

# **Influencing Variables and Scenarios for the Frozen Fruit Agro-export Sector: The Peruvian Case**

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## **Abstract**

In recent years, the agro-export sector in Peru has undergone constant changes caused by the political context, technological advances, among others, which affect the market share of Peruvian producers compared to other countries producers in this sector. This research focuses on identifying the most influential variables to determine future scenarios in the Peruvian agro-export sector of frozen fruits. The study analyses mango, blueberry and strawberry exports in Peru, in order to promote the development and growth of this sector. It has a mixed approach and follows Godet's prospective strategy as a research methodology. To this end, interviews were conducted with experts to find the most influential variables and factors were identified for the analysis of key variables using the Multiplicative Cross Impact Matrix Applied to a Classification (MICMAC) method and the construction of scenarios using the System of Cross Impact Matrices (SMIC) method. The conclusions of the study indicate that the variables with the greatest impact are exogenous, such as the implementation of agricultural technologies and adequate cold chain logistics. These results allow us to propose possible scenarios that can be used to develop improvement proposals for the future development of the sector.

## **Keywords**

Frozen fruits, export, freezing technologies, Peru, prospective.

## **1. Introduction**

According to López (2016), the export of frozen fruit represents a business opportunity for the country, as it provides greater income and employment generation that contributes to improving the quality of life of the population. In addition, it could represent an opportunity to position these products as a country brand.

With the export of frozen fruit, a country with a high wealth and variety of agricultural products such as Peru could serve as an incentive for large foreign companies to invest in new projects, generating greater development and a more sustainable economy as a country. According to Fresh Fruits magazine (2019), the Peruvian market registered a growth of up to 10% of its frozen fruit market share, which represents economic progress for the country in 2019.

In order to know the competitive level of each country, it is essential to know the data on the volume of exports and imports of frozen fruit. As far as the Commission for the Promotion of Peru for Exports and Tourism (PROMPERU) is concerned, the estimated volume of exports is 28%, which generates a lower income in contrast to other countries. It should be noted that, in the year 2020, the volume of income has decreased considerably at a global level due to the circumstances of the pandemic that the world is going through.

Regarding the issue of demand for this product, there is an export opportunity in the United States (USA) due to the fact that there is an increase due to a new trend and preference for frozen and preserved fruits through the freeze-drying process in that country; an important point why the American public prefers these products is the maintenance of quality in a uniform manner (Diario Gestión 2017). It is also essential to highlight that agro-exports to the United States have grown at an average rate of 14%, thanks to the FTA with the United States established in 2009 (Castillo 2019).

Furthermore, the technological factor is a key factor for the optimal export of frozen fruit. Fikiin (2003) mentions that the Individual Quick Freezing (IQF) method focuses on increasing the contact surface between the cooling medium and the food to be frozen. For this, the product must be smaller in size to be more efficient and must have a high-water content such as raspberries or pineapple slices; distributed in such a way that there is no contact between them.

Likewise, the aim is to control the cold chain throughout the entire supply chain, from the arrival of the fruit, its processing, storage and transport to the different points of export. According to Cortés (2009), Peru has 89% of

perishable products and does not have a proper cold chain to reach the final consumer. Therefore, freezing processes are used to preserve seasonal fruits such as strawberries, oranges, papayas, etc.; or fruits with short shelf life such as blackberries, blueberries, among others.

It should be noted that the freezing process applied to fruits is important to improve the volume of exports by sea, especially because it takes longer travel times, applying appropriate conditions at the refrigeration and freezing points to avoid deterioration and possible damage to the product (Li et al. 2018).

According to a report by PROMPERU and the Ministry of Foreign Trade and Tourism (MINCETUR), Peru is among the world leaders, ranking sixth in total exports of frozen fruit pulp and fifth in frozen fruit, excluding strawberries, blackberries and raspberries (MINCETUR and PROMPERU 2021).

In the top 5 of the world market for frozen products, Poland is positioned as the first exporting country with 9.6% of the market, followed by Serbia with 8.3%, Chile and Canada with 7.6% and finally Mexico with 5.3% (SIICEX and TradeMap 2021).

According to TradeMap (2021), Peru has a 4.5% share of the world market with 127,543 tons of frozen pulp exported, which represented a value of 259,023 thousand dollars in 2020. It is worth noting that there is an increasing trend in the number of exports. As indicated in the same report, in the period from 2016 to 2020, there was a growth of 20% and in the last two years (2019-2020), a growth of 33%. For this reason, it is proposed to seek a progressive increase in this indicator by offering appropriate solutions through this research.

## **1.1 Objectives**

General objective: The objective of this research is to generate future scenarios on the Peruvian agro-export sector of frozen fruits.

Specific objectives: The first objective is to identify, validate and weight the exogenous and endogenous variables. The second objective was to distribute the variables in quadrants in the dependence-motricity matrix (MICMAC). The third objective was to generate and validate future scenarios applied to the Peruvian agro-export sector of frozen fruit.

## **2. Literature review**

According to Super User (2017), freezing is the most relevant technique in food preservation because the nutrient content is retained to a large extent. This method consists of the application of sensible heat changes, related to the change in temperature, and a latent heat change, linked to the change in physical state, by which the product is brought to its freezing point, converting a product from a liquid to a solid state.

As mentioned by Otero, Guignon and Sanz (2013), the freezing method prevents the proliferation of bacteria and various microorganisms in food; however, they may have certain chemical alterations such as oxidation of vitamins and fats contained in them. In addition, freezing preserves products in short-term periods in which water crystallizes and the appropriate storage temperature is  $-18\text{ }^{\circ}\text{C}$  to avoid the development of microorganisms and negative effects on the food (Aguilar 2012).

The reason why the refrigeration method is not chosen is to preserve the organoleptic characteristics such as smell, color, shape, among others. According to Morocho (2017), studies were carried out in which it was found that refrigeration methods for peeled fruits generate damage to the quality of the fruit, causing decomposition; therefore, it is more convenient to freeze the food to preserve quality standards established by the client.

According to Olmue (2014), the IQF method is a type of quick-freezing process in which the aim is to reduce the number of microorganisms, preserve the characteristics of the product that has just been harvested; when this process is used, it is not necessary to apply any type of chemicals or preservatives in order to preserve the product while maintaining the quality until the final consumer.

Gómez (2013) states that the application of IQF technology in the fruit export sector can be an interesting attraction for markets with high purchasing power such as the United States, Saudi Arabia and Japan; for this reason, a high quantity of fruits such as berries (blueberries, raspberries, blackberries and currants) are in demand because they have a greater capacity for preservation when exposed to low temperatures for freezing.

According to Guanotuña (2007):

It is definitely a process aimed at providing the consumer with greater ease of use of the product, as it does not have to thaw large portions of stems with the inherent complications, it does not need to be thawed before use (because its freezing process does not involve water) and it can be kept for a long time in the freezer without losing its properties. (p. 25).

This technology is applied by maintaining the cold chain throughout the process from the reception of fresh fruit to the storage of frozen fruit using IQF technology. As detailed by Jaramillo (2015), microbiological analyses

concluded that the application of IQF technology reduces the amount of mass in frozen fruit by approximately 27% compared to traditional methods of conservation and storage of the product.

Another new technology applied to freezing is ultrasound-assisted freezing. This method is applied by means of low-frequency and high-intensity waves to increase the percentage of air contained in the fruit in order to provide optimal preservation conditions for the fruit (Acton and Morris 1992). It should be noted that according to Petzold and Aguilera (2009), other technological processes such as cryoconcentration or freeze-drying allow the formation of large crystals to make sublimation easier.

Additionally, a method to better control the crystallization process may be the application of electromagnetic fields. According to Mohanty (2001), freezing occurs rapidly and uniformly throughout the product, rather than from the surface into the food as in traditional methods. The magnetic effect generated in the product at the molecular level allows the production of smaller crystals with a higher quantity than a usual freezing system (Woo and Mujumdar 2010). Also, Tanaka et al. (2002) stresses that this process has little use at the industrial level because it is used for larger products and requires high investment cost equipment in any company.

It should be noted that there is another freezing technology which is by applying variations in pressure. With the application of this method, the shelf life of the product can be extended by applying high hydrostatic pressures using a steel cylinder filled with a food grade fluid that will transmit the pressure (Balasubramaniam et al. 2008).

According to a 2002 United Nations Environment Programmed (UNEP) report entitled "Industry as a partner for sustainable development", wastage amounts to up to 50% in developing countries, mainly tropical products, while in 17 developed countries, wastage is as high as approximately 10% even with adequate refrigeration facilities (Aguirre 2012).

The cold chain must start immediately after the product has been refrigerated or frozen and the first link is storage, at a suitable temperature, in the same facility of origin. From this moment on, the cold chain must be responsible for maintaining the product at the corresponding temperature at all times, during transport from the factory to the wholesaler's facilities (it is understood that transport also includes loading and unloading operations), during the time the wholesaler stores the product, during transport to the retailer's facilities, during the time the retailer stores the merchandise and especially while it is on display to the public in the sales area and finally, as the final link in the chain, at the consumer's home (Hernández 2008).

Guzmán (2017) argues that some disadvantages of the application of the cold chain are the high levels of investment in specialized infrastructure, high operating costs such as labor costs for the remuneration of operators and technicians. The specialization required for adequate training of operators implies a higher risk in the implementation of the necessary equipment and techniques.

As mentioned by Auquiñivin and Páucar (2020), there were low rates of variation and non-significant differences over storage time in pH, Brix, water activity (frozen), moisture percentage, fat, ash, carbohydrates and total calories for freeze-dried and frozen fruit pulp, indicating that these variables were stable in each product throughout the 60-day storage time. Statistically significant differences were observed for titratable acidity and protein over time. The microbiological results indicated preservation of the freeze-dried and frozen fruit according to the parameters evaluated in this study for each of these products, since all samples analyzed met the microbiological standards according to current regulations (Franco and Maldonado 2016).

This makes it necessary to acquire freezing equipment, cold stores, refrigerated transport, equipment and others with the aim of helping to provide greater stability in the average yield and temperature of the products to avoid breaking the cold chain that can guarantee the preservation of quality standards (Umaña 2011).

Logistics (2016) indicates that equipment suitable for the export of frozen fruit is mainly at sea and land level. These are described below.

As mentioned by Loyola (2019), a refrigerated container or normally known as a reefer within the maritime sector, is a type of container used to transport perishable cargo. It is found in sizes of 20 and 40 feet, and the front incorporates electrical machinery with refrigeration and heating systems. Its purpose is to maintain a specific temperature inside and is mainly used for storage, import and export of cargo requiring refrigeration.

Based on information from Sertrans (2016), refrigerated vehicles are those that incorporate a cold production device that allows, from an average outside temperature of 30 °C, to reduce the temperature inside the empty box being able to maintain it in a range between 12 °C and -20 °C; on top of that the vehicle is incorporated with insulating walls (including door, floor and roof) to limit the heat exchange between the external environment and its transport interiors.

### **3. Methodology**

This study has a mixed approach as one of the main sources of information is the perception of people related to the Peruvian agro-export sector; this is done through in-depth interviews (qualitative method) with the subject of the study, who are academic experts in the frozen fruit agro-export sector, and semi-structured interviews with senior managers and mid-level personnel of Peruvian fruit exporting companies (Hernández et al. 2010). In addition, surveys (quantitative method) will be carried out with the subject of study related to the agro-export sector to obtain data that will be relevant to validate the results obtained and generate future scenarios in a better way.

As mentioned by Hernández et al. (2003), the research design can be non-experimental in that it can be designed to avoid deliberately manipulating variables to be observed in their natural environment and to provide an analysis of the observations made.

This is why the study is considered to be non-experimental, as no manipulation of the information collected is sought intentionally and it is known that the interviewees have been previously informed about the information and the objectives of carrying out this research (Hernández et al. 2003).

Apart from that, Sampieri (2003) argues that the non-experimental design can be longitudinal because the time in which data collection is carried out periodically over time, in order to make inferences or predictions about the sector to determine possible changes and consequences in its external and internal variables. Based on the above, the study has a non-experimental longitudinal design, i.e., data can be collected through interviews in order to make inferences about the agro-export sector and generate future scenarios.

As mentioned by Ramos (2020), exploratory research is applied to phenomena that have been little researched before in which linguistic studies are applied to evaluate the interaction between the human being and the phenomenon to be investigated. Furthermore, descriptive research consists of exposing the presence of the phenomenon in the human group as an economic sector, seeking to specify the subjective representations that arise from the human group related to the phenomenon.

In terms of scope, the research is exploratory-descriptive because it seeks to provide general and detailed information about the phenomenon or problem in order to describe and detail its variables that will be studied with precision in the future (Ramos 2020). This scope is fundamental to be able to generate future scenarios later.

In order to establish the research phases and the methodological strategy, Godet's (2007) prospective structural analysis will be used. This methodology is based on the collective reflection of a group of experts to describe and analyze a system based on the relation of influential variables. The process of this methodology consists of three stages: identification of key variables, analysis of actors' strategies, and exploration of the field of possibilities and reduction of uncertainty (Godet 2007).

On the other hand, Ceplan (2014) proposes a prospective analysis applied to sectors. This comprises five stages: design of the conceptual model of the sector, identification and analysis of trends, identification of strategic variables, diagnosis of strategic variables and construction of scenarios.

For the present research, both proposed methodologies will be taken as a reference and the process will be adapted in three phases: identification of strategic variables, analysis of strategic variables and scenario building. The following figure outlines the methodology to be applied.

METHODOLOGY	MIXED WITH PROSPECTIVE STRATEGY		
SUBJECT OF STUDY	PERUVIAN EXPORT COMPANIES OF FROZEN FRUIT (blueberry, mango, strawberry)		
PHASE	IDENTIFICATION OF STRATEGIC VARIABLES	ANALYSIS OF STRATEGIC VARIABLES	SCENARIO BUILDING
SCOPE	Exploratory / Descriptive	Exploratory / Descriptive	-
GENERAL OBJECTIVE	Validate the exogenous and endogenous variables that impact the sector.	Distribute the variables in quadrants of the MICMAC matrix.	Generate future scenarios for the Peruvian agro-export sector of frozen fruits.
SPECIFIC OBJECTIVES	<ol style="list-style-type: none"> <li>1. Identify exogenous and endogenous variables.</li> <li>2. Validate the variables.</li> <li>3. Add weightings to the variables.</li> </ol>	<ol style="list-style-type: none"> <li>1. Tabulate the exogenous and endogenous variables.</li> <li>2. Establish the axes and distribute the variables in the MICMAC matrix.</li> </ol>	<ol style="list-style-type: none"> <li>1. Validate the findings obtained from phase 2.</li> <li>2. Generate future scenarios on the Peruvian agro-export sector of frozen fruits.</li> </ol>
METHODS	<ol style="list-style-type: none"> <li>1. Review of the state of the art (to meet objective 1).</li> <li>2. Porter Matrix and PESTEL (to meet objective 1).</li> <li>3. Semi-structured interviews with a variety of experts (to meet objective 2 and 3).</li> <li>4. Structural analysis matrix method (to meet objective 3).</li> </ol>	<ol style="list-style-type: none"> <li>1. Semi-structured interviews with a variety of experts (to meet objective 1).</li> <li>2. MICMAC Matrix Method (to meet objective 2).</li> </ol>	<ol style="list-style-type: none"> <li>1. Delphi method (to meet objective 1 and 2).</li> <li>2. Surveys (to meet objective 2).</li> <li>3. Régnier's abacus method (to meet objective 2).</li> </ol>
UNIT OF ANALYSIS	Senior managers in logistics, foreign trade and operations (to apply for interviews)	Mid-level logistics, trade and operations staff (to be interviewed)	Academic experts on the Peruvian agro-export sector of frozen fruits (to apply the surveys)

Figure 1. Methodological strategy

#### 4. Data collection

It is important to note that this research was conducted with the objective of analyzing the incidence of external and internal factors in the Peruvian agro-export sector. Therefore, it is essential to carry out the analysis of the PESTEL matrix, which provides a more external view of the sector, while the analysis of Porter's five forces matrix provides a better understanding of the sector at the internal level.

Based on the literature review, the Porter's five forces and PESTEL matrices were developed. The analysis of the elements that form part of the context of the Peruvian frozen fruit agro-export sector is shown below, considering political, economic, social, technological, ecological and legal factors. The competitive environment is also analyzed, focusing on the internal forces that influence the sector.

According to the PESTEL matrix approach of the agro-export sector, there are political factors such as political instability and agrarian strikes due to the agrarian promotion law between 2020 and 2021. In addition, there are economic factors such as the dollar exchange rate that affects fruit export prices; also, social factors such as the trend towards consumption of packaged foods due to their high-quality standards. Furthermore, technological factors such as advanced irrigation systems and crop monitoring through sensors have a high impact; as well as ecological factors such as the lack of sustainable agriculture and poor management of organic waste are negative for the sector. Finally, there are also legal factors such as Free Trade Agreements (FTAs) that benefit the agreements with the United States and the improvement of food standards. According to Porter's five forces matrix of the agro-export sector, rivalry between companies in the industry is observed as the growth of demand in the sector and the search for differentiation by improving the quality of products. Secondly, the risks of entry of potential competitors such as the high costs in the sector for infrastructure, labor, among others; also, the bargaining power of buyers because there are several places where frozen fruit is purchased. In addition, the bargaining power of suppliers allows for a diversity of suppliers of raw materials and inputs. Finally, the threat of substitute products because there continues to be a greater demand for fresh fruit than for frozen fruit.

## 5. Results and discussion

### 5.1 Endogenous and exogenous variables in the frozen fruit agro-export sector

Based on the literature review and the previous theoretical retrospective analysis of the frozen fruit agro-export sector, PESTEL and Porter's forces analysis, a list of exogenous and endogenous variables was drawn up for the sector studied. As recommended by Godet (2007) and Ceplan (2014), these variables were subjected to a validation process through interviews with experts, which resulted in a total of 14 variables that were taken into account for the research.

The variables obtained and validated by experts, which affect the Peruvian agro-export sector of frozen fruits, are shown below. These are classified according to their nature, into endogenous variables (Table 1) and exogenous variables (Table 2).

Table 1. Endogenous variables in the Peruvian agro-export sector

Variables	Code	Description
Increased availability of fresh fruit	DISPFF	This variable refers to the high availability of fresh fruit over frozen fruit, which is less well accepted in many countries and is therefore processed in smaller quantities because it requires more investment.
Costly barriers to entry	BAIC	It refers to the fact that, when applying processing technologies to obtain frozen fruit, a high level of investment in infrastructure, machinery and equipment is required to offer quality products to their customers. This situation does not exist in Peru because the country has certain economic, social and political limitations.
Variety of raw material, input and technology suppliers	VARPROV	The variable is related to the large number of suppliers of raw materials such as fruits obtained from agricultural crops, inputs such as water, electricity, among others. In addition, technology is related to refrigerated transport equipment, freezing equipment.

Table 2. Exogenous variables in the Peruvian agro-export sector

Variables	Code	Description
Shift in demand towards products with higher quality standards	VARDEM	It consists of increasing or reducing the quantities demanded which are frozen fruits with the best quality. In the case of the US public, products are preferred while maintaining uniform quality; always preserving the cold chain.
Logistical and export costs of frozen fruit	CTLOG	It is based on all costs linked to the export of frozen fruit. Logistical costs involved in which harvesting is charged (about 10 soles), transport costs, maquila (operational) costs, export costs, among others.
Price changes in the sector	VARPREC	Price variations currently occur on a weekly basis, the impact of which is negative for the agro-export sector due to the constant uncertainty of these changes.
Employment generation	GEEM	The export of frozen fruit represents a business opportunity for the country as it provides a greater generation of income and employment that contributes to improving the quality of life of the population. It could also represent an opportunity to position these products as a country brand.

<b>Variables</b>	<b>Code</b>	<b>Description</b>
Current political situation	SITPOL	The influence of this factor on the agro-export sector is low. With regard to situations such as the political crisis that developed due to the presidential elections, the appointment of Pedro Castillo as president, among others.
Free trade agreements (FTAs)	FTA	A free trade agreement (FTA) is a legal instrument that is binding in nature, i.e., mandatory, whose objective is to consolidate access to goods and services, to encourage private investment and to have stable laws and regulations to facilitate the flow of trade in goods, services and investment between the signatory countries.
Current situation of transport linked to the agricultural sector	SITTRANS	This situation has an impact on the agro-export sector because there will be delays and delays in the delivery of products.
Cold chain logistics	LOGCDF	Related to the implementation of the cold chain with adequate logistics in the agro-export sector, a loss of income due to spoiled products could be avoided.
Implementation of agricultural technologies	TECNAGR	This refers to the acquisition of drones to apply fertilizers on large crops; conversely, to carry out irrigation projects in the sector to improve the use of water in crops.
Freezing technologies	TECNCONG	The application of these technologies is carried out in order to maintain the cold chain and new technologies can be used to obtain frozen fruit.
Environmental impact of poor waste management	IMPAMB	It is linked to the impact generated by waste generated by the agricultural sector such as fertilizer wastewater, also fruit rejected for spoilage and generating land contamination.

As Godet (2007) indicates, in order to develop the first phase of the research, which consists of the identification of strategic variables, the unit of analysis is consulted through interviews to find out the points of view and suggestions on the establishment of the possible variables that have an impact on the agro-export sector. On the results obtained from the interviews, the experts agree that an adequate application of the cold chain and an appropriate management of logistic costs are relevant variables in the entire production and export process in the frozen fruit sector.

According to Espinoza (2021), he argues that the higher cost of frozen fruit compared to fresh fruit is important and there is a greater quantity of products for consumption without the customer having to wait until a certain season for the consumption of products such as strawberries. Another important point he made was with regard to the impact of the pandemic on the economic, political and social level. On the economic side, he pointed out that price variations in the sector are currently made on a weekly basis, generating uncertainty in the sector. In the political aspect, he mentioned that free trade agreements (FTAs) have a great impact on the agro-export sector according to the political decisions of the government of the day; and in the social aspect, he referred to the application of new sanitary measures that were applied in companies such as social distancing, personal disinfection processes and the intensification of the use of GMP standards in fruit processing plants.

Engineer Huambachano (2021) focused on the technological aspect from his perspective; the implementation of adequate refrigeration systems should be a priority given that it is currently deficient in Peru; to improve this situation, a large investment in transport is required and he stressed that it is necessary to implement the IQF technique because it is the most practical and least expensive freezing method that currently exists.

Professor Espinosa (2021) also mentioned the importance of FTAs for the future of the agro-export sector and its consequences as factors to be taken into account when assessing the future of the sector, given the increase in demand for frozen fruit in recent years worldwide.

## 5.2 Analysis of key variables

Prior to the second phase of the research, which consists of the analysis of the key variables, the structural analysis matrix is carried out in order to identify the most relevant variables in the system. According to Godet (2007), this consists of a matrix of direct influences based on the results of the interviews and the assessments provided by the unit of analysis evaluated, i.e., the sample of experts in the sector.

From this previous analysis, the MICMAC (Matrix of Cross Impacts Multiplication Applied for a Classification) was elaborated, in which the variables were qualified according to their levels of motricity (y-axis) and dependencies (X-axis) in a Cartesian plane. In addition, the MICMAC matrix is divided into 4 zones, the most influential of which is the zone of key variables used for the analysis of the agro-export sector.

As Godet (2007) indicates, the key variables, located in the upper right quadrant, are those with the highest degree of dependence and influence, which will be considered as the strategic ones for the research.

On the other hand, the so-called platoon variables are those located in the blue zone. "These correspond to the medium motor and dependent variables. They are usually located in the middle part of the motor axis (environmental variables) or in the middle part of the dependence axis (regulatory variables)" (Ballesteros and Ballesteros 2008).

Also, there are the motor, autonomous and outcome variables, which will not be considered for the next phase of scenario generation as they do not meet the level of motricity and dependence of the key variables (Godet 2007).

The MICMAC matrix is shown below (Figure 2), which was validated by interviews with sector experts. In the graph, key variables identified as key variables are logistics and export costs of frozen fruit, price variation in the sector, cold chain logistics, implementation of agricultural technologies and freezing technologies. These variables are the ones that will be taken into account for the scenario generation stage.

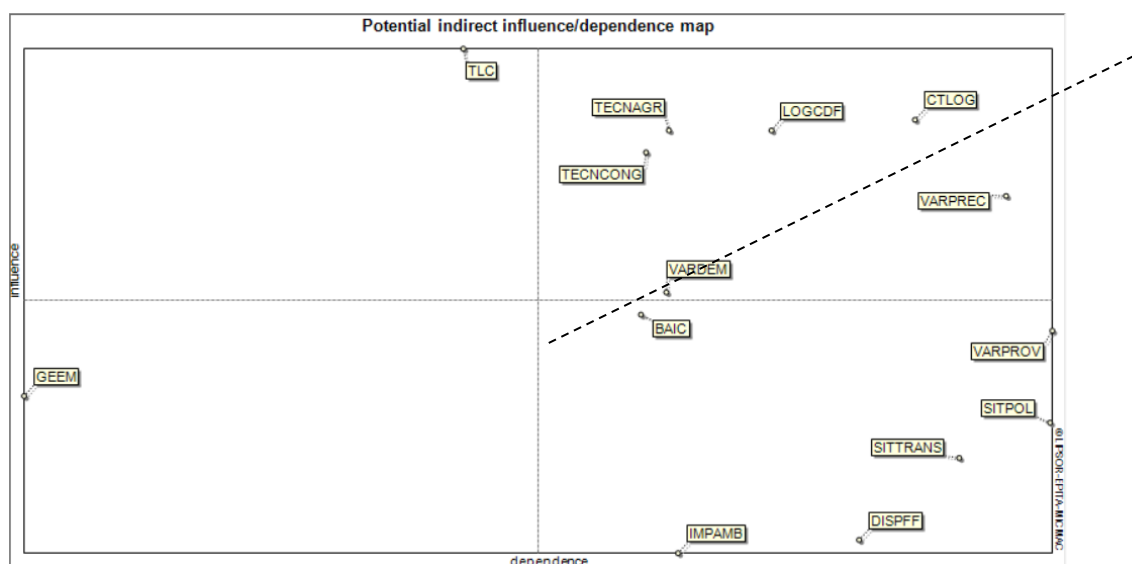


Figure 2. MICMAC Matrix (Extracted from MICMAC software)

Based on the results obtained in the MICMAC matrix, it is observed that the key variables in the system are exogenous in nature, i.e., they are part of the external forces that influence the sector. It is also observed that these variables are highly related to technological and economic aspects according to the experts. This can be explained by the fact that the proper implementation of cold chain logistics, freezing and agricultural technologies are closely linked to logistics costs and price variation in the agro-export sector.

The almost null presence of variables in the quadrants called driving and autonomous variables means that there are no variables with high influence and low dependence with the exception of FTAs. Moreover, the high concurrence in the zone of outcome variables means that there are several variables with high influence and low dependence in the sector, which are both exogenous and endogenous in nature.

Also, the platoon variables in the system under study (moderately driving and dependent) are demand variation and costly barriers to entry.



### 5.3 Scenarios building

In the third stage of the development of the methodological strategy, the construction of future scenarios is carried out. For this purpose, the Cross Impact Matrix System (CIMS) methodology proposed by Godet (2007) will be used. Based on this, 3 hypotheses were put forward for each key variable validated in the previous stage. These hypotheses were based on a bibliographic analysis and were subsequently validated through interviews with different experts in the sector. Likewise, each of the interviewees was asked about the hypothesis with the highest probability of occurrence and finally, a consensus was reached on the choice of hypotheses colored blue in the following table.

For the construction of future scenarios, 3 hypotheses were put forward for each key variable of the sector analyzed. These hypotheses were based on a bibliographic analysis and were finally validated through interviews with different experts in the sector. After having carried out the necessary consultations with the experts, the probable scenarios for the key variables were presented, which are shown below:

Table 3. Likely scenarios of key variables

Key variables	Scenario 1	Scenario 2	Scenario 3
<b>Logistical and export costs of frozen fruit</b>	By 2028, logistics and export costs for frozen fruit will increase by 7%.	By 2028, logistics and export costs for frozen fruit will increase by 10%.	By 2028, logistics and export costs for frozen fruit will increase by 15%.
<b>Price changes in the sector</b>	By 2028, prices for the frozen fruit sector will increase by 7%.	By 2028, prices for the frozen fruit sector will increase by 10%.	By 2028, prices for the frozen fruit sector will increase by 15%.
<b>Cold chain logistics</b>	By 2028, cold chain logistics is expected to grow by 5%.	By 2028, cold chain logistics is expected to grow by 10%.	By 2028, cold chain logistics is expected to grow by 15%.
<b>Implementation of agricultural technologies</b>	By 2028, the implementation of agricultural technologies would improve the situation in agricultural fields by 10%.	By 2028, the implementation of agricultural technologies would improve the situation in agricultural fields by 15%.	By 2028, the implementation of agricultural technologies would improve the situation in agricultural fields by 20%.
<b>Freezing technologies</b>	By 2028, the implementation of IQF and other freezing technologies in companies in the sector would improve by 10%.	By 2028, the implementation of IQF and other freezing technologies in companies in the sector would improve by 15%.	By 2028, the implementation of IQF and other freezing technologies in companies in the sector would improve by 20%.

On the contrary, the analysis of the construction of scenarios will be carried out using the 'SMIC Prob Expert' software, which consists of a programmed capable of evaluating variables and generating the probabilities of occurrence for the designated probable scenarios. As mentioned by Godet (2007), he recommends the use of specialized scenario projection software for prospective research, provided that experts in the sector to be evaluated have been consulted at all times.

By obtaining the probable scenarios, it was possible to reach a unified opinion with the experts that the scenarios proposed should be as realistic as possible based on the context of the current Peruvian reality. As indicated by Durance (2008), the perspectives of the experts and the data provided by them should be taken as a high priority for the correct establishment of scenarios, the probabilities of impact on the sector and the dependence between variables, if any. Under this point, experts were also consulted on the probability of occurrence and the conditional probabilities of realization and non-realization of key variables.

After an analysis of 32 scenarios of event occurrence possibilities, the 3 most relevant scenarios will be considered for the research. These scenarios are the following:

- Scenario 1:  
Sc. 1: 11111  
This is the initial scenario. It has a probability of occurrence of 37.2%. The values "11111" mean that all hypotheses for each variable come true in a period of 5 years, at 37.2%. By 2028, logistics and export costs for frozen fruit would increase by 10%, prices for the agro-export sector would increase by 10%, cold chain logistics would increase by 15%, the implementation of agricultural technologies would improve the situation in the fields by 15% and the implementation of freezing technologies in the companies of the sector would improve by 15%.
- Scenario 32:  
Sc. 32: 00000  
It has a probability of occurrence of 28.8%. The values "00000" means that, in the next 5 years, at 28.8% no hypothesis is realized.
- Scenario 17:  
Sc. 17: 01111  
It has a probability of occurrence of 6.7%. The values "01111" mean that the first hypothesis does not come true. That is, at 6.7%, the logistic and export costs of frozen fruit would not have an increase of 10% for the next 5 years.

On the other side, for the scenario analysis, the sensitivity of the key variables was taken into account. Based on the probabilities of the key variables extracted from the software on the basis of expert opinion, the variable with the greatest impact on the frozen fruit agro-export sector for the proposed scenario is cold chain logistics. Godet (2007) argues that it is necessary to obtain the impact probabilities of the variables to check if there is a correlation with the influence and dependence of the variables, as long as the factors are in the proposed conditions and it is taken into account that there is no disturbance. The degree of incidence and dependence of the key variables of the study is also evaluated.

To conclude this stage of the research, it can be deduced that the agro-export sector has the cold chain logistics and agricultural technology as the most influential and dependent factors, respectively. Both variables are closely related to the technological aspect, which is more important than the economic aspect; however, both factors are fundamental when analyzing the reality and context of the frozen fruit agro-export sector.

#### **5.4 Validation of results**

In order to carry out an adequate validation of the results obtained; it is advisable to apply the Delphi method because it guarantees better results in the experts' points of view. According to Godet (2007), this method consists of the application of interviews to predict and propose probabilities of scenarios about a sector, which in this case is the agro-export sector. Another very important point is the constant supervision by experts in the sector.

For privacy reasons, each expert interviewed will be given a number, for example, experts 1, 2, 3 and 4. These experts are the ones who have carried out the validation for the second and third phases of the research. As mentioned by interviewee 1, he points out the importance of the implementation of freezing and agricultural technologies that allow the improvement of the organoleptic characteristics of frozen fruit. In addition, the interviewee argues that in the third phase, mention should be made of the conditions of the scenarios generated in the evaluated sector.

According to interviewee 2, he argues that climatic conditions are relevant because they have a high impact on what would become the cultivation of the analyzed fruits. In the case of the third phase, the interviewee comments that it is necessary to take into account the different circumstances that may affect the scenarios proposed in the research. Likewise, interviewee 3 admits that, thanks to his extensive experience in the sector, logistics costs are very important because they can have a high influence on prices in the sector. In the case of interviewee 4, he warns that the expectations for the agro-export sector in the reality of Peru are not entirely favorable due to the constant political instability that currently exists in the country.

#### **6. Conclusions**

Once the strategic variables were identified and validated, it was concluded that there are exogenous variables that are fundamental for the sector, such as the implementation of freezing and agricultural technologies, cold chain logistics, price variations in the sector, free trade agreements, the political situation and transport, among others. In addition, there is also the presence of endogenous variables such as greater availability of fresh fruit, costly entry barriers, variety of suppliers (raw material, inputs and technology). It should be noted that the weights of the variables are important for their distribution in the strategic matrix.

After having carried out the distribution of the variables in the dependence-motricity matrix (MICMAC), it was possible to conclude that the key variables obtained for the frozen fruit agro-export sector are exogenous in nature.

With the validation and generation of the scenarios, it is concluded that the scenario with the highest probability of occurrence is that by the year 2028, the logistics and export costs of frozen fruit will increase by 10%, the prices of the agro-export sector will increase by 10%, the logistics of the cold chain will increase by 15%, the implementation of agricultural technologies will improve the situation in the field by 15% and the implementation of freezing technologies in the companies of the sector will improve by 15%.

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