The Agrifood network of lupine bean (*Lupinus mutabilis*) in Ecuador: A characterization of the value chain with a socioeconomic and productive perspective

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Summary

The fruits and vegetables sector in Ecuador despite its gradual growth in local and international markets has captured the interest of state institutions and academic centers who have focused their studies on agronomic aspects of non-traditional products without consider socioeconomic, productive and performance problems; such is the case of lupine bean value chain. To this extent, the aim of this article was to present an analysis of lupine bean value chain in Ecuador through the identification of stages, agents, flows and activities (primary and support) from the socioeconomic and productive point of view for which a systematic methodology was used involving aspects of the agro-economic process. As a result, it was determined that lupine bean value chain in the production and postproduction stages requires the diversification of marketing channels, the implementation of refrigerated storage modules located in the supply centers, the strengthening of associative and / or cooperative structures; and the productive planning programs to provide a potential competitive advantage.

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1. INTRODUCTION

Exports of fruits and vegetables in Latin American countries has showed a moderate annual increase (4.2%) during the period between 2010 and 2015, this growing trend reflects the influence of factors such as production diversity, agronomic conditions and foreign investment (ECLAC, FAO, IICA, 2015). Another important aspect is that the productive chain of fruits and vegetables in Latin America is affected by losses generated at different levels of stages and subsystems. The underutilization of production resources, caused by social, economic and political aspects make the implementation of solutions difficult in terms of practicality (FAO, 2011) ECLAC, FAO, IICA, 2015).

It is important to note that, Latin American countries show comparative advantages in the agricultural sector, therefore, it is crucial that they must consolidate competitive advantages by incorporation of efficient technology and management systems to their productive processes (Orjuela et al., 2008). It is necessary to compete under Value Chains schemes**,** achieving a sustainable development in the agricultural sector, and generating a harmonious work that eases the performance of each practice, providing fluency and stability to the work of some productive agents (Miranda, 2011; Scott, 2013).

According to FAO (2010), The fruits and vegetables sector in Ecuador has been experiencing a growing tendency in its production, contributing around 16% to agricultural GDP, without consider the production of potatoes and bananas. Glas et al., 2015; MAGAP, 2015, mentions that the fruits and vegetable sector in Ecuador still shows a weak integration and coordination among its agents, which makes it impossible to strategically plan future actions and the stable development of each stage of the sector (Rojas et al. 2012;) (Barrera et al., 2015).

In this context, it has been identified that the size of farms is small, which implies increased transactional costs (Blandon et al., 2009); futhermore, the excessive diversification of plantations by producers increases the problem of marketing, because transport processes become inefficient. In the case of fruit production, the size of farms is higher but with a lesser degree of crop diversification, presenting a better coordination in the logistics of harvest, classification and other procedures demanded by national and foreign markets.

The production of fruits and vegetables is a viable economic alternative for average and small farmers, allowing them to simultaneously expand their supply and get opportunities of commercialization in various market niches. One example is the production chain of lupine bean in the Interandean zone of Ecuador, where this study was focused on, and its performance has been improved by the expansion of intensive production units from traditional models, improving its participation significantly in international markets (MAGAP, 2015). For all the aforementioned an in-depth study related to the value chain of lupine bean is necessary, considering its social impact, growth potential, market competitiveness and other aspects of economic development.

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The aim of this study was to analyze the value chain of lupine bean across the stages, agents, flows and activities (primary and support), considering socioeconomic and productive aspects, allowing the expansion of knowledge of the same one and contributing with the planning of competitive strategies.

2. MATERIALS AND METHODS

The current study was carried out at the Inter andean zone 3 of Ecuador (provinces of Cotopaxi, Tungurahua and Chimborazo) which is located geographically at 0 ° 42 ' latitude South and 80 ° 00 ' longitude West, with an average altitude of 3500 meters above sea level and an approximate extension of 59810 km². The average temperature of this zone ranges between 15 and 25 ℃. A systemic methodology was applied which involves socioeconomic, integration, production, performance and linkage aspects among the agents, reflecting the economic process of the value chain of lupine bean, as explained below:

- Identification of agents that make up the stages of the value chain. Information from the last census of 2013 generated by the Ministry of Agriculture, Livestock and Fishing (MAGAP) and the registration of companies involved in the value chain of lupine bean provided by the Ministry of Industries and Productivity (MIPRO), were taken into account. In addition, Porter's value chain scheme was applied, grouping the agents in the primary and support stages and identifying the flows of minor and major importance.

- Sample size description. In order to determine the size of the sample at the producer level, the continuous variable that was used was the "Number of lupine bean producers registered by the MAGAP" of the provinces involved, the formula made by Sukhatme (1953) was used. Therefore, the sample of producers of lupine bean was distributed as follows: 46 in the province of Cotopaxi, 45 in Tungurahua and 37 in Chimborazo. Whereas in the post-production stage, the information of participating companies, registered in the Ministry of Industries and productivity, was used.

- Value chain analysis. It was carried out through the application of surveys and structured interviews that contemplated variables of a productive, socioeconomic and performance aspect, aimed at representative agents, obtaining a diagnosis of the current situation of the value chain.

- Measuring the value chain. The dual (horizontal and vertical) structural measure existing in the value chain was established based on the information collected from the agents. The measuring scheme reported by Gereffi and Fernandez-Stark (2016) was applied.

3. RESULTS AND DISCUSSION

3.1. Identification of agents that make up the stages of the value chain

The Interandean zone of Ecuador, because of its territorial characteristics, capacities and population dynamics, is considered the Agricultural collection center of the country and is an important commercial node at national level, according to the information provided by the MAGAP presented in table N° 1, it was identified that for the production stage of lupine bean of zone is counted with 0.065% of fruits and vegetables producers. At the same time the province of Chimborazo stands out for owning the largest number of hectares for the production of lupine bean.

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Table 1. Total number of agricultural producers, producers of the fruits and vegetables sector, producers of lupine bean and production area of lupine bean of the provinces of Cotopaxi, Tungurahua and Chimborazo.

| Province	Total number of agricultural producers	Total number of producers of the fruits and vegetables sector	Total number of Lupine Bean producers registered by the MAGAP	Area (hectares) of Lupine Bean production registered by the MAGAP
Cotopaxi	182.528	43.011	315	182,27
Tungurahua	169.223	37.689	373	106,32
Chimborazo	246.132	68.453	274	218,51

Source: MAGAP, (2013)

Moreover, in the post-production stage, 30 companies registered in the Ministry of Industries and Productivity are identified. Between them, are Corpocasa, La Cuencana, Ecuaconservas, Ajitra, Inphec Agroindustrial among others, of which 35.2% are purely processors, while the 52.5% processor and/or exporters. Simultaneously, it was found that 61.2% work with lupine bean, while the remaining process both lupine bean and other vegetable products and finally it was found that 45.3% of the registered companies intervene in the domestic market, while the 27.8% are exporters of various types of lupine bean-based products and others.

With regard to distributors registered by the Ministry of Industries and Productivity, that are: Corporación La Favorita, Corporación el Rosado, Iberia Foods S.A., Gorizur among others, of which the first three are large companies that operate as retailers; while the remaining distributors are medium-sized enterprises of wholesale commercial activity.

The distributors previously mentioned have characteristics in common: they have products based on lupine bean within their business portfolio, they are not producers or processors, their suppliers are usually processors and producers, their main method of negotiation is through direct credit, and they operate in zone 3 of the country.

The following is the scheme of lupine bean value chain in the Interandean Zone 3 of Ecuador, detailing the agents involved in it as presented in Figure 1.

Figure 1. Agents and flows identified in the value chain

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Inputs/loans flow   - - - - - - - - - - -   Products flow: high importance ▬▬▬▬   Low importance: ————
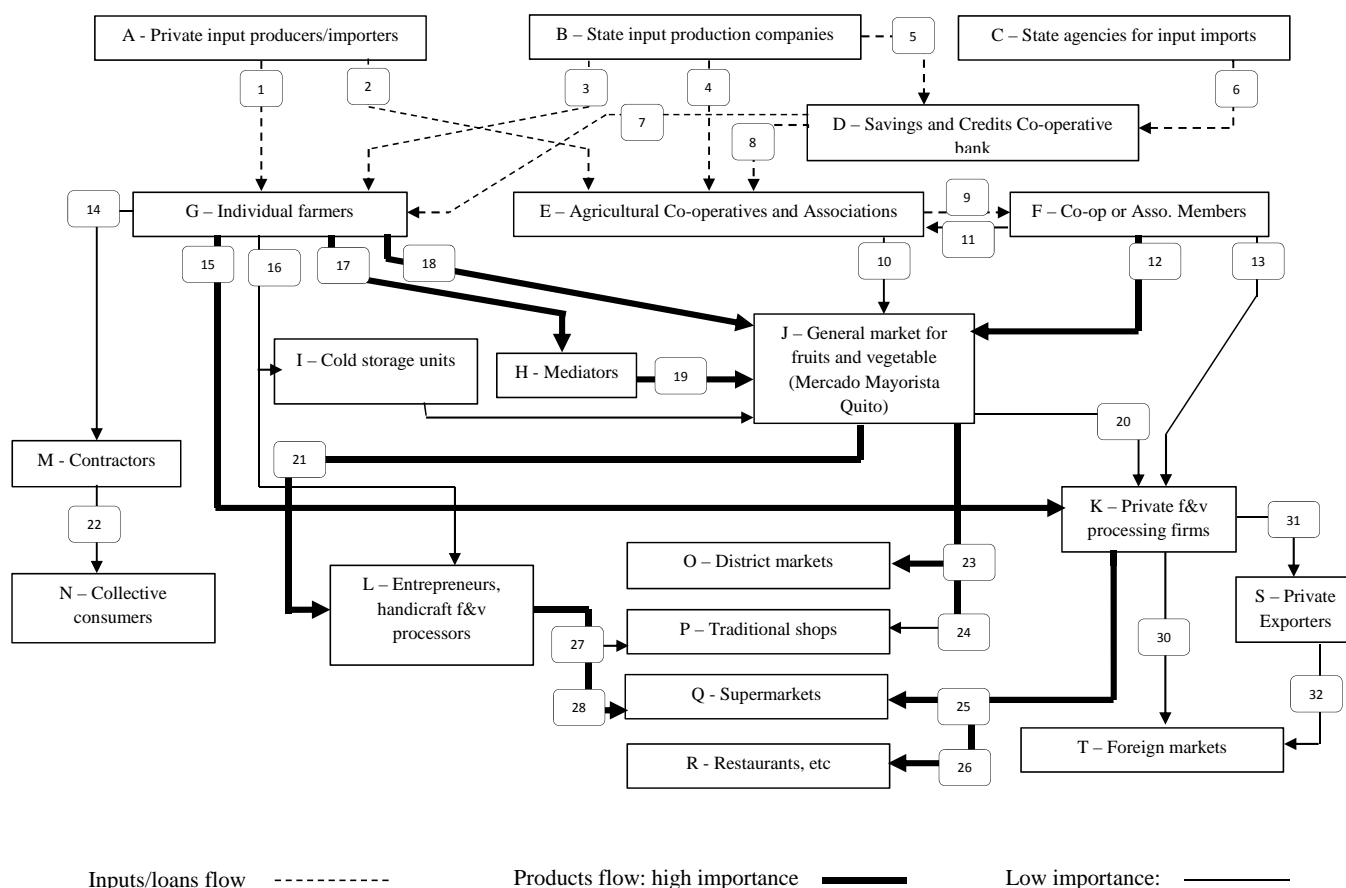
In the Figure 1, outlines the value chain with its starting point in support activities, carried out by agents such as state and private producing companies, which provide flows of supply of seeds, machinery, fertilizers, among others property, in the same way, credit unions and the state bank are involved, who are responsible for financing the different activities along the value chain.

The next stage is the production; this is carried out by individual farmers, associations and/or agricultural cooperatives. These agents initiate high-value production flows, which are directed towards intermediaries, provincial distribution centers, district markets, private fruits and vegetables processors, entrepreneurs and artisans. In turn, these types of flows were identified in the transfer of high value-added consumer goods between transformers and retail marketing chains.

Finally, low-importance production flows were identified with the reduced participation of processors and exporters in international markets.

3.2. *Value chain analysis*

Pre-production.

It begins with the intervention of governmental and/or state companies that generally supply inputs as fertilizers, seeds and technical training through several extensionist programs, it simultaneously has the intervention of research institutes whose contribution is focused on improving productive yields, vegetable improvement and processing technology, as well as the participation of private suppliers of inputs supplying packaging material, machinery, additives, technology and advice on technical and market aspects.

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Production

Socioeconomic Factor. This stage has producers between 35 and 55 years, mostly are men (56%), their academic education is primary (35%) and secondary (32%). The 28% of the producers are members of associations and 32% are cooperative partners. Their source of financing in 67% are own resources and 29% corresponds to debt.

Productive Factor. In terms of land ownership, 51% own land and 22% work in society. The 45% of the respondents have a land extension greater than 1.5 ha, and the cultivation area for lupine bean goes between 0.1 to 1.2 ha on average. At the same time, 86% apply cultivation techniques to open field.

The graph 1 shows that precocious variety is the most cultivated followed by the traditional variety. According to Peralta et al., (2012) there are about 35 varieties of lupine bean that differ mainly by color, size and yields. It also mentions that in Ecuador there are several varieties developed by the National Institute of Agricultural Research (INIAP), adapted to the Ecuadorian agroclimatic conditions, with size of medium to large, and they are marketed in the national and international market niches.

According to Camarena et al., (2016) Perú has been the largest producer of lupine bean within the Andean Community of Nations and Australia is the largest one in the world cultivating mostly *Lupinus mutabilis Sweet*.

Graph 1. Percentage of lupine bean varieties grown in Ecuador
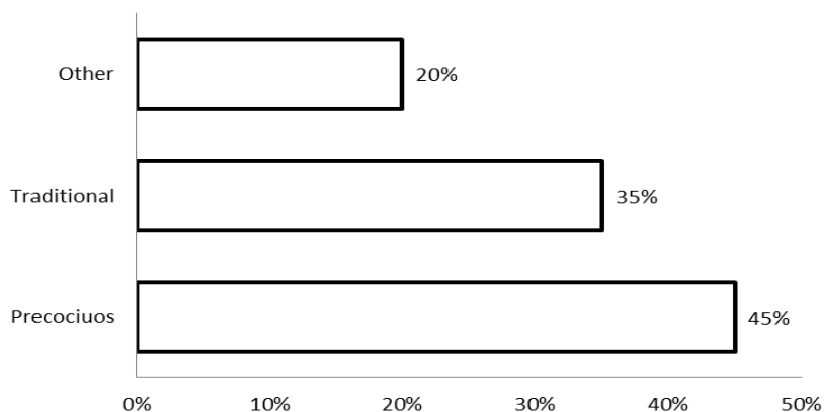
Graph 2. Productive yields in ton/ha of the value chain of lupine bean
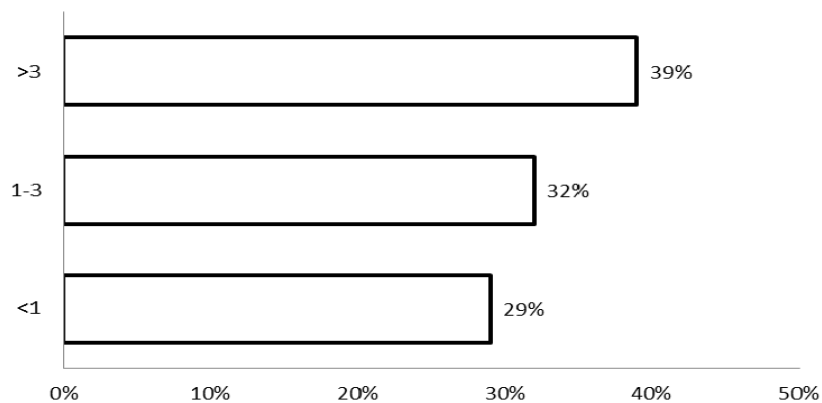
According to the results presented in graph 2 and comparing with the yields reported by Tapia (2016) and where he mentions that the yield of lupine in Ecuador is 1.8 -2.2 ton/ha while in Perú is around of 1.9-2.8 ton/ha, it is observed that the value chain under study presents very similar values in this variable. In addition, it is important to mention that only 27% of producers apply post-harvest techniques.

Performance Factor. The variable gross profit showed that the producers reached between 5500.00 – 6000.00 USD/year and the net income was observed an average value between 3100.00 – 3900.00 USD/Ha/year. It is important to mention that MINAGRI (2017) reports a gross profit that goes between 10 and 11% for the lupine bean producers in Perú, while INIAP (2017) reports 9.5 – 10.7% of profit for Ecuadorian producers.

Post-Production: Processors

Socioeconomic Factor. With respect the registered companies it was found that 21% are small companies and that includes processors and/or exporters, 39% microenterprises, 19% medium and another 21% large companies. The 58% of registered companies are members of associations and 39% are cooperative partners. On the other hand, with regard to financing 46% of them operate mostly with their own resources and debt, and 17% run it through debts and shares in the stock market.

Operative Factor. The 42% of companies outsource transportation service and 58% use their own and/or rented transportation. In addition, 31% of companies mention that lupine is their main raw material and the 95% of companies are not producers of lupine bean showing more a sort of vertical coordination instead of integration. Additionally, it was found that their suppliers are both producers (50%) and middlemen (50%). The 45% of them have contracts with suppliers and the 37% indicate that their method of negotiation is by non-credit.

Graph 3. Decisive factors in the price during the acquisition of lupine bean by the processors.
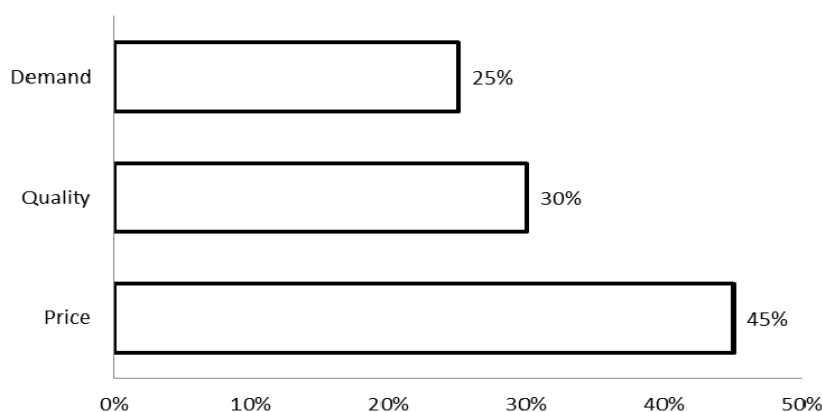
In graph 3, it is shown that 45% of companies indicate that the market price is the decisive factor in the acquisition of lupine bean. In turn they mention that the characteristics most appreciated during the purchase are the color (26%), the consistency (35%), the size and shape (30%), the physical damage and others (9%). In addition, it was found that 42% of the companies do not carry out the purchase when the lupine bean presents a low quality. On the other hand it was established that 43% of the processors market lupine bean in second and fourth gamma and its delivery is made in 36% to the international market and 49% to the domestic market.

Graph 4 : Decisive factors in the price of lupine bean to the customer.
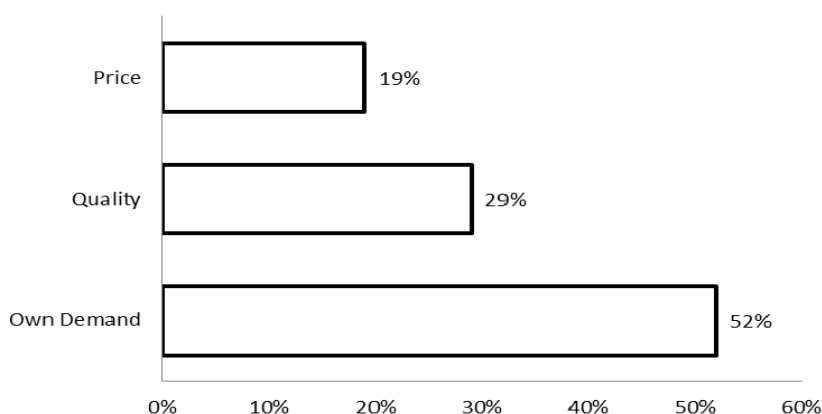
The results shown in graph 4 indicate that for 52% of companies the customer's own demand is the decisive factor in the price of lupine bean.

Post-Production: Distributors

Socioeconomic Factor. Among the distributors it was found that 50% are SMEs and the remaining 50% are large companies. The 50% of distributors are members of associations and 100% do not belong to cooperatives. On the other hand, with regard to financing, the 72% of them operate mostly with their own resources and debt, while 28% run it through debts and shares in the stock market.

Operative Factor. The 50% of the companies outsource the transport and the remaining 50% use their own transport. It was also recognized that none of the distributors are producers of lupine bean and that their purchase is directly with producers without the need of middlemen. In turn, all negotiations are by credit with a period of 20 to 40 days.

The decisive factor in the price of lupine bean to its suppliers depends exclusively on their own demand for fresh and/or processed products, while their price to the final consumer is the result of the performance of products on shelves and established profit margins.
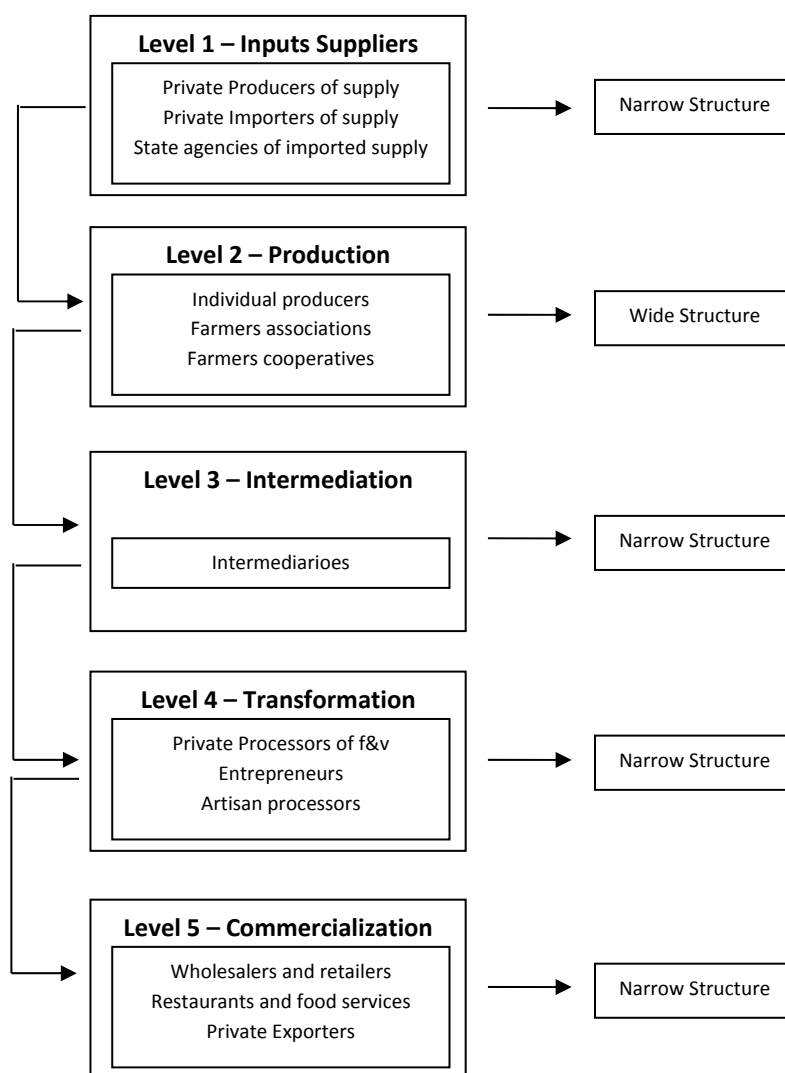
3.3. Dimensioning of the value chain

The dimensioning found in the value chain under study shows the following schemes presented in Figure 2 and Figure 3.

Figure 2. Horizontal dimensions of lupine bean value chain
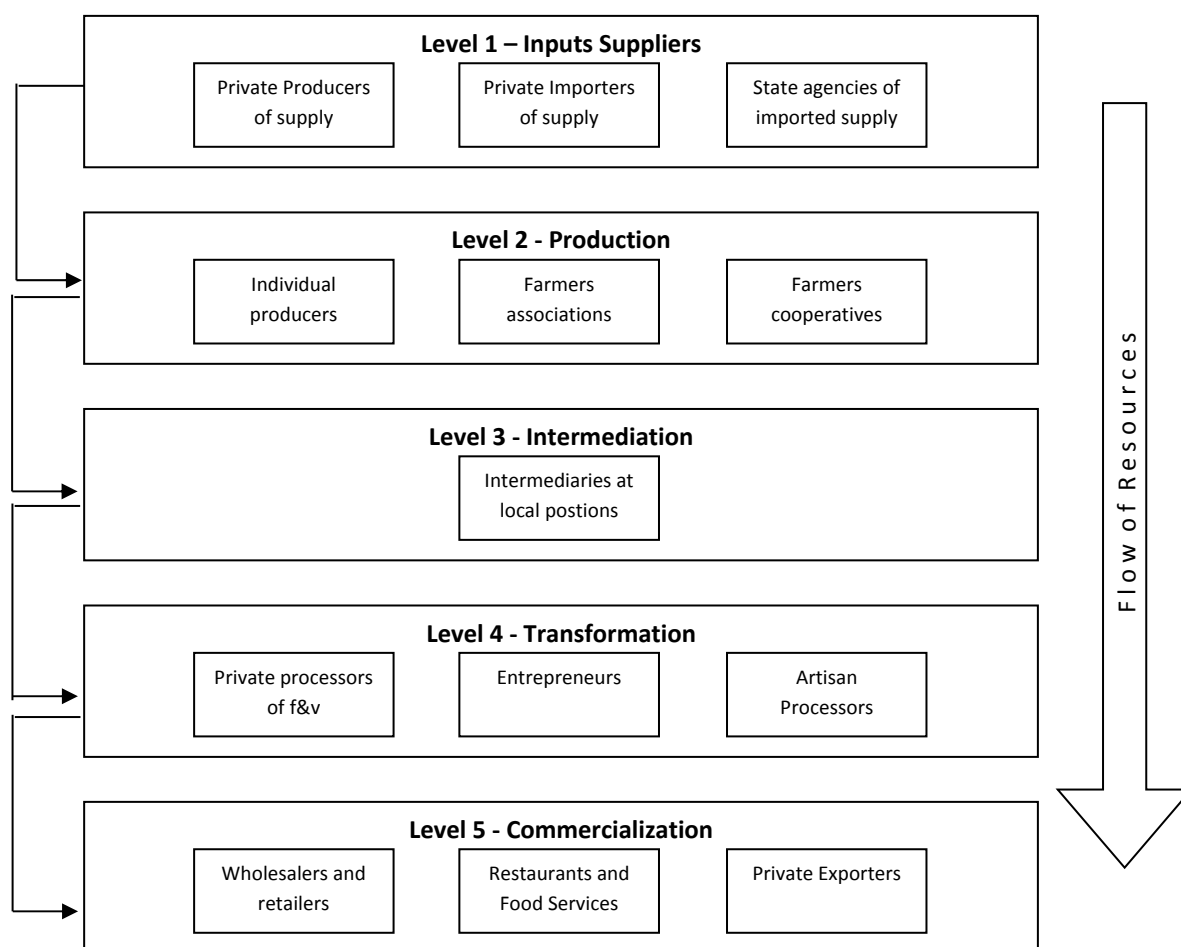
In Figure 2, it is shown that the horizontal dimension describes 5 levels grouping the different agents according to the similarity of their activities, where level 1 is in charge of the provision of resources (support activities), level 2 focused on the agricultural production of lupine bean, level 3 with agents involved in the process of transaction of the product, level 4 directed to generate goods with added value, and level 5 as responsible for the transfer of goods to the final consumer.

Figure 3. Vertical dimensions of the lupine bean value chain

With regard to the vertical dimension described in Figure 3, it is shown that the value chain under study describes levels 1, 3, 4 and 5 as narrow structures, i.e. levels that have a low level of fragmentation (relatively few agents), while level 2 presents a large structure by the highest number of agents involved.

The governance process of a value chain generated by the dimensioning allows to understand the dynamics between stages and agents. For Mendoza et al., (2016), the fruit value chain in Bolivia presents a fragmented stage of production, and with a low participation of small businesses in the processing linkage. The value chain of lupine bean in the Interandean zone of Ecuador presents a relatively fragmented stage of production in comparison with the other stages (processing, distribution) where the intervention of agents is reduced, concentrating there the market power of this product.

4. CONCLUSIONS

In the pre-production stage, where public and private institutions are involved, the main support activities are carried out and where the flows of tangible and non-tangible resources necessary for the performance of the value chain are created, also it does not present difficulties that represent a slowed growth in the different primary activities and flows of products of high and low importance.

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On the other hand, the production stage has producers with favorable demographic characteristics (age and location), but in the same way it presents aspects that require attention, for example, the strengthening of associative structures and cooperatives, with a business vision that promotes the chain, improving its participation in national and international markets. An additional aspect are the productive factors, these require a re-engineering, that results in the significant increase of the area of cultivation of lupine bean, improvement in the techniques of production and yields as well as a broad application of post-harvest practices.

The lupine bean value chain in the Interandean zone presents a post-production stage that clearly defines the power of processors and distributors. Small businesses are mostly involved in value-added activities and present a very important percentage of membership in associations. A clear example is the presence of the ANFAB (National Association of Food and Beverage Manufacturers), an entity that brings together more than 2000 companies and has established itself as a strategic partner in the country's food and agriculture sector.

Moreover, the distribution companies also present an important sense of associativity, but they are characterized by the business model with which they operate, for example, participating in the stock market, implementing methods of negotiation under credit that generate positive cash flows, and establishing decisive factors in prices towards suppliers and consumers.

Finally, the analysis of the measuring indicates that the value chain under study requires diversification of marketing channels able to expand markets, the implementation of refrigerated storage modules located in supply centers, and productive planning programs that reduce crop dispersion, oversupply and improve the allocation of support resources, as well as the governance of it.

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