustainable management, among other relevant aspects. The fruit and vegetable market was very competitive, dynamic, and profitable. Therefore, the chain understudy required focal actors (companies) that promote possible horizontal and vertical synergies between the stages. This strategy suggested studies that deepen collaborative behavior and coordination mechanisms. Finally, the investigation presented limitations in performance estimation; thus, we recommended environmental and institutional indicators to analyze sustainability comprehensively.

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Table 1: 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	129	189	153
Area of Inca berry (ha)	259.69	329.09	274.52

Source: Ministry of Agriculture - Ministry of Agriculture of Ecuador (2016)

Table 2: Participating companies in the industrial sector and Inca berry chain within Cotopaxi, Tungurahua and Chimborazo provinces

		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
Fruit and vegetable processing firms		54	176	82
Inca berry processing firms		15	27	10

Source: National Secretariat of Development -Senplades (2017)

Table 3: Description of socio-economic variables analyzed in the producers sample

	Maximum	Mean	Std. Deviation	Range
Age	52	45	5	29Y-35Y=0, 36Y-40Y=1, 48Y-48Y=2, More than 52Y=3
Cooperative partners	1	0.88	0.329	Yes = 1, No = 0
Association member	1	0.79	0.409	Yes = 1, No = 0
Gender	1	0.82	0.387	F = 1, M = 0
Education level	3	1.55	0.645	School=0, HighSchool= 1, University= 2
Income level (USD)	2	1	0.816	Less than 700/month=0, 701 to 1700= 1, More than 1700= 2

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