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A SCENARIO FOR THE DESIRABLE FUTURE OF THE COLOMBIAN AGRI-FOOD SECTOR 2030 – FOCUSING ON ANDEAN NATIVE CROPS

Results from the 1st and 2nd futures workshops of the PECOLO
project in Colombia

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1. BACKGROUND – CHARACTERISTICS OF THE AGRICULTURAL SECTOR IN COLOMBIA

Characteristics of Colombia

Colombia is located in northern South America. It covers an area of 2.13 million km², of which 1.14 million km² is on the mainland. It has a population of approximately 44 million inhabitants, of which 84% are located in urban areas and 16% in rural areas (Departamento Administrativo Nacional de Estadística de Colombia, 2018).

One of Colombia's main characteristics is its orography, which includes three mountain ranges: the Eastern, Central and Western. Therefore, the country has been cataloged as a biological and cultural diversity hotspot. Some areas of the country receive up to 12,000 mm of rainfall per year and in general, average temperatures are inversely proportional to mountain altitude.

Administratively the country is divided into 32 departments and 1101 municipalities, which can be grouped into different organizational units (Ministry of Agriculture and Rural Development of Colombia & National Administrative Department of Statistics of Colombia, 2015b). One such scheme divides the country into six regions: Insular, Caribbean, Pacific, Orinoco, Amazon and Central.

The Central area comprises 17 departments, occupying approximately 25% of the continental national territory. It is located between 100 and 5410 meters above sea level¹. This is the most important agricultural region. Climatic conditions are stable and average temperatures vary little. Rainfall patterns are generally monomodal or bimodal², depending on the region, which allows greater control over some of the variables affecting crop development.

Agricultural Census

According to the last National Agricultural Census, land use in Colombia is distributed between natural forests (56.7%), agricultural activities (38.6%), non-agricultural activities (2.2%) and other activities (2.5%) (Colombian Ministry of Agriculture and Rural Development & Colombian National Administrative Department of Statistics, 2015a).

The agricultural sector contributed 6.3% of Colombia's national gross domestic product (GDP) in 2017. The main products of the agricultural subsector are concentrated in the Central region, where 32.5% of the country's perennial crops are planted. These include coffee, palm oil, bananas, sugar cane, rubber, and cocoa (Cárdenas et al., 2018).

Andean crops have shown significant growth in recent years. In addition to cereals such as oats and barley, quinoa has been among the most important temporary crops. In some cases, production declines

¹ According to (Cárdenas et al., 2018), the departments of the central region are: Antioquia, Caldas, Caquetá, Huila, Quindío, Risaralda and Tolima. Also included are Boyacá, Cauca, Cesar, Chocó, Cundinamarca, Nariño, Norte de Santander, Putumayo, Santander and Valle del Cauca.

² The distribution of rainfall is concentrated in one or two annual periods.

have occurred where crops have been affected by climate variability, including droughts and flooding (Cárdenas et al., 2018; Corporación Colombia Internacional, 2012).

Central Players of the Colombian Agri-Food Sector

There are numerous actors in the Colombian agri-food sector. The key public authority of the agri-food sector is the Ministry of Agriculture and Rural Development of Colombia (MADR). Advisory bodies overseen by the MADR include the National Commission for Agricultural Credit, the Advisory Committee on Forestry Policy and the Higher Council for Rural Land Management, among others. There are also other entities attached to the MADR, such as the Colombian Agricultural Institute (ICA), the Rural Development Agency (ADR) and the Unit for Rural Land Planning, Land Adjustment and Agricultural Use (UPRA), among others. There are also different related entities such as the Agrarian Bank or Banco Agrario de Colombia S.A. (BANAGRARIO), the Fund for the Financing of the Agricultural Sector (FINAGRO) and the Supplies Corporations. Finally, there are two corporations with mixed participation³: the Colombian Agricultural Research Corporation (formerly CORPOICA, now AGROSAVIA) and the Colombian International Corporation (CCI) (Ministry of Agriculture and Rural Development of Colombia, 2019).

The Colombian Farmers' Society stands out for its role in the private sector. It is the oldest association in the sector, having been established in 1871 and transformed into the Colombian Agriculturer's Society (Sociedad de Agricultores de Colombia - SAC) in 1906. The National Federation of Coffee Growers was established in 1927 as a response to the crisis in Colombia associated with the First World War. Other related associations are the National Association of Cane Growers (Asocaña) (1959), the National Federation of Cattlemen (Fedegan) (1963), and the National Federation of Palm Oil Growers (Fedepalma) (1962) (Junguito Bonnet, 2019).

Some of the international organizations that are directly and indirectly related to the sector are the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme, the Inter-American Institute for Cooperation on Agriculture, the World Health Organization, the Pan American Health Organization, the United Nations Development Program, the Tropical Agricultural Research and Higher Education Center (CATIE), the International Center for Tropical Agriculture (CIAT), and the International Fund for Agricultural Development (IFAD), among others (UN Environment - One Planet Network, 2018).

Similarly, there are various players along agricultural value chains. From suppliers of raw materials (seeds, fertilizers, etc.) to end users, these include producers of varying sizes, processors, marketers and consumers. There is also a very important group in charge of transport and logistics (Tecnoalimenti S.C.p.A., 2006).

Finally, there are several relevant research institutions. These include universities and research centers, as well as technical groups associated with municipalities, which are referred to as Municipal Units of Agricultural Technical Assistance.

³ These corporations receive both public and private funding.

Clustering and Organization of the Sector

The Ministry of Agriculture and Rural Development of Colombia oversees the country's agricultural sector. To organize the sector, it has established groups called "clusters." These are regional structures that undertake deliberate and concentrated efforts to catalyze the development of economic conglomerations, i.e. the entire public and private institutional system that supports the crops present in that specific region. Clusters include universities, research centres, NGOs, etc. Examples of clusters in Colombia are the Cacao of Antioquia Cluster, the White Protein Cluster⁴ and the Coffee of Antioquia Cluster (Castellanos, Rojas, Villarraga, & Ustate, 2001).

The purpose of a cluster is to work around production chains, based on a strategy created in the 1990's by the Colombian government intended to foster productivity and regional competitiveness. Under this strategy, decision-making at the regional level is decentralized by crafting policies whose methodologies include business practices (Castellanos et al., 2001).

The most important production chains managed by the MADR's Directorate of Production Chains are cocoa, forestry, fruits, corn, palm oil, soy, rice and forest pasture systems, among others. Each one of these chains has its own development goals. To achieve them, the Ministry organizes national roundtables. These involve, in the first instance, the institutions assigned to the Ministry, as well as unions and to a lesser extent agricultural producers, depending on the specific chain and the union to which its producers belong. Some unions, such as the National Federation of Coffee Growers of Colombia, have recognized representatives and solid structures with significant political power. In other chains, such as the cocoa and fruit chains, small and medium producers are well represented, while large landowners mainly control those concerned with corn, soy, rice, palm products, rubber, and forestry.

Development and investment projects based in agreements between the public and private sectors respond to the immediate needs and requirements of the production chains by creating short-term initiatives. Such is the case for the "Colombia Siembra Strategy⁵", which in 2016 proposed to promote the planting of one million new hectares of crops to foster inclusive, sustainable and competitive development of the Colombian countryside (Ministry of Agriculture and Rural Development of Colombia, 2016). This suggests that there is an interesting opportunity to promote foresight and future research studies for the development of the sector in the country.

⁴ White protein refers to the Spanish "proteína blanca", meaning poultry, egg, and pork production.

⁵ "Colombia planting or sowing"

Agricultural Policies

There are different policies that guide the actions of the different stakeholders in the sector. In 2015, the OECD developed a detailed analysis of agricultural policies in Colombia (OECD, 2015). As a result, it was found that:

- The country has abundant natural resources that are a basis for agricultural potential
- Different reforms have been developed that contribute to building a stable macroeconomic framework.
- The agri-food sector's contribution to GDP is falling, even though it remains significant for creating employment.
- Although poverty rates have fallen, inequality remains very high.
- The agricultural sector faces significant structural challenges.
- The institutional framework has profound weaknesses.
- Productivity is low, with competitiveness impacted by poor infrastructure and weak supply chains.
- There are conflicts related to land tenure (e.g. unequal access) and land use.
- There is a lack of innovation in the sector.
- Export competitiveness has declined.
- Producers have different support mechanisms, mainly including market price and input subsidies. Such support is high, being one point above the OECD average and on a par with Korea (1.9%).

This situation invites different governmental and private actors to think of new models that allow the integration of disruptive solutions to improve the condition of the sector.

Among other measures, the following agricultural policy instruments are being applied in Colombia: i) National policy instruments; ii) Market price interventions; iii) Production-based payments; iv) Payments for variable inputs; v) Subsidized interest rates; vi) Insurance; vii) Tax concessions; viii) General services provided to the agricultural sector as a whole; ix) Infrastructure; x) Research and development; (xi) Marketing and promotion; (xii) Inspection services; (xiii) Land restructuring programmes; (xiv) Trade policy instruments; (xv) Import tariffs; (xvi) Tariff quotas; (xvii) Safeguards; (xviii) Import licensing; and (xix) Food and SPS security (OECD, 2015).

Finally, the OECD presents five policy recommendations: i) Support for agriculture should focus on long-term structural reforms; ii) Improved land rights and land use should contribute to the long-term growth of the agricultural sector; iii) The institutional framework of agricultural policy should be improved; iv) The agricultural innovation system needs to be strengthened; and v) Further integration into international agri-food markets is essential.

These recommendations were used as inputs for group discussions involving different participants during the workshops held during the PECOLO project.

The Strategic Plan for Science, Technology and Innovation of the Agri-Food Sector in Colombia – PECTIA

One of the results of the OECD’s recommendations was the PECTIA. This is one of the most comprehensive documents in which the agricultural sector in Colombia has been considered, involving the development of a 10-year outlook (covering the period from 2017–2027). The main document is made up several chapters. One chapter focuses on the conceptual and methodological framework, followed by a diagnostic chapter in which the megatrends of the sector and a RDI agenda is explained. A third chapter presents the strategic plan involving six specific factors and transversal enablers. The fourth chapter presents the implementation mechanisms and follow-up actions (Administrative Department of Science, Ministry of Agriculture and Rural Development of Colombia and Colombian Corporation of Agricultural Research (CORPOICA), 2016).

In addition, Agrosavia’s⁶ website contains a library with specific documents organized by department and production chain as well as other relevant annexes. The document that covers quinoa will be discussed later.

One of the main inputs of the PECTIA is the identification of megatrends of the global environment affecting the agricultural sector (see Table 1). These were also some of the key inputs of the PECOLO project’s workshops.

Table 1. Megatrends of the global environment identified in the PECTIA. Source: Administrative Department of Science et al., 2016, p. 26.

Megatrends	Key aspects
Dynamics of urban consumption	<ul style="list-style-type: none"> • New consumption patterns with negative health consequences. The three main problems identified were obesity, malnutrition and undernutrition (Guzmán 2014). • More diverse food consumption; foods processed for cooking at home; and take away foods/home delivery.
Production, processing and distribution of food	<ul style="list-style-type: none"> • 50–70 % of the total food cost for urban consumers in emerging economies is in the post-farming segments found of the value chain. • Direct sales and commercial arrangements have a positive effect on marketing and income.
Food quality and safety	<ul style="list-style-type: none"> • Observations on the links between supermarkets and food safety, diets and prices in developing countries show that supermarkets are promoting food quality and safety.

⁶ Available at <https://repository.agrosavia.co/handle/20.500.12324/12759>

The Sector's Contribution to the Economy

Although the agricultural sector's share of national GDP has been decreasing, its added value has grown significantly. In 1965, it represented 27.2% of GDP, equivalent to US\$ 4.9 trillion, while in 2018 this had declined to a 6.3% share, equivalent to US\$ 24.2 trillion⁷ (The World Bank, 2019a, 2019b).

The sector's GDP growth has been below the level of growth in the nation's GDP as a whole. In terms of production value, an average growth rate of 2.6% has been reported. A trade surplus has been recorded, with agricultural products having a 3% share of exports that is mainly composed of bananas, sugar, and coffee. However, imports of products such as corn, wheat and soybeans have increased (Departamento Administrativo de Ciencia et al., 2016).

Challenges of the Agricultural Sector

In Colombia, the agricultural sector is facing several complex challenges. PECTIA (Departamento Administrativo de Ciencia et al., 2016) defined a series of factors affecting the agricultural sector's environment in the face of global dynamics.

The first challenge is competitiveness. A series of 11 free trade agreements have created competitive advantages for the sector in exporting flowers, fruits, vegetables, beef and cocoa, among others. However, PECTIA stresses that the cost structure of the sector is highly dependent on imports that are difficult to replace. It is also noted that by 2013, 65.5% of technical assistance was concentrated in farms less than 5 ha in size.

Secondly, the environment is being challenged by the expansion of the agricultural frontier into vulnerable ecosystems. In the case of Andean crops, conservation areas and *páramos*⁸ are being especially affected. Additionally, the uncontrolled use of agrochemicals is increasing pressures on soil, air and water.

The third point concerns climate change, including the variation in climate caused by the El Niño and La Niña effects, which increase pests, diseases and water stress, among other impacts.

The fourth issue is food security, where PECTIA emphasizes that Colombia has improved its ranking in the global hunger index, but very slowly when compared to other countries in the region. The impact of malnutrition, undernourishment, and problems of access to food nationally are also highlighted.

The fifth concern is the production and economy of rural areas. Rural participation in agriculture stands out, with 87% of production units even though they are home to only 24% of the population. Most units are less than 5 ha, and 67% of permanent workers are also members of the producing household.

Sixth on the list are challenges surrounding land tenure and rural development. Many properties have inadequate production resources, relying mainly on water and soil. In addition, most of the productive units (74%) are not worked by their legal owners. At the same time, 15% of agricultural lands have been stripped and abandoned and the remaining 5.8 million hectares given to existing mining titles or new land uses.

Seventh comes rural poverty and employment. 56.6% of the inhabitants of rural areas live in poverty, with 23% in extreme poverty. Basic needs are not being satisfied for 53% of these households. This means that peasants are the group with the least opportunities in society, as 83% have no machinery or infrastructure to carry out production activities and 89% have not applied for loans.

⁷ The analysis is made in Constant USD for 2010.

⁸ *Páramos* are highland ecosystems, treeless highland plateaus in tropical South America.

Finally, the eighth challenge is rural-urban migration. Approximately 100,000 people per year move from rural to urban areas: 60% for economic reasons and 40% because of violence. There is also evidence of youth migration due to lack of employment, agricultural consolidation, and other problems affecting national production.

Other challenges in the sector are mainly of a political and technical nature. The Organization for Economic Growth and Development (OECD)'s analysis of agricultural sector policies highlights, among other things, the low level of government investment in public services and goods, rural conflict, lack of infrastructure and scarce economic resources, all of which make it difficult to create the conditions for growth (OECD, 2015). On the other hand, with regard to technical challenges, the Banco de la República highlights low average yield per hectare compared to other countries due to lack of technification as one of the major problems in the sector. This makes the country uncompetitive in international markets (Cárdenas et al., 2018).

Andean Crops in Colombia

The Andean Mountains are the longest continental mountain range on the planet. They are 8500 km long, extending from southern Chile (Tierra del Fuego), to Venezuela while passing through Bolivia, Peru, Ecuador and Colombia. The Andes are part of the ring of fire⁹, which is one of the reasons for its complex terrain (between 0 and 6800 m). This mountain range has been characterized as one of the great centers of origin and domestication of numerous food plants that are now cultivated in various ecological areas (Guerrero, Gallucci, Michalijos, & Visciarelli, 2011).

In the southern part of Colombia, the Andes have a first division in the Nudo de Los Pastos a second one later on, forming in total three distinct mountain ranges: Western, Central and Eastern. This condition, along with other factors such as geographical location, the influence of weather, and hydrogeological systems, has benefited the country's biological and cultural diversity. Thus, Colombia is the most biodiverse country when measured as the number of different species per square meter (Ochoa, 2011).

⁹ Also known as the Rim of Fire is an area of the basin of the Pacific Ocean with a high volcano activity (earthquakes and eruptions). This has defined a complex orography. As a result, both cultural and biological diversity in this region is very high.

Types of Crops

The abundance of biological diversity has resulted in the development of many Andean crops, each specific to their national territory. Below, we list some of the major crops.

Table 2. Main Andean crops in Colombia. Source: own elaboration, based on (Izquierdo & Roca, 1998; Tapia, 1997).

Common Name	Scientific Name
Grains	
Amaranth	<i>Amaranthus spp.</i>
Chachafruto	<i>Erythrina edulis</i>
Chia	<i>Salvia hispanica</i>
Guama	<i>Lonchocarpus domingensis</i>
Pigeon pea	<i>Cajanus cajan</i>
Kiwicha	<i>Amaranthus caudatus</i>
Qanihua	<i>Chenopodium pallidicaule</i>
Quinoa	<i>Chenopodium quinoa</i>
Tarwi	<i>Lupinus mutabilis</i>
Tubers	
Achira	<i>Canna indica</i>
Ahipa	<i>Pachyrhizus ahipa</i>
Arracacha	<i>Arracacia xanthorrhiza</i>
Rubas Chuguas, or Olluco	<i>Ullucus tuberosus</i>
Cubios, or mashawa isano	<i>Tropaeolum tuberosum</i>
Maka	<i>Lepidium meyenii</i>
Oca (ibias)	<i>Oxalis tuberosa</i>
Pope	<i>Solanum tuberosum</i>
Yacon	<i>Smallanthus Sonchifolius</i>
Fruits	
Pumpkin	<i>Cucurbita maxima</i>
Cowpea (Cherry)	<i>Vigna unguiculata</i>
Curuba	<i>Passiflora tarminiana</i>
Guatila	<i>Sechium edule</i>
Wild Mora	<i>Rubus ulmifolius</i>
Papayuela	<i>Vasconcellea pubescens</i>
Tree Tomato	<i>Solanum betaceum</i>
Cape gooseberry	<i>Physalis peruviana</i>

Productivity

Several studies have shown that the productivity of agricultural systems in Colombia is below global averages. Studies of the main agricultural products have shown that, except for cocoa and coffee, the agricultural yield in tons of product per hectare per year is lower than the global average (Loboguerrero, 2018). In general terms, this low ratio is due to a number of different factors, including inefficient technologies for crop management and control, and inefficient and costly infrastructure for logistics (mainly inputs).

When analyzing Andean crops specifically, the trends are similar. In the case of quinoa, for example, Peru reports yields of between 1.16 and 4 tons per hectare. In contrast, Colombia has average yields of only 1.7 tons per hectare.

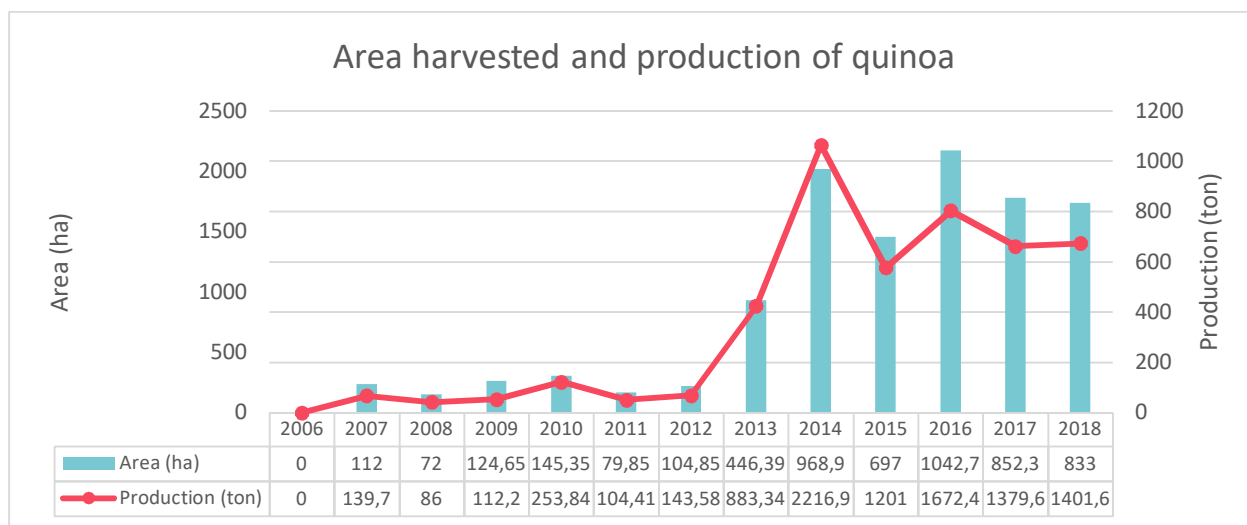


Figure 1. Area harvested and quinoa production in Colombia. Source: (Agronet, 2019)

Functional Components and Nutrition of Andean Crops

Functional foods are those that deliver health benefits to consumers beyond nutritional factors. In some cases, they are referred to as nutraceutical foods, since, in addition to contributing to nutrition, they may have a pharmaceutical purpose in providing health benefits to consumers. Components of different foods that provide these kinds of benefits include carotenoids, dietary fibre, fatty acids, sterols, pre- and probiotics, and lactobacilli, among others (Keservani, Sharma, Ahmad, & Baig, 2014).

Leidi et al. (2018) present a detailed study of the functional properties of four Andean crops. A synthesis is presented below:

- Aracacha (*Arracacia xanthorrhiza*) is used in traditional medicine to facilitate the elimination of the placenta. It also works as an anti-inflammatory, diuretic and antidiarrheal. Aracacha has a low glycemic index as well as varying carotenoid content. It also contains phenolic compounds, which have been found to work against cancers and cholesterol.
- Yacon (*Smallanthus sonchifolius*) has traditional medical uses in treating diabetes and kidney problems. This tuber contains FOS, which is considered a prebiotic, as well as antioxidants.
- The ahipa (*Pachyrhizus ahipa*) is a tuber that is not well-known in Colombia. It is cultivated in the Andean region and has benefits for digestive and kidney problems. Its starch content can reach 65%, which makes it a functional food for celiac diets.
- The cubios (*Tropaeolum tuberosum*), also known as mashua or isaño mashawa offers benefits for the skin, liver and kidneys. It contains a significant concentration of vitamin C, antioxidants and glucosinolates. Glucosinolates promote anti-fungal, anti-bacterial, antioxidant and anti-cancer activity in the body.

The Role and Challenges of the PECOLO Project in the Colombian Context

The PECOLO project supports the development of innovation environments for native Andean crops in Peru and Colombia. Andean crops are important at local, regional and international levels and have a great potential for growth. Andean crops present a wide variety of benefits for producers, as well as for consumers seeking healthy and functional food alternatives. Implementation of good agricultural practices and appropriate technologies can help reduce the sector's environmental impacts and support climate change adaptation.

Currently, agriculture in Colombia and other Andean countries face several challenges and opportunities. These include environmental and technological factors, business models, and national agendas.

The first factor includes issues related to climate variability, modeling of climate change scenarios, availability of water resources and soil contamination, among others. These factors significantly affect productivity, increase exposure to pests and diseases and translate into public health problems associated with bioaccumulation and biomagnification of elements such as heavy metals along the food chain.

Second, the appropriate use of soft (knowledge) and hard (tools) technologies is highlighted. Colombia has been characterized by small producers using basic technologies. This makes it difficult to control productive variables such as the management of nutritional variables to identify optimal points of application, technical soil studies, use of rudimentary machinery, development of inefficient work culture and increased food loss due to cultural management practices.

Third, the business model of small producers has been considered a permanent challenge in the country. This consists of short-term planning, without ensuring the purchase of the product. Usually, small producers work their plot (land) and due to market failures are only able to sell their products, which are mostly without added value, at low prices. In some cases, the price received does not cover production costs. This means that the small producer needs to subsidize some of the products, reducing their profit and undermining the economic sustainability of production.

Fourth, it highlights national agendas. One of the great challenges, but also a great opportunity, corresponds to the historical moment in which the country finds itself today. The peace agenda negotiations included two fundamental elements: 1) return to the countryside¹⁰ and 2) strengthening of the agro-productive sector. Thus, national institutions (including Ministries, Governments, Mayors and funding agencies, among others), have set their sights on strengthening this sector and promoting innovation ecosystems that favor the work of small producers.

Finally, a great challenge will be to establish a permanent process or program for foresight looking at Andean crops in cooperation with key actors. Dreyer and Stang (2013) suggest that the following criteria should be met when designing good foresight programs:

1. Identify the target audience precisely. It should not be about a "type" of person or a generalized "political community", but instead address a definable and specific list of organizations and individuals,

¹⁰ Due to decades of internal conflict, millions of Colombians had to leave the countryside. <https://www.unhcr.org/colombia.html>

2. Include the participation of this target audience in the establishment of the agenda and in the different stages of the prospective process. Ensure that the products are targeted to their requirements,
3. Communicate clearly and directly in language accessible to the target audience,
4. Maintain close links with decision-makers and policy makers,
5. Establish a clear relationship between foresight issues and the political agenda of the moment,
6. Cooperate with other agencies, both nationally and internationally,
7. Develop consistent sources of long-term funding,
8. Work iteratively. Foresight work often involves a large group of participants, and converting their inputs into useful products is difficult without feedback loops,
9. Establish programs rather than isolated projects. There is a learning curve for doing foresight work. Programs allow for a learning process and continuity of personal involvement,
10. Create scenarios, use them, and then create new scenarios based on feedback and verification.

From the above criteria, it is easy to understand that the four-step foresight process that was carried out during this 2.5-year project is only a starting point for a sustainable innovation environment or system. The development of a comprehensive program requires further funding, coordination and commitment from the stakeholders of the current project.



2. METHODS

Futures Studies and Foresight

Futures studies and foresight as a theoretical and methodological approach

Futures studies was established as a scientific field in the 1940s (Flechtheim 1971) and is today an academic field in several countries. Futures studies refers to a systematic, holistic, multidisciplinary and critical long-term analysis of futures topics and their alternative developments. It is essentially the study of multiple alternative futures and not an art of prediction (Amara 1981). Futures studies is about exploring future images. A central method for doing this is using scenarios.

Foresight is a more recent development. It is a very practically oriented approach to futures thinking, debating about the future, and creating the future. Foresight provides a framework and structured debate platform for a group of people concerned with common issues at stake to jointly think about the future in a structured and constructive way. Both futures studies and foresight aim at supporting decision-making (i.e. policy makers, experts, companies, and other stakeholders) to develop visions of the future and pathways towards these visions (Heinonen et al., 2017). Foresight is applied as a strategic tool – as strategic foresight – in companies and governments, but it can be applied in any organisation hoping to explore its future prospects and to develop new innovations (Von Schomberg 2007). Typically, foresight is conducted within companies and governments and has a slightly shorter time horizon (3-5-10 years), whereas futures studies are more often made in academia and research institutions. However, this distinction does not always hold true. In the PECOLO project, foresight is used to generate futures information and to develop innovation environments focusing on the Andean native crops. It is ultimately a starting point in developing a platform for new forms of cooperation and inclusive innovations.

The participation of stakeholders from different organizations and sectors is a key component of foresight. The objective of inclusive foresight is to use participation to create awareness, anticipate desirable futures, create policy processes, and meet societal expectations related to decision-making processes. Participation is crucial to reach shared goals and visions and can even be used as an indicator in evaluating the success of foresight work (Bourgeois and Sette, 2017).

Futures studies considers different types of *potential* futures. The three classical categories of potential futures are *possible futures*, *probable futures*, and *desirable* (or *preferable*) *futures* (Amara 1981). Later futures literature identifies a fourth category of *plausible futures*. An avoidable or threatening future, as an opposite of desirable or preferable futures, may also be identified. Too often, however, the emphasis is solely on probable futures, leaving out a huge number of missed opportunities that can only be described through an open exploration of possible futures. Another point of attention in futures work is that one should pay attention to future alternatives, remaining aware of and even preparing for undesirable alternatives.

The *futures workshop* is one of the best-known and most used participatory methods in the field of futures studies. It is a convenient way of producing, collecting and communicating views and ideas about potential future developments. In an ideal case, a futures workshop process consists of several successive workshops where the range of potential futures, key challenges and means to influence future developments would be elaborated over the course of the process (Slocum, 2003).

The origin of futures workshops is often associated with the work of the Austrian futurist Robert Jungk. Jungk developed the basic form of a futures workshop to increase democratic participation and to “incorporate a wide range of views, ideas and proposals of people whose lives are affected by some decision” (Bell, 2003). Commonly used names for different types of futures workshops are, for instance, foresight workshops, scenario workshops, backcasting workshops and stakeholder workshops.

Despite differences in names and defining features, all these methods share many common characteristics. Most notably, all of them are efforts to collect and refine the creative ideas and views on possible future developments of the people and organizations taking part in the workshop (Lauttamäki, 2016). Working together to co-create desirable futures creates ownership and the actors are more likely to commit to the action plans proposed.

Futures studies and innovation environments

Innovations can take many forms. For example, they can be new products, services, or forms of cooperation. We can distinguish technological and social innovations. If we think about the novelty and effect of an innovation, radical and incremental innovation can also be considered separate categories.

What is typical for innovations, especially product innovations, is that they often take a long time to develop. Thus, it is important to understand how future developments influence the innovation processes, so that the organization(s) can be prepared for possible future directions. According to Van der Heijden (2006), the link between futures research and innovation can be further strengthened by the lead time and level of uncertainty involved in the innovation process.

The concept of an *innovation environment* describes all the external features and aspects of an organization or company’s working environment that potentially affect its innovation activities and ability to produce innovations. This company-oriented definition can also be substituted with spatial attributes like “regional” or “local”, or with content attributes, such as the development of Andean native crops in the case of PECOLO. Ranta (2012) defines an innovation environment as a whole of independent organizations and institutions in which different individuals and organisations act either purposely or without knowledge of each other in same direction, in order to improve the operational preconditions and business activities of a particular field. When we are talking about actor groups and the dynamics between these groups within a specific geographical region, we can refer to it as a regional innovation environment.

The Futures Process

The PECOLO process consisted of four participatory futures workshops held between 2017 and 2019 (figure 2 below). In the first workshop in 2017, an environmental or horizon scanning of the Colombian agro-food sector was carried out using various methods commonly used in future studies and by FFRC. In the second workshop the outputs of the first workshop were used as an input to develop alternative scenarios up to 2030, with a focus on the desirable scenario. In the third workshop roadmaps were developed for the desirable scenario, and finally in April 2019 an action plan for the sector was co-created by the stakeholders.

The workshops included participants from academic institutions, the public and private sectors and NGOs. The academic experts were selected for their expertise in Andean crops. Representatives from governmental institutions were invited with the aim of potentially influencing future political decisions. Food

companies and NGOs working in Andean native crops were invited as well. The participation of stakeholders from various sectors brings together different perspectives and encourages cooperation. It also creates a basis for local knowledge and a bottom-up planning process. Working together to co-create desirable futures creates ownership and the actors are more likely to commit to the action plans proposed.

In each futures’ workshop, stakeholders representing different sectors and organizations were divided into groups of 5-7 persons. The aim was to form groups with diverse backgrounds to ensure a variety of perspectives and expertise. During the process, the participants also strengthened their foresight thinking, benefitting their organization and their own professional development. No previous knowledge of futures studies and foresight was required. In each workshop each group had a facilitator. With a few exceptions, all the facilitators were local experts who were trained to use the methods chosen for that workshop. The experts from Finland Futures Research Centre supported the work of each group and the facilitators.

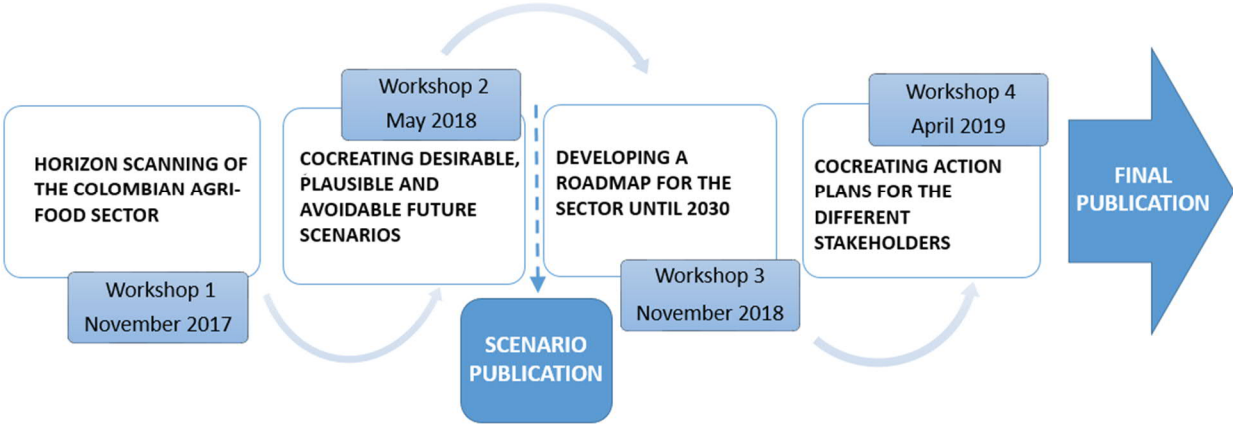


Figure 2. The four-step process of the project for the development of the innovation environment for Andean native crops.

Workshop 1 methods

In the first workshop, horizon scanning was carried out for the purpose of mapping the key topics that define the Colombian agro-food sector. In Futures Studies terminology, Horizon Scanning (or Environmental Scanning) refers to identifying “new developments that can challenge past assumptions or provide new perspectives about future threats or opportunities” (Gordon and Glenn, 2009). Topics and issues related to the agro-food sector, with a focus on the Andean native crops, were discussed among the experts using three futures studies tools.

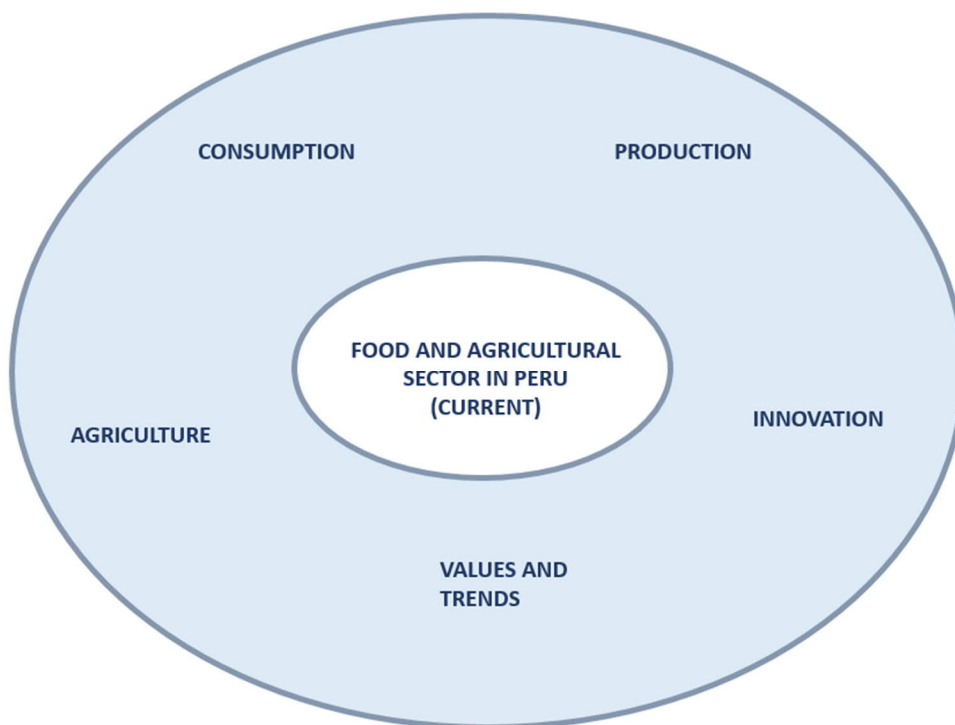


Figure 3. An adapted version of the futures wheel (or state-of-the-art-wheel).

The first method was an adapted version of the Futures Wheel (figure 3), a “current state of the art wheel” used as a tool for organizing ideas and inspiring discussion. The objective was to create a shared understanding of the current state of the sector. This method was originally created by Jerome C. Glenn in 1971. Since then, it has been used as a tool for brainstorming in a structured way. A Futures Wheel is commonly used in workshops as a tool to engage participants in thinking about issues and their consequences. Whereas the original Futures Wheel is generally used to identify and frame future topics, in this case the adapted version was used to frame current topics.

The key focus of the discussions was written in the middle circle. In the outer circle five key topics around which the discussions were focused were added. These were *consumption*, *production*, *innovation*, *values and trends*, and *agriculture*.

The groups started the discussions by focusing on the general issues defining the current agro-food environment in Peru, writing each topic on a separate post-it note which was then placed in the inner circle. The outer circle topics with a focus on the agro-food sector were then identified using the same procedure.

In the second step, a PESTEC table (table 3) was used as a tool to systematically map PESTEC factors (Political, Economic, Social, Technological, Environmental, and Cultural) defining the agro-food sector. In this PESTEC table, megatrends, trends, weak signals, and wild cards were identified for the each of the PESTEC factors. This method helped the experts to think about the topics from different perspectives and even use their imagination, as the identification of weak signals and wild cards is not always easy.

Table 3. The PESTEC table used to cover megatrends, trends, weak signals and wild cards (potentially) affecting the Colombian agro-food sector.

	MEGATRENDS/ MEGATENDENCIAS	TRENDS/ TENDENCIAS	WEAK SIGNALS/ SEÑALES DÉBILES	WILD CARDS/ EVENTOS INESPERADOS
POLITICAL/ POLITICO				
ECONOMIC/ ECONÓMICO				
SOCIAL/ SOCIAL				
TECHNOLOGICAL/ TECNOLÓGICO				
ENVIRONMENTAL/ AMBIENTAL				
CULTURE/ CULTURAL				

As a final step, each of the expert groups first identified the five key topics and issues from the Futures Wheel and PESTEC table that in their opinion were the key topics defining the agro-food sector. Then, they used them as inputs for an ACTVOD table (table 4). For each of these five topics (which were different for all groups) *Actors*, *Customers*, *Transformational processes*, *Values*, *Obstacles* and *Drivers* were identified.

ACTVOD futures workshop is indebted to several earlier concepts developed within futures studies. It is an attempt to combine elements of exploratory and normative futures studies in one session, intending to spur creativity and produce interesting results in a straightforward and time-efficient manner (Lauttamäki, 2016).

Table 4. The ACTVOD table used in the last session of workshop 1. Each group chose the five most important topics from the two previous steps of the group and identified actors, consumers, transformational processes, values, obstacles and drivers for each of them.

	[TOPIC 1]	[TOPIC 2]	[TOPIC 3]	[TOPIC 4]	[TOPIC 5]
ACTORS/ ACTORES					
CONSUMERS/ CONSUMIDORES					
TRANSFORMATIONAL PROCESSES/ PROCESOS DE TRANSFORMACIÓN					
VALUES/VALORES					
OBSTACLES/ OBSTÁCULOS					
DRIVERS/ MODULADORES DEL CAMBIO					

Workshop 2 Methods

The objective of the second workshop was to develop scenarios for the Colombian agro-food sector until 2030 using a futures table. Each of the groups co-created their own futures table and a scenario narrative for what they saw as the sector’s desirable future.

A scenario is a description of how the future may unfold according to an explicit, coherent and internally consistent set of assumptions about key relationships and driving forces. A scenario consists of two key elements: 1) A description of the end-state, i.e. what does the world look like at the end of the time horizon for which the scenario has been developed (e.g. in 2030 in the case of PECOLO) and 2) A logical storyline explaining how this future came about, describing a sequence of events in a timeline. The selection of a name for the scenario helps to differentiate, communicate and remember them (Van der Heijden, 2006). In the PECOLO process, desirable, avoidable, and plausible future developments were identified. All of these is a type of possible future.

Using the results of the first workshop, participants of the second workshop selected six important factors from the first workshops defining the agricultural innovation system, keeping in mind that the factors should cover the sector in the broadest way possible. The participants were given the advice to consider PESTEC aspects when selecting the factors, although they were not restricted to this framework. Each group then constructed a Futures Table (Table 5).

The tables consisted of nine lines and five columns. The six factors picked from the results of the first workshop became variables of the futures table (left hand column), and participants filled in four different possible futures states, or future developments, for each of these variables (from A to D) using their expert knowledge of the field. Relevant Megatrends, Black Swans and Weak signals affecting all these futures states were also suggested.

Once the table was completed, participants drew paths for desirable, avoidable, and plausible scenarios. Each group wrote a scenario narrative for the desirable scenario.

To have one combined version that the participants could agree upon, the experts received a draft of the combined futures table and the scenario narrative and were asked to give any further feedback they chose.

Table 5. *The futures used as a tool to create alternative futures (desired, plausible and avoidable).*

	ALTERNATIVE FUTURE STATE A	ALTERNATIVE FUTURE STATE B	ALTERNATIVE FUTURE STATE C	ALTERNATIVE FUTURE STATE D
VARIABLE 1				
VARIABLE 2				
VARIABLE 3				
VARIABLE 4				
VARIABLE 5				
VARIABLE 6				
Megatrends				
Weak Signals & Black Swans				

3. RESULTS

Workshop 1 Results: Horizon Scanning

The first workshop was held in Bogotá in November 2017, with the participation of both academic and non-academic actors (including territorial entities, companies, and mixed organizations).

The objective of the first workshop was to frame the current innovation environment and the development challenges for the next 10 years, in order to create a common understanding of the issues that define the current innovation environment of the Colombian agro-food sector and specifically native Andean crops.

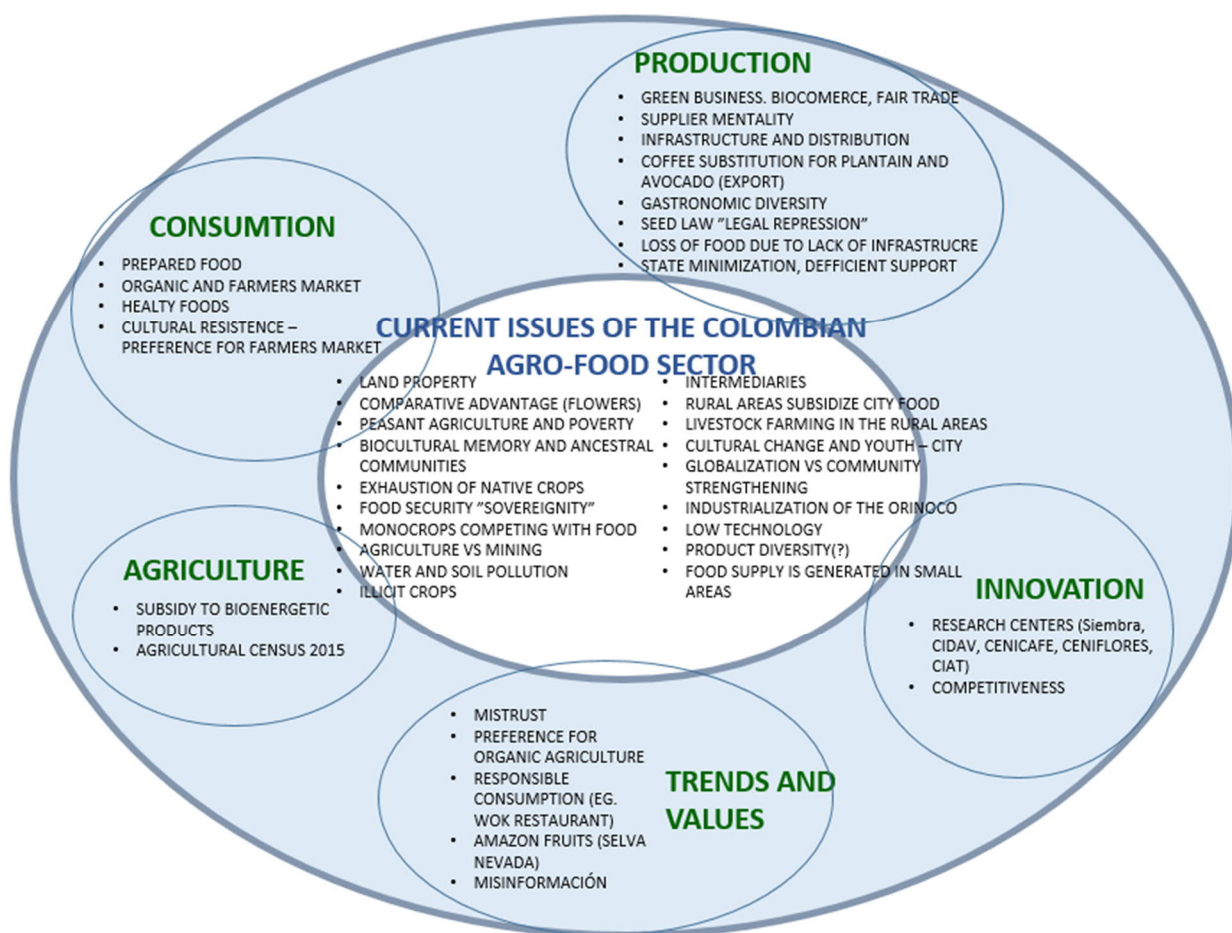


Figure 4. The futures wheel (used as current state of the art Wheel) of one of the expert groups.

Table 3. The results of the PESTEC table of one of the groups.

FACTORS	MEGATRENDS	TRENDS	WEAK SIGNALS	WILD CARDS
POLITICAL	<ul style="list-style-type: none"> SUSTAINABLE DEVELOPMENT OBJECTIVES CORRUPTION DOMINANT MONETARY POLICY 	<ul style="list-style-type: none"> POLARIZATION DEFORESTATION POSCONFLICT VENEZUELA CRISIS 	<ul style="list-style-type: none"> EMPOWERMENT OF WHAT IS RURAL AND SUSTAINABLE MIGRATION FROM URBAN TO RURAL AREAS 	<ul style="list-style-type: none"> CONFLICT CHANGE IN AGRARIAN POLICY BI-NATIONAL CONFLICT
ECONOMIC	<ul style="list-style-type: none"> UNSUSTAINABLE PRODUCTION GLOBALIZATION 	<ul style="list-style-type: none"> UNFAVOURABLE FTAs AGROINDUSTRY IN THE ORINOCO REGION ENTRY INTO THE OECD 		<ul style="list-style-type: none"> CHANGE FROM A MINING TO AN AGRICULTURAL ECONOMY AS THE VISION FOR DEVELOPMENT
SOCIAL	<ul style="list-style-type: none"> CONSUMERISM 	<ul style="list-style-type: none"> FORCED DISPLACEMENT LESS RURAL WORKFORCE ORGANIC CONSUMPTION 	<ul style="list-style-type: none"> FAMILY DIVISION 	
TECNOLOGICAL	<ul style="list-style-type: none"> ALTERNATIVE ENERGIES 	<ul style="list-style-type: none"> HARBOUR MODERNIZATION 	<ul style="list-style-type: none"> TECHNOLOGICAL GAP APPS FOR THE COUNTRYSIDE 	<ul style="list-style-type: none"> GMO AND NANOTECH TOXIC EPIDEMICS
ENVIRONMENTAL/ ECOLOGIC	<ul style="list-style-type: none"> CLIMATE CHANGE 	<ul style="list-style-type: none"> ECOSEALS, ECOLABELS COMPETITION OF FOOD PRODUCTS WITH BIOFUELS AND MINING WATER AND SOIL POLLUTION 	<ul style="list-style-type: none"> DISASTERS 	
CULTURAL	<ul style="list-style-type: none"> ENVIRONMENTAL AWARENESS 	<ul style="list-style-type: none"> FARMERS MAINTAIN THEIR "STRENGTH AND FIGHT" 	<ul style="list-style-type: none"> HEALTHY FOODS 	<ul style="list-style-type: none"> OVERCOMING MENTAL BLOCKS

The PESTEC analysis was used to map the megatrends, trends, weak signals, and unexpected events covering the Colombian agro-food sector's political, economic, social, technological, environmental and cultural aspects. Using different types of tools allows participants to observe the sector of interest from different angles.

The ACTVOD table was used to identify and discuss which actors, consumers, transformation processes, values, obstacles and factors were related to the five topics that each group chose to pursue after completing their PESTEC analysis and the Futures wheel. The results of the ACTVOD analysis were also used in the following workshop in which the scenarios were developed.

Table 4. Results of the ACTVOD table of one of the groups.

	WATER AND SOIL POLLUTION	CONSUMPTION OF ORGANIC AND NATURAL PRODUCTS	LESS LABOR	POOR INFRASTRUCTURE	LAND PROPERTY
ACTORS	<ul style="list-style-type: none"> ILLICIT CROPS CATTLE FARMING MINING INDUSTRIALIZED AGRICULTURE INDUSTRY URBAN POPULATION 	<ul style="list-style-type: none"> ORGANIC TRADERS ORGANIC PRODUCERS ENVIRONMENTAL ORGANIZATIONS 	<ul style="list-style-type: none"> MIGRATION OF YOUNG POPULATION TO CITIES DISPLACED PEASANTS 	<ul style="list-style-type: none"> AGRICULTURAL MINISTRY NATIONAL AND DEPARTMENTS MUNICIPALITIES INVIAS – NATIONAL ROADS INSTITUTE 	<ul style="list-style-type: none"> MINISTRY OF AGRICULTURE LANDLORDS PEASANTS
CONSUMERS	<ul style="list-style-type: none"> ECOSYSTEMS URBAN AND RURAL POPULATION 	<ul style="list-style-type: none"> VEGANS AND VEGETARIANS ORGANIC CONSUMER NATUROPATHIC MEDICINE 	<ul style="list-style-type: none"> AGRIBUSINESS ENTREPRENEURS 	<ul style="list-style-type: none"> RURAL POPULATION TRADERS TRANSPORTERS 	<ul style="list-style-type: none"> SHARECROPPERS LAND TRADE
TRANSFORMATIONAL PROCESSES	<ul style="list-style-type: none"> ENVIRONMENTAL EDUCATION CONSTRUCTION OF DAMS (HYDROELECTRICITY) MONOCROPS INDUSTRIALIZATION MINERAL EXTRACTION TERRITORIAL PLANNING 	<ul style="list-style-type: none"> CLEAN/CLEANER PRODUCTION OF FOOD CLEAN TECHNOLOGY/ENERGY 	<ul style="list-style-type: none"> FARMER TRAINING AGRICULTURAL CRISIS LOSS OF TERRITORIAL IDENTITY POSTCONFLICT 	<ul style="list-style-type: none"> INSTITUTIONAL STRENGTHENING RURAL MODERNIZATION CONTRACTING PROCESSES ENTRY OF MORE EFFICIENT TECHNOLOGIES (4th GENERATION TECH) 	<ul style="list-style-type: none"> AGRICULTURAL REFORM
VALUES	<ul style="list-style-type: none"> ORGANIC PRODUCTION UTILITARIANISM, PURE CAPITALISM ENVIRONMENTAL CONSERVATION 	<ul style="list-style-type: none"> ENVIRONMENTAL AWARENESS FRUGALITY 	<ul style="list-style-type: none"> UNDERVALUATION OF RURAL WORK 	<ul style="list-style-type: none"> ROAD SECURITY 	<ul style="list-style-type: none"> TERRITORIAL IDENTITY
OBSTACLES	<ul style="list-style-type: none"> LACK OF EDUCATION WEAKNESS OF THE STATE CORRUPTION 	<ul style="list-style-type: none"> PURCHASING POWER CONSUMISM 	<ul style="list-style-type: none"> LOW LEVEL OF EDUCATION POVERTY IN RURAL AREAS GENERATIONAL REPLACEMENT (SUCCESSION) INTERMEDIATION 	<ul style="list-style-type: none"> ROAD MONOPOLY CORRUPTION 	<ul style="list-style-type: none"> RURAL VIOLENCE
DRIVERS	<ul style="list-style-type: none"> THE STATE, PUBLIC INSTITUTIONS TRADE UNIONS UNIVERSITIES ACADEMIA COMMUNITARY ORGANIZATIONS (PEASANT & INDIGENOUS COMMUNITIES) 	<ul style="list-style-type: none"> ORGANIC FOODS ACCREDITATION ORGANIC AGRICULTURE ORGANIZATIONS 	<ul style="list-style-type: none"> AGRO-INDUSTRIALIZATION 	<ul style="list-style-type: none"> BUDGET PUBLIC POLICY 	<ul style="list-style-type: none"> PEACE AGREEMENT

All of the issues identified by the stakeholders in the agro-food sector using their Futures wheels and PESTEC and ACTVOD tables were analysed. The most frequently cited topics described by the groups were selected for the next step of the analysis and grouped by their relation to different main topics (see Figure 5). **Error! Reference source not found.**

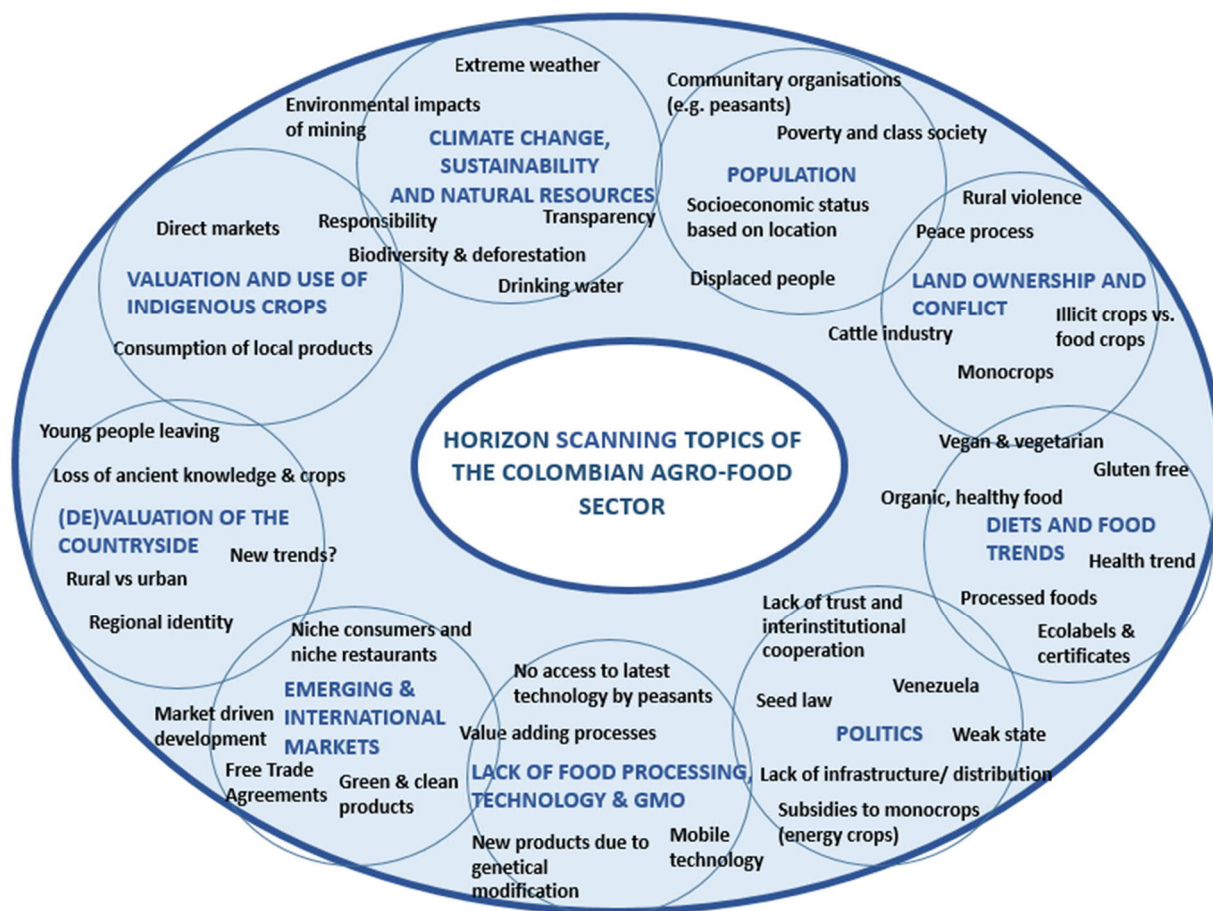


Figure 5. Results of the workshop 1 with topics (in a circle) and the issues (linked to topics).

The ten major topics consistently addressed by all groups (Figure 5) were: population issues; land and conflict; food diets and trends; public policy; lack of food processing, technology and GMOs; emerging and international markets; (de)valuation of the countryside; valuation and use of native crops; and climate change and natural resources. The analysis of the results is structured according to these focal areas, which are also sometimes referred to as lenses. While sorting the various topics into thematic groups aids in examining the issues in detail, it is important to keep in mind that these topics form a system in which the different parts are interconnected.

Population

In Colombia, the latest national census was conducted in 2018. A total of 48 million people was counted, of whom 51.2% are women and 68.2% are between 15 and 65 years of age. Municipal capitals are inhabited by 77.1% of the population, while 15.8% is dispersed across rural areas. Women head 40.7% of households. This phenomenon has complex aspects, given that according to DANE (National Administrative Department of Statistics in Colombia), Colombian households headed by women have a higher incidence of poverty.

Four specific tensions were identified in the workshops: 1) poverty and class society; 2) internally displaced people; 3) the socioeconomic relationships between the countryside and urban areas; and 4) community organizations.

Poverty and the class society

Between 2008 and 2016, both monetary and multidimensional poverty have been reduced, by 14 % and 12.6 % respectively. Currently, the level of monetary poverty is at 28%, while multidimensional poverty is at 17.8%¹¹. Socioeconomic differences remain very marked in Colombia. According to the World Bank, Colombia registered a Gini index of 49,7¹² for 2017, which means that 1% of all income earners garner 20% of the wealth produced in Colombia. About 20% of the Colombian population lives in poverty, particularly in the departments of Guainía (65%), Guajira (51.4%) and Chocó (45.1%).

This difference has increased the tension among the population and is associated with the lack of opportunities and equitable access to education, healthcare, and other basic needs.

Displaced people

For decades Colombians have been affected by displacement. Some displacements are associated with natural events such as floods, landslides and earthquakes. Some recent cases include an avalanche of Armero (1985), an earthquake in Armenia (1999) and an overflow in Mocoa (2017). There are also phenomena such as forest fires and droughts that have affected communities and small agricultural producers in particular.

The second major cause of displacement is forced displacements due to violence. In Colombia violence has been a constant since the Spanish conquest in 1492. At the time of Independence and since the 1940s, a driver has been conflicts that have given rise to guerrillas and extra-legal paramilitary groups. UNHCR has registered 7.8 million persons internally displaced within Colombia due to violence since 1985. As a consequence, belts of marginal settlements in which it is difficult to meet basic needs have grown up around the country's major cities (primarily Bogotá, Medellín, Cali and Barranquilla), resulting in social problems. Many of the displaced are small farmers who come to these cities to seek alternative livelihoods for their families. This is one of the elements that has stood out in peace negotiations. The agreements that the national government currently has aim at facilitating the return of people to the countryside and improving the conditions of rural populations.

¹¹ https://colombia.unfpa.org/sites/default/files/pub-pdf/ASPCOLOMBIA_resumenejecutivo_WEB%20%281%29.pdf pg 11

¹² <https://datos.bancomundial.org/indicador/SI.POV.GINI?locations=CO>

Thirdly, international migration, mainly between Colombia and Venezuela, also stands out. Migration between Colombia and Venezuela has been ongoing for a long time. In the second half of the twentieth century, nearly 800,000 Colombians migrated to Venezuela due to the oil-fueled growth of the Venezuelan economy and the violence in Colombia. Since 2010, migration has reversed because of the economic crisis in Venezuela. It is estimated that there are currently more than 1,300,000 Venezuelans living in the country¹³.

The socioeconomic gap between the rural and urban areas

The socioeconomic gap between the rural and urban population is marked by lack of access to education and public services, and the informality of the productive sectors. Parra-Peña et al. (2013) first identified that the higher the level of income, the higher the educational level, and that in the countryside, the percentage of people who complete secondary education is significantly lower than in the city. Secondly, they highlight that in rural areas, public services for electricity, aqueduct and sewerage cover only 20% to 62% of people, compared with 85% to 99.8% coverage in urban areas nationwide. Finally, the level of informal work in the city stands at 40% while reaching up to 46% in the countryside.

Community organizations

According to the Ministry of Interior of Colombia, a Community Organization is a means through which communities organize, lead and promote community processes through participation. Since 1973, Municipal Associations of Community Action Boards have formed a part of the municipal order. These are spaces where small producers and other residents of different municipalities can have an impact on public policies and social development programs.

Land Issues and Conflict

As in other parts of the world, one of the main socio-political conflicts in Colombia is associated with the difference among land vocation, land use and land tenure . In Colombia there are five major tensions that were identified in the workshops: 1) Cattle raising; 2) Illicit crops versus food production; 3) The peace process; 4) Rural violence; and 5) Monocultures.

Cattle raising

In Colombia, cattle herding has been a long-standing tradition. It is recorded that cattle entered Colombia in 1536 driven by Sebastián de Belalcázar¹⁴. From its beginnings in the north, this activity gradually spread throughout the country, creating livestock models that have come to be associated with conflicts over its location, extent and unsustainable practices. Historically, cattle raising has contributed to the deforestation of natural forests.

¹³ <https://www.unhcr.org/news/press/2019/6/5cfa2a4a4/refugees-migrants-venezuela-top-4-million-unhcr-iom.html>

¹⁴ <https://agronegocios.uniandes.edu.co/2016/03/16/origen-de-la-ganaderia-extensiva-en-colombia/>

According to the agroecological zonification map created by the Agustín Codazzi Geographic Institute (IGAC)¹⁵, Colombia has 114 million hectares of land, of which only 10 million have soils suitable for agricultural crops. Currently, 14 million hectares are being used for livestock, while only 2.7 million have been deemed suitable for this use. This creates a conflict between differing vocations and land uses, affecting overall productivity and the ability to supply enough food for the country's population.

Illicit crops vs. food production

Another tension related to land use and conflict is associated with small producers' illicit crops, which are mainly coca leaves. As of 2017, the country had about 170,000 hectares of illicit crops. Some of the impacts arising from illicit crops are deforestation, displacement, local food shortages and food insecurity, pollution of water sources and emissions. Additionally, this issue has resulted in international conflicts with neighboring countries (mainly Ecuador) Aerial spraying has been used as a method of non-manual eradication of illicit crops. Aircrafts deploying glyphosate have had to fly above the recommended height for spraying to be out of range of armed groups, dispersing herbicides into non-Colombian ecosystems in addition to their intended targets.

However, Colombia has a very strong policy on crop substitution. This includes manual eradication in addition to aerial methods. Restoration processes are required to remediate soil contamination, in order to allow small producers to grow quality food at low cost.

Peace process

The peace process is the result of negotiation between the Colombian government and one of the country's oldest extra-legal groups, the FARC. In 2016, the "Final Agreement to the End of Conflict and the Construction of a Stable and Lasting Peace" was signed. This document highlights 6 elements: 1) A comprehensive rural reform; 2) Political participation (of the FARC); 3) The end of conflict; 4) A solution to the problem of illicit drugs; 5) Victims right to truth, justice and reparation; and 6) Implementation, verification and endorsement of the peace deal.

The first element is directly related to small producers and the transformation of the countryside and society. Its objective is to eradicate extremely rural poverty and, among other aims, to reduce the gap between the countryside and the city by promoting the development of peasant farmers (*campesinos*), family and community agriculture. The goal is that rural people: a) have land; b) can productively use the land and make their living of it; and c) are able to participate in the planning processes of their regions¹⁶.

Rural violence

When discussing rural violence, it is important to note that this is not only violence related to the armed conflict, but also domestic violence. In both cases, violence can take various forms: physical, psychological, sexual, economic, and negligent.

¹⁵ <https://igac.gov.co/es/noticias/ganaderia-al-rojo-vivo-solo-deberia-imponerse-en-el-24-de-colombia-igac>

¹⁶ http://www.altocomisionadoparalapaz.gov.co/herramientas/Documents/Nuevo_enterese_version_6_Sep_final_web.pdf

In 2015, there were about 27,000 reported cases of domestic violence. However, most cases are not reported, making official statistics only the tip of the iceberg. Some of the possible causes of domestic violence include low levels of education and income, high alcohol consumption, unemployment resulting in a sense of futility, and cultural traditions, among others.

On the other hand, the violence associated with the armed conflict involves power struggles, the recruitment of children by different groups, the appropriation of lands and the lack of a state presence. In all of these cases, small producers are also affected.

Monocultures

Monocultures are large areas of land cultivated with a single species. Currently they are known as large-scale crops and are generally associated with negative environmental impacts such as soil erosion, increased use of agrochemicals for the control of pests and diseases, reduction of biological diversity and negative impacts on the traditions of the local community, such as the cultural practices of small farmers and indigenous peoples. However, they are very profitable alternatives to these types of crops, which makes them an element of analysis in programs aimed at the sustainable development of agriculture in the Colombian countryside. Some of the main products grown as monocultures in Colombia are sugar cane, palm oil, coffee, rice, tobacco, bananas, cocoa and avocado, among others.

Diets and Food Trends

The third most frequently mentioned factor in the horizon scanning for the agri-food sector in Colombia was diets and food trends. In the last decade consumption trends have varied significantly. Some of the causes are gastrointestinal diseases such as heartburn, gastritis and cancer, as well as obesity and its associated conditions. Increased concern about the environmental and social impacts of food has also had a significant impact, promoting local foods and those produced with few or no chemicals. Within this topic area, 6 key sub-themes were identified: 1) Processed foods; 2) Organic food; 3) Gluten free diets; 4) Vegan and vegetarian diets; 5) Food certifications; and 6) Healthy eating trends.

Processed foods

The consumption of processed foods has increased in Colombia. The arrival of national and international companies has led to increased access to low-cost processed foods for consumers. The range of processed foods is wide and includes everything from minimally processed foods with no added ingredients (such as washed and cut vegetables ready for consumption, shelled nuts, etc.), to highly-processed products, such as oven-ready frozen foods. In addition to frozen foods, processed foods include canned foods, foods with added ingredients (preservatives and dyes, for example) and highly processed products like cookies, candies and sausages.

Organic foods

Organic agriculture has experienced significant growth globally and it is an interesting market alternative for Colombia. However, there are restrictions associated with the certifications required by certain markets,

which creates obstacles for small producers and consumers. Trust certification programs have had success in some other countries. In Mexico, for example, a valid local verification exists for some regional markets. In Europe, some countries have created low-cost certifications for national markets. This has promoted cleaner production and responsible consumption programs that are free of agrochemicals.

Gluten-free diet

Gluten-free diets have also recently become more common in Colombia. This trend has opened possibilities for new products such as gluten-free breads, pastas, cookies, beers and dressings. However, gluten-free products are often deficient in calcium, fiber, and iron, among other key nutrients that can be found in fortified wheat flour.

Vegan and vegetarian diets

Vegan and vegetarian diets that involve limiting or eliminating animal protein in one's diet are also a growing trend in Colombia. These can take the form of the most strict vegan diets (no animal products at all), as well as a spectrum of vegetarianism based on a range of allowances, such as for consumption of eggs (ovo vegetarians), milk (lactovegetarians), or fish (pecetarian). There are also so-called Flexitarians, who choose to eat meat, fish and animal products infrequently.

One of the reasons for the adoption of vegetarian or vegan diets is concern about the treatment of animals. Climate change and other environmental impacts are another key reason. In Colombia, vegetarian and vegan options in restaurants are becoming more common and an increasing amount of vegan foods can be found in supermarkets. As a result, vegan and vegetarian diets are a very relevant issue for consideration in workshops 3 and 4 (the roadmap and action plans for the agro-food sector).

Food certifications

Different types of food certifications intended to provide information to consumers were mentioned numerous times. Consumers are increasingly seeking more information and detail about food products and the ways they are produced. There are countless existing certificates offering different types of information related to the environmental sustainability of specific foods.¹⁷

However, there are several challenges related to certification. One of them is the cost of certification processes for small producers. In order to facilitate the certification of small farmers, some certification bodies have developed certification programmes specifically for small producer associations, which link several small producers together into a larger production unit. Another challenge is that consumers are not always aware of what certifications mean, keeping them from recognizing their added value.

In Colombia, the Ministry of Environment and Sustainable Development has created the Colombian Environmental Seal. This certification covers 24 different categories, one of which is food products.¹⁸

¹⁷ It is important to note that environmental labels include ecological (carbon emissions, water consumption and good agricultural practices), social (fair trade) and economic (designation of origin) variables.

¹⁸ <http://www.minambiente.gov.co/index.php/component/content/article/366-plantilla-#4%C2%BFcu%C3%A1les-son-las-categor%C3%ADas-de-producto-disponibles-para-optar-por-el-sac>)

Health trend

Food trends and discussions around diets have resulted in greater interest by the community in improving the health conditions of the general population. This issue is of national interest and efforts to address it are led by the Colombian Ministry of Health. Studies have shown that malnutrition and undernutrition are problems associated with the habits and lifestyles of Colombians. In recent years, rates of cardiovascular problems, diabetes, obesity, and cancer have increased and are correlated with these nutritional problems.¹⁹

The agri-food sector in Colombia could improve the quality of life of the population through education programs and the development of nutrition models geared toward reducing health risks.

Politics/Policies

The fourth main issue workshop participants raised is policies related to the agro-food sector. Seven sub-topics were identified in this area: 1) Lack of infrastructure to facilitate distribution; 2) Subsidies for biofuels; 3) Seed laws; 4) Lack of trust; 5) Weak state; 6) Lack of inter-institutional cooperation; 7) Policies relating to the situation in Venezuela.

Lack of infrastructure to facilitate distribution

The enabling conditions for the development of any policy include the will of the parties, opportunity and facilitating mechanisms. One of the fundamental issues for making agricultural policies work is the development of infrastructure that facilitates food distribution, i.e., transportation. According to the Global Competitiveness Index, Colombia ranks 109th out of 137 countries in terms of its infrastructure.

Efforts to improve infrastructure should consider not only road transport, but also the strengthening of rail, river and sea routes to promote trade by connecting the country internally and internationally.

Subsidies for Biofuels

A second policy aspect is that of subsidies for monocultures, particularly those that play a role in energy programs. As part of projects to encourage the development of alternative fuels, the State promotes the development of biofuel programs. Subsidies include tax exemptions for alcohol fuel processes. According to some interest groups, this practice negatively affects the food security of communities.

Seed Act

The third issue that was raised in this area concerns the Seed Act (more formally, Resolution 003168 of 2015 of the Colombian Agricultural Institute). This resolution regulates and controls the production, import and export of seeds that have undergone genetic improvement for commercialization and sowing in Colombia. It also governs the registration of agronomic evaluation units and/or research units for plant breeding.

¹⁹ <https://www.minsalud.gov.co/salud/publica/HS/Paginas/alimentacion-saludable.aspx>

This resolution has been widely criticized by different sectors. Among other concerns, critics point to the lack of intellectual property protections for seeds produced by indigenous, Afro-Colombian and peasant communities.

The Seed Act applies to processes of genetic improvement of rice, corn, cotton, potato, sorghum, peas, oats, barley, wheat, soya, sesame, peanuts, yucca and beans. There is ongoing debate about how small farmers will deal with the use of non-certified seeds.

Lack of confidence

The fourth point relates to the lack of trust between producers and consumers at a national level. This is due to issues such as misleading product information, such as the stated origin of irrigation water for certain products. This lack of trust has been dealt with to some degree through third-party certification. However, cases of producers using expired or unverified certificates have been found.

Another element associated with the lack of trust is the scourge of corruption in the sector. Some years ago, for example, the Government promoted a benefit program for producers called *Agro Ingreso Seguro* (AIS), which offered low-interest loans for productive projects. However, the program ended up benefitting a few large producers and national politicians. Cases of corruption have also been reported in other government agencies such as the Colombian Agricultural Institute (ICA), requiring the intervention of the Colombian Ministry of Agriculture and Rural Development and other entities.

Weak state

The State's presence on the ground across the whole of Colombia's national territory has been weak historically because of the country's long-running armed conflict. In some regions, municipal institutions have made it difficult to oversee production processes, improve infrastructure and develop local policies that generate added value for agri-food products.

Lack of inter-institutional cooperation

A lack of inter-institutional cooperation has followed from weak central authority. In some cases, the relative autonomy of different institutions has makes dialogue and participation with different interest groups difficult. Similarly, at the municipal level there are tensions between State agencies and some other actors (mainly small farmers). In the case of small farmers, acting collectively is difficult, although this would likely result in a significant improvement in their capacity to negotiate with other interest groups.

Policies with the situation in Venezuela

Finally, a fundamental issue is current tensions with Venezuela, which have led to a change in the dynamics of both the border and the rest of the country in recent years. In addition to the management of the international conflict, increased migration offers an interesting opportunity for the agri-food sector in Colombia. The development of supply and support programs for the population of Venezuela, as well as the movement of labor and know-how, could increase Colombia's competitiveness relative to other international markets. However, other types of migration and social security policies for migrants are necessary to develop this potential strength, measures which simultaneously risk worsening internal conflicts.

Lack of Food Processing

Agricultural activity in Colombia has mostly developed as a traditional practice through generations and is now facing several problems. Among them is the lack of infrastructure for irrigation, which forces tasks such as the planting of many species to be performed during rainy periods. This kind of seasonal production means that prices of harvested products depend heavily on supply and demand levels and are subject to significant price variations. Consequently, agricultural activity is less and less attractive and profitable.

In addition, the focus of agriculture has primarily been on the production and marketing of raw materials. If not properly treated and stored after harvesting, these products lose quality over time, resulting in lower prices. In addition, many of these raw materials are sold as fresh products, with intermediaries then adding value and attractive packaging to boost prices. These intermediaries are the ones who end up with the greatest profits while producers face the greatest risks and are often forced to accept prices that do not compensate for the investments they have made.

In order for agriculture to become a profitable activity that benefits producers, primary production must be transformed and commercialized to integrate all the links of production chains. In other words, it must become an agro-industry. However, to be considered as such, the raw materials that are processed must be obtained from agricultural, livestock, forestry and fishing activities. Added value can be given to primary agricultural production through different practices or levels of processing. These can range from the simplest ones, such as sorting, washing, packaging, refrigeration, and dehydration to transformation into more elaborate products such as jams and preserves, which require more technology and equipment. In this sense it is necessary to look for mechanisms that encourage producers to provide added value, so they are the ones who benefit. However, to achieve this, government policies and interdisciplinary work involving the public, private and academic sectors are needed to encourage and modernize agriculture in the country.

Technology

As explained above, traditional agricultural practices have developed over generations. Their purpose has been solely to obtain a product, with neither productivity nor profitability being scrutinized. For example, the same fertilizers are consistently applied because no soil analyses are available to guide farmers in providing the specific nutrients that are needed by their soil for each vegetative cycle. Farmers also lack any information about which fertilizers or manure are most suitable for particular crops. Traditional agricultural activity has not facilitated farmers' access to technologies that would allow them to make primary production processes more profitable using technical means or through adding value to the raw materials they produce. Greater technical assistance would create a situation where producers themselves would receive a better price by engaging in some level of processing of their agricultural products, instead of leaving this to the intermediaries who now benefit from doing so.

Impact of Genetically Modified Organisms on Food Consumption

Just hearing the term "genetically modified organism" can lead to rejection or distrust in many people, because its true meaning is not widely understood. When one delves deeper into and reflects on issues such as how food production is related to food security and the damage that pathogens or insect pests can cause to certain plant species, the reasoning behind the use of this technology may become clearer. In fact, it is focused on the protection or conservation of certain plant species to guarantee the productive

capacity and conservation of other plant species. There is no doubt that GMO foods can create fears regarding the effects that these products may have on human and animal health. There are still no conclusive results about these issues, because long-term monitoring is required. Regulations require the presence of this type of organism to be reported on product labels. The interpretation this label is given by consumers depends on what knowledge they have on the subject.

Emerging and International Markets

Colombia's location and the diversity of its agro-ecological and temperature conditions allows for comparative advantages in sowing and producing a wide range of agricultural products throughout the year. Many of these products are widely accepted in foreign markets, particularly when they are made available off-season in European countries. Such is the case for fruits such as lulo (*Solanum quitoense Lam*), passion fruit (*Passiflora edulis Sim*), uchuva (*Physalis peruviana L*), pitahaya (*Hylocerus undatus*), mango (*Mangifera indica*), soursop (*Annona muricate*) and others. The primary destination countries for both fresh and pulp products of Agribusiness (2019) are European and Asian, as well as the United States. Andean crops, especially quinoa (*Chenopodium quinoa Wild*), are in demand in these markets. Organic quinoa is preferred and fetches better prices. It is surprising that these products are in greater demand abroad than in their countries of origin.

Market-driven development

It is very important to bear in mind that the market communicates what consumers want. In that sense, agricultural production must focus on meeting consumers' food requirements. The idea is not to produce speculatively to see how products sell and who buys them, but instead to produce in response to what consumers demand. This is the opposite of historical practice, which has at times led to an over-supply of some products and shortages of others, creating price fluctuations that end up affecting the purchasing power of those with less income.

Consumer and restaurant niches

Various trends in the consumption of certain foods, particularly those of animal origin, have arisen over time because of changing attitudes. Groups such as vegetarians and vegans have become more prominent. They are seeking a variety of foods that can substitute or replace proteins, vitamins, minerals and nutrients they do not get from meat and animal products. In response to this need, shops, supermarkets, and restaurants are beginning to appear offering a wide range of fresh and processed products that can meet the tastes of this segment of the population.

Free Trade Agreements

Colombia is currently subject to 15 free trade agreements²⁰. Despite this, the value of imported products remains greater than those exported. This demonstrates that from an economic point of view, these agreements do not favor Colombia as a whole and benefit its farmers even less. This situation has discouraged agricultural production of cereals and grains, and large swathes of land on which cereals have traditionally been cultivated are no longer used for this purpose or growing any other crop. It is necessary to work to ensure that exports exceed imports and that the FTAs are truly beneficial for agricultural producers.

Clean products

Consumers have become increasingly aware of and concerned about the serious environmental effects that conventional agricultural production's indiscriminate use of chemical products has been having on natural resources and human and animal health since the Green Revolution. This awareness has led to changes in food consumption and demand trends. Consumers now require their products to be produced without the use of chemicals, i.e. in organic, ecological, or biological ways. According to the convention for Spanish-speaking countries, these approaches are collectively referred to using the term *Ecological*. While in Europe this trend began as early as 1930, in Colombia regulations were introduced only in 2006.

Although cleaner production is a trend and ultimately a necessity, it is important to consider that there may be few incentives for a producer to obtain an organic seal for their product. This process is expensive and time-consuming, despite the increase in price that their products might see as a result.

(De)valuation of the Countryside

Even though the countryside is the place where agricultural and livestock products are grown and harvested to supply urban centers with food, urban dwellers often seem to be unaware of its importance. In fact, peasants are seen as different and inferior persons to city inhabitants because of their situation, and awareness of the contributions the countryside and its inhabitants make must be increased in order for them to receive due consideration.

Ancestral memory and depletion of Andean crops

Knowledge about our ancestors allows us to understand our identity. The failure to take time to look back and investigate the practices of our ancestors is linked to the disappearance of native crops.

Colombia has 102 indigenous communities comprised of 1.2 million people. Many of them do not have a written language, which has made it difficult for histories, including those of ancestral crops, to be passed on. However, in recent years, work has been done to recover ancestral traditions. Preserving the memory of practices such as the use and cultivation of certain seeds strengthen this issue as part of the country's agri-food discussions.

²⁰ The agreements are available at <http://www.tlc.gov.co/acuerdos/vigente>.

Territorial identity

Each geographic region has distinctive environmental, social and cultural characteristics. This allows their inhabitants to value, appreciate and take advantage of the conditions in which they live, whether for the establishment, cultivation and production of a certain plant species, the promotion of tourism, gastronomy, or other activities that over time become typical of each region.

New trends

As mentioned above, consumers are currently looking for products that present fewer risks to their health, that are produced using environmentally friendly processes, that are not processed or do not contain preservatives, and that are easy and quick to prepare.

Young people leaving the countryside

The countryside is becoming depopulated. Young people are not choosing agricultural work precisely because they do not see agriculture as an activity to which they can devote themselves in the way their parents and previous generations have done. Agricultural activity is not profitable and therefore they do not envision themselves as part of the future of the countryside, preferring to look for other types of employment. Those who remain in the countryside are in many cases older people, who due to their age are no longer allowed to work in the fields.

Rural Vs. Urban

The rural sector, despite being the pantry of food production that feeds city dwellers, is not seen as a viable income-generating business for farmers. Because of this, it is no longer attractive for new generations. This situation is encouraging rural dwellers to migrate to large cities, where they often struggle with unemployment and life in conditions of poverty.

As already mentioned, there is significant socio-cultural tensions between rural and urban populations. One of the great challenges that the country has is to be able to present opportunities that allow inhabitants of the countryside to improve their quality of life, including strengthening infrastructure that would allow them to connect more effectively with other communities.

Valuation and Use of Indigenous Crops

In pre-Hispanic times, native crops were the basis of production and food for the inhabitants of the Andean region. Following the arrival of the Spanish, many of these species were relegated to obscurity in Colombia. Today, the research of important organizations such as NASA and the tendency of consumers to prefer foods grown using good agricultural practices that provide an adequate nutritional balance in addition to sometimes being qualified as functional foods and nutraceuticals, have led to these crops being reevaluated. They offer the comparative advantage of being flexible enough to be processed into a rich and varied set of products. This allows them to become the basis of local small businesses. Unfortunately, those who grow these foods are also those that consume them the least, and nowadays the largest areas of cultivation are outside the crops' areas of origin.

Direct markets

All links in the agricultural production chain must be integrated to eliminate intermediaries and give importance to local markets. This will ensure that growers sell their products directly to consumers, thus guaranteeing the quality of the product by not having to transport it over long distances, which can lead to its deterioration. Most importantly, this would enable producers to set prices rather than having to accept the ones imposed by buyers. Currently, many products are harvested and transported to large supply centers where they are purchased in bulk, only to later be distributed again to rural areas or even their places of origin. This has the effect of both diminishing the quality of these products and increasing their price.

Accountability and transparency

Accountability and transparency are two terms that must be implicit in the development of any human activity. Producers, consumers and regulatory bodies have co-responsibility to carry out their activities in ways that respect natural, social and built environments, three fundamental elements for improving the perceived value of Andean crops in Colombia.

Consumption of local products

Since the variety of plant products that can be grown in each region is so wide, there should be incentives to consume them where they are produced. This would help to boost the income of those who grow crops and avoid the consumption of foreign products in their place. Encouraging local food consumption should also be part of the country's regional policies.

As a global trend, consumers prefer products with low carbon footprints from transport. There is a market opportunity for small producers to generate good quality local products with added value.

Climate Change, Sustainability and Natural Resources

There is no doubt that climate change is a phenomenon that is affecting the entire planet. It is caused by a variety of factors, including the use of fossil fuels, livestock activity, and deforestation, among others. Agriculture is a cause of environmental change as well as being heavily impacted by it. One cause is the use of fertilizers, particularly nitrogenous ones. Effects include the ways in which increases in temperature change conditions for plant species, affecting their yield. In order to guarantee the continuity of production they must establish themselves in colder areas. The importance of climate change is so great that Pope Francis, in his Encyclical Letter *Laudato* (which means *to praise*), catalogs it as an undeniable phenomenon and proposes a series of strategies both at the state and personal level to help mitigate its effects.

Biodiversity and deforestation

Many forest areas are home to a diversity of fauna. Human intervention in forest areas, such as clearing land for agriculture or raising livestock, causes animal species to migrate or disappear, reducing biodiversity. In addition, climate change is allowing pests and diseases to spread to areas where they were previously uncommon. Ultimately, ecosystem resilience is also affected.

Vertical migration to the highlands, along with temperature changes, benefits some regions that previously did not have suitable conditions for agri-food production. However, conflicts may occur where the original inhabitants are displaced to make way for this new use of land.

The environmental impacts of mining

The practice of mining, whether legal or illegal, creates serious consequences for natural environments such as the contamination of water and soil and the fragmentation of ecosystems. It also has effects on human health. In addition, higher wages in mining regions make it difficult for small agricultural producers to hire workers for planting and harvesting. This dilemma demands new models for both production systems.

Storms and droughts

Climate variability can be a very relevant aspect of understanding crop behavior. The effect of climate change has distorted rainfall patterns. Rains no longer occur in the same well-defined seasons, affecting the planting schedule for growers. They now appear in very frequent and intense seasons, causing flooding and damage to crops. This concentration also involves prolonged periods of drought.

The effects of floods on a community are highly visible. However, when it comes to agricultural production, droughts can be much more devastating for small producers. Both phenomena need to be monitored to offer early warnings and avoid potential losses.

Drinking water

Because of the increase in temperature, many glaciers are melting due to global warming. This puts the availability of drinking water at risk. The contamination of water sources is also associated with other factors, such as the displacement of animals and increasing microbial resistance, which should also be considered in analyzing future planning scenarios.



Workshop 2 Results: Scenarios

The second workshop was held in Bogotá in May 2018, with the participation of both academic and non-academic actors (including territorial entities, companies, and mixed organizations).

The objective of the second workshop was to define a set of alternative scenarios for the innovation system of the agro-food sector until 2030, using the results of the previous workshop and supporting material presented earlier in this document. To create the different scenarios, the futures table method was used.

Each workshop group developed a futures table describing a desirable, plausible and avoidable future. Each group chose the six key variables that they believed will affect the sector most until 2030. The variables in the left column (see Table 8 below) were identified from the results of the horizon scanning workshop. Then the alternative future states (A, B, C, D) for each variable were identified. After this, the paths were identified to reach the three alternative futures – desirable, plausible, and avoidable futures (see the green, yellow, and red dots in Table 8 below). In addition, megatrends, weak signals and wild cards that would or could affect the future states were identified and taken into account when considering the scenario options. Table 8 below presents the results of one of the groups.

Table 5. Final Futures Table of one of the groups. The green dots indicate the desirable future according to this group of experts, based on their narrative description of the desirable scenario. The yellow dots indicate the plausible future and the red dots indicate the avoidable future.

Variables	Future States	A	B	C	D
1. Public Policies		10 % budget increase ●	3 % budget increase ●	Remains 1%	The budget is reduced below 1% ●
2. Foundations of the economy		Diversified base: services, agro-industry, tourism and extraction ●	Participatory and sustainable agro-industrial model ●	Non-value-added agricultural model ●	Total dependence on extractive economies ●
3. Value Chain		Shared value models ●	Fair Trade (reduction of intermediaries) ●	Inefficient value chains ●●	Monopolies that hinder competition in the market. ●
4. Trends in production and consumption		Food security and sovereignty. ●	Improvement in cost-quality ●●	Protection of the domestic market ●	Shortages of domestic products ●
5. Climate change		Compliance with the Paris agreements ●	Adaptation Systems for the National Agro-food sector ●	We continue with the current trend ●	Drastic changes in climate variability and climate conditions ●
6. Access to technologies		Strengthening of the relationship between academia - companies - state for the development of new technologies applied to specific contexts ●	Support for the acquisition of applied technologies ●	Training and transfer to small producers (applications) ●	There are no changes (technologies). ●
Megatrends	Industrialization of food (biotechnologies); production efficiency; global markets (supply - prices) quality				
Weak Signals & Black Swans	Healthy eating; protectionism of the state, impact of pollinators, risk of supply				

After the workshop all the tables were reviewed and analyzed. A summary output table was made combining the key findings from the futures table work of all the groups (Table 9 below). The results of the summary table were verified by sending them to the stakeholders and asking for their feedback. The common variables included in the final futures table were the following:

Formalization of land tenure

The process of formalizing land tenure proved to be a key driving force of the local agri-food sector, affecting all other variables in the tables and future scenarios. The formalization of land tenure in Colombia is complex and multi-faceted; historically, it has been a slow and ineffective process. The experts invited to our workshops examined this very important issue.

Avoidable scenarios for Colombia are described as futures in which there is a high concentration of power, with land and water resources in the hands of a small wealthy minority. In these avoidable future states, influential families and multinational companies control not only resources, but also the state and the economy. Here, the use of land is inefficient, the use of pesticides increases, and peasants and family farms disappear completely. The displacement of citizens from rural areas to the cities becomes a problem in a society where social inequality is greater than ever.

The process of land formalization goes hand in hand with the efficient use of productive land. At the national level, it is easier for the State to monitor stakeholders and establish national and regional plans when land ownership is formalized. In addition, it is also easier to ensure social security for workers. In the desirable future for Colombia, land planning initiatives are defended, and environmental management plans are developed for different communities. When land use is guaranteed to farming families, there is growth in the number of small-scale farms as well as organic agriculture, ensuring a diversity of crops and cultivation methods. Following this line of thought, as land tenure has been formalized, there is a variety of technologies, expertise and techniques that are used for agriculture, resulting in diversity and innovation. With a strong relationship between universities, producers and the private sector, new technologies can be developed in specific contexts. In short, the formalization of land tenure stimulates innovation systems for further growth and development.

After the second workshops were organized, Colombia elected a new President of the Republic. Therefore, a key issue is: how will the election of Iván Duque affect the peace process and thus the formalization of land ownership in Colombia?

Agricultural production systems

Agricultural production systems are made up of numerous components and drivers that interact in complex ways to influence the sustainability of production. In the context of Colombia and this workshop, the experts focused on the role of large-scale intensive farming versus small-scale family farming and peasant farmers. This topic is also closely related to peace building and land formalization, as larger numbers of formal land titles mean more family farmers can control their productive land. In a desired future situation, there are more small-scale farmers contributing to the national economy, although large farms still exist to certain extent.

Formalization of work

In Colombia, a high percentage of people have informal jobs. According to the National Administrative Department of Statistics (DANE), between 40 and 50% of people employed in metropolitan areas have informal jobs. Informality is defined by receiving income, which can vary, without making contributions to the social security system. This is a big problem for the development and sustainability of the economy in the country. In the agriculture sector, this model is predominant. During the workshop discussions, the

need to define a new model to strengthen the economy and formalize the work of small farmers was highlighted.

Transfer of Technology (ToT)

Technology transfer and collaboration between academia and other sectors of society was the most common topic raised. In fact, it is present in all groups. The Desirable Futures include the promotion of different production techniques and a strong relationship between producers, academia, the State and the private sector.

The expert groups suggest that technologic research, development and innovation (RD&I) activities should include traditional knowledge and its applications. In the same vein, one group noted that the quality of life in rural areas should be improved through access to education, health, employment, and communication technologies. Desirable futures take into consideration that access to sustainable productive technologies is intrinsic to long-term development, and that technology transfer should be promoted to bring incentives to family production units.

Evaluation of water and soil management and environmental impacts

In Colombia, most agriculture is done in open ground. This means that very few variables are controlled when compared with systems such as high-tech greenhouses or crop automation systems. Most of the technology packages delivered to small farmers include fertilizers and pest control measures that use chemical inputs. However, very few have soil and water analysis studies to identify the additional measures required by their crops. Therefore, inefficient use of inputs affects the maximum profitability that is achievable by small farmers, while also contributing to increased eutrophication of lentic water bodies.

Culture of innovation by merging new technologies with ancestral knowledge

The value of ancestral knowledge was a recurrent theme in some groups, who related this topic to ToT. Expert groups that mention this issue in their discussions promote the recognition of ancestral production systems and traditional knowledge as a part of agricultural innovation.

Avoidable scenarios for these groups include the disappearance of peasants and family farmers and the lack or loss of ancestral knowledge. To address these problems, groups suggested rescuing, studying and testing ancestral techniques as a way to inspire future technologies and convert traditional knowledge into innovation. It was also suggested that existing traditional activities be protected.

The three scenario options (desirable, plausible, and avoidable futures) that resulted from the second workshop are shown in Table 9.

Table 6. The synthesized Futures Table.

Common Variables		Most desirable future: "A more democratic and inclusive Colombia".	Avoidable future: "A future for a few"	Plausible future: "More of the same"
FORMALIZATION OF LAND TENURE	Political Aspect	Land ownership is formalized in large quantities throughout the country and millions of farmers receive land titles. The Democratic territorial governance increases the efficiency of land use.	High concentration of power, land and water resources in the hands of the rich and powerful minority.	The formalization of land tenure is done in stages, but the process is slow, so there are still large areas under the control of the rich and powerful minority.
AGRICULTURAL PRODUCTION SYSTEMS	Economic aspect	Some of the major existing farms, and a large and increasing number of small-scale producers and family farms are present and, to a large extent, contribute to the national economy.	Economy based on large scale and intensive agriculture. Farmers families and traditional production is marginalized; few small-scale producers are specialized in exclusive products.	Very similar to that of today, but as there is more formalized land, there is also a greater number of formalized family farms and small-scale producers.
FORMALIZATION OF WORK	Social aspects	Incentives for employers who employ workers formally. Social policies will allow a better social protection for workers, workers' rights, decent wages, safe work environments, healthy working conditions and adequate working hours, training and technology.	Most rural workers, especially migrants and women, live in vulnerable conditions of informal work.	Greater number of formalized work than today, but still a great disparity between the statistics in both rural and urban contexts. Urban workers are, in general, in formalized jobs, while rural workers are mainly in informal jobs.
TRANSFER OF TECHNOLOGY (TOT)	Technology	Strong relationship between producers, the academy, the state and the private sector. Different production techniques are defended.	Know-how and technology belong to a small sector of society. Very little technical assistance to farmers. High protectionist mechanisms for intellectual property.	Cross-sectional associations are mainly led by the private sector. Cooperation initiatives that work well receive good salaries, however, these are limited.
EVALUATION OF WATER AND SOIL MANAGEMENT AND ENVIRONMENTAL IMPACT	Environmental aspect	Land Planning. Sectoral planning. Land-use plans include watershed management, integrated management of solid	Unsustainable use of water resources. Improper disposal of solid waste. Misuse or inappropriate use of crop residues. The ignorance	Land management, water and waste management, etc. are set in place (as in the desirable future) but is only available to a

		waste, the EIAs are a fact. The use of fertilizers is controlled through legislative action and is fulfilled in practice.	or lack of culture in the protection of the environment. The uncontrolled use of fertilizers.	limited sector of agricultural producers, mainly legal small farmers. It is more difficult to monitor what is being done by the producers on unregulated land and large-scale producers.
CULTURE OF INNOVATION BY MERGING THE ANCESTRAL KNOWLEDGE WITH NEW TECHNOLOGIES.	Cultural aspect	<p>Traditional populations are respected and recognized as an important group of society.</p> <p>Ancestral knowledge and production systems are a heritage of society. The know-how of the indigenous people is studied in universities and both producers and indigenous people participate as actors. The laboratories of innovation and new techniques and technologies are developed within this cooperation.</p>	<p>Traditional populations are considered as an obstacle to development. The rights of indigenous peoples are reduced, and indigenous peoples are marginalized.</p> <p>The majority of R+D+i (Research, development, and innovation) is based on imported knowledge, ignoring ancestral experiences.</p>	<p>Traditional populations are among the poorest in society and are marginalized. There is, however, social protection to some of the recognized groups. Their production systems are studied and applied in innovation laboratories, but indigenous peoples themselves are not actors in the innovation process.</p>
MEGA TRENDS	Global climate change (anthropogenic impact on the environment, loss of biodiversity, etc.); urbanization; the empowerment of women (gender equality); changes in the characteristics (population growth, aging of the population, increasing migration); changes in the work environment; formalization of work: digital transformations (automation, robotics, artificial intelligence, 3D printing and other digital innovations), the fragility of representative democracy; social inequalities; sustainable development as a driver of environmental concerns and policy formulation; overexploitation of natural resources			
WEAK SIGNALS AND BLACK SWANS	<p>The peace process; political and social disturbance; Civil war; Military Coup d'état; international wars; legalization of drugs.</p> <p>Consumers production; incursion of resistant pests or fungi; free trade agreements; biopiracy.</p>			

Based on the combined futures table presented above, a scenario narrative was developed for Colombia's desirable future in 2030.

The Scenario of a Desirable Future: a Colombia with Greater Democracy and Inclusion

We are in 2030, and the population in rural areas has good living conditions and many opportunities to develop in various fields. Schools and health centers are located throughout the country and it is not necessary to travel long distances to receive medical treatment or good quality education.

Rural communities are highly connected to urban centers. Access to the Internet is considered a human right. In order to maintain competitiveness in a global market, Colombia followed a global trend of connecting farmers to the Internet to improve production systems, with farmers having frequent access to satellite data. Farmers need to be online to receive technical advice on their crops, as new data acquisition devices and sensors have made the Internet of Things (IoT) increasingly common. In addition, farmers, academic institutions and government support entities have a very strong connection, and the different types of farm data are constantly shared with universities and private companies for analysis and evaluation in pursuit of the development of research projects, technology transfer and the integration of new knowledge, including the ancestral know-how of different regions.

Digital transformations have contributed to the work of farmers to some extent but have also made some processes much more complex. Almost all producers in Colombia are now equipped with a device that is connected to the internet. The "Smart Phone" is the old name for this. The devices used today, in 2030, are much more developed than the "Smart phones" we used to have in 2020. They are rarely used to call each other; they use applications (Apps) to collect and process data about agricultural processes. The user interface of this new device is easy to use and they are desired by members of younger generations due to the competition they face. Valuable education is provided through these applications.

As each farmer is equipped with a mobile device connected to the internet, they have access to real-time data from their production systems. Satellite images allow accurate knowledge of their land and the development of maps, climate models, and models to mitigate risks and improve productivity. Similarly, border control is more effective, and conditions for controlling Colombian territory and land use are better not only for the government but also for civil society. As rural households have stable internet connections, long-distance adult education has been growing, and online courses have become more and more common for the public.

Thanks to the implementation of the Peace Accords signed in 2014, small farms are common in the Colombian landscape. As the formalization of land tenure has become more efficient in the past decade, conflict zones have been replaced by productive family farms. Of course, some large farms still exist, but this is not the main method of production. A large number of small-scale producers and family farm environments are present and contribute significantly to the national economy.

As Colombia is a country where practically everything grows due to its rich diversity in climate and conditions, small farms grow a wide variety of products, using a wide range of cultivation methods. When land use is guaranteed to farming families, there is growth in small-scale and organic agriculture, ensuring a diversity of crops and planting methods. As producers, universities and the private sector cooperate in research, development and innovation (R&D&I), some family farms use scientific research to measure and evaluate farm production processes, giving them a better understanding of how different agricultural processes can co-exist and how they can contribute to developing innovative sustainable agricultural practices.

Thanks to state support, R&D&I in food production has been successful in Colombia, because traditional knowledge and applications have been incorporated alongside new technologies. The knowledge of

ancestral techniques has been studied and tested in a way that inspires the development of technology, turning ancestral knowledge into innovation. With the support of universities, the technical training of Colombian peasants and access to technologies for improving agricultural production has allowed the widespread use of mechanization and precision agriculture, controlled irrigation and efficient water management. The use of soil conservation practices, weed and pest management, and practices to reduce waste and post-harvest losses have made it possible to position Colombia as a country with important water reserves and a world producer of food.

This greater interconnection of Colombia, where various sectors of society collaborate to develop sustainable food production, has been reflected in other sectors of society beyond agriculture. As stakeholders recognize the value of ancestral production systems, there is a movement to rescue ancestral techniques and protect existing traditional communities. Traditional peoples, who have historically been marginalized by society, are now valued as important assets to the country. Traditional populations are respected and recognized as an important sector of society. Ancestral knowledge and production systems are a heritage of the society. Technical knowledge is studied in universities, producers participate as actors in laboratories of innovation and new techniques and technologies that are produced with this cooperation. An example of the recovery of ancestral knowledge with the enhancement of new technologies allowed Colombia to become a producer of ancestral Andean crops that were lost a decade ago, including Amaranth and Guatila among other crops. The reasons for helping to "resurrect" the development of the Quinoa production chain in Colombia were its high adaptation to climate change, resistance to pests, nutritional properties, and biological properties that allow the conservation of soils with minimum tillage, improving production by rotating crops and avoiding soil degradation and erosion. Currently, Colombia is a world leader in the development of products based on the use of the entire Quinoa plant.

Although there are digital transformations that have affected both rural and urban societies, not only in Colombia but throughout the world, the main driver of change in Colombia's rural sector has been of a different kind: formalization. The formalization of land tenure, land use, work, education and of providers, to name a few, have created a significant change in Colombia's rural society. As land use and tenure have been formalized, territorial governance is more democratic.

When land is formalized, it is easier for the State to monitor stakeholders at the national level and to establish national and regional plans. The Government of Colombia - in cooperation with universities, producers, traditional peoples and civil society - has created long-term sectoral planning for the country. Every farmer, whether large or small, has to submit his or her land use plans to the State, as well as environmental impact assessments (EIAs) of their agricultural activities. Land use plans and EIAs must include watershed management and waste management, among other requirements. The use of fertilizers is controlled by legislative measures and has a high degree of compliance in practice.

The formalization process has made it easier to guarantee social security for workers. Employers who hire workers within formal systems receive incentives. Social policies enable better social protection of workers, workers' rights, decent wages, safe working environments, healthy working conditions and working hours, training and the use of appropriate technologies. The women's rights movement has grown not only in Colombia but throughout Latin America, and there is a greater demand for social policies aimed at protecting women, giving them better opportunities, and empowering them to continue their studies and careers. Among other incentives, day care centers are growing in the rural regions of the country, allowing women to be active citizens who work and pay their taxes. When women have equal opportunities for education and work environments, they contribute to the promotion of local and global communities.

4. DISCUSSION

In this chapter we will discuss of the results presented in the previous section, as well as how they influence each other. The first workshop focused on Horizon Scanning, while in the second workshop parameters for future scenarios were defined.

When reviewing the factors identified in the Horizon Scanning, Columbian society was found to be the main element. Poverty and the effects of social class differences continue to show up in agricultural communities. Displacement due to both the armed conflict and environmental factors such as economic crises, climatic variability and cultural issues also remains significant.

A second identified element is associated with land conflicts, including disputes over different potential uses. Rivalry between producers of illicit and food crops, rural violence and the implications of the peace process are evidence of a transition in the country's economy and political systems. Different actors have become disconnected and lack common ground. An example of this is seen in the ways centralized decision-making system fail to take local needs into account. Many of the problems that have been identified from this perspective are those that have previously led to social conflict in the 1950s and 1960s, where more equity and better conditions were sought by small producers. However, this conflict became blurred in the 1980s as the trade in illegal drugs increased. Thirty years later, this set of problems remains one of the core development challenges for agriculture in the country.

The third element, changes in diets and food consumption trends, allows for new opportunities for small producers. Free trade agreements, together with change in the business models of small farmers, have led to interesting opportunities to create local value. However, in some cases the demands of consumers are very expensive for small producers. Certified organic foods often generate cost overruns for small producers. Likewise, environmental impact studies for crops of less than 5 hectares are not cost-effective for farmers. This phenomenon was identified in the PECTIA report, showing the need to define alternative ways of giving consumers access to the information they want that are also attractive to producers. Trusted local certificates are an interesting model in this regard. In Guadalajara, Mexico, a very low-cost model of good practices and organic products has been implemented, facilitating the integration of these concerns in response to current market requirements.

A fourth element identified in the workshops is that of public policy. This is directly related to the process developed by the OECD for analysing public policies and demonstrates the need to strengthen both the institutional framework and the capabilities of different actors. As previously mentioned, in the past relations between different actors have been disjointed, giving rise to the conflicts seen a few decades ago. However, in the latest national development plans, the agri-food sector has been highlighted as one of the pillars to be considered. Although it does not make a significant contribution to GDP, as evidenced above, it is important to note that this sector is a major generator of employment. Thus, it remains a decisive factor in the formulation of bottom-up policies that allow for new intervention models to be defined by interest groups.

A fifth element is a lack of food processing. This is directly related to the sixth element of emerging and international markets. The competitiveness of the agri-food sector requires adding value to products. In Colombia, many products are lost along the value chain due to the lack of capacity to add value. The ability to add value could open up space in international markets for small producers of fruits and vegetables that require significant energy and time for their primary production, allowing them to take advantage

of current global demand. To do this, it is necessary to improve local and national infrastructure, since at present the costs of processing and transport are often too much for small farmers. As a result, there are many programs to strengthen technical capacities at the local level in support of new business models. It is also important to strengthen associations and cooperative work to build attractive models for the market.

As a seventh theme, there is the importance of revaluing ancestral practices. Although some practices can generate negative environmental impacts, the cultural traditions around sowing, harvesting and transformation strengthen the social dimension of development. Some communities currently lack a sense of belonging, which is reinforced by other indirectly associated elements such as the low quality of rural education and infrastructure. Motivating young people to stay in the countryside requires offering attractive training alternatives, leisure opportunities and other elements that improve lifestyles in rural communities.

The eighth topic, directly related to the previous one, is about the valuing and use of indigenous crops, which strengthen cultural and biological diversity by using ancestral practices and heirloom seeds. The culture around food has been one of the most important points in preserving the customs, history and worldview of indigenous groups. From these activities, the functionality of many Andean foods in alternative medicine practices have been identified and documented. Efforts to describe how indigenous sages (mamos and taitas) use the components of different products to improve the health of their communities are ongoing.

Finally, the Horizon Scanning identified climate change, sustainability, and natural resources as important elements of analysis. Based on the IPCC's global scenarios, the work of IDEAM (the national entity in charge of contributing national reports for the IPCC) and local studies, the vulnerability of small producers is will increase under climate change. The challenges that this creates for local and national food security became a starting point for the following workshops, in light of interest in the empowerment of institutions and small producers to face these changes more resiliently.

The second workshop resulted in the construction of the scenarios which will serve as the basis for the third and fourth workshops. The construction of the futures table consolidated the activities and analysis of the first workshop to define desirable, plausible and avoidable scenarios. Here we found a set of six common variables between the different groups, along with megatrends, weak signals, and Black swans.

First, the formalization of land tenure. This has been one of the most important elements in the discussion of agri-food production in Colombia. The possession of vacant lots, the lack of land ownership and problems stemming from illegal occupation, are all factors that have contributed to violence and other social problems, affecting the capacity of communities for agri-food sector development. In the first part of the document, this was identified as one of the challenges in the Colombian context, which is being addressed in various ways by the government. The peace process, together with changes in agrarian policies, have worked to reduce stakeholders' vulnerability in terms of land tenure and use. However, this remains a critical point for the authorities, given the complexity of demonstrating land ownership.

Second, agricultural production systems have been affected by the comparative technical capacity and land ownership of different kinds of producers. Small farmers face a broad disadvantage compared to large-scale producers, who have better opportunities to negotiate over inputs and labor and, therefore, to set market prices. In Colombia, the creation of associations of small producers has been encouraged. As observed earlier, such efforts have had very good results in some sectors (sugar, cane, coffee, for example). However, this remains a significant challenge for Andean crops and products, given the dynamics of the current market.

Third, the formalization of work is a fundamental aspect of the desirable scenarios. The many jobs located in this sector make it imperative to consider the needs of the community in order to contribute to

the social security system and generate long-term financial security. Informal employment is the cause of multiple social problems, including lack of planning, lack of banking access and difficulty saving and investing in technological improvements among other issues. This drives down the profit margins of small producers, who often need to use proceeds from production to pay off debts for inputs and labor, weakening their business model.

Fourth, technology transfer was identified as a primary variable. Technologies for agri-food production present different levels of complexity, from the automation of production and control of growth factors (e.g. temperature, nutrients, pests) to high-quality processing. For a small producer it is difficult to access credit or high-tech transfer programs. However, it is interesting to look at the development of low-cost and local technologies that improve crop conditions. Low-cost air and water quality monitoring systems facilitate farmers' production. There are also programs led by different private companies that support small producers in using cleaner production principles to reduce the environmental impact of their activities.

Fifth, and related to the previous point, the analysis of water and soil was defined as a common point among the working groups. One of the problems discussed by the work teams is the lack of local capacity to carry out required studies. Because of this, many small producers do not have the kind of detailed analyses that would allow them to optimize growth and transformation variables affecting their production processes. Therefore, it is necessary to invest in detailed studies that allow small producers to have enough information to improve production decision-making.

Finally, the alignment of new technologies with ancestral knowledge is a fundamental element for achieving the desirable scenarios. Colombia is characterized by its high biological and cultural diversity, with 98 types of general ecosystems and more than 8000 specific ones, as well as 102 indigenous peoples (~1.9 million people in total), ~4.5 million people with a NARP background (Black, Afro-Colombian, Raizal and Palenquera) and ~2,700 gypsies or Rom²¹. Additionally, peasant populations have extensive knowledge of planting variables (periods of rain and drought, temperatures, pests and diseases, etc.).

This points to the importance of dialogue between different parties that would allow for the use of cutting-edge technologies, the integration of ancestral knowledge and real-time analysis of the conditions of a changing environment. Each of these elements was reflected in the scenario of a desirable future for Colombia in 2030, which is a Colombia with greater democracy and inclusion. This scenario will be the main input for the next two workshops.

²¹ <http://www.siac.gov.co/biodiversidad>, <https://www.onic.org.co/noticias/2-sin-categoria/1038-pueblos-indigenas>, <https://www.dane.gov.co/index.php/estadisticas-por-tema/demografia-y-poblacion/grupos-etnicos/informacion-tecnica>

5. GLOSSARY

The following futures studies terminology is frequently used in futures studies and in these PECOLO workshops.

Megatrends

Megatrends are long-term phenomena that shape our world and societies. Megatrends are triggered by major changes, such as changes in the environment, shifts in demographics or technological breakthroughs (Dumitrescu 2011). Although some regions of the world may experience a megatrend with more intensity than others, and processes can be very slow in some contexts while moving very quickly in others, megatrends are global behaviors.

Because megatrends are global and affect every sector, in the context of Futures Studies some megatrends are consistently seen across various contexts. These are climate change, growing pressure on ecosystems, urbanization, changes in demographics (population growth, aging of the population, migration), changes in work, empowerment of women (gender equality), digitalization (automation, robotization, artificial intelligence, augmented reality, virtual reality, and other technological innovations), to name a few.

Trends

A trend is a general tendency or direction of movement/change over time. Trends are experienced by everyone and create broad parameters for global shifts in attitudes, policies, and business focus over periods of several years. What is interesting about trends is that normally most actors, organizations or even nations cannot do much to change them. They are larger than the power of individual organizations and often nation states as well (Saritas and Smith, 2011).

Examples of trends are (according to Saritas and Smith, 2011) eg. gradually increasing concerns for the environment in terms of sustainability, human and animal health, and global warming; a growing push for greater efficiency and decarbonization of the energy system because of environmental and energy sector concerns; and the proliferation of nation states and groups of people seeking self-determination.

Weak Signals

Weak Signals are incidents or phenomena that, as they happen, do not seem to be significant or connected to other signals. However, as futurist Sirkka Heinonen (2017) points out, as the future unfolds, we may learn that these weak signals had a crucial role in the development of something. Collections of weak signals may develop into trends.

In the 1980's climate change was mentioned for the first time. It was then a weak signal, but later on science and our societies came to understand that climate change could threaten our whole existence.

Black Swans/Wild Cards

Black swans and wild cards are often used interchangeably. The term Black swan was introduced into the Futures Studies literature by Nicholas Taleb's 2007 book *The Black Swan: The Impact of the Highly Improbable*. In his book, Taleb defines Black Swans as events that rare, of extreme impact, and that have a retrospective predictability. This means that black swans can rarely be predicted beforehand, but signs that could have led to their prediction can be identified afterwards. Looking back at history, the internet and

the 9/11 attacks in New York were Black Swans. We could not see them coming but once they had happened, they had significant impacts on the societies they affected.

In Foresight processes it becomes important to include the possibility of unforeseen situations and surprises because they often reshape the trajectories of events and situations (Saritas and Smith, 2011). Thinking of black swans is a complicated task, exactly because they are essentially unexpected. However, speculating about how these unknown events may affect the future is an important part of futures thinking (Ferreira-Aulu 2017:16).

Plausible Futures

Plausible futures are those we think 'could' happen based on our current understanding of how the world works (physical laws, social processes, etc). They are based on the knowledge we have today. Their foundations are current scientific work, methodologies and processes (Voros 2003:17)

Possible Futures

Possible futures according to Voros (2003) are those futures that we think 'might' happen, based on some future knowledge we do not yet possess, but which we might possess someday.

Probable Futures

Probable futures according to Voros (2003) are those futures we think are 'likely to' happen, usually based on (in many cases, quantitative) current trends.

Desirable Futures

Desirable futures (also known as preferable futures) are those we "want to" happen. They are more emotional than cognitive, and they depend on who is asked. They derive from value judgements and are more overtly subjective than the previous three classes (Voros, 2003).

Avoidable Futures

The future we do not want to happen.

Drivers of change

Drivers of change are factors causing change and affecting the future. According to Saritas and Smith (2011) they concern "those forces, factors and uncertainties that are accessible by stakeholders and create or drive change within one's business or institutional environment. These tend to be more immediate and relevant and distinct to different types of stakeholders and also they can be both adapted by or strongly impact stakeholders, sometimes rapidly". Some examples of drivers of change are policy and regulatory changes that lead to changed government priorities and company actions, demand for certain products or services that shift the markets, or climate change.

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