Sustainable Agriculture and Healthy Food in Chile

Spring Vineyard. Elqui Valley, Andes part of Atacama Desert in the Coquimbo region, Chile © Shutterstock

Chile

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Summary

Chile is located in the far SW of South America. It occupies an area of 756,100 km², making it the world's longest country and, possibly also the narrowest.

It has a population of 17 million, with a growth rate of 1%, where 13% is over 60 and 13% is rural population. Life expectancy at birth is 79, and the agricultural sector represents 8.6% of the country's labor force.

Its agriculture, marked by a great diversity of climates and soils, permits the cultivation of a broad range of species, which include aquacultural ones. They not only provide a significant portion of the population's staple food but also contribute significantly to world food, especially salmon, fruit and wine, which makes it possible to generate a Gross Domestic Product (GDP) of $258.16 billion USD, representing 8% of the total, expressed in GDP per capita, which totaled over $23,000 USD in 2014.

The country has highly trained human capital and a solid infrastructure for conducting R&D&I, which has allowed it to be successful in eradicating the child nutritional deficit that prevailed until the first half of the last century, through the implementation of effective public policies. At present, however, the problem is related to a worrying level of obesity, which also affects the adult population, for which aggressive public policies are beginning to be promoted.

Exports created two types of agriculture in **Chile**: one to supply food for the local population, developed by Peasant **Family Agriculture, in small, low-tech plots of land; and commercial agriculture, with a great deal of technology and significant foreign investment,** designed to produce for world markets

1. Introduction

Chile is located in the far SW of South America, occupying an area of 756,098 km², which extends for 4,329 km from 17°30' to 56°30'. This is equivalent to one tenth of the Earth's circumference, making Chile the longest country in the world. But it is also one of the narrowest, since it has an average width of only 180 km, around the West parallel 70°.

This layout creates a variety of climates, ranging from desert at the North end to steppes in the South. In the Central portion, between latitudes 27° and 43° S, Mediterranean and temperate climates predominate. Precipitation occurs mainly in the winter, increasing toward the South and decreasing from the coast to the mountain range. This section of the country is generally free of extreme-weather phenomena such as polar winds, hail, tornadoes or excessive snow, which makes it very suitable for agriculture, which, however, must mostly be irrigated. Moreover, this zone forms a sort of island separated, in the North, from the rest of the mainland by the world's most arid desert, in the South, by everlasting ice, in the West, by the Pacific Ocean and, in the East by the Andes, which separate it from neighboring countries.

There is enough information to indicate that agriculture in Chile was fostered by the peoples who inhabited this territory before the arrival of the Spaniards and that it evolved as a result of successive invasions, first by the Incas, the most developed people in South America and then, by the Spaniards. The influence of the Incas reached as far as Chiloé (50°S), when they introduced new crops and irrigation techniques and roads to facilitate the trading of agricultural products. Thus, agriculture evolved from an activity mainly intended to supply food to the population, until export agriculture became a major contributor to the country's Gross Domestic Product (GDP) when, toward the late 19th century, a period of food-product exports began that was consolidated in the 80s. This consolidation also contributed to the expansion of trade liberalization, encouraged by free trade treaties and other economic complementarity agreements strongly promoted from the early 1980s onward. Currently, food-product exports are concentrated on fruits, shipped fresh to the Northern hemisphere when they are out of season there, and artificially reared salmon exported to various markets around the world. The wine industry has also developed significantly since the 80s, becoming a key player in the Chilean agri-food sector and the global wine industry. Moreover, small quantities of other products such as milk, meat and honey are exported, without much added value.

In the context described, the advent of export agriculture created two types of agriculture: one dedicated to supplying food for the local population, developed by Peasant Family Agriculture, in small, low-tech plots of land; and commercial agriculture, with a great deal of technology and significant foreign investment, designed to produce for world markets. The country is currently committed to generating and using new production techniques, with environmental and socially sustainable criteria, including several certification systems, such as Corporate Social Responsibility Systems (CSR), Good Agricultural Practices (GAP), Good Hygienic Practices (BPH), Good Manufacturing Practices (BPM), and increasingly products that mention their attributes such as carbon footprint, water footprint, environmental footprint, fair trade and antioxidant content.

From a nutritional point of view, the country has successfully eradicated the child nutritional deficit prevalent until the first half of the last century, through the implementation of effective public policies, including free breakfasts and school lunches for the most vulnerable population. Nowadays, however, the problem has shifted to the worrying level of obesity, which also affects the adult population (Araya, 2006). Current public policies are designed to encourage the consumption of healthier foods, with low sodium, fat and sugar content, for which active population education campaigns have been launched, together with a new food-labeling law, taxes on sugary drinks and a law regulating the advertising of processed foods.

2. Demographic inventory

According to figures from the 2012 census, the total population of Chile is 16,634,603 people, and it is estimated that by the end of 2017, it will exceed 17.5 million people. According to the same census, the population growth rate declined from 1.24% in the decade from 1992 to 2002 to 0.99%

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for the decade from 2002 to 2012, a downward trend that is expected to continue in the following decades.

Of this total, 87% of the population is urban and only 13% rural. There is also a tendency for the rural population to continue to decline as the country develops.

In the Latin-American context, Chile is the country that has increased its life expectancy at birth most quickly. Between 1970 and 2015, it increased from 60.5 to 77.4 years in men and from 66.8 to 83.4 years in women. Likewise, life expectancy after 60 has increased rapidly, totaling 20.9 years in men in 2016 and 24.4 years in women. At the same time, the number of senior citizens increased by a factor of 5.3 between 1950 - when population aged 60 or over totaled 416,741 - and 2010, when the number rose to 2,213,436.

The magnitude of the increase in life expectancy, coupled with declining fertility, will cause high, sustained growth of the elderly population, at least for the next two or three decades, which involves important equity issues, since there are obvious differences in the population linked to socioeconomic status, gender and place of residence, which will need to be addressed.

Agricultural activity is labor-intensive, and the sector that generates most employment in the country. In 2014, the forestry and livestock sector created 685,000 jobs, including seasonal work, representing 8.6% of the country's workforce.

3. Agricultural inventory

The Office for Agricultural Studies and Policies (ODEPA) of the Ministry of Agriculture regularly publishes a report summarizing available data on Chilean agriculture. According to the latest report, published in 2015 (ODEPA, 2015), mainland Chile has an area of 75.6 million hectares (ha), 51.7 million of which are suitable for silvo-agriculture and 35.5 million of which are used for agricultural livestock raising or forestry. However, due to geographical and economic factors, the area under cultivation currently stands at just 2.12 million ha. This area is distributed among 1,303,210 ha of annual and permanent crops, 401,018 ha of sown fields and 419,714 ha of fallow land. A total of 17,070,776 ha are covered by native forest and bushes; 12,549,478 by natural meadows; 2,707,461 by forest plantations, and 1,062,352 by improved pastures. Of the remaining area, 15,942,424 ha comprise sterile, arid or stony lands, and 242,742 have an indirect use in infrastructure, mainly roads and canals.

Of the 1.3 million ha with annual and permanent crops, 704,575 ha are used for annual crops, 296,587 ha for fruit trees, 137,593 ha for wine-grape vines and 78.072 ha for vegetables. **Table 1** shows the five main crops for each of these groups. As for meat production, poultry accounts for the largest share, with 669,100 tons (t) in meat carcasses, pork, 520,100 t; beef, 224,100 t; lamb, 10,000 t and horsemeat 7,600 t. The country also has approximately 460,000 head of dairy cattle with a yield of 2.691 million liters of milk per year.

This agricultural area and production have generated a GDP totaling US $ 258.16 billion in 2014, expressed in GDP per capita, calculated as purchasing power parity by the International Monetary Fund (IMF), of $23,057 USD. Of this total, the silvo-agricultural sector contributed just 2.3%, but if the activities that add value to the primary products and services produced in the sector are considered, the contribution rises to about 8% of GDP.

Table 2 displays the evolution of the fruit area in Chile, which shows how dynamic the sector is. There have been significant changes in land use, related to the increase or decrease of the area-under-cultivation of the different species, due to variations in international demand - especially in developed countries -, water and labor availability and the possibilities of mechanization.

4. The current Chilean agricultural development model

In the 1950s, agriculture was considered the weakest aspect of the Chilean economy, since it was the country that exported least and imported most agricultural products. This was the starting point from which Chile embarked on this new phase of modernization and agrarian transformations. In this context, agricultural, livestock, forestry and fishery exports in the 1960s amounted to $52.5 million USD. By the 1980s, they stood at approximately $1.84 billion USD, a significant, sustained increase, which has continued to this day. This evolution, in the case of fruit, which is perhaps one of the most emblematic, was possible due to the country's geographic situation, giving it the opposite season to the Northern hemisphere, a favorable exchange rate and the development of a National Fruit Development Plan promoted by the Production Promotion Corporation (CORFO) in the 1960s. This plan led to the training of a large contingent of professionals through a joint program with the University of California (US) and a flexible vision of agricultural entrepreneurs to adapt to the commercial requirements of international markets, as well as a trade liberalization policy in which Chile initially explored a partnership in blocs and subsequently opted for multilateral liberalization. Regarding the latter, Guerrero and Opitz (2017) report that Chile has signed 26 trade agreements with over 64 countries, including trade blocs such as the European Union. **Table 3** displays Chile's trade balance with the world. It shows that the agricultural sector is the most important one for exports and imports, in addition to which it has the most positive trade balance, followed by the forestry sector.

An agroexport model was generated, whose growth and development engines have been fruit growing, mainly table grapes, apples and stone fruits. This was followed by winemaking, seeds, berries, poultry and pork and even certain dairy products, such as cheeses. This model, initially led by transnational corporations, both in production and supply of inputs, has given way to medium and large producers who have joined the export chain directly, acting as producers and exporters.

Table 1. Area occupied by the 5 main species of the relevant categories of agricultural crops in Chile

Category	Area (ha)	Main species	Area (ha)
Annual Crops	704.575	Wheat	263.000
		Corn	125.200
		Oats	90.449
		Potato	50.524
		Raps	49.448
Fruit	296.587	Table Vines	48.500
		Apple trees	36.205
		Avocado trees	29.000
		Walnut trees	27.941
		Cherry trees	20.591
Wine vines	137.593	Red wine varieties	101.752
		White Wine Varieties	35.841
		Pisco Varieties	8.202
Vegetables	78.072	Maize for human consumption	9.727
		Lettuce	6.673
		Tomato	5.038
		Onion	4.454
		Marrow	3.989

Source: ODEPA.

Table 2. Evolution of area cultivated with fruit trees in Chile (ha). 2010-2016

Species	Year 2010 (ha)	Year 2016 (ha)	% Variation 10/15	Share (%)
Table vine	52.655	48.582	-7,7	15,7
Walnut tree	15.451	30.964	100,4	10,0
Avocado trees	34.057	29.933	-12,1	9,7
Red apple tree	27.633	29.168	5,6	9,4
Cherry trees	13.143	24.498	86,4	7,9
Olives	12.874	20.343	58	6,6
European plum	12.442	11.952	-3,9	3,9
Canning peach	10.676	9.481	-11,2	3,1
Kiwis	10.922	8.866	-18,8	2,9
Pear trees (European and Asian)	6.225	8.781	41,1	2,8
Almond trees	7.617	8.113	6,5	2,6
Green apple tree	7.396	6.895	-6,8	2,2
Orange trees	7.435	6.766	-9	2,2
Lemon trees	7.235	5.911	-18,3	1,9
Nectarine trees	5.376	5.339	-0,7	1,7
Japanese plum trees	6.209	5.326	-14,2	1,7
Peaches to be eaten fresh	3.249	2.015	-38	0,7
Apricot trees	1.469	887	-39,6	0,3
Other fruit trees	25.426	45.706	79,8	14,8
Total	**267.491**	**309.528**	**15,7**	**100,0**

Source: Prepared by ODEPA with information from CIRÉN. 2017.

Table 3. Trade balance of crop-livestock products by sector: Chile and the world (thousands of dollars)

Sector	Jan-Dec 2016	Share (%)
Exports by sector		
Total crop livestock	15.037.317	
Agricultural	9.090.265	60,5
Livestock	1.237.317	8,2
Forestry	4.709.735	31,3
Imports by sector		
Total crop livestock	5.137.768	
Agricultural	3.320.246	64,6
Livestock	1.562.740	30,4
Forestry	254.782	5,0
Trade Balance for products		
Total crop livestock	9.899.549	
Agricultural	5.770.019	58,3
Livestock	-325.423	-3,3
Forestry	4.454.953	45,0

Source: prepared by ODEPA with information from the National Customs Service. Figures subject to review by value variation reports (IVV).

In the case of wine, the situation is somewhat different, since vineyards have traditionally been family-owned, but in the 1980s some of them became open corporations with professional staff. This is the case of vineyards such as Concha y Toro, Santa Rita and San Pedro (Mora, 2017). Maintaining this rate of development with large export figures, opening and consolidating international markets, compliance and adaptation to new requirements, among others, entails moving toward more sustainable agriculture. Particular importance is given to water availability, water and fertilizer efficiency, the relationship between mining and agriculture and agriculture and forestry, projections for the use of natural resources in general and climate change, as well as the search for a harmonious relationship with the land and its people.

5. Perspectives and projections for Chilean agriculture

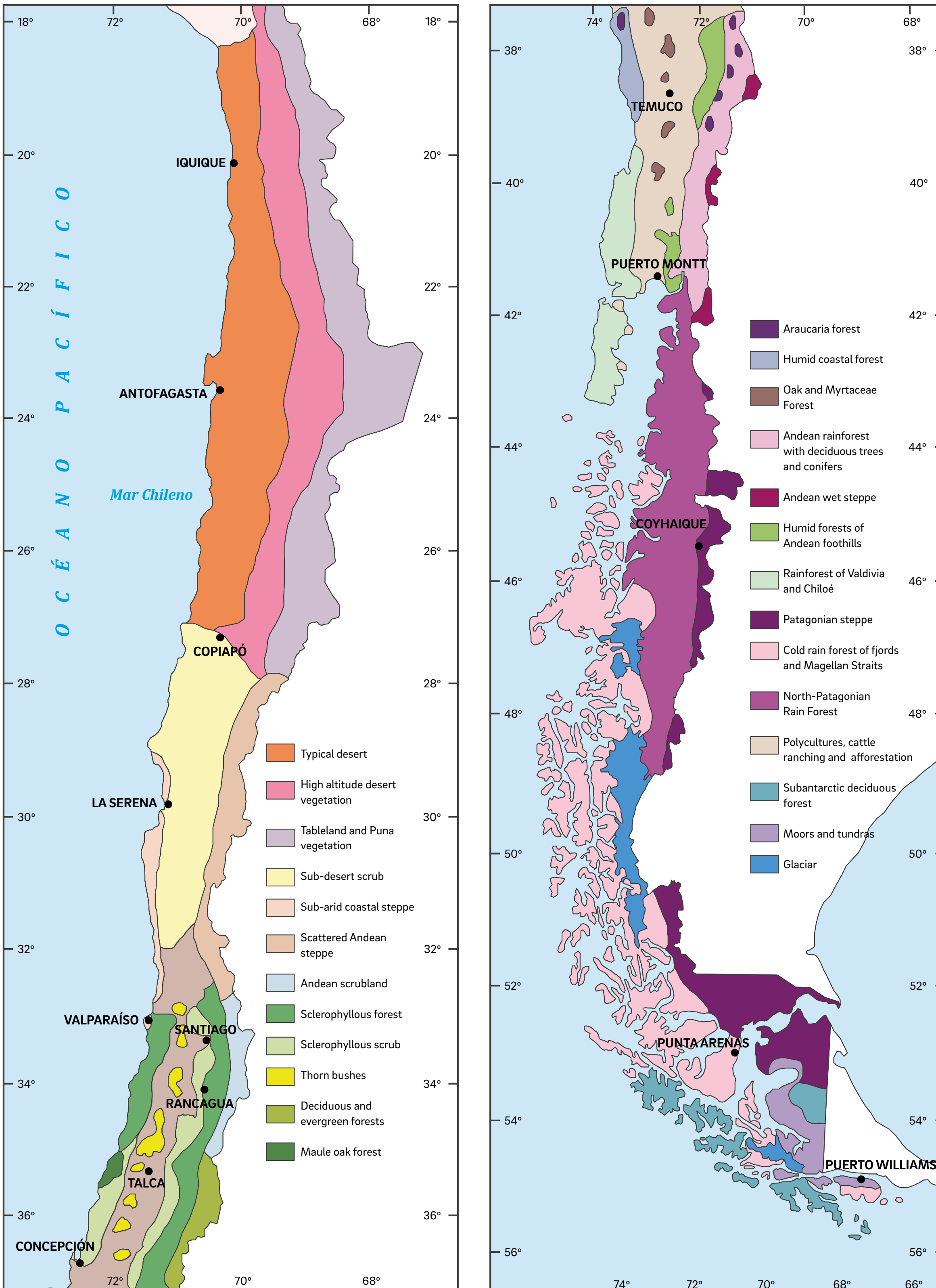
Chile is self-sufficient in exportables (fruit, wines, salmon and other items mentioned earlier). However, the same is not true of products that constitute the basis of its diet, as in the case of wheat and maize, the latter being closely related to pork and chicken productive chains, the main protein sources for feeding the population. As for wheat, the main source of food raw material in Chile, the area under cultivation has declined drastically since 1970, currently standing at approximately 285,000 ha. Although the same period has seen a significant increase in yield, local production is insufficient, meaning that it has been necessary to import this cereal. Soil no longer used for wheat production has been employed in new plantations, including small fruits trees (blueberries), European hazelnuts and other more profitable crops.

In the remaining crops, Chile is relatively self-sufficient, as in the production of vegetables and grain legumes, which are sporadically supplemented with imports, when circumstances so require.

From the point of view of production process management, there are a number of shortcomings regarding the use of productive resources, the mitigation of the negative environmental effects of production, the diversification of production, food safety and, in economic aspects, such as the development of markets, marketing training for producers and the improvement of distribution channels. The latter must be made more transparent and reliable, so that producers can also begin to play a commercial role.

This is an analysis from the point of view of food security under the current conditions of production and trade liberalization. However, this self-sufficiency and sustainability is no longer only conditioned by natural processes, but requires greater technology applied to productive and commercial processes and, above all, in relation to the energy required for the production process. According to Rodríguez et al. (2015), Chile faces an energy paradigm based on fossil-fuel use, which will lead to land-use changes and affect agricultural development. In this relationship between agriculture and climate change, GreenHouse Gas (GHG) emissions are an essential point, since they are derived from modern farming systems. For example, it is possible to highlight them in the use of synthetic fertilizers, land-use change to increase production for a growing population, and methane emissions due to the increased demand for animal protein linked to population growth. The latter also implies a decoupling between production and consumption, which leads to transport and processing activities in which GHG are also generated. Consequently, agriculture should not only consider climate-change adaptation, but also have the potential to contribute to its mitigation. Today and in the future, the relationship between agriculture and climate change must necessarily be linked to other sectors, including the environment, energy and trade. This will involve the creation of new instances of coordination, as well as the building of new professional and academic capacities in the areas mentioned. Consequently, maintaining the sustainability of the Chilean agri-food sector will require expanding the institutional and *ad hoc* public policy to encourage the search for innovative and creative multisectoral solutions, in a multidisciplinary professional and academic context internationally connected through

Map 1. Map of Biogeography of Chile and Vegetation Zones



Source: Educar Chile http://ww2.educarchile.cl/UserFiles/P0001/Image/CR_Imagen/Mapas%20IGM/mapas_chile/biogeografia.gif treaties and trade agreements. On the road to achieving competitive and sustainable agriculture, it is important to recognize the work embodied in the National Plan for Adaptation to Climate Change (Ministry of the Environment, 2015). This plan emphasizes the availability, management, research, innovation and optimization of water use, agroclimatic risks, integrated pest and disease control, genetic improvement and investment in relation to climate- change adaptation and information, among other aspects.

6. Aquaculture in Chile

Aquaculture is the set of activities designed to breed aquatic plant and animal species. In this section, we will focus exclusively on animal aquaculture, with particular reference to salmon farming, which has become a major contributor to Chile's GDP. The SalmonChile Website (HYPERLINK "http://www.salmonchile.cl/es/historia-en-chile.php" \\ l "1921-1974" provides an accurate summary of the history of salmon farming in the country. It notes that the introduction of exotic aquaculture species in Chile occurred in the first half of the last century thanks to the initiative of the Fisheries Development Institute (IFOP), an entity created by the Corporation for the Promotion of Production (CORFO). For over 50 years, it worked on the introduction of technologies for the cultivation of various aquaculture species. In 1974, rainbow trout (*Oncorhynchus mykiss*) began to be farmed for domestic consumption and export, and in 1976 the first Coho (*Oncorhynchus kisutch*) and Chinook (*Oncorhynchus tshawytscha*) salmon eggs were imported to the Los Lagos region for purely commercial purposes. In 1978, the state decided that this activity required a certain degree of regulation and created the Under-Secretariat of Fisheries and the National Fisheries Service (SERNAPESCA). In the early 1980s, salmon farming had been established, and by 1985 there were 36 farming centers operating in Chile, with total annual production amounting to more than 1,200 t. Years later an unprecedented boom in the salmon industry began, culminating in the definitive consolidation of the industry and the creation of the Salmon and Trout Producers Association of Chile AG, now SalmonChile. In 1990, national salmon farming ventured into salmon breeding and the first eggs from Coho salmon were obtained in Chile. This milestone is remembered as the first scientific advance in Chile and the starting point for the industry's takeoff. However, July 2007 saw the first case of Infectious Salmon Anemia (ISA), a disease caused by a virus of the *Orthomyxoviridae* family of the genus *Isavirus*. Officially reported in a farm in Chiloé, it affects Atlantic salmon farmed in sea water. This disease created a sectoral crisis that affected the industry's productive process. Like all crises, the process also created opportunities that drove the industry's new productive model. The Chilean salmon aquaculture industry is the now second largest export sector in the country and the world's second largest salmon producer after Norway, creating over 70,000 direct and indirect jobs, with a presence in more than 70 markets.

The Chilean aquaculture development model proved extremely successful. It was based on intensive aquaculture, with significant investments in technology and with great similarities to the development of agriculture, especially livestock production. Aquaculture was identified as one of the most important activities for Chile's economic development and international competitiveness, as a result of which it is now the world's second largest salmon producer. As for the profits obtained, they totaled US $3,526 million in 2015 for 590,101 t. Of these, Atlantic salmon (Salmo salar) accounted for 68%, Coho 21% and rainbow trout 11% (SalmonExpert, 2016).

In other words, aquaculture in Chile followed international guidelines, operating primarily on the basis of introduced species. Mass introductions were carried out in the 19th and early 20th centuries, especially of rainbow trout on all continents with the exception of Antarctica, with almost no considerations for the environment. This species, which is native to the northern hemisphere like other salmonid species, was introduced in virtually all the hydrographic sources capable of maintaining it. In South America, it lives as a naturalized population from the Venezuelan Andes to the southern areas of Argentina and Chile, and is farmed in 50%

of its countries. When this took place, it was considered a great contribution to the aquatic fauna of the geographical areas where it was introduced, due to its beauty and sport-fishing potential. However, very little is known about the ecological damage produced to the diversity of local systems or the number of displaced species, which must have been considerable. Nevertheless, the introduction of salmonids into Chile constituted the basis of its aquaculture development. In their analysis of the status of the conservation of aquatic resources in South America, Neira et al. (1999) report that in Chile over 30 aquatic species have been introduced for their development in fish farms (Infante and Neira, 2002).

Both fishing and aquaculture have an environmental cost. However, an in-depth analysis shows that the threat of aquaculture is far less than that posed by continuing to supply protein demand through fishing in natural marine stocks, owing to increased control over production, harvesting, processing and transport, resulting in less waste and energy expenditure. Fishing for certain species of economic interest affects those that are accidentally caught through by-catch, as in the case of sharks trapped by nets spread to catch swordfish, which seriously affects them because of their low population recovery rate and, more importantly, the so-called trash-fish caught by the increasingly efficient ocean-trawling technologies, which Alverson et al. (1994) estimated at 28.7 million t annually, most of which is simply discarded. In fishing for certain species of shrimp, by-catch often comprises a high percentage of juveniles of other commercially important species.

Aquaculture can not only significantly contribute to global food demands, but also directly contribute to the conservation of aquatic resources and their genetic diversity. To this end, the concept of sustainable use of natural resources must be developed in conjunction with the concept of sustainable aquaculture, in any of its development models rather than in opposition to it. Most of the species used in aquaculture today are very similar to wild populations. In many cases this activity depends on the collection of juveniles or eggs from natural populations. The growth and development of aquaculture is following patterns very similar to that observed in livestock production in recent decades. The development of livestock production, from extensive cattle, sheep, goat and other animals, to intensive cattle production and even the industrial production of poultry, pigs, rabbits and so on, together with their extraordinary contribution to world food, produced a significant reduction of biodiversity and genetic variability. Natural poultry, pig and cattle populations were replaced by a few highly selected breeds, and crosses and synthetic genetic lines with enormous productive efficiency, yet little genetic variability. This occurred mainly because wild populations were used directly. In many cases, they were removed from their natural environment or their natural environments were invaded or severely modified, and they were selected on the basis of human requirements. These mistakes must strenuously be avoided with aquaculture resources and fortunately, there is still time to do so.

7. Nutritional Research

A full summary of the history of nutrition and food research in Chile is presented in the publication *Desarrollo de la nutrición y alimentación en Chile en el siglo XX* (Nutrition and Food Development in Chile in the 20th Century) (Valiente and Uauy, 2002). It reports that in Chile, food has always been considered a human right, which has driven the permanent commitment of the government, the community, professional groups and academics to develop this area. Accordingly, nutrition and food research in Chile began early in the 20th century, under the aegis of a handful of leaders in food and nutrition. These include Drs. Eduardo Cruz-Coke, Jorge Mardones-Restat, Alejandro Lipchutz, Anibal Ariztía, Julio Meneghello, Adalberto Steeger, Arturo Scroggie, Arturo Baeza-Goñi, Herman Schmidt-Hebbel, Francisco Mardones Restat and Fernando Monckeberg, as well as Professor Julio Santa María. They undertook their actions in academic groups comprising various professions, working at the service of the country, especially in favor of the underprivileged and vulnerable, such as children, pregnant women, the elderly, and the poor and marginalized groups. These professionals served at various centers such as the Dietitian School of the University of Chile, founded in 1939; the Nutrition Unit of the Ministry of Health, created in 1952; the Department of Nutrition of the Catholic University, formed in 1956; the Laboratory of Pediatric Research, of the University of Chile, established in 1957 and the Department of Nutrition and Diabetes of the San Juan de Dios Hospital.

These centers have now evolved and been consolidated at the following centers:

The Institute of Nutrition and Food Technology (INTA) of the University of Chile. This is the main center for basic research in nutrition and related sciences, a leader in the area of childhood diarrhea and malnutrition, endocrinology, anemias and micronutrients, and clinical nutrition, with an emphasis on chronic diseases and aging and a long history of studies of the conditioning factors of food, especially its supply, consumption and biological utilization. This Institute gives courses on Nutrition in Pediatrics, Food Surveillance Systems and Food and Nutrition Policies and Programs. In terms of teaching, it offers several Master-degree Programs in Healthy Foods, Clinical Nutrition, Human Nutrition and Aging and Quality of Life. (http://www.inta.uchile.cl).

The Department of Nutrition of the Medicine Faculty of the University of Chile. This department undertakes research related to the science of nutrition and food, creating methodologies in the fields of public health and clinical nutrition, and performs nutritional interventions and advances in the areas of metabolism, biochemistry, cell biology and molecular biology. It contributes to the training of undergraduate students in medicine, nutrition and dietetics, dentistry, nursing and medical technology. At the graduate level, it participates in the Master-degree Programs in Human Nutrition and the Doctoral-degree Program in Nutrition and Food, and Public Health (http://www.medicina.uchile.cl/facultad/campus-y-departamentos/campus-norte/112599/nutricion).

The Department of Nutrition and Dietetics of the San Juan de Dios Hospital. It has pioneered the study, teaching and control of diabetes mellitus. It also has a Food Education Center and provides individualized dietary therapy to patients referred from the outpatient and hospital rooms requiring special diets and enteral formulas (http://biblioteca.usac.edu.gt/tesis/06/06_3057.pdf).

The Department of Nutrition, Diabetes and Metabolism of the Catholic University. It studies problems such as obesity, diabetes mellitus and dyslipidemias, integrating human genetics, metabolic studies, clinical practice and public health. The department is the pillar of nutrition at the Catholic University, participating in teaching at the undergraduate level in Medicine and other degree programs, as well as postgraduate teaching in the area of (http://medicina.uc.cl/nutricion/).

The Nutrition and Food Department of the Ministry of Health. This department seeks to protect the population's health, by promoting healthy eating habits and ensuring the consumption of safe food of good nutritional quality. To this end, it develops regulations and programs to control the factors, elements or agents present in food, which pose a risk to the health of consumers and/or which may have a major influence on the morbidity and mortality profile (http://www.minsal.cl/alimentos-y-nutricion/).

The Department of Food and Nutrition of the Institute of Public Health. This is the country's main food laboratory. It undertakes epidemiological-surveillance activities, performing chemical, microbiological, parasitological, toxicological and other analyses in food matrices. It has two sections: Food and Nutrition Chemistry, and Microbiology of Food and Water. The former has laboratories on nutrients, additives, contaminants, bio toxins, pesticide residues, residues of veterinary drugs, dioxins and gluten (http://www.ispch.cl/saludambiental/alimentos_nutricion/).

In addition to the aforementioned working groups, Chile has professional organizations that focus on nutritional matters, such as the College of University Nutritionists of Chile AG (http://www.

nutricionistasdechile.com). There is also the Chilean Nutrition Society (& fA) (https://www.sochinut.cl), which publishes the Revista Chilena de Nutrición (http://revistasochinut.org).

In addition to these organizations, in 2005, the Government of Chile created a Presidential Advisory Commission called the Chilean Agency for Food Safety (ACHIPIA), tasked with reviewing the institutions that control, inspect and inspect food in Chile and proposing a National Food Safety Policy (http://www.achipia.cl).

Last, it should be noted that several universities provide degree programs related to nutrition, at both the professional and technical level. Universities offering ten semester courses include the University of Chile and the Catholic University of Chile, together with several other regional universities that also supply these programs such as the University of Valparaiso, University of Talca, University of Tarapacá and the University of Magallanes, which offer degree courses in Nutrition and Dietetics, while the University of Los Lagos provides a Nutrition and Food program.

8. Agricultural research

According to Elgueta (1982), agricultural research began in Chile in the 19th century, when the National Agricultural Society (SNA) - a private trade organization created in 1838 - realized that agricultural education and research were essential for agricultural development. Thus, in 1851, the Practical Agricultural School was created to train agricultural workers in "modern" agricultural techniques. Subsequently, in 1869, the country's first Agricultural Experimental Station was created, in an area adjacent to the city of Santiago that became known as the Agricultural Training College Farm. Later on, in 1872, within the Training College Farm, the SNA created the Agricultural Institute, where the first agricultural professionals were trained (Agronomists and Agricultural Engineers), for which teachers trained in France were brought over. In 1881, three hectares of the Training College Farm were specifically set aside for testing varieties, which marked the beginning of genetic improvement in Chile. In 1915, the Agricultural Institute was renamed the Agronomic Institute. In 1927, it was transformed into the Faculty of Agronomy and Veterinary Medicine, and in 1928, it was incorporated into the University of Chile.

At the same time, in 1924, the Ministry of Agriculture, Industry and Colonization was created, which was granted development faculties in 1927. Two years later, the Department of Genetics and Agronomy was created, and subsequently renamed the Department of Genetics and Plant Science. This department also launched breeding programs, performing variety assessments, especially on wheat and other cereals, and fodder species. These evaluations were undertaken at various experimental stations created throughout the country. In the mid-1950s, the Department of Genetics and Phytotechnology was transformed into the Department of Agricultural Research, which in 1964 became a private, publicly funded organization called the Institute of Agricultural Research (INIA). To this day, it is responsible for conducting agricultural research for the Ministry of Agriculture.

INIA was created by the Institute of Agricultural Development, the Corporation of Production Promotion, the University of Chile, the Pontifical Catholic University of Chile and the University of Concepción. It has national coverage and ten Regional Research Centers. Its main capital comprises approximately 200 plant researchers and it is financed by public and private funds, research projects and the sale of technological inputs. Its mission is to generate and transfer strategic knowledge and technologies on a global scale to produce innovation and improve the competitiveness of the Chilean agri-food sector. It aims to become a leading institution in the generation and transfer of sustainable knowledge and technologies for agro-food innovation.

By the beginning of the last century, other universities joined the teaching and research effort of SNA and the University of Chile. In 1904, the Catholic University of Chile created the degree course in agronomy. Over time, other universities began to offer degree courses in agronomy and set up experimental stations to support teaching. This is how the agronomy degree program came into being at the University of Concepción (1954), The Austral University of Chile (1954), Tarapacá University (1963), the Catholic University of Valparaíso (1963), the University of Talca and the University of La Frontera (1982).

Since its inception, agricultural research was designed to guarantee the country's food security, understood as guaranteeing food for the population, since from the time of Independence, this was regarded as a fundamental task for sustaining the future of the nation. That era was characterized by the predominance of the agricultural sector in the country's economy. It was not until the late 20th century that research emphasized agricultural exports.

As in the rest of the world, breeding programs were primarily responsible for the sustained increases in the yields of the main food crops. They were created with food security in mind and following the CGIAR (Consultative Group on International Agricultural Research) global model, culminating in the Green Revolution, which permitted an exponential increase in yields, but also involved the overuse of inputs such as water, fertilizers and pesticides. It was not until the late 20th century that a concern for genetic improvement arose, not only for the benefit of farmers, but also of consumers (food quality), and the issue of sustainability came to the fore.

At the same time, the National Commission of Science and Technology (CONICYT) created several regional centers linking agronomic and nutritional objectives on the basis of preexisting regional capacities (http://www.conicyt.cl/regional/category/centros-regionales/centro-regional/).This is how the Regional Center for Healthy Food Studies (CREAS) was created, in the Valparaíso Region, together with the Center for Advanced Studies in Fruticulture (CEAF) in the O'Higgins Region; the Center for Studies in Processed Foods (CEAP) in the Maule Region; and the Center for Agronomic Nutritional Genomics (CGNA) in the Araucanía Region. In 2016, CORFO financed the first center for food innovation as part of a consortium with several Chilean universities.

Chile also has several associations for the dissemination of agronomic advances, such as the Academy of Agronomic Sciences (http://www.academiaagronomica.cl), the College of Agricultural Engineers (http://www.ingenierosagronomos.cl), the Agronomic Society (http://www.sach.cl) and the College of Engineers in Natural Resources (http://www.cirn.cl). All these institutions significantly contribute to the political and social support of the advances in sustainable agriculture that will be developed in the country.

9. Aquaculture research

Although Chilean aquaculture began with the introduction of exotic species, the second half of the 19th century saw the introduction of the golden carp (*Carassius auratus*) in 1856, the common carp (*Cyprinus carpio*) in 1878 and the European common trout in 1883. At the beginning of the 20th century, one of the major milestones was the construction of the Rio Blanco Pisciculture in 1902, where the first rainbow-trout embryos (*Oncorhynchus mykiss*) were improved in 1905. Subsequently, in 1914, the fish farm of Lautaro was built on the banks of the Cautín River in the Araucanía Region to farm trout in southern Chile. This was followed by a second phase characterized by the creation of mollusk farming centers (*oyster farming*), with the construction of the Quetalmahue Oyster Farm in 1930; "Ranching" initiatives designed to create commercial fisheries, based on the introduction of salmonids and the drawing up of central aquaculture-development plans (oyster, mussel and fish farms), when the Quellón Mussel Farm was built in 1943. Institutions were also created to research aquaculture. The Institute for Fisheries Development (IFOP) was founded in 1964. During this period, a concerted effort was made to create human capacities associated with the aquaculture sector and fisheries, through the creation of courses such as Marine Biology, Oceanography and Fisheries Engineering, including the groundbreaking creation of the Aquaculture Engineering degree major at the University of Chile in 1976.

The most significant change, however, took place in the 1980s, which was already preceded by the start of the northern oyster cultivation (*Argopecten purpuratus*) in 1974 and the giant mussel (*Choromytilus chorus*) farmed since 1978. This marked the beginning of *Glacilaria*, chorites (*Mytilus chilensis*), Chilean oyster (*Ostrea chilensis*), abalone (*Haliotis* spp.) and Turbot (*Scophthalmus maximus*) farming, but above all the salmon industry with three species: Pacific salmon or Coho (*Oncorhynchus kisutch*); Atlantic salmon (*Salmo salar*) and rainbow trout (*Oncorhynchus mykiss*). The University of Chile played a key role initiating the first Genetic Improvement Program for Coho Salmon in 1992 and the first Genetic Improvement Program for Northern Scallop, both in collaboration with the Institute of Fisheries Promotion, and implemented the first Associate postgraduate programs, such as the Master in Aquaculture in 1996 and the first Doctorate in Aquaculture in 2004, the latter in conjunction with the Catholic Universities of the North (UCN) and Catholic University of Valparaíso (UCV). These were joined by the Master in Aquatic Resource Management of the UCV, the Master in Aquaculture of the UCN, and those of the Catholic University of Temuco and the University of Santo Tomás. These activities helped launch high-quality research in the country to support the aquaculture industry.

In Chile there are several research institutes associated with aquaculture, both public and private. State institutes include the Instituto de Fomento Pesquero (www.ifop.cl) with national presence, Fundación Chile (www.fundch.cl), also located throughout the country, albeit on a smaller scale, in the Chinquihue Station (http://www.fundacionchinquihue.cl/web/), located in the Los Lagos Region, and with the Catholic University of the North, the Aquapacífico Center (http://fch.cl/aquapacifico) in Tongoy. Those in the private sector include Aquainnovo (http://www.aquainnovo.com), the Salmon Technological Institute (INTESAL) –answerable to the Salmon and Trout Producers Association (http://www.intesal.cl/es/)- and the Science for Life Foundation (http://www.cienciavida.org) among others.

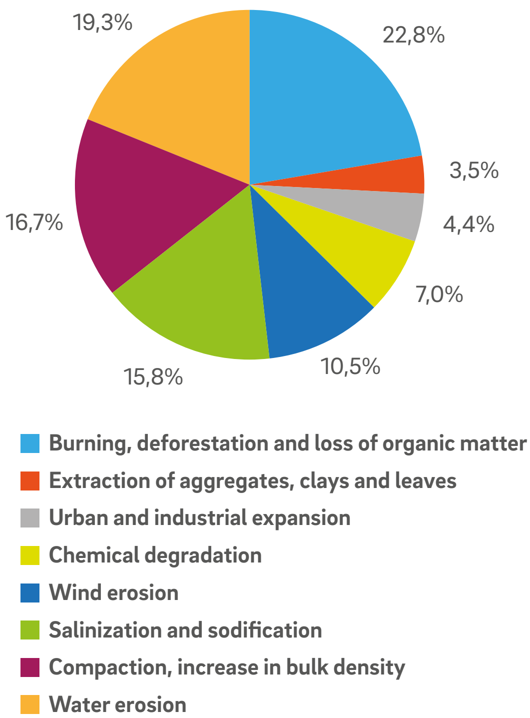
10. The soil resource

Soil is one of the pillars of Chile's agricultural development. Chile's agricultural soils are located in various climates that enable the growth of a broad variety of crops such as cereals, oilseeds, grain legumes, forage crops, and horticultural, fruit, ornamental and industrial crops such as sugar beet.

An interesting dimension to analyze is the relationship between agricultural and urban land. In this regard, Rivas and Traub (2013) point out that it is necessary to recall that underlying the agricultural and forestry sector there are a series of economic activities that provide a social, economic and cultural matrix that lend identity and cohesion to the non-urban area of Chile. In this respect, in order to become a global agri-food power, the development of the agri-food sector must have a normative framework that guarantees certain minimal conditions for the economic, social and environmental development of the sector that will ensure the sustainability and availability of natural and productive resources. At the same time, Chilean soils have also been widely used for forestry purposes, displacing agricultural activity in certain areas, which has had a significant impact on agricultural activity. This is the case of monocultures of Monterey pine (Pinus radiata) and eucalyptus (Eucalyptus globulus), both used for both wood and cellulose pulp. The exponential growth of the forestry industry occurred as a result of the Forest Development Law (Decree No. 701), which allowed state subsidies of up to 75% of the total cost of afforestation for forestry companies and which now enables the forest sector to contribute 2.7% to Chile's GDP.

Chile's agricultural production tends to be heavily dependent on natural resources particularly on the soil resource, which has undergone varying degrees of degradation, with water erosion the main cause of this deterioration (**Figure 1**). This has had a major impact on the reduction of productive potential. This must be considered for future agro-food policies, not only to boost production but also to encourage its conservation.

Figure 1. Various degrees of soil degradation in Chile



11. Energy resources

With regard to energy resources, most of the Chilean agricultural sector uses energy from fossil fuels with high carbon emissions, like other Latin-American countries. The success of agricultural firms is closely linked to energy demand and use for their productive processes. Therefore, having efficient, constant energy supply systems is key to agricultural development. The energy costs of agricultural production processes, such as irrigation, milking, frost-control mechanisms and various agroindustrial processes, are important factors in companies' costs. Due to the above, the sector is seeking solutions to reduce these, especially through energy efficiency and the use of techniques based on Non-Conventional Renewable Energy (NCRE). These techniques have had an enormous impact on certain activities. Solar and wind energy also allow the surplus to be exported to the national electricity grid, based on Law 20,698, which favors the generation and use of NCRE. However, these efforts are not sufficient due to the high amounts of energy consumed by agriculture. In fact, Chile is making a significant effort to have a resilient system linked to energy consumption by sector and subsector. At present, only macrofigures are available for the agricultural sector (**Figure 2**), where a total consumption of 63,700 GWh/year is estimated. Of this total, less than 2% is used in irrigation for a cost equivalent to more than 200 MM USD/year.

In a context where the global trend is to reduce carbon emissions and generate low GHG emissions, it is essential to propose an agricultural production policy with low energy requirements and negative environmental effects. This requires focusing efforts on contributing to climate change rather than a strategy focused on adaptation to climate change, in order to reduce carbon emissions, which on average are estimated at 10 Pg C/yr (Houghton et al. 2012). That is why, in order to develop sustainable agriculture, it is necessary to consider a diversification of energy sources, generating energy self-consumption propitiated by the current laws to encourage the use of NCER.

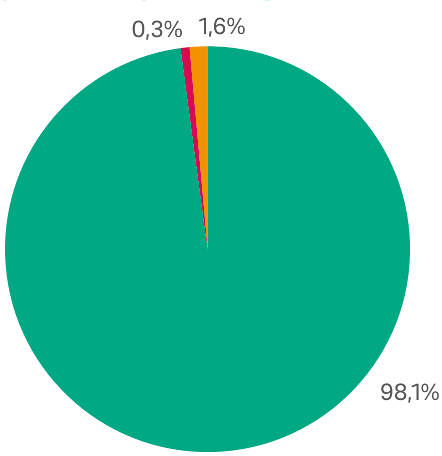
12. Water resources and climate change

A review of 58 studies related to climate change and 47 focused on water security and climate change shows that the impacts of climate change on the availability of water resources in Chile will be reflected in both a rise in average environmental temperature and a decrease in annual rates of mean precipitation (Fuster et al., 2017). As an example, studies show that for the 2010-2015 period, the Central Chile zone experienced a precipitation deficit of 21% with respect to the 1990-1999 decade. This was known as a "mega-drought", in which a quarter of the deficit experienced was attributed to climate change of anthropic origin (Boisier et al., 2016). This deficit generated a marked decrease in the water supply expressed in the reduction of water flows and water-storage reservoir levels (Bravo et al., 2014).

Regarding climate-change projections in the country, an increase in temperatures was calculated throughout the national territory for the p2031-2050 period with respect to the 1961-1990 period, with a gradient from highest to lowest from North to South and from mountain range to ocean, with values ranging from 0.5°C (Magallanes) to 2.5°C (Altiplano). At the same time, the tendencies projected by the same author indicate a decrease in precipitation in the Central-South zone of between 10 and 15% for the 2031-2050 period, consistent with most of the models applied. A downward trend in precipitation was considered for the North, although this projection is not robust. Finally, in the South, a 5% decrease in rainfall is expected for Patagonia, whereas for Magallanes, rainfall will increase by 5%.

Other effects of reduced precipitation are evident in glaciers, which in general, throughout much of mainland Chile and South America, have experienced major shrinkage and losses of volume, directly impacting the dynamics of rivers and lakes (Durán-Alarcón et al. 2015). These impacts have been described in the Central zone with evidence of increases in flow rates in the melting season in watersheds that have experienced a marked decrease in ice cover. In the southern part of the country, glacial retreat has been accompanied by the sudden emptying of subglacial lakes, which have created sharp increases in flow (Dirección General de Aguas, 2012), whereas in Patagonia it has been estimated that between 2003 and 2011, glaciers reduced their mass at a rate of 29 ± 10 Gt per year.

Figure 2. Energy consumption in Chile



From the perspective of climate change, potential impacts on the components of the cryosphere - whether glaciers, snow or permafrost - predict that changes in temperature and precipitation levels could alter normal snow accumulation and melting patterns. However, impacts on ecosystems dependent on these bodies of water have not been quantified to date. Although the evidence indicates that most of Chile's glaciers are experiencing a systematic regression, the lack of knowledge about the effect that climate change will have on its evolution makes it impossible to project these trends in a prediction model. Likewise, a shortage of information on the dynamics of permafrost and rock glaciers makes it impossible to infer their future behavior in response to a change in climate.

But not only would the availability of water resources be affected by climate change: there is ample scientific evidence indicating that the main climate forcants that modulate both the interannual variations of precipitation and the frequency and intensity of extreme hydrometeorological phenomena in Chile are affected by climate change. Boisier et al. (2016) have projected that the effect of climate change on climate forcing will have a direct impact on the frequency and intensity of extreme events such as droughts and floods. Therefore, under the RCP 8.5 emission scenario, for example, a significant increase in the period of recurrence of drought events with a duration of three years or more in Central Chile is projected for the 2050-2100 period, in relation to the 1950-2000 period.

Last, projected changes in climate under different scenarios are expected to have a direct effect on both the quantity and the timing of the flows of the countr's basins, which together with the expected impacts on the various components of the cryosphere, will condition the availability of water resources to meet human and ecosystem needs.

Nevertheless, it is important to point out that the analysis of the availability of water resources in a context of climate change must consider at least the physical availability determined by climatic patterns and the legal availability established by Water Use Rights (DAA). Although the latter is a legal aspect, it contributes to intensifying the effects of climate change: since the potential consumption of water does not decrease on the basis of physical availability; water systems will therefore be increasingly under pressure. Thus, water security due to climate change will be potentially affected mainly by: (I) the decrease in the physical availability of the resource; (ii) the increase in the frequency of extreme events, and (iii) the rise in turbidity and pollution, resulting from the increase in the frequency of extreme events, which affects water quality.

13. Food losses

All agricultural activity involving the production, handling, transport and exhibition-for-sale of a fresh agricultural product is affected by a reduction of the initial volume. This loss, whatever its origin, ultimately leads to a loss for the producer, who owns the product until it is sold. This loss, which is irreparable, translates into a reduction of the general availability of food, in addition to an expenditure of energy consumed in producing something that will not achieve its intended purpose.

FAO began work on food loss in the 1980s, earmarking $10 million for this purpose. Since then, many other institutions have gradually been incorporated, mainly from the governments of countries in the Northern Hemisphere, complementing and providing critical information on food losses. FAO saw the need to propose a scheme to classify information, depending on the form and timing of losses. Thus it determined the differences between what it called "losses" and "waste". Losses occur during harvesting and throughout the postharvest process and handling of a product that does not reach the consumer. Conversely, waste is the loss of food that takes place after it is acquired by the consumer, which includes value-aggregation processes (local and industrial processing). Generally speaking, in developing countries, the ratio is 60% losses and 40% waste, whereas in developed countries, the reverse is true.

Globally, a loss of 1.3 billion t of food per year is estimated. In Chile, there is very little research on food losses and on the causes of the waste and the volumes they entail. Most of the available information is estimates made on the basis of projections using a few local indices. This is the case of the fruit industry, where Chile produces 5 million t of fruit, 2.4 of which are for domestic consumption. If 10% of this were lost, we would be talking about 240,000 t. A study by the Center for PostHarvest Studies (CEPOC) of the Faculty of Agronomic Sciences of the University of Chile determined the causes of losses during the selection and packaging process for export. In the case of table grapes; it was determined that deficiencies in pruning bunches, excessive weeding and small grapes or those damaged by thrips were the main causes of discarding. These determinations served to improve the agronomic practices of clustering, the application of agrochemicals and the thinning of berries, which allowed a substantial increase in the percentage of exportable fruit. Currently, the quality-control work in the selection, packaging and packaging rooms of fruits have made it possible to maintain an acceptable level of quality in fruit exports. However, reports on insufficient condition and quality are continuously received from remote export markets. As an example, cranberry in destination markets may display quality and condition problems such as soft, dehydrated and bruised fruits, which is solved by harvesting at low temperatures (22%), using MAP bags (28%), applying postharvest CPPU (15%) and harvesting when the fruit is totally blue (5%).

The main study on losses in products commercialized for the domestic market in free fairs/farmers' markets and supermarkets was conducted by Boitano (2011). The weekly declines of fresh products at the Free Trade Shows of the Metropolitan Region of Santiago reached a total of 2,391 t, equivalent to 19% of the total. Of these, 1,745 t (22%) were vegetables, 496 (18%) fruits and 150 (7%), potatoes. Some products have more significant losses. This is the case of lettuce, of which 144,060 t are produced and 11,530 t are lost, which amounts to 40% (11,530 t), representing a loss of US $2,128/ha. At the end of 2009, an initiative was implemented to take advantage of products considered non-tradable, but in good condition, which are delivered to non-profit institutions, and farmers can treat them as waste food in their tax declarations. The organization's activities have expanded and it reports that as of December 2016, 16.2 t of food have been recovered, equivalent to more than 46,000 food rations delivered to 187 solidarity organizations that have reached almost 140,000 vulnerable people.

14. Nutrition and food policy

Currently in Chile, the prevalence of overweight and obesity in children and adults reaches figures that rank Chileh among the top countries in the Organization for Economic Cooperation and Development (OECD) with more than 10% obesity in children under the age of 6, over 25% in elementary students and over 60% with overweight among those over 15. The prevalence of other Non-Communicable Diseases (NCD) is also very high in this population, with more than 30% of people with hypertension, about 40% with dyslipidemia and more than 10% of people with type 2 diabetes *mellitus*. Prevention of these diseases is closely linked to lifestyle, particularly diet. In this respect, the 2010 National Food Consumption Survey shows that 95% of the Chilean population requires changes in their diet and does not comply with healthy eating recommendations.

The strategies Chile is implementing are based on the approach of health, social determinants of health and food environments. This policy addresses the sociodemographic, cultural and economic factors in which people live, including availability and access to healthy food, eating habits and culture, food marketing and advertising, school and work environment, and information available on food (nutrition labeling), among the most relevant factors. Modifying food environments requires structural government policies, and legislative, regulatory and fiscal policies such as taxes and subsidies. Chile, adopting the recommendations of international experts and based on available scientific evidence (OECD, DELSA/HEA, 2010), has implemented Law 20,606 on the nutritional composition of food and its advertising. Likewise, taxes on sugary drinks were increased, the strategy of promotion and social participation was reformulated, and Law 20.860 on food advertising was implemented. Finally, multidisciplinary programs have been implemented to treat people with malnutrition due to excess in Primary Health Care (PHC), based on healthy living counseling.

Recently, Chile has implemented several measures as basic policies for a healthier life:

- Law 20606 on the nutritional composition of food and its advertising: This Law came into force in June 2016, with the purpose of protecting the population's health, especially that of children, by incorporating a regulatory framework that (i) provides clearer and more comprehensible information to consumers through clear warnings stating "HIGH IN" sodium, sugars, saturated fats and calories; (ii) forbids advertising directed at children under 14 years of age of "HIGH IN" food, and (iii) it prohibits the sale, gift and promotion of "HIGH IN" foods in pre-basic, elementary and middle-school educational establishments. Thus, healthy choices are encouraged through more information, ensuring healthy supplies in schools and reducing the incentive to purchase less-healthy foods. The implementation of this Law involved a mass media campaign for 6 months before its entry into force and after its passage, in order to deliver the positive message of preferring fresh, natural foods, homemade culinary preparations and making the population aware of the new "HIGH IN" stamps to encourage them to choose foods with fewer stamps or without them.

- Increased taxes on sweetened beverages: As a fiscal tax measure, the Tax Reform Act of 2014 incorporated a corrective tax on sugary non-alcoholic beverages, modifying the tax rate of these products according to their sugar content. Thus the tax on products that did not exceed the established sugar content limit was reduced by 10% and increased by 18% when it exceeded it. The maximal limit was 6.25 g of sugars per 100 ml of product.
- Reformulation of the promotion and social participation strategy: The new Healthy Municipality, Communes and Communities strategy is designed to strengthen the role of the country's regions in bringing about changes in community environments that encourage a healthy lifestyle. With regard to the issue of healthy eating, municipalities are urged to program interventions such as municipal ordinances prohibiting the sale of "HIGH ENERGY" foods in the vicinity of schools and health centers, complementing Law 20,606; new points for free fairs/ farmers' markets; social mobilization events in favor of a healthy life; citizen dialogues and intersectoral health forums around healthy eating; and schools for social managers and leaders that would enable them to continue local actions to improve food environments.
- Law 20,860 on food advertising: This Act supplements Law 20,606 by increasing advertising restrictions, so that all advertising of "HIGH IN" foods on cinema and television during daytime hours (6:00 a.m.-11 p.m.) is prohibited. This Law also prohibits the advertising of "breast milk substitute" foods.
- Healthy Living Program in PHC for people with malnutrition due to excess: This program is aimed at the population over 2 which is overweight, obese or has other risk factors. There is a doctor, nutritionist, psychologist and physical education instructor, who apply a series of protocolized individual and group activities in order to modify food and sedentary behavior and decrease risk factors among the population attended. This program is run in over 80% of the country's primary health centers.

The impact of all these measures on the population's health must be evaluated in the long term. For the time being, and after the first few months of its implementation, there are tentative findings regarding the attitudes and perceptions of consumers on the main axes of action of the new labeling and advertising regulation. Studies undertaken by several academic institutions and market-research centers agree that the population evaluates the measures implemented positively and approximately 40% declare that they are willing to make changes in their food-purchasing habits. In a study commissioned by the Ministry of Health, the results show that 43% of the population compares the stamped food labels at the time of purchase and that they influence their decisions in more than 91% of cases. Moreover, 94% of the respondents approve of the obligation to label food as "HIGH IN".

Another relevant effect as a result of the regulation is related to the technological modifications implemented by the food industry, to decrease the concentration of critical nutrients such as sugars, sodium and saturated fats, as well as energy. According to an official report by the Chilean food industry, in approximately 18% of the foods that participated in the study, adaptations were made in their formulation to improve their nutritional composition. The findings reported so far are positive regarding their immediate effect and promising in the long term. These may be the first achievements resulting from the modification of the food environment. The challenge is to give continuity to these policies, strengthen them and evaluate the change in eating habits and the prevalence of obesity and other NCD.

Valiente and Uauy (2002) argue that the Chilean case proves that it is possible to improve health and nutrition in the absence of substantial progress in economic terms, despite the persistence of certain vulnerable groups which, although they are able to afford food, do not have access to a quality diet, and also display inequalities in access to health, resulting in quality-of-life indices below the national level.

On the other hand, there is a very significant group of adults suffering from diseases related to overeating and poor dietary composition. In this regard, Masi and Atalah (2008) report that people older than 70 represent 4.4% of the national population, a percentage that will almost double (8.2%) by 2025. Moreover, they add that the financial constraints of many senior citizens, together with the psychological, sensory and metabolic alterations that occur at this age, mean that a significant fraction of them receive poor nutrition. As a way of addressing this problem, Masi and Atalah (2008) report the existence in Chile of two programs targeting this group of persons: One is the "Complementary Feeding Program for the Elderly" (PACAM) and the other the "Golden Years Milk Drink" (BLAD), which have had effects in the short term, although their long-term impact is still being studied.

15. Final Conclusions

Chile has a solid institutional, political, scientific and technical base, which would enable it to be at the forefront of sustainable agriculture and healthy nutrition. Chile's performance in the face of challenges in agriculture and nutrition continues to meet the highest international standards and allows us to address enormous challenges due to its solid institutions that have created various lines of development. Looking ahead, Chilean agriculture is expected to be able to consolidate its production systems to meet to the new domestic and international agri-food demands. These emphasize products derived from modern, innovative agriculture that guide their development, prioritizing the sustainability of the natural resources used in their production and the food requirements of a society that increasingly demands products that will make it possible to adopt a healthy diet.

References

Alverson, D.L.; Freeberg, M.H.; Pope, J.G.; Murawski, S.A. (1994). A global assessment of fisheries by catch and discards. FAO Fisheries Technical Paper N° 339, Roma: FAO.

Araya L, Héctor; Atalah S, Eduardo; Benavides M, Xenia; Boj J, Teresa; Cruchet M, Sylvia; Ilabaca M, Juan; Jiménez de la Jara, Jorge; Mardones S, Francisco; Muñoz P, Fernando; Pizarro Q, Tito; Rodríguez O, Lorena, & Rozowsky N, Jaime (2006). Prioridades de intervención en alimentación y nutrición en Chile. *Revista chilena de nutrición*, 33(3), 458-463. https://dx.doi.org/10.4067/S0717-75182006000500001

Boisier, J., Rondanelli, R., Garreaud, R. and Muñoz, F. (2016). Anthropogenic and natural contributions to the Southeast Pacific precipitation decline and recent megadrought in central Chile. *Geophysical Research Letters*, 43(1), pp. 413-421. DOI: 10.1002/2015GL067265

Boitano, L.A. (2011). *Análisis de la cadena de distribución en la comercialización de productos frescos en Chile: frutas y hortalizas.* Memoria de Título. Ing. Civil Industrial. Facultad Ciencias Físicas y Matemáticas, Universidad de Chile.

Bravo, M., Flores, R., Galindo, R., Garreaud, R., Muñoz, E., Serey, A. y Viale, M. (2014). Determinación de posibles impactos en la gestión de los abastecimientos humanos de agua situados en la zona metropolitana de Chile, provocados por fenómenos asociados al cambio climático. *Aquae Papers*, 5, 6-29. http://dgf.uchile.cl/rene/PUBS/AquaePapers5es.pdf

Dirección General de Aguas, Ministerio de Obras Públicas (2012). Variaciones recientes de glaciares en respuesta al cambio climático: Características glaciológicas de los glaciares San Rafael, Nef y Colonia, campo de hielo norte. Series de Informes Técnicos (SIT) N° 302. http://documentos.dga.cl/GLA5500.pdf

Durán-Alarcón, C.; Gevaertb, C.M.; Mattar, C.; Jiménez-Muñoz, J.C.; Pasapera-Gonzales J.P.; Sobrino J.A.; Silvia-Vidald, Y.; Fashé-Raymundo, O.; Chavez-Espiritu, C.W.; Santillan-Portilla, N. (2015). Recent trends on glacier area retreat over the group of nevados Caullaraju-Pastoruri (Cordillera Blanca, Perú) using landsat imagery. *Journal of South American Earth Sciences*, 59, 19-26. https://doi.org/10.1016/j.jsames.2015.01.006

Elgueta, M. (1982). La investigación agrícola en Chile: Evolución histórica. en: Elgueta, M. y E. Venezian (eds). *Economía y organización de la investigación agropecuaria.* Talleres Gráficos INIA, Santiago, Chile. pp 109-141

Fuster, R., K. Astorga, C. Escobar, K. Silva y R. Urbina (2017). *Estudio de seguridad hídrica en Chile en un contexto de cambio climático para elaboración del plan de adaptación de los recursos hídricos al cambio climático.* Informe Final. Santiago Chile. 129 pp. In press.

Guerrero A. y Opitz R. (2017). *Inserción de la agricultura en los mercados internacionales.* Oficina de Estudios y Políticas Agrarias. 115 pp.

Houghton, R. A., House, J. I., Pongratz, J., van der Werf, G. R., DeFries, R. S., Hansen, M. C., Le Quéré, C., and Ramankutty, N. (2012). Carbon emissions from land use and land-cover change. *Biogeosciences*, 9, 5125–5142. DOI:10.5194/bg-9-5125-2012.

Infante, R. y Neira, R. (2002). Diagnóstico del sector acuicultor en Chile. *Prospectiva Chile 2010: 4. La Industria de la Acuicultura.* MINECON. pp. 59-78.

Masi, Celia & Atalah, Eduardo (2008). Análisis de la aceptabilidad, consumo y aporte nutricional del programa alimentario del adulto mayor. *Revista médica de Chile*, 136(4), 415-422. https://dx.doi.org/10.4067/S0034-98872008000400001

Ministerio de Agricultura de Chile, Ministerio de Medio Ambiente de Chile (2013). *Plan de Adaptación al cambio climático del Sector silvo-*

agropecuario. Propuesta Ministerial elaborada en el marco del Plan de Acción Nacional de Cambio Climático 2008-2012, 63 p.

Ministerio del Medio Ambiente, Gobierno de Chile (2015). *Plan Nacional de Adaptación al Cambio Climático.* Santiago de Chile, agosto de 2015, Imprenta Maval. 80pp. http://portal.mma.gob.cl/wp-content/uploads/2016/02/Plan-Nacional-Adaptacion-Cambio-Climatico-version-final.pdf

Mora, M. (2017). *Structural features of the wine sector in Chile.* In press.

Neira, R.; Bustos, E. & Avila, M. (1999). National and regional perspectives on aquatic genetic resources in Latin America. In: R.S.V. Pullin, D.M. Bartley y J. Kooiman (eds.), *Towards Policies for conservation and sustainable use of aquatic genetic resources.* ICLARM Conf. Proc. 59:59 pp.

Oficina de Estudios y Políticas Agrarias (ODEPA) (2015). *Panorama de la agricultura chilena*. Oficina de Estudios y Políticas Agrarias, Ministerio de Agricultura de Chile. 138 pp.

Rivas T. y Traub, A. (2013). *Expansión urbana, cambio de uso del suelo, pérdida del patrimonio agropecuario, recursos públicos*. Oficina de Políticas Agrarias, Ministerio de Agricultura, 6 pp. http://www.odepa.cl/wp-content/files_mf/1387811651expansionUrbana.pdf

Rodríguez, A., López, T., Meza, L. & Loboguerrero, A. (2015). *Innovaciones institucionales y en políticas sobre agricultura y cambio climático. Evidencia en América Latina y el Caribe.* CEPAL. 133 pp.

SalmonExpert (2016). Resultados 2015 y proyecciones 2016. Magazine articles. Publicado el 25/03/16. https://goo.gl/P5HoaM

Valiente B., Sergio & Uauy D., Ricardo. (2002). Evolución de la nutrición y alimentación en Chile en el siglo XX. *Revista chilena de nutrición*, 29(1), 54-61. https://dx.doi.org/10.4067/S0717-75182002000100008