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

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

FINLAND FUTURES RESEARCH CENTRE
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INTRODUCTION

PECOLO, or *Native crops for sustainable and innovative food futures in Peru and Colombia*, is a collaboration project between University of Turku, Finland (UTU), Universidad Nacional Agraria La Molina, Peru (UNALM) and Universidad el Bosque, Colombia (UEB). From UTU, Finland Futures Research Centre (FFRC) of University of Turku coordinates the project. In addition, Functional Foods Forum and Department of Biochemistry of University of Turku participate in the project.

The investment in education, research and development is the key for innovation and long-term growth. Despite the economic growth, per capita expenditure in higher education, research, development and innovation (RDI) in Peru and most of the region remain very low compared to the international examples of RDI expenditure. New efforts to increase public spending in those areas has been made and there are now more available opportunities to benefit from international RDI networks. Traditionally the role of the higher education is only to train educated employees and the RDI collaboration with the private sector is not common. As in most of the Latin American countries, the investment in RDI of agricultural sector is far from reaching the internationally recommended levels. Private or public investments made in food and agricultural research and development not only increases the overall agricultural productivity, but also promotes sustainable economic growth in other sectors throughout the food value chain. There is a variety of technologies and scientific knowledge available to promote sustainable agriculture, but these should be adopted and developed in accordance with local circumstances.

The Andean region is exceptionally rich in biodiversity, harbouring an important centre of domestication of global food crops, such as potato, quinoa, corn, peanut and tomato. Such biodiversity provides a great potential to discover or, re-introduce, nutritionally rich local varieties and utilize them to develop innovative food applications. Utilization of native plant crops provide promising solutions to address the wider sustainability goals, such as re-discovering crops more resilient to the changing climate and providing local source of nutritious food. Diversification of the local diets with local grains enables better nutrition and can also contribute to food security in areas where food production is threatened by climate change.

The PECOLO project has a special focus on the development of innovation environments around Andean native crops. Futures research and foresight methodologies are used as novel tools for developing innovation environments in cooperation with academic, public and private sector organizations and NGOs.

In addition to the development of innovation environments, the project has capacity-building and mobility components in specialized topics in food science such as nutrition and functional foods, and in sustainability issues along the food value chain, such as environmental impacts of food production, sustainable diets and food waste and loss. The project funds PhD student mobility from the Peruvian and Colombian partner universities to Functional Foods Forum and the Department of Food biochemistry in Turku University, Finland. PECOLO project is funded by the Ministry for Foreign Affairs of Finland between 2017−2019 under the HEI-ICI Programme (*Higher Education Institutions Institutional Cooperation Instrument*).

This publication is the first of the two publications for Peru that will be published as an outcome of the PECOLO project's four step futures process around Andean native crops. The publication covers the methods and the results of the 1st workshop, which focused on horizon scanning of the current state of the agri-food sector, as well as the methods and the results of the 2nd workshop, which focused on development of scenarios for the Peruvian agri-food sector with a special focus on Andean native crops. The second PECOLO publication (published later in 2019) will present the roadmaps and action plans for the agri-food sector stakeholders in Peru and Colombia.

BACKGROUND – THE FOOD SECTOR AND ANDEAN CROPS IN PERU

The Food Sector in Peru

Peru has a population of 30 million inhabitants. Despite the uncertainty of the international environment, Peru has remained as the strongest economy of the region with growth rates around the potential output growth (6−6.5%) over the past 10 years. Peru's Food production is characterized by low levels of productivity or competitiveness of small farmers, as well as great vulnerability to climatic variations which have led to losses of up to 15 000 hectares per cropping season. The country has a food dependency in oils (58%) and cereals (43%), and 87% of wheat, 60% of hard yellow corn, 34% of sugar and 13% of milk is imported (FAO 2019).

Agriculture today is the main source of income for 2.3 million families representing 34% of Peruvian households (80% of rural households and 11% of urban households), generating approximately 8% of Gross Domestic Product (GDP). It should be noted that 64% of rural families devoted to agricultural activity live in the *Sierra*, the mountainous region, where 37% of Peruvians live in poverty and 60% in extreme poverty (FAO 2019).

Food in Peru derives from domesticated plants and animals as well as hunting, fishing and the collection of non-timber forest products. Close to 65% of the national agriculture depends on native genetic resources, such as potatoes, maize, sweet potato, Andean grains (quinoa, kiwicha and kaniwa, or kañiwa in Spanish), fruits (avocado, papaya, tuna, camu-camu, cherimoya, custard, capulí, cherry, sweet cucumber, etc.), roots (arracacha, yacon, maca), Andean tubers (oca, mashua, olluco), cocoa (common cocoa, macambo, etc.), legumes (pallar, beans, pashullo) and several other crops. About 95% of the national livestock is based on native forage resources. Native Genetic resources, especially camelids (alpaca, llama, and vicuna) and minor species (guinea pig, creole duck) form a very important part of the national livestock farming. The Peruvian sea offers annually about 400.000 tonnes of fish and seafood and the Lake Titicaca close to 4.000 tonnes of fish for national consumption.

In the Sierra domestic camelids (llama and alpaca) constitute a very important source of protein supply for Andean mountain communities. The meat is consumed fresh, but it is also stored in the form of jerky or dried meat for the times of scarcity. It is estimated that yearly consumption reaches at least 300.000 heads of alpaca and 100.000 of llama, which is equivalent to at least 8 million kg of meat per year. In the Amazon nearly 80.000 tonnes of fish and some 15.000 tonnes of "bushmeat" (meat from the hunting of wild animals) are consumed every year. Fish and meat are the most important sources of protein for the Amazonian population. For example, the cities of Iquitos and Pucallpa consume 18.000 and 12.000 tonnes of fish per year respectively. In contrast, Amazon livestock production attains just 10.000 tonnes of meat, and, if we consider the breeding of minor animals, the entire production of proteins in the Amazon Region based on livestock (cattle plus smaller animals) reaches some 35.000 tonnes per year (Brack 2004).

According to the Instituto Crecer (2018) in the context of the analysis of the current situation, crop and livestock production increased about 8% during the first half of 2018, accumulating 13 months of continuous growth. A determining factor in this expansion is the dynamics displayed by the agricultural sub-sector that grew by 10% during the first half of this year thanks to the recovery of crops that were

affected by the El Niño phenomenon. In the North rice, banana and lemon suffered the greatest impact. These crops are destined for the domestic market. The phenomenon also affected crops destined for industry production and to the external market such as sugar cane, hard yellow maize, paprika and avocado. These crops account for nearly a quarter of the gross value of production in the agricultural sector. In addition, the livestock subsector grew by 6% in the first half, a behaviour explained by the good performance shown by the poultry industry. During 2019, agricultural activity is expected to grow about 4% driven mainly by crops which destinations are in the international markets, as well as by the poultry industry. The forecasts of the Multisectoral Committee ENFEN (*El Comité encargado del Estudio Nacional del Fenómeno El Niño* or The Committee in charge of the National Study of the El Niño Phenomenon) also have an impact on the projection, as they indicated in their August 2018 report the absence of extraordinary rains in the summer of 2019.

On the other hand, until July 2018, agricultural exports amounted to US$ 3.518 million, 15% higher than the amount registered during the same period of 2017, highlighting the greater global demand for Peruvian fruits such as blueberries, avocados, mangoes, bananas and fresh grapes, which explain 34% of the total basket of agricultural produce for export. However, during this same period, the traditional products of the country, such as coffee beans and fresh asparagus, fell about 6% and roughly 1% respectively in FOB value. The unfavourable behaviour of coffee exports was due to the price fall. In the case of asparagus, lower sales in volumes abroad were due to the decline of its performance levels due to the age of plantations that are replaced with other higher profitability crops such as the cranberry. Given this trend of the main products for agro-export, it is estimated that by the closure of 2018 exports would have exceeded US$ 7.000 million, which drives projections of agro-exports for 2019 close to US$ 8.000 million. The growth dynamics of imported foods by the Asian economies will be decisive during 2019 and thereafter.

Andean Crops and Grains

The Andean region is exceptionally rich in biodiversity and is a great example of the knowledge and adaptation of farmers to their environment for more than 5000 years. Its richness in agro-biodiversity is within the traditional agricultural systems of native communities and more than 20 different food crop species and a large number of native varieties are still under cultivation (native species such as potatoes, quinua, kañiwa, oca, olluco, mashua, lupine and different high altitude fruits) (FAO, 2019).

The main Andean grains in Peru are quinoa (*Chenopodium quinoa*), kaniwa (*Chenopodium pallidicaule*), kiwicha (*Amaranthus caudatus*) and tarwi (*Lupinus mutabilis*). Quinoa, kiwicha and kaniwa can be used in the same way as cereals such as wheat, rice and barley. The advantage of these grains is their great nutritional value. Andean grains have proteins of high biological quality, dietary fiber and oils with essential fatty acids. They are also rich in micronutrients such as iron, calcium and vitamins, especially vitamin B and vitamin E and bioactive compounds that are beneficial to the health (Repo de Carrasco, 2014). Tarwi is a legume with a very high content of protein and oil, comparable to soy. The advantage of the tarwi, apart from its higher content of protein compared to soy, is its adaptability in the ecological conditions of the Andes.

Andean grains have been consumed in various traditional ways. Quinoa is traditionally consumed in Peru and Bolivia and it is used in cooked form in soups and other traditional dishes (*quispino, tactte* and *pesqhe*) or as a replacement for rice. The quispino is a baked bread made with quinoa flour and raw animal fat, which is consumed during long trips and can remain preserved for at least six months without

refrigeration. The Tactte is a small cake made with quinoa flour, fried in animal fat, with a crusty consistency. The Pesqhe is a porridge made with de-saponified quinoa grains. Kiwicha is often used as "kiwicha pop", a puffed kiwicha, and the kaniwa as kaniwaco, toasted flour. All the Andean grains can be ground to make flour used in baking and pastry products resulting in nutritious products.

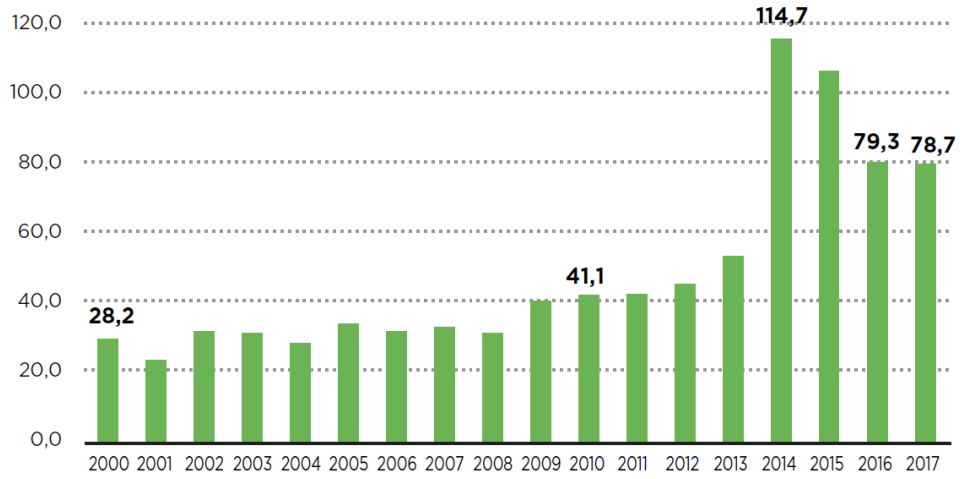
Quinoa is also used in traditional medicine for its anti-inflammatory and disinfecting properties and also as an insect repellent. In Bolivia, the quinoa plant is used for bruises and luxations (Mace et al.2005). The Mapuche Indians in Chile use quinoa as a diuretic, to treat catarrhal infections, and externally for the treatment of wounds and cuts (Houghton and Manby 1985). During the past years new products based on Andean grains, such as protein and energy bars, dairy substitutes, snacks and gluten-free products such as bread and pasta based on Andean grains have emerged in the markets.

The Role of Andean Grains in the Peruvian Economy

The main Andean grains that are cultivated and produced in Peru are quinoa, kiwicha, kaniwa and tarwi (or lupin in english). In 2017, the harvested area of these four grains as a whole was 80.000 hectares, with a total production of 100.000 tonnes, the Sierra region being the main producing area (MINAGRI, 2018a). More than 100 Peruvian companies are dedicated exclusively to the processing or transformation of Andean grains (quinoa.pe, 2013).

Quinoa is the most representative Andean grain and has been produced in Peru for centuries. In spite of this, during the 1990s, production fell below 20.000 tonnes, but starting in the year 2000, the situation began to revert steadily until the year 2013, when the production reached 52.000 tonnes (Figure 1). It is the year that FAO announced the "International Year of the Quinoa", consolidating its position as one of the most nutritious foods. In the year 2014 production reached a record high of 115.000 thousand tonnes, due to higher production in the regions of Puno, Arequipa and Ayacucho, and also because of improvements in performance. Production falls of the following years were mainly due to the price fall (national and international).

(Peru: National Quinoa Production, 2000−2017)
(Thousands of tonnes)



Source: MINAGRI-DGESEP-SIEAPerformed by: MINAGRI – DGPA – DEEIA

Figure 1. *Quinoa Production.*

Quinoa of the Sierra, the mountain region, is characterized by its organic nature. Although it has lower yields, the price paid in the market is higher than for the conventional quinoa. On the contrary, coastal quinoa has greater productivity due to pesticide use. In the year 2017 the area harvested reached 62.000 hectares. The productivity improved to 1.7 tonnes/hectare in 2014 but dropped slightly in 2017 to 1.3 tonnes/hectare (MINAGRI, 2018a).

For tarwi there was a decrease in production of 1% per year between 2000 and 2006. However, production increased from that year at 5 % per annum, reaching a volume of 14.000 tonnes in 2016. This increase is explained by the improvement in productivity and also by the growth of the harvested area, highlighting Cusco, Puno, La Libertad and Huánuco. In the year 2017 the area harvested was 10.000 hectares, decreasing slightly in comparison to the previous year. With respect to performance, it reached 1.3 tonnes/hectare during 2017 (MINAGRI, 2018a).

The kaniwa production has been growing steadily in recent years, reaching 5000 tonnes in 2017. The main producing areas were Cusco, Puno and Arequipa. In the year 2017 the area harvested was 6200 hectares, slightly higher than the previous year. Performance has remained constant over the last 18 years, between 0.6 and 0.8 tonnes/hectare (MINAGRI, 2018a).

The production of kiwicha has been declining since 2015, reaching 2700 tonnes in 2017, explained by the volatility of the harvested area. The main producing areas are Cusco, Apurimac and Ancash. In the year 2017 the combined harvested surface was 1400 hectares and the yield was 1.9 tonnes/hectare (MINAGRI, 2018a).

Andean grains have a very large potential, both from the point of view of the food industry as well as the pharmaceutical industry. The grains can be used as flours, flakes, extrudes, mixtures, instant products, among others; as well as in cosmetics and nutraceuticals. In addition, the promotion of these grains increase the added value of the entire value chain, generating more jobs in the different stages: the field, post-harvest, transport, processing, marketing, etc. A directory of companies that work with Andean grains is presented in the portal Quinoa.pe (2013). On the other hand, it is necessary to propose strategic planning not only in terms of the output but also industrialization of Andean grains, encouraging greater added value in order to be able to reach local and international consumers directly and thus achieve the highest margins possible (Mayandia et al., 2017).

Import and Export of the Andean Grains

In Peru, the major producing regions of Andean grains are: Puno, Junin, Arequipa, Cusco, Huancavelica, Ancash, Ayacucho and Apurimac, which account for more than 90% of national production (ADEXData-Trade, 2018).

According to the National Plan of Agricultural Crops (Bell 2018−2019) (MINAGRI, 2018b) in the year 2017 there was a harvested area of Andean grains of 74.000 hectares. Of these, 62.000 hectares were quinoa.

Exports of quinoa in Peru began in the 2005 (Carimentrand et al. 2015), where the main exporting regions are Ayacucho, Puno, Junín, Cusco, Apurimac and Huancavelica. Together, they register exports for the year 2017 of 52.000 tonnes, with a FOB value of 122 million US$. Figure 2, shows the development of quinoa exports in tonnes, as well as the variation of the FOB value during the period 2013− 2017 (ADEX-Datatrade, 2018).

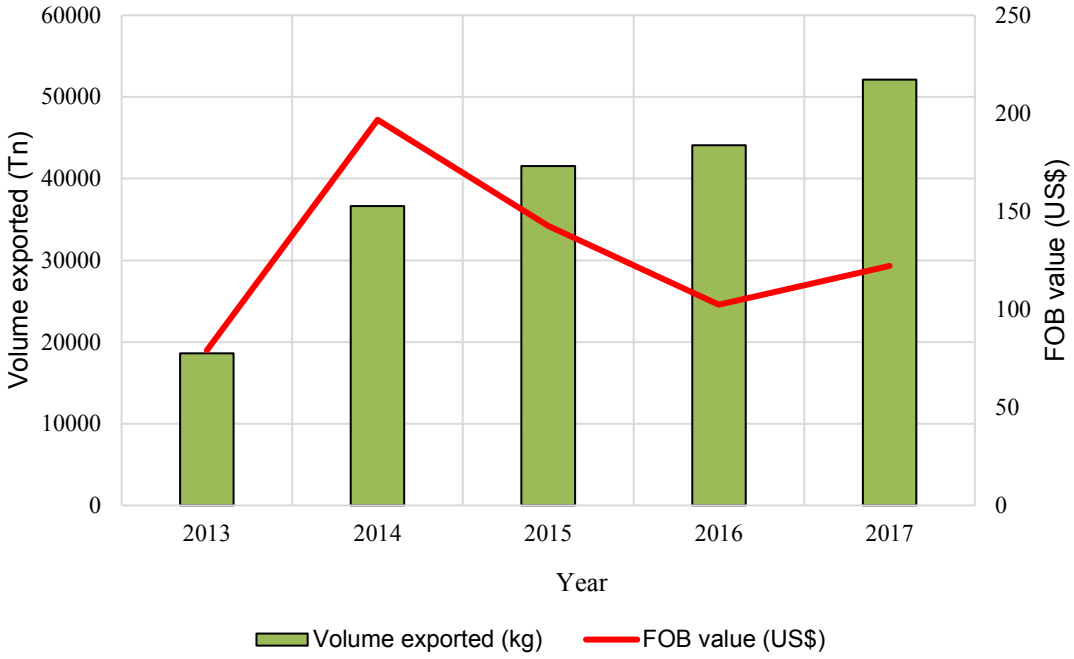


Figure 2. *Evolution in tonnes and FOB value for quinoa exports during the years 2013−2017.*

The main countries where Peruvian quinoa is exported are United States and Canada, accounting for more than 50% of the entire market (Ku, 2017; Carimentrand et al., 2015), followed by some European countries (Italy, United Kingdom, Germany, Spain, Netherlands, Belgium). The presence of quinoa in Asia is still very small, but it is expected that the phytosanitary protocol for entry into China is signed during the first quarter of the year 2019.

National production does not meet all the demand for quinoa and both legal and illegal imports of Bolivian quinoa exist. According to IICA (2015) the import volume of quinoa from Bolivia in 2015 was 80 metric tonnes. The illegal imports enter as unregistered imports together with other smuggling through the Peru-Bolivia border of Desaguadero. In 1990 illegal imports reached around 1700 tonnes and in 1994 a total of 4 000 tonnes of Bolivian quinoa was imported illegally (IICA/UNDP 1991, Pinget and van der-Heyden 1994). In general, illegal imports have a tendency to increase.

According to IICA (2015) domestic consumption of quinoa per capita in Peru during the past 14 years has been 1.4 kg/year considering illegal imports, which fluctuate between 1.0 and 2.3 kg per capita and year, and 1.12 kg/year without taking the illegal imports in consideration. The growth of consumption was about 6 % during the period 2000−2014, showing strong growth during the last year of the period due to the significant growth of production, which was 77% in 2013. In regional comparisons it was found that during 2013 the consumption in the Puno region was 0 to 3 kg per person per year (IICA 2015). Hinostroza (2014) estimated that the per capita monthly average consumption of quinoa of the urban consumer was between 0.2 and 0.4 kg and the rural consumption (in the Mantaro Valley of Junín region) was between 1.1 and 1.4 kg. In general, there is a tendency of increased consumption of quinoa as well as other Andean grains.

The consumption of quinoa has been concentrated in large urban centres and among the population in the higher income segments with access to information, while the lower income segments have a lower consumption due to the higher price and the budget constraints they face. In the poorest segment of the

population the consumption of quinoa competes with wheat and rice due to their lower price. This population segment has also been affected by the decisions to cease out social programs which purchased quinoa, affecting food security negatively (IICA 2015).

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

Foresight, as well as planning, seeks to guide the actions of the government, as well as the other stakeholders involved in the management of public policies. The participation and involvement of the different actors must be ensured in the process of the construction of the future (Del Carpio, 2016).

Medina (2014) indicates that foresight is useful for structuring a permanent social dialog that promotes the integration of the State, the market and society around structured processes for thinking, discussion, modelling the future and exercising strategic monitoring of the present facts, which has impacts on the strategic decisions of the society.

Therefore, instead of a project, the first challenge is to establish a permanent process and foresight system concerning Andean grains in cooperation with the key stakeholders. In this sense, the development of good foresight programs (Dreyer and Stang 2013) requires that the following criteria must be met at the time of designing them:

1. Identify the target audience with precision. They should not be a "type" of persons or the "political community", but a definable and specific list of organizations and individuals
2. Include the participation of this target audience in the establishment of the agenda and at different stages of the foresight process. Make sure that the products are directed to them,
3. Communicate clearly and directly in a language that is accessible to the target audience,
4. Maintain close ties with the decision-makers and policy-makers,
5. Establish a clear relationship between the foresight topics and the current political agenda,
6. Cooperate with other agencies, at the national and international level,
7. Develop consistent sources of long-term financing,
8. Work iteratively. Prospective studies often involve a large group of participants, and the conversion of its inputs into useful products is difficult without feedback loops,
9. Establish programs instead of isolated projects. There is a learning curve in foresight studies. Programs allow the learning process and staff continuity,
10. Create scenarios, use, and create new ones based on feedback and verification.

From the above criteria, it is easy to understand that the four-step futures process that this specific two-year project will carry out, is only a starting point for a functioning innovation environment, foresight system or program. Developing a full-fledged programme requires further funding and commitment of not only the stakeholders of the current project, but also the Peruvian government.

According to the field guide of Andean crops by the FAO (2007) the scope of Andean crops could be (i) tubers that include potatoes, oca, olluco and mashua, (ii) Andean roots as the arracacha, yacon, achira, chagos, ajipa and maca, (iii) Andean grains which include corn, quinoa, kaniwa, kiwicha and tarwi and (iv) andean fruit such the aguaymanto, tree tomato, pasifloras, pushgay and elderberries.

In the future, a key decision will be to decide which of all the value chains of the Andean crops should be considered. This is particularly important given that the Andean region is rich in biodiversity, and this abundance can disperse efforts. In this specific project the key Andean grains, quinoa, kañiwa and tarwi have received the main focus.

The production and value chains of the various Andean crops differ greatly from each other and they differ also between the territories. In addition, they show different behaviours if you focus on exports, on the domestic market or in local markets.

Therefore, given that the approach developed in the project is broad and general, and is only a starting point for a foresight system or an innovation environment, a second challenge is to go deeper in the specificities of each value chain in the Peruvian territories. Additional foresight workshops are to be developed in the territories in order to identify the aspirations of the actors and their demands towards the academy in terms of RDI. These are future necessities and actions that needs further funding in order to get long-term results.

A third challenge is to achieve the articulation of the RDI projects that are developed in the various chains: (i) inputs, (ii) agricultural production, (iii) transformation and (iv) marketing, without losing sight of the interests of the final consumers. A possible solution to these are RDI foresight agendas.

Finally, to build a full-fledged foresight system, according to the framework for assessing the impacts of foresight systems proposed by Amanatidou & Guy (2008), the results and immediate impacts should be (i) new combinations of interest groups, (ii) shared visions of the future, (iii) changes in mentality, and (iv) multidisciplinary research, among others (see figure 3 below). To this end, the PECOLO project is an important step and starting point, but it must consolidate a permanent space for reflection and collective action oriented to the future from the part of the National Agrarian University of La Molina (the Peruvian project partner and coordinator of the PECOLO project) to ensure possible immediate, tactical and strategic impacts.

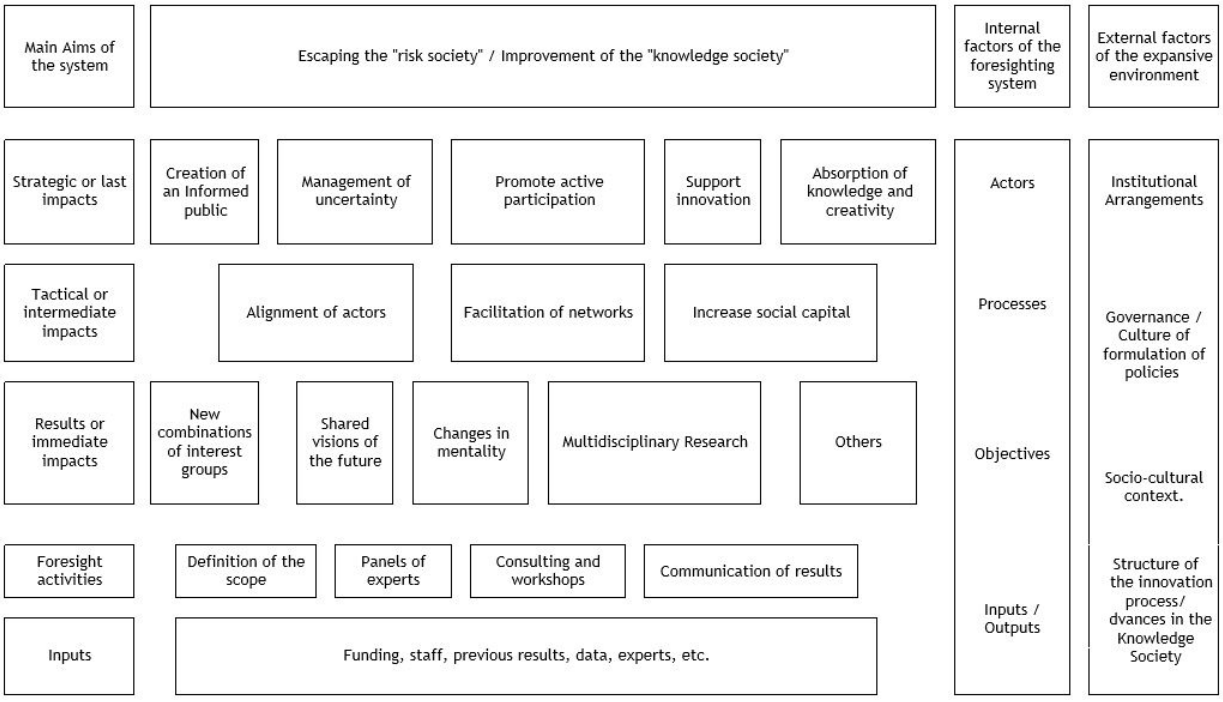


Figure 3. *Framework for the Foresight system. Source: Amanatidou y Guy (2008), p. 552.*

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 means a systematic, holistic, multidisciplinary and critical long-term analysis of futures topics and their alternative developments. It is essentially a study of several alternative futures and not an art of prediction (Amara 1981). Futures studies is about exploring future images and a central method for doing it is by using scenarios.

Foresight is a more recent development, very practically orientated 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, 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, it is foresight that is being 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, but this difference is not clear. In PECOLO project foresight is used to generate futures information and to develop innovation environments focusing on the Andean native crops and ultimately a starting point for a platform for new forms of cooperation and inclusive innovations.

Participation of stakeholders from different organizations and sectors is a key component of foresight and the objective of inclusive foresight is, through 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 is even considered as an evaluation indicator for the success of a foresight work (Bourgeois and Sette, 2017).

Futures studies considers different types of *potential* futures. The three classical approaches are: *possible futures, probable futures, and desirable* (or *preferable)* futures (Amara 1981). Later futures literature identifies in addition *plausible future*. Also an avoidable or threatening future as an opposite of desirable or preferable futures can be distinguished. Too often, however, the emphasis is only on the probable futures leaving out a huge number of opportunities that will be missed unless an open exploration of possible futures is made. Another point of attention in futures work is that one should pay attention to future alternatives and be aware and even prepared to non-desirable 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 on 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 during the course of the process (Slocum, 2003).

The origin of futures workshops is often attached to the work of the Austrian futurist Robert Jungk, who 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 notable being an effort to collect and refine 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 and can be e.g. new products, services or new ways 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 be separated.

What is typical for innovations, especially for product innovation, 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. The link between futures research and innovation can according to Van der Duin (2006) be further established by the lead time of the innovation process and the uncertainty of the innovation process.

The concept of *innovation environment* describes all external features and aspects of organization or company included in its working environment that potentially effect on its innovation activities and therefore its ability to produce innovations. This company orientated definition can also be e.g. with spatial attributes like ”regional” or ”local” or with content attributes such as the development of Andean native corps in the case of PECOLO. Ranta (2012) defines innovation environment as a whole of independent and institutions in which different individuals and organisations act on purpose or without knowledge of each other in same direction in order to improve operational preconditions and business activities of particular field. When we are talking about action groups and dynamics between these groups on a specific geographical region we can refer to it as a regional innovation environment.

METHODS

The Futures Process

The PECOLO process consists of four participatory futures workshops between the years 2017−2019 (figure 4 below). In the first workshop in 2017 an environmental or horizon scanning of the Peruvian agri-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 until 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 different stakeholders in the sector was co-created by the stakeholders.

The workshops included participants from academy, public and private sectors and NGOs. The academic experts were selected according to their expertise in Andean crops. Representatives from governmental institutions were invited with the aim to potentially influence future political decisions. Food companies and NGOs working in the area of Andean native crops were invited as well. The participation of stakeholders from various sectors brings together different perspectives and encourages cooperation. It also foments 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 the stakeholders representing different sectors and organizations were divided into groups of 5−7 persons. The aim is to have groups with divers set of backgrounds to ensure a variety of perspectives and expertise. During the process the participants also strengthened their foresight thinking to the benefit of their organization and for 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. The experts from Finland Futures Research Centre supported the work of each group and the facilitators.

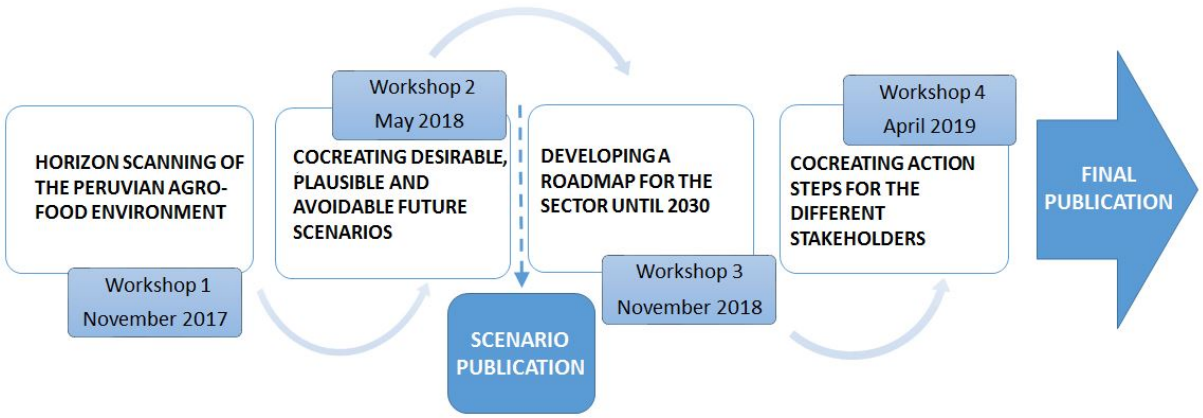


Figure 4. *The four step process of the project for the development of the innovation environment for Andean native crops.*

Workshop 1 Methods

In the first workshop, horizon scanning with the purpose of mapping the key topics that define the Peruvian agri-food sector was carried out. The topics and issues related to the Peruvian agri-food sector with a focus on the Andean crops were discussed among the experts by using three futures studies tools.

First, an adapted version of the Futures Wheel (figure 5), a "current state of the art wheel", was used as a tool for organizing ideas and to inspire the discussions with the aim of framing the current topics defining the Peruvian agri-food sector. 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, and since then, it has been used as a tool for brainstorming in a more structured way. 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 the future topics, in this case the adapted version was used to frame rather the 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 written. These were *consumption, production, innovation, values and trends,* as well as *agriculture*. In Futures Studies terminology, Environmental or Horizon Scanning refers to identifying "new developments that can challenge past assumptions or provide new perspectives about future threats or opportunities" (Gordon and Glenn, 2009).

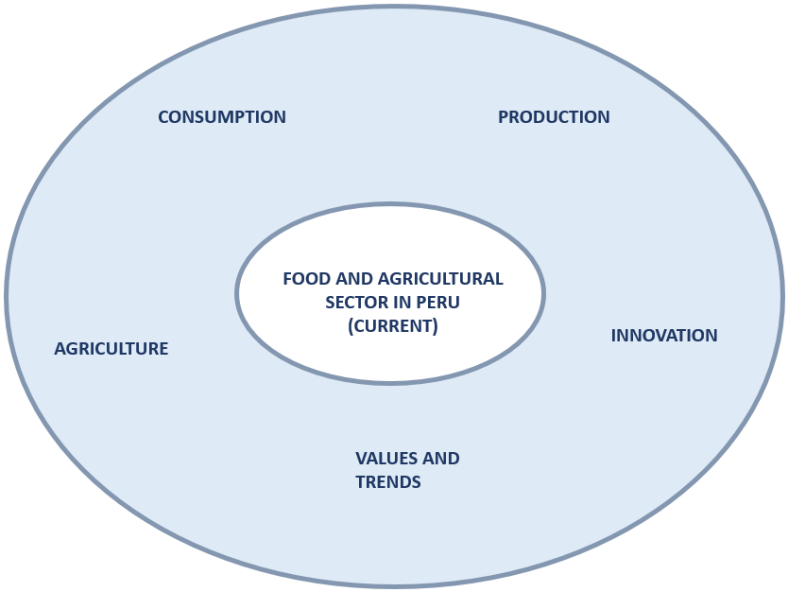


***Figure 5**. The adapter version of the futures wheel (state-of-the-art-wheel).*

The groups started the discussions with focusing on the general issues defining the current agri-food environment in Peru and writing each topic on a separate post-it which was placed in the inner circle. Similarly the outer circle topics with a focus on the agri-food sector were covered.

In the second step, a PESTEC table (figure 6) was used as a tool to systematically map PESTEC factors (Political, Economic, Social, Technological, Environmental, and Cultural) defining the agri-food sector. In this PESTEC table megatrends, trends, weak signals and wild cards for the each identified PESTEC factor was identified. 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.

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

Figure 6. *The PESTEC table used to cover megatrends, trends, weak signals and wild cards (potentially) affecting the Peruvian agri-food sector.*

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 agri-food sector, and used them as input in the ACTVOD table (figure 7). Then, 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 a number of earlier concepts developed within futures studies. It is an attempt to combine elements of exploratory and normative futures studies in one session, and it has the ability to spur creativity and produce interesting results in a rather simple and time-efficient manner (Lauttamäki, 2016).

	[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					

Figure 7. *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.*

Workshop 2 Methods

The objective of the second workshop was to develop scenarios for the Peruvian agri-food sector until 2030 using the futures table as a tool. Each of the groups co-created their own futures table and a scenario narrative for the 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 with differentiation, communication and memorability (Van der Heijden, 2006). In the PECOLO process desirable, avoidable, and plausible future developments were identified. All of which are possible futures.

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 not being restricted to it. After this, each group constructed a Futures Table (figure 8).

The tables developed in the PECOLO workshops 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. Also Megatrends, Black Swans and Weak signals affecting all futures states were stated. Once the table was completed, participants drew paths for desirable, avoidable, and plausible scenarios. Each group wrote a scenario narrative for the desirable scenario.

	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				

Figure 8. *The futures used as a tool to create alternative futures (desired, plausible and avoidable).*

In order 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 their feedback.

RESULTS

Workshop 1: Horizon Scanning

The first workshop was organized in November 2017 at UNALM. 50 participants attended the workshop and they formed 6 groups. The experts represented the following organizations:

- Academia: 25 participants
- Public sector: 11 participants
- Private sector: 13 participants
- Non-Governmental Organizations: 1 participant

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 topics defining the existing innovation environment of the Peruvian agri-food sector and specifically the Andean native crops.

The key findings were analyzed and summarized into a wheel by topics grouped by the themes (Figure 9). In other words, the most frequently mentioned topics of each of the three sessions (adapted futures wheel, PESTEC and ACTVOD) were grouped into themes.

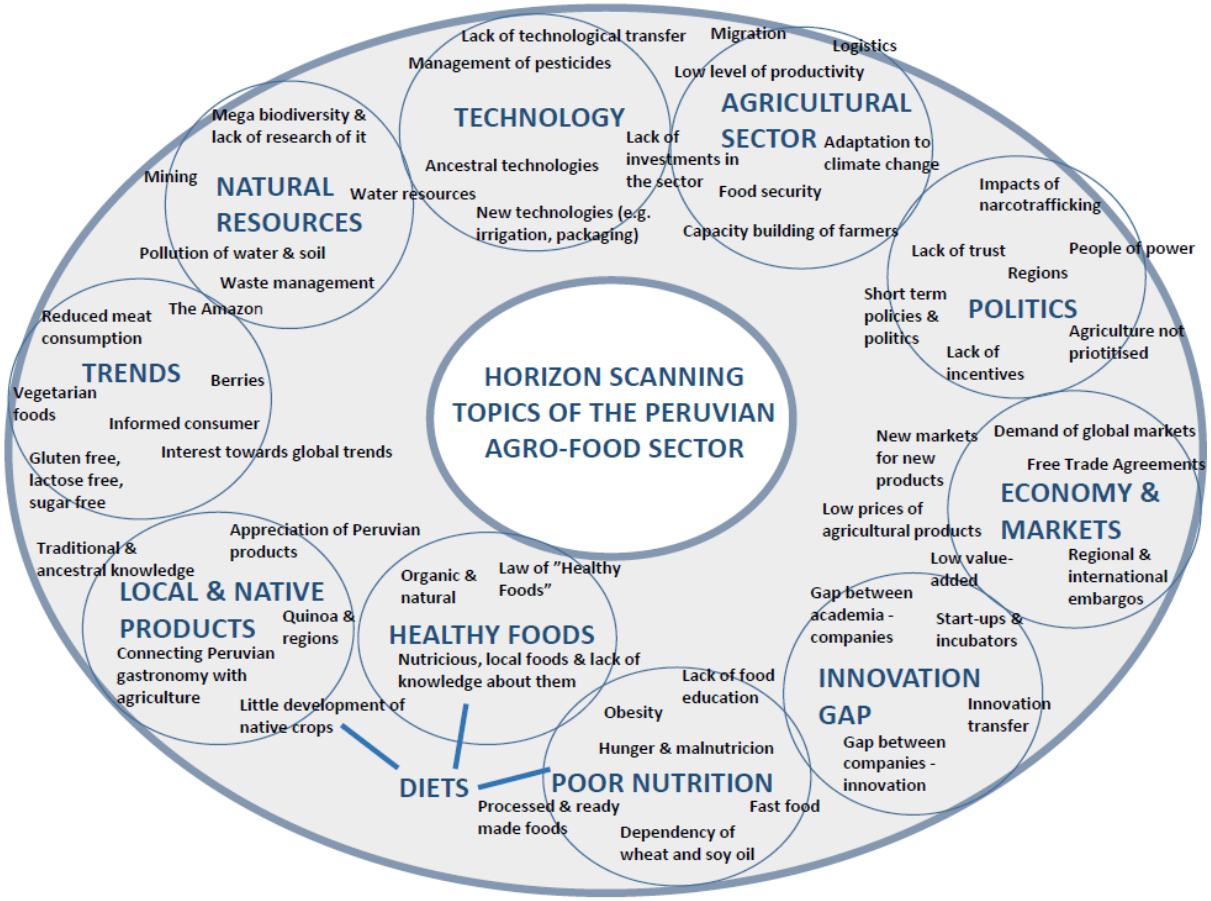


Figure 9. *The most frequently mentioned topics of each of the three sessions grouped in themes.*

Ten major topics were brought up systematically throughout the groups; the role of technologies; natural resources; politics; economy and markets; innovation gap; topics related to diets and nutrition such as poor nutrition; healthy options; local and native products; food trends; and the agricultural sector in general. Analysis of the results is structured through these key focus areas or lenses. While the structuring the various topics into thematic groups helps to examine the topics, it is important to keep in mind that these themes form a system where the different parts are interconnected to each other.

Technology

Technology was elaborated on, noting the lack of updated technologies and transfer capacity, and their necessity for e.g. management of pesticides, irrigation, and food packaging.

Natural Resources

The short term planning and low level of political interest poses challenges to sustainable management of natural resources, of which Peru is abundant of. The problematics related to environmental pollution caused by mining and inadequate water and waste management, and plain research gaps in terms of megabiodiversity of the Amazon and other regions indicate that there is a lot of potential yet simultaneously enormous threats to the sustainable development of Peruvian agricultural sector.

Especially the government's prioritization of the extractive industry over other sectors was frequently discussed. Participants stated that the agricultural sector is not prioritized enough in national decision making.

Agricultural Sector Linked to Local, National and Regional Politics

A number of issues linked to politics were seen as hinders for the development of the agricultural sector. The short-term policy-making, lack of incentives, trust and focus, and the impacts of narco-trafficking were not fully considered and tackled by the government.

Multiple issues linked to local, national and regional politics in the agricultural sector were brought up. Adaptation of the agricultural sector to the climate change, the general lack of investments and capacity building, low productivity, and issues of food security were mentioned. Migration from rural to urban areas, or urbanization, is a megatrend affecting strongly also Peru and its agricultural sector. Especially young people leave the countryside to look for opportunities in the urban areas. Furthermore, lack of logistics and functioning infrastructure were mentioned as issues for the development of the agri-food sector. Peru is a vast and mountainous country. Without a functioning logistic and infrastructure the agricultural sector can't develop and grow. These link very much with local, national and regional politics.

Economy and markets

Economy and market issues were stressed as factors to both hinder and boost the sector. On the one hand, there was the urge to find new markets for new products, and the global markets were acknowledged to play an important role in the context of the ago exports. On the other hand, the free trade agreements and regional and international embargos were seen in a questionable light and may eg. lead to negative consequences such as low prices of Peruvian agricultural products. The low value adding industry was also considered as a key issue.

Innovation gap

Innovation gap was demonstrated through the urge for better innovation transfer, improved collaboration between the academia and companies, as well as among the companies themselves. There is a need for food sector start-ups and platforms for such co-creative work.

Diets/nutrition/healthy foods/local and native products

Peruvian superfoods have gained a status in the global health food, or so called “super food” markets, and there is a constant demand for new products. On the other hand, their low prices and low value added may not necessarily attract a new young generation of farmers, and the insecurity of global markets add another layer to the setting. On the other hand, ancestral cultivation and processing technologies were emphasized as a source of sustainable knowledge and potential. Peru has an astonishingly diverse and long history and heritage of different ways of utilizing crops. Valuation of traditional cultures and ancestral knowledge is essential to the sustainable development of local and native products. More efforts is needed also in the dissemination of the native crops, also on the national level. Linking strategically the native crops with the Peruvian gastronomy, which has become increasingly popular globally, could help in the dissemination and marketing of the products of the Peruvian farmers.

Many local products are organic and highly nutritious, yet these qualities are not much known of. Such lack of “food education” is a partial cause of poor nutrition, along with poverty and inaccessibility. Dependency of soy and wheat imports, consumption of fast food and processed foods has led to poor nutrition. More efforts are needed for the dissemination of nutritious local foods. In addition, the new law “Alimentación Saludable”, Healthy Food Law, requires that the food companies give information about the non-healthy ingredients such as salt, sugar and saturated fat in their products. Many processed products are rich in these ingredients and the Andean grains offer a nutritious alternative to these products.

Trends

Global food trends, such as reduced meat consumption, vegetarianism and veganism, gluten free, lactose free and sugar free options are gaining popularity at least a certain consumer niche. If the trend continues, the informed consumers in the global markets provide growth potential for the Peruvian “super food” sector, with the berry export being a relatively recent one.

As a conclusion, the potential of targeting domestic markets and widening the offer in the international market is evident. Still, despite of international demand, focus needs to be put also on national issues of poor nutrition, lack of education and knowledge, sustainable management and prioritization of biodiversity and natural resource management, and increasing political prioritization and valuation of not only the crops, but also the farmers, the ancestral knowledge and the millennia of heritage. Sectoral facelift in terms of consumption and identity making needs to go hand in hand with sufficient rural livelihoods.

Workshop 2: Scenario Development

The second workshop was organized in May 2018 at UNALM. 45 participants attended the workshop and formed 7 groups. The experts represented the following organizations:

- Academia: 18 participants
- Public sector: 12 participants
- Private sector: 14 participants
- Non-Governmental Organizations: 1

ALTERNATIVE FUTURES VARIABLES	A	B	C	D
1. Investments	Public and private investment increased GDP by 25% for exports.	Public private investment has improved but it fails to reverse the deficit.	The GDP is maintained at 10% increasing food imports.	A change in the political orientation generates a reduction in investment.
2. Training of Farmers	100% of producers are trained.	Efficient training policy.	Limited increase in training levels.	Resistance to training in ancestral policies.
3. Food Security	Food security is guaranteed.	Implementation of policies to promote food security.	Low levels of irrigation control threaten food security.	Widespread food imports.
4. Climate Change Adaptation	Climate change is used for the benefit of agricultural production.	Adaptation to climate change.	Low adaptation to climate change (high vulnerability).	Without adaptation.
5. Gap Companies - Innovation - New technologies in irrigation	The triple helix works jointly for the implementation of R+D+i.	No access to R+D+i	Resistance to innovation.	Reduced R+D+i
6. Articulation of the link Agronomy - Gastronomy	Preference of Andean grains in gastronomy.	Increased demand of Andean crops thanks to trends (Peruvian gastronomy, Andean crops).	Low level of participation of Andean crops in gastronomy	No use of Andean crops in gastronomy.
Megatrends	Healthy eating - Use of transgenic products. - Climate change.			
Weak Signals & Black Swans	Legalization of drugs - Adverse Reactions on health through the consumption of Andean crops.			

Figure 10. *The finalized futures table of one of the groups. The green dots indicate the desirable future of the expert group, based on which the desired scenario narrative was written. The yellow dots indicate the plausible future of this group of experts, and the red dots indicate the avoidable future.*

Each of the futures tables were analyzed. The commonly mentioned topics of the groups were identified and structured under themes as in the first step. The results summarizes the most common topics mentioned by the expert groups.

Transfer of Technology (ToT) / Gap between companies and academia / Cooperation /Inter-sectorial Cooperation / Public-Private Partnerships

Technology Transfer and partnership between academia and other sectors of the society was the most common topic and present in all the results of all the expert groups. Desirable futures include promotion of different production techniques and a triple helix model of innovation.

The results show that the lack of trust hinders technology transfer across sectors, as well as intersectional cooperation for research, development and innovation.

Peruvian experts also added that in a desirable future scenario, ancestral practices are highly valued and traditional populations are respected.

Climate Change

Climate change will have major effects in the food production systems. Most groups included Climate Change as a megatrend in their tables. This is an important issue when thinking of the agri-food innovation systems in 2030. What are the weather changes expected for Peru? How will The Andean region be affected? How can, and should, Peru and its agri-food sector adapt to the changing climate?

One group had Climate Change as a variable in their Futures Table presented as alternative ways the government and the society could tackle climate change issues (for example by complying to the Paris Agreement or disregarding it, by adapting agriculture to the changing climate, or not, making food systems more vulnerable).

Traditional Populations & Ancestral Production Systems

All the expert groups that mentioned this issue in their discussions promoted the appreciation of ancestral production systems and traditional knowledge for the development of agricultural innovation. This way the topic is closely related to the ToT and innovation mentioned above.

Avoidable scenarios of these groups included the loss of ancestral knowledge, resistance to training farmers to use ancestral knowledge, and negative impacts of machinery in the context of ancestral producing systems, when/if they are technified. As answers to tackle these issues, the groups suggest to rescue ancestral techniques, study and test them in a way to inspire future technology and turn this ancestral knowledge into innovation.

Food Labels / Certified food products / Fair Trade / Informed Consumers

Although labels and certificates for different purposes, food certification and labeling is a growing trend linked to the demand to inform consumers. The labels or certifications were mentioned by four groups. Labels were mentioned on a general level but also more specifically GMO, gluten-free and other allergens. The growing trend of “informed consumers” puts pressure not only on the producers and industries, but also on policy makers.

Health benefits of Andean crops

All the groups included the health factor in their Futures Tables. Peruvian experts were confident that the globally growing trend of healthy eating will benefit the commercialization of Andean crops. Andean grains, such as quinoa, are promoted as healthy foods or “super foods”.

In many of the desirable scenarios, Peruvian Andean crops are used in the kitchens of well-known chefs around the world. These scenarios are built in the idea that Peruvian food is internationally esteemed, that the healthy compounds of the products are highly valued, and that the most sophisticated consumers seek Andean products.

Food Security vs. Hunger

Food Security and the fight for hunger and malnutrition is present in many of the Peruvian Futures Tables and scenarios. The elimination of malnutrition in Peru is an important driving force in shifting towards a desirable future. According to experts attention on the most vulnerable sectors of the society should be paid.

Culture of Healthy Foods in Educational Programs

Still related to food security and healthy eating, many expert groups discussed the importance of education programs promoting healthy eating habits in Peru.

According to the desirable scenarios of the experts, in the 2030 the Peruvian consumer could apply healthy habits in their daily lives, not related to food consumption, but also practicing sports and having a healthy sleep cycle, if multiple campaigns of nutrition education and healthy lifestyles are driven by the civil society.

In addition to a better comprehension of nutrition, education can also empower citizens to make better choices for their own lives and their surrounding environment. When improving education, especially in the rural areas, there is a higher chance for a more sustainable management of land and water resources.

Megatrends, Weak Signals and Black Swans

The participants were asked to list megatrends, weak signals and black swans that could affect the future of the agri-food innovation system in 2030.

When compiling the megatrends proposed by all groups of experts, most of the common megatrends were indeed included on the list. However, surprisingly, only climate change was present in the discussions of almost all groups.

Signals mentioned in the tables were: Climate Change (5 groups), Healthy eating (5 groups), Scarcity of water resources (2 groups), Human Migrations (2 groups), Asian center of power (1 group), Environmental pollution (1 group), Technological exploitation (1 group), Population growth (1 group), Use of transgenic products (1 group), Increased adoption of new technologies in agriculture and food industries (1 group), Aging of the rural population (1 group), The El Niño phenomenon (1 group), Corruption (1 group), Narco State (1 group), Increased malnutrition and hunger (1 group), Informed Consumer (1 group)

After the workshop a combined futures table (table 1) was made with the objective of having one common desired futures table covering the key aspects of the groups. This table was based on PESTEC+H aspects, where H stands for health, as this was an important and frequently mentioned topic among the experts. The table below includes thus the most frequently mentioned issues extracted from the results of the groups, structured by the PESTEC+H approach and divided into desirable, avoidable and plausible future variables.

Table 1. *The combined futures table based on the outputs of workshop 2.*

Variables		DESIRABLE FUTURE STATE "A more democratic and inclusive Peru"	AVOIDABLE FUTURE STATE: "Future for a few"	PLAUSIBLE FUTURE STATE: "More of the same"
POLICY	POLITICAL	Priority from national government to the agri-food sector	No priority. Existing laws are not reinforced and policies are not implemented	Policies exist on paper, but many of them are not developed or implemented due to lack of articulation.
Agricultural Production Systems	Economic	Increased investment from domestic and foreign private capital to the agri-food sector. The government has transparent processes and agri-food sector receives sufficient budget allocations. Increasing number of cooperation between academy-private sector, as well as pubic-private partnerships.	Little to no investment from private capital to the agri-food sector. Budget allocation processes are unclear giving room for corruption.	Although there are investments from domestic and foreign private capital to the agri-food sector, producers receive only a small share of it. Although budget allocation processes are transparent in principal, hidden costs are questioned by the civil society
Formalisation of Work	Social	Incentives to employers who employ workers within formality. Social policies allow for a better social protection of workers, workers' rights, decent wages, safe work environments, healthy working conditions and hours, training and technology.	Large number of rural workers (especially migrants and women) live in vulnerable conditions of informal work.	Larger number of formalized work than today, but still a large disparity between statistics in rural and urban contexts. Urban workers are in general working in formalized jobs, while rural workers are mainly working informally.
Transfer of Technology (ToT)	Technology	Strong relationship between producers, academia, the State and the private sector. Different production techniques are advocated	Know-how and technology belongs to a small sector of society. Very little technical assistance to farmers. High protectionism mechanisms for intellectual property.	Intersectional partnerships are mainly lead by the private sector. Cooperation that works well receive good compensations, however, these are limited to just a sector of the society.
ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE AGRIFOOD POLICIES	Environmental	MINAM (Ministry of the environment) and MINAGRI (Ministry of agriculture) join forces to develop sustainable agri-food polices such as responsible management and conservation of land and water. Both the public and private sector is committed to the responsible environmental management and the	Poor environmental management in combination with climate change and the priority given to the extractive industry leads to loss of biodiversity and polluted and toxic waters and soils.	Peru is highly vulnerable to the climate change but the adaptation measures are weak and poorly implemented despite existing adaptation policies. Water stress hinders the growth of the agriculture sector.

		academy receives funding for biodiversity research.		
Culture of Innovation merging anscestral knowledge with new technologies	Cultural	Traditional populations are respected and recognized as an important sector of the society. Ancestral knowledge and production systems are a patrimony of the society. Indigenous know-how is studied in universities, producers participate as actors in innovation labs and new techniques and technologies are produced with this cooperation.	Traditional populations are considered hindrance to development. Rights are compressed and indigenous people are marginalized. Most RDI is done based on imported knowledge, disregarding ancestral experiences.	Traditional populations are amongst the poorest of the society and are marginalized. There are, however, social protection to some recognized groups. Their production systems are studies and implemented in innovation labs, but indigenous peoples themselves are not actors in the innovation process.
THE NATIONAL AND INTERNATIONAL ROLE OF PERUVIAN CROPS AND CUISINE	Health	Peruvian Andean crops are internationally valued; most sophisticated consumers seek Andean products, which are also used in the kitchens of well-known chefs around the world. Andean crops are affordable to the not-so-sophisticated consumer too. Healthy compounds of the produce are highly valued.	Healthy eating is a trend enjoyed only by those who can afford. Peruvian Andean crops are produced for very exclusive consumers who demand an extraordinary quality of produce.	Healthy eating continue to grow as a trend nationally and internationally. Peruvian Andean crops are sold for export, but suffer from high competitiveness as producers in other countries produce similar products at a lower price.
Megatrends	Climate change; Biodiversity loss and environmental degradation; Urbanization; Empowerment of women (gender equality); Changes in the demographics (population growth, aging of the population, growing migration); Changes in work environment; Formalization of work: Digital transformations (automation, robotization, artificial intelligence, 3D Printing, and other digital innovations), Fragile representative democracy; Social disparities; Sustainable development as a driver for ecological concerns and policy making; Overexploitation of natural resources			
Weak Signals & Black Swans	Political and social disturbance; Civil war; Coup d'état; International wars; Legalization of drugs; Production by consumers; Incursion of resistant pests or fungi; Free trade Agreement; Biopiracy.			

Based on the combined futures table a scenario narrative for the desired future state in 2030 for Peru was written.

Peru: a Biodiverse Country that Transcends

It is 2030 and the policy-making, the responsible, sustainable and healthy food production is a priority to the Government of Peru. The agri-food sector has steadily been growing, and the Government of Peru have created favorable policies to agri-food sector, boosting social services to rural communities, developing education and healthcare infrastructures, and educating the entire society about the benefits of sustainable production, sustainable societies and sustainable development as a whole.

As conditions to developing the agri-food systems become more favorable, there is a growth on private investment from domestic and foreign private capital.

The food industry, which plays a fundamental role in the value chain, has the available raw materials and inputs, as well as technologies that have been developed in collaboration with the academy. The food industry has an access to credits and capital, offers employment, contributes to the economy through taxes and generates economic flow and foreign currency for the country. The industry has become a key component for economic and social development, is protected against piracy and works in close cooperation with the academy and the public sector. Research, technological development and collaborative innovation seek to address the challenges of the agri-food export as well as food security.

Since the impeachment of the Peruvian president in 2018, anti-corruption policies have been developed further, thus, the books for this type of investment are open and budget allocations are transparent.

Favorable policy conditions, in addition to a transparent budget allocations foment public-private partnerships and associations to develop. Now, in 2030, there is a strong relationship between producers, academia, the State and the private sector. As different sectors cooperate, new types of production techniques are being developed, and Andean crops are produced more efficiently.

As producers, universities, and the private and public sector cooperate for RDI, new types of production techniques are being developed, and Andean crops are produced more efficiently. Some family farms operate as testing grounds for innovative methods of production.

There has been substantial investments on circular economy and bioeconomy in order to face the resource scarcity and to minimize and take the advantage of agricultural waste flows. RDI has focused heavily on the circular economy and sustainable business models, which in 2030 play an important role also in the agri-food sector. This has resulted in new competitive and sustainable advantages for Peruvian companies and for Peruvian products in the global market.

RDI of food production has been successful in Peru also because of traditional knowledge and traditional applications have been incorporated with new technologies. Known ancestral techniques have been studied and tested in a way to inspire the development of technology, turning ancestral knowledge into innovation.

In this scenario, where various sectors of society collaborate to the development of sustainable food production, other sectors of society also benefit from this. For example, as stakeholders recognize the value of ancestral production systems, there is a movement of rescuing ancestral techniques and protecting existing traditional communities. Traditional peoples are valued as important assets for the country. Ancestral knowledge and production systems are a patrimony of the society. Indigenous know-how is studied in universities, producers participate as actors in innovation labs and new techniques and technologies are produced with this cooperation.

Policies for a sustainable agri-food sector are successfully implemented throughout the country as a joint cooperation between the Ministry of Environment and the Ministry of Agriculture. The private sector, including the extractive industries, have incentives to use of land and water resources in a responsible

and sustainable manner. Since the growing importance and request for resilient and sustainable policies, the academic sector receives an increasing number of funding for biodiversity research.

Following the anti-corruption policies, the transparency of budget allocations, and intersectoral cooperation, Peru also experience an advance in the formalization of work. There is a growing incentive to formal employment. Social policies allow for a better social protection of workers, workers' rights, decent wages, safe work environments, healthy working conditions and hours, training and technology. The women's rights movement has grown not only in Peru but in whole Latin America. There is a higher demand for social policies aimed at protecting women, giving them better opportunities, and empowering women to pursue education and careers. Among other incentives, daycare providers are growing in the rural regions of the country, allowing women to be active working citizens and tax-payers. When women have equal opportunities for education and work environments, they contribute to the advancement of local and global communities.

Peruvian Andean crops are esteemed internationally; most sophisticated consumers seek Andean products, which are also used in the kitchens of well-known chefs around the world. Andean crops are affordable to the not-so-sophisticated consumer too. It is easy to recognize different kinds of products with the ease of certifications and labels on the packaging of the products. Healthy compounds of the produce are highly valued.

DISCUSSION

The scenario developed as a result of the futures workshops presents the desired future for the Peruvian agri-food sector with a focus on Andean native crops. The scenario is a narrative of the desired future situation in 2030 and serves as a basis for the next steps. In the next steps of the project, in the workshop 3, a road map that focuses on the things that will have to happen between 2019−2029 in order for the scenario to be a reality in 2030, is developed. In the last step, in the 4th workshops, an action plan with concrete action steps for the stakeholders will be made. These results will be presented in the final project publication.

Looking at the desired scenario, we can see that two of the megatrends that could have a dramatic impact on agriculture is climate change and the loss of biodiversity. Adding to this the already existing and increasing scarcity of water resources and the degradation of soils Peru, a many other regions around the globe, could face the biggest challenge of its history. This will be a huge challenge for the Peruvian government to solve and solving these existential threats are crucial to achieve the desired scenario. Even the most likely futures identified by the stakeholders of the workshops concluded that given Peru's vulnerability to climate change, water stress and weak or poorly applied policies, the growth of the agricultural sector would be in danger.

Another challenge that emerges from the scenarios is that Peru needs to maintain its leadership position that it should have in the future in the exports of Andean grains, as well as its international influence on food and gastronomy. According to Bazile et.al. (2016) the number of countries that grow quinoa has increased rapidly from only 8 in 1980 to 40 in 2010 and to 75 in 2014. They also indicate that another 20 countries have planted quinoa for the first time in 2015. Taking the growing number of new producers into considerations, the stakeholders of the PECOLO workshops suggest that the most likely scenario for Peruvian quinoa is to face a greater competition given that the competing market would offer similar products at a lower price.

In addition, in the workshops and in the results there is an important dialogue between the relationships of local ancestral knowledge and global knowledge in terms of innovation. According to the FAO's initiative Globally Important Agricultural Heritage System (2019), some of the examples on traditional knowledge include ancient terraces to convert the steep slopes in crop productive zones, the "camellones" ridges fields and the "cochas", small lagoons used as rain fall humidity reserves in the high plateau, as well as Laimes or Aynokas which are the lands for a crop sectorial rotation system used by the traditional communities. Sustainable water management is a key sustainability factor describing these systems (FAO[2], 2019).

This situation is torn between the generation of innovations that utilizes the traditional knowledge of indigenous peoples, but without openly recognizing them for their traditional knowledge and their role within the generation of innovations, or to include them in an active way and making them benefit in economic terms. This turns out to be a challenge, given that the most likely scenario is that innovation laboratories will learn from traditional knowledge, but not give them ownership of it. It is thus crucial to include ethical discussions into the innovation processes and projects and ensure the representation and participation of the indigenous peoples in the innovation processes.

In order to improve the innovation environment of Andean crops, co-operation and trust between all stakeholders should be developed. Without co-operation and trust information and knowledge will not

spread among stakeholders. Trust is needed, because in a network of stakeholders one cannot expect to win and benefit all the time, but in longer run all participants of network benefit for being part of it. If somebody seeks for quick and dirty wins, trust is lost and it is hard and time consuming to get it back.

The role of the desirable scenario and vision is to help the decision making of different stakeholders, both public and private. We argue, that the desirable scenario developed during the PECOLO project can be accepted by various stakeholders. The main challenge is to communicate and disseminate it to stakeholders, otherwise its benefit will be minimal. The road map and action plan developed in the third and fourth workshops will give concrete suggestions to strategic and operative decision-making for coming years.

GLOSSARY

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

Megatrends

Megatrends are long-term phenomena that shapes our world and societies. Megatrends are triggered by major changes, such as changes in the environment, shift 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 or very quickly in others, megatrends are global behaviors.

Because megatrends are global and affect every sector, in the context of Futures Studies, a set of megatrends are commonly seen in various contexts. These are climate change, growing pressure on ecosystems, urbanization, changes in the 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 a movement/change over time. They are experienced by everyone and often in more or less the same contexts and create broad parameters for shifts in attitudes, policies and business focus over periods of several years that usually have global reach. What is interesting about trends is that normally most players, 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 increased concerns for the environment in terms of sustainability, human and animal health, and global warming; Increasing push for greater efficiency and decarbonization of the energy system because the environmental and energy sector concerns; and proliferation of nation states and groupings of people seeking self-determination status.

Weak Signals

Weak Signals are incidents or phenomena that, as they happen, they do not seem to be significant or connected to other signals. However, as futurist Sirkka Heinonen (2017) points out, as the future unfolds, we learn these weak signals had a crucial role on the development of something. A collection 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 out societies became to understand that the climate change would threaten our whole existence.

Black Swans/Wild Cards

Black swans and wild cards are often used interchangeably. The term Black swan was introduced in the Futures Studies literature after Nicholas Taleb's book "The Black Swan. The impact of the highly improbable" (2007). 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 its prediction can be explained 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.

In Foresight processes it becomes important to include the possibility of unforeseen situations and surprises because they often do reshape the trajectories of events and situations (Saritas and Smith, 2011). Thinking of black swans is a complicated task, exactly because they are unexpected in its essence, however, speculating 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) possible futures that ‘could happen’ according to our current knowledge of how things work. They are are based on the knowledge we have today. Its foundations are the 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

(or preferable futures) Desirable future is what 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) “It concerns 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”. 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 are examples of drivers of change.

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