HASS AVOCADO BOARD

2020

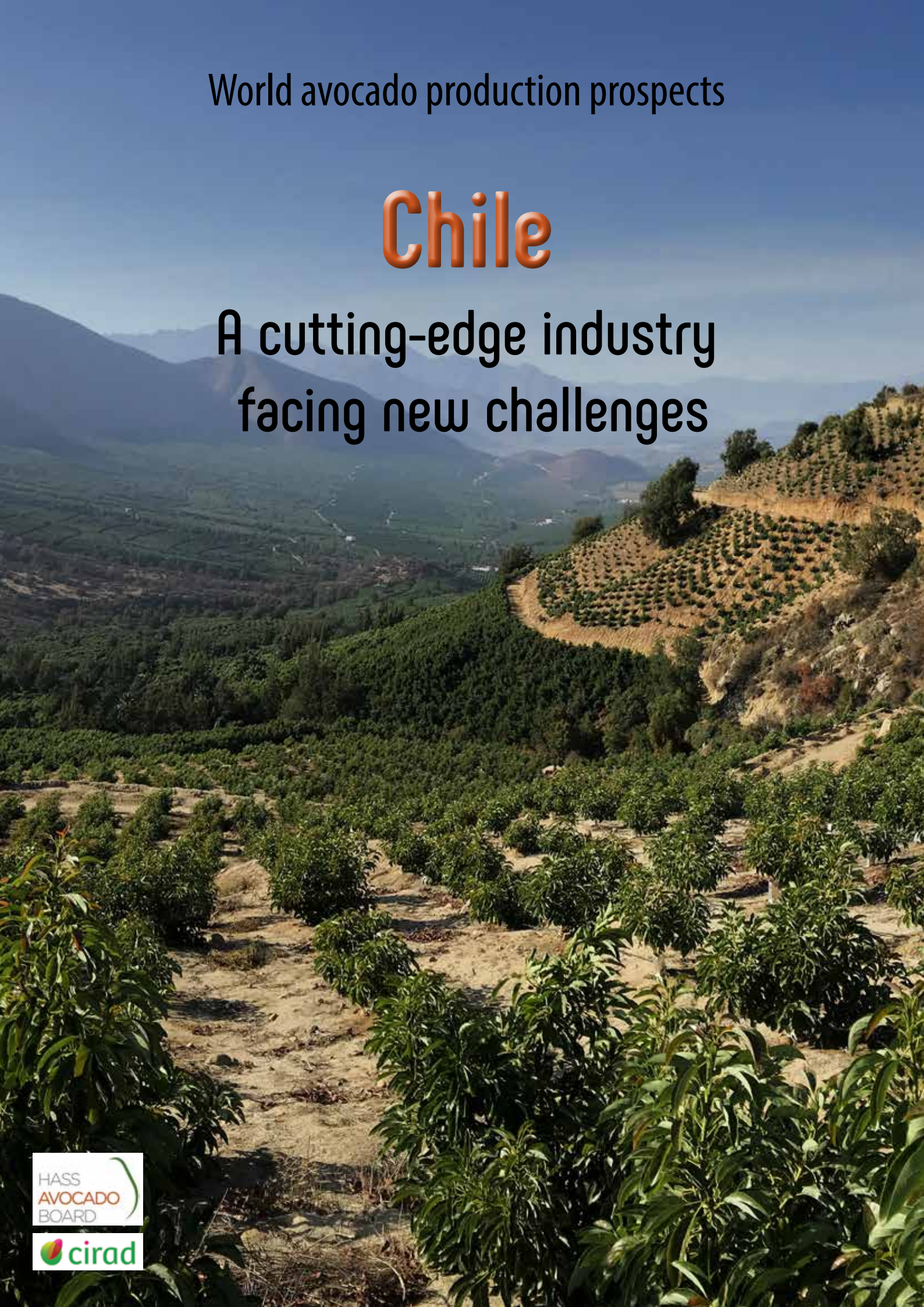
Country Profile: Chile

Producer country profile produced by *CIRAD, The Centre De Cooperation International En Recherche Agronomique Pour Le Développement, in collaboration with HAB, The Hass Avocado Board.*

World avocado production prospects

Chile

A cutting-edge industry facing new challenges



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Acknowledgements

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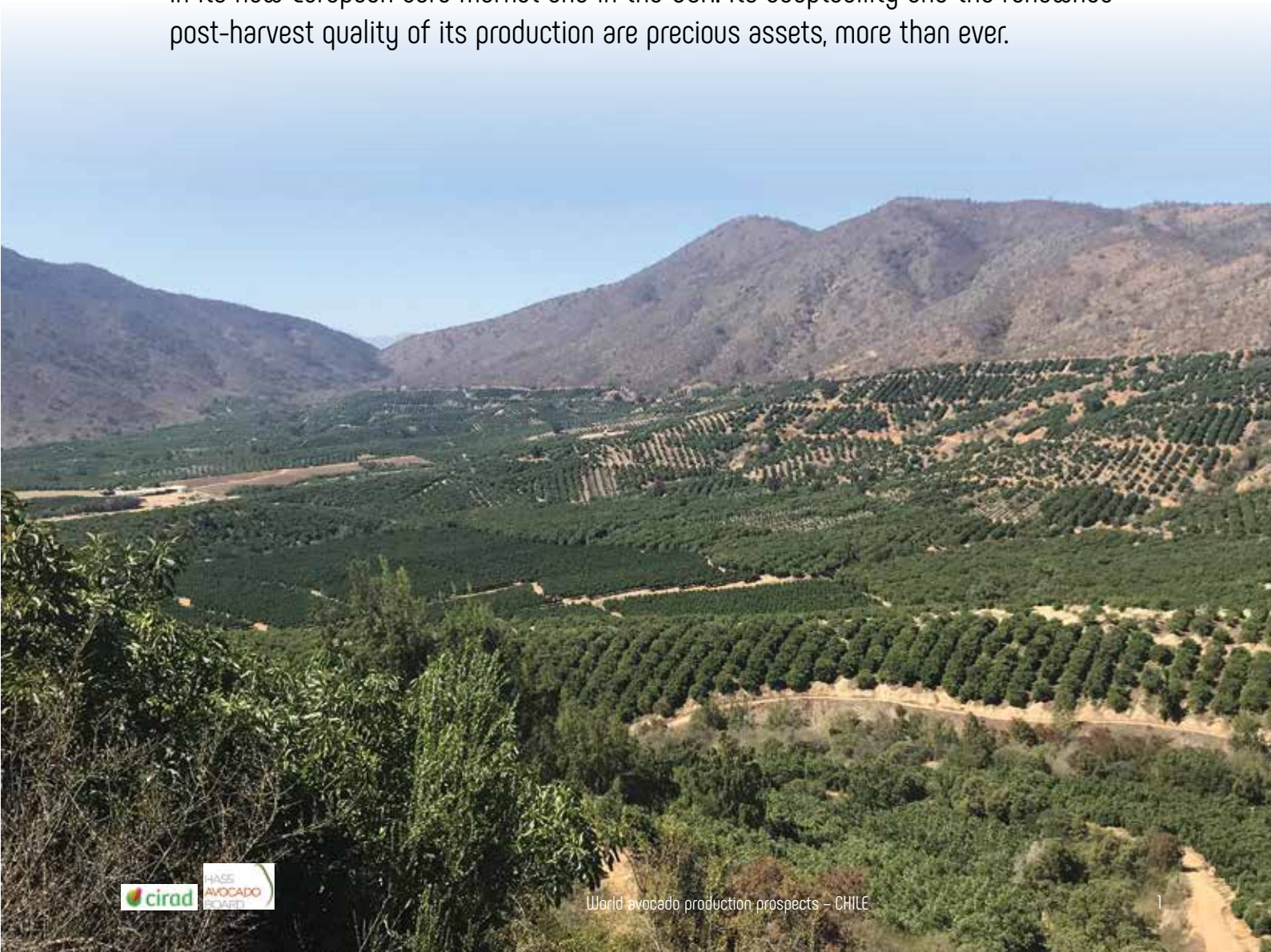
Photo credits: Carolina Dawson, Eric Imbert, Comité de Palta

The avocado in Chile

The Chilean avocado industry, which was the first to show the way to the US market, is the world number three, with export volumes of around 150 000 t per season. The Chilean industry fundamentally relies on its high adaptability. First of all, it has been able to make the most of the restrictive pedoclimatic conditions, thanks to top-flight technical know-how, setting a precedent in Latin America. It then managed to reinvent itself in commercial terms when the US market, on which it had been built, saw a drastic increase in competition. Since the last decade, it has faced major new challenges, with the appearance of a recurrent structural drought, which has really tested its structure, and strong competition gradually coming to prominence, both in its new European core market and in the USA. Its adaptability and the renowned post-harvest quality of its production are precious assets, more than ever.



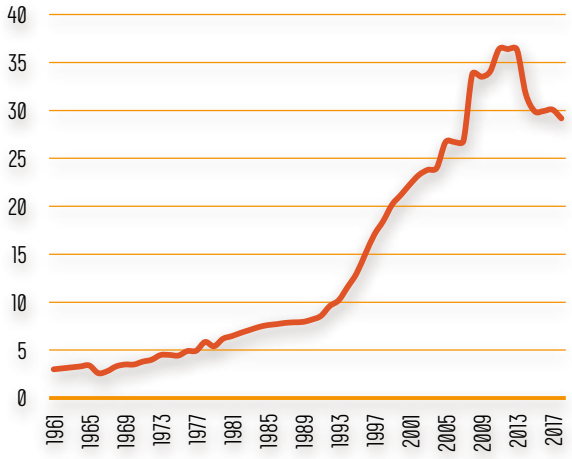
History

An industry built on the US market, now with diversified outlets

The avocado is not a native plant. The introduction of this species to Chile is not documented, but probably occurred toward the early 17th Century, possibly from the Peruvian coast via the network of Franciscan missions, which made a major contribution to the distribution of the Mexican races all the way down the western part of South America. The first plantation appear to have been established toward the mid-19th Century in Aconcagua Valley. The first introductions of improved Californian plant stock began in the late 1920s, with twenty or so varieties, including Fuerte, at the initiative of the Ministry of Agriculture and then an individual. It was the latter, Don Roger Magdahl, who initiated their spread from his "Huerto California" nursery, in Quillota. He too was the first to introduce Hass, in 1944.

During the 1960s, the Chilean State implemented a policy of developing the export fruit sector (National Fruit Plan – Frei government), aimed at harnessing the country's comparative advantages, i.e. its phytosanitary assets, a Mediterranean climate and the ability to produce in the counter-season of the markets of the "rich" Northern Hemisphere countries. To do so, it relied in particular on Californian know-how in the field (cooperation agreement between universities in Chile and California). This plan, and the liberal economic policy conducted by the Pinochet military government from 1973, enabled the emergence of an export apple industry, and above all an export grape industry in the latter half of the 1970s. The avocado sector remained small-scale, centred mainly on local varieties and Fuerte (which were locally known as "palta Chilena" and "palta Californiana" respectively), with the domestic market as the sole outlet until the mid-1980s (planted area approximately 7 600 ha).

Avocado - Chile - Cultivation areas
(in 000 hectares | sources: FAO, ODEPA)



The Avocado industry started to focus on exports at this period, motivated by the booming US market thanks to the promotion actions implemented by the California Avocado Commission. The crop seemed particularly interesting to grape producers for its high complementarity with the grape in terms of production calendar. Flows to this new market, approximately 3 000 t during the first export campaign in 1985-1986, rapidly increased. Chilean exporters and Californian operators opted to cooperate by offering, on the Chilean side, produce to make up for the absence of the local crop from mid-September to mid-December, and from the Californian side, well-established distribution networks. This market proved highly lucrative in the absence of major competitors, with Mexican imports at the time still prohibited for sanitary reasons. This was the Chilean industry's golden age. There was a boom in planting, going from 9 000 ha to more than 20 000 ha during the 1990s, with many investors taking an interest in the crop, whether or not they came from the world of agriculture (including financial groups).

Chile in a few figures:

- **Population:** 18.73 million inhabitants in 2018 (source: World Bank)
- **GNI/capita:** 14 670 USD/year (source: World Bank, 2018)
- **Agriculture:** 3.6 % of GDP (industry 30 %) (source: World Bank, 2018)
- **Value of agricultural exports:** 10.2 billion USD (source: ODEPA, 2019)

Main fresh fruits exported: (source: ODEPA, 2019)

- **Cherry:** 1 474 million USD
- **Grape:** 1 248 million USD
- **Apple:** 620 million USD
- **Blueberry:** 560 million USD
- **Avocado**: 357 million USD

This rapid growth was accompanied by a technical revolution. The industry's centre of gravity moved inland, toward zones where land was cheap, while developing an original production system providing protection from a higher frost risk: the plantations are situated on the steep foothills of the Precordillera, at sufficient altitude to avoid the cold of the valleys while enjoying very good sunshine levels. High density started to become common practice, in particular to accelerate the return on investment. The Comité de Paltas, the body in charge of representing the industry and implementing promotions on both the international and local markets, was created in 1991. The golden opportunity that represented the US market became even more attractive from 2002-2003 with the launch of HAB's powerful promotion programme in the USA, and then a free trade agreement between the two countries (zero Customs duty, subject to quota).

COMITE DE PALTAS CHILE

The context changed radically in the 2000s, in both commercial and climate terms. Economic returns saw a distinct deterioration, with very strong Mexican competition coming to the fore, taking advantage of its ideal position to serve the US market (49 non-producing States open to Hass from Michoacán, starting from 2004). Furthermore, adverse climate conditions set in, with a major spell of frost in 2007 and the appearance that same year of a drought which would become recurrent throughout the following decade. Professionals pulled off a successful commercial conversion, by focusing on two main markets. On the one hand, local sales were increased with the support of major promotion efforts by the Comité de Paltas. On the other hand, the export flows gradually switched to the European Union. To establish the Chilean Hass on this strategic market, albeit initially less lucrative than its US counterpart, an equalisation fund was set up by the exporters themselves so that those switching to this destination could receive financial compensation. Finally, on the strength of their produce's assets in terms of post-harvest and phytosanitary quality, the professionals have managed to open up a very wide portfolio of diversification markets, both near and far, in particular Argentina and China, to name only the biggest ones. Nonetheless, the drought, which has become almost structural and set in during the 2010s, forced them into uprooting or mothballing large surface areas. The cultivation area, in excess of 35 000 ha at the beginning of this period, has stabilised at 29 000 ha according to the latest land registry figures, with some of these surface areas no longer productive.

Location

Structural climate constraints

The spatial distribution of the cultivation area is subject to the multiple climate constraints in place, due to the particular geography of this country. Chile comprises a strip of land 4 300 km long, i.e. extending over more than 20° in latitude, and measuring between 90 km and 440 km across at its extremes. It is bounded by natural borders such as the Atacama Desert to the north, the Andes Cordillera to the east, Patagonia to the south and the Pacific to the west. So the country has a great diversity of climates, varying not only according to latitude but also the rapid elevation in relief from west to east, with peaks of more than 6 000 m located a hundred or so kilometres from the coast. The presence at sea of the Humboldt cold current also plays a major role, limiting both the temperature level and the rainfall, in particular in the mid-north of the country.

So the avocado has been planted in zones with a Mediterranean climate, thereby limiting the frost risks, and endowed with surface or underground water resources (river valleys descending from east to west from the Cordillera). These zones are concentrated in the central part of the country over approximately 500 km between Vicuña in the north (mid-north of Region IV) and Peumo (north of Region VI), generally in the "intermediate depression" (part situated between the coastal mountain belt and the Andes Cordillera, at a modest altitude of between 300 and 850 m). The temperatures are temperate near the coast and more extreme inland. By way of example, the minimum and maximum temperatures are 1 to 2°C and up to 30°C near the sea in Valparaiso, and - 2 to - 3°C and 36 to 37°C in Santiago inland.

Avocado – Chile – Climate characteristics

Characteristics	Coastal zone	Inland zone
Number of hours where temperature is >13°C	1 000-1 300	>1 400
Humidity	high (40-90 %)	low (25-80 %)
Frost risk	low	high, outside of sloped areas
Wind	medium to strong	weak
Extreme temperatures	summer: 10-26°C winter: 2-18°C	summer: 18-33°C winter: 0-22°C
Rainfall	low	very low
Cloudiness	High in spring/ summer	none
Harvest	late	early

Professional sources

The River Aconcagua valley is the main production centre (approximately 40 % of surface areas), with plantations situated both in the mid-valley zone (Quillota, La Cruz, Ocoa) and further upstream (San Felipe, Los Andes, Putaendo). This historic production zone enjoys a good supply of high-quality water, and is renowned as one of the best in the country.

The River Maipo and Mapocho valleys are in second position (approximately 25 % of surface areas). Temperatures are fairly extreme in the Talagante/Melipilla zone, and much more temperate in the coastal part (San Antonio), though this is subject to high cloudiness. Furthermore, these two rivers have high salinity levels (in particular the Mapocho).

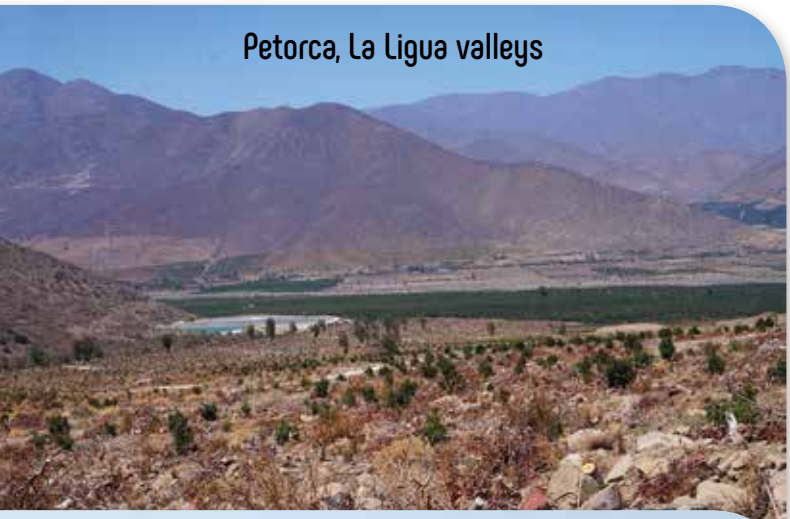
Region IV comes in 3rd position, with approximately 15 % of surface areas (River Elqui, Limarí and Choapa valleys). The presence of major water infrastructures on the Rivers Elqui and Limarí makes up for a very limited precipitation level and a hot climate. The La Ligua/Petorca region, previously a big player, has seen a dramatic decline for lack of sufficient irrigation water (absence of retention infrastructures, low river flow speed, with the source too low to receive snow meltwater).

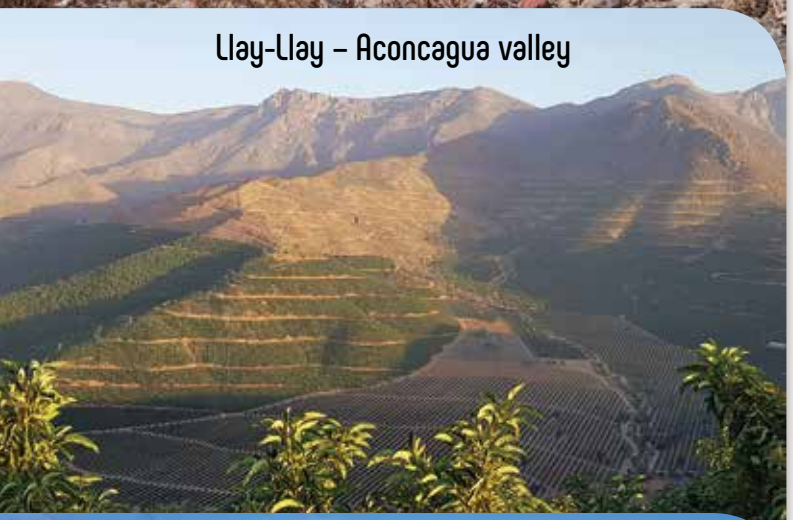
Region VI reportedly makes up just under 10 % of surface areas. While this zone does have assets in terms of water availability, thanks to a more generous rainfall, the presence of the River Cachapoal and the Rapel retention dam, areas with a climate favourable for the avocado are limited, since there is a high frost risk.

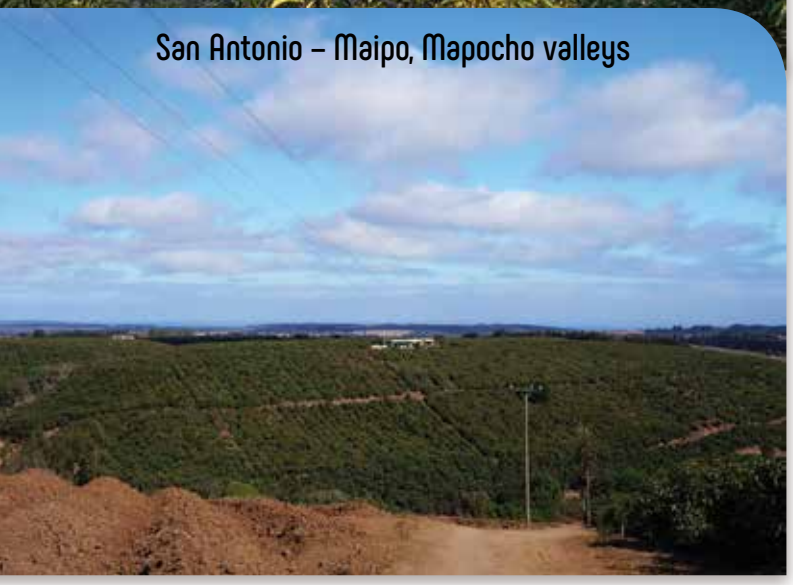
The avocado in Chile

Production zones
(source: ODEPA/CIREN 2017-2018)

Cultivation area of approx. 29 000 ha







Elqui, Limari, Choapa valleys: 3 983 ha
(Region IV)

Petorca, La Ligua valleys: 4 807 ha
(Region V)

Aconcagua valley: 11 922 ha
(Region V)

Maipo, Mapocho valleys: 6 719 ha
(Metropolitan Region and Region V)

Cachapoal valley: 1 169 ha
(Region VI)

Avocado – Chile – Cultivation area by region

Regions	Zones	2017-18 cultivation area, land registry (ha)	2020 cultivation area, estimated (ha)	Rainfall (mm)	Koppen climate
Region IV		**3 983**	**3 400**	**80**	**Bsk/Bwk**
River Elqui valley	Vicuña	362	300	80	Bwk
River Limari valley	Ovalle	1 998	1 800	80	Bsk
River Choapa valley	Illapel	1 623	1 300	80	Bsk
Region V		**16 729**	**13 000**	**200/430**	**Bsk/Csc**
La Ligua/Petorca valley		4 807	2 500	200/250	Bsk
Aconcagua valley		11 922	10 500		
	Quillota/ Marga Marga	*7 743*	*6 000*	*380/430*	*Csc*
	San Felipe/ Andes	*4 179*	*4 500*	*200/250*	*Bsk*
Regions V/VI					
Maipo/Mapocho valley		6 835	7 500	440/460	Csa
	Talagante/ Melipilla/Maipo	*4 492*	*4 000*	*440*	*Csa*
	San Antonio	*2 343*	*3 500*	*450*	*Csa*
Region VI		**1 356**	**2 500**		
Cachapoal valley	Peumo	1 169		960	Csb
Total		**28 903**	**26 400**		

Sources: CIREN, professionals

Koppen class:

- **Bwk** = desert climate, with mean temperature <18°C
- **Bsk** = semi-arid climate, with mean temperature <18°C
- **Csc** = warm temperate climate, with dry, short and cool summer
- **Csa** = warm temperate climate, with dry and hot summer
- **Csb** = warm temperate climate, with dry and temperate summer

La Serena
Elqui
Vicuña
Coquimbo
Ovalle
Limarí
Illapel
Choapa
Petorca
Cabildo
La Ligua
Panquehue
La Calera
Hijuelas
La Cruz
Aconcagua
Quillota
Llay-Llay
Viña del Mar
Quilpué
Valparaíso
SANTIAGO
María Pinto
Melipilla
Talagante
San Antonio
Santo Domingo
Maipo
Embalse Rapel
Cachapoal
Peumo
Pacific Ocean
Río
Diamante

0 100 200 km

Production system

The production system is high-tech, in response to the fairly tough pedoclimatic constraints: cutting-edge water management, use of high density or girdling to increase productivity, etc. The training level of personnel running the orchards, and of the technical advisers, is high, especially thanks to the benchmark agricultural training provided by the country's universities, which are among the best in Latin America (Pontificia Universidad Católica de Chile, Universidad de Chile, etc.). This system also has the twofold peculiarity of the plantations being established on the slopes of the Precordillera and the high planting densities used.

On the sometimes steep slopes of the Precordillera

Large-scale plantations are not seen on such steep slopes in any other part of the world! This original production system was dreamt up based on the Californian model, during the industry boom of the 1990s. The valley lowlands had already been harnessed or was very expensive, but some good land was still available in the parts situated further upstream, albeit on much rougher terrain. This also meant being able to address the much higher frost risk in these more inland zones. To do so, the plantations are set up half-way up the slopes, avoiding the valley bottoms exposed to frost by radiation (accumulation of heavier cold air in the low parts). Furthermore, the rows are aligned in the direction of the slope, so that this cold air can drop below the planting areas rather than remain in them. The exposed hill faces in the north, which have better exposure in the Southern Hemisphere, are favoured. As a general rule the plantations are set up on ridges, so as to have a higher land height, since these hills generally have very shallow soils. This system enables increased heat accumulation (1 300 to 1 800 hours above 13°C in orchards situated in the higher parts, as opposed to 1 000 to 1 300 hours in the valley bottoms), thereby shortening the production cycle. According to a professional estimate, 90 % of the cultivation area is planted on slopes of more than 10 %, with a gradient of up to 60°.

Girdling

The highest planting densities in the world

With 800, 1 100 or even 1 600 plants/hectare, Chile's planting densities are staggering, and still practically unique in the world! This technical choice is able to achieve quicker returns on investment, with a small initial yield starting from two years, and then yields of 12 to 14 t/ha from the third year. It is particularly well suited to hillside planting. This system requires tree size control: the shallowness of the hill soils combined with the competition between the densely planted trees, naturally contribute to limiting their vigour. Nonetheless, pruning is essential, and use of growth regulators is common. The limited tree height means that harvesting can be done without ladders, a crucial point for personnel safety in the steeper zones. This system is only possible if sanitary pressure is very limited, as treatments are very difficult to apply due to lack of space between the rows. Significant surface areas of orchards are still managed with more conventional densities (of around 550 plants/ha). In many of these systems, growers use clonal rootstocks and girdling of one of the primary branches (depending on the tree's condition) in order to increase productivity.

Soils: lack of porosity a limiting factor

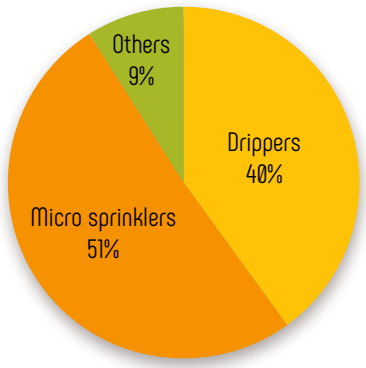
Roughly speaking, there are two types of soil in Chile. Alluvial alfisols cover the lower parts of the valleys. They are generally fairly shallow, alkaline and low in organic matter. The soils of the slopes are different. They are generally granitic or basaltic (Maicillo), clayey, low in organic matter and often stony. Their depth varies, but they are often shallow (30 cm to 1.50 m). Overall, the fine textures and lack of porosity (lack of aeration) of these soils are limiting factors. In some cases, plantings are made on ridges, to increase the depth of the shallow soils.

Water and irrigation: a resource under strain in certain zones, but generally good quality

Use of irrigation is essential, given the insufficient rainfall level: from 450 mm to less than 100 mm from the south to the north of the avocado heartlands in a normal year. Furthermore, it is centred on the winter period from April to October, with a peak from May to August. Hence requirements vary according to the regions, with evapotranspiration ranging between 750 mm on the coast in Region VI and 2 000 mm in the semi-arid Elqui valley (Region IV). Therefore they vary within a wide range from 5 000 to 14 000 m^3/ha (7 000 to 9 000 m^3/ha in most of the production zones in Region V).

Given the low water availability, the irrigation systems used are very high-tech, generally in the form of micro-sprinklers coupled with soil moisture measurement systems. Good irrigation management is essential in order to prevent problems of root asphyxiation, given the low soil porosity. The water is pumped from the rivers and/or groundwater (wells of varying depth). Some big growers have equipped themselves with reservoirs. The irrigation water varies in quality, depending on the catchment area. There are major salinity problems in the Rivers Maipo and Mapocho, which pass through zones abundant in salt-rich Jurassic sedimentary-volcanic rocks further upstream. The waters from other rivers are generally of fairly good quality. However it tends to deteriorate, especially in the valley bottoms.

Avocado - Chile - Irrigation systems
(source: CIREN 2017-2018)

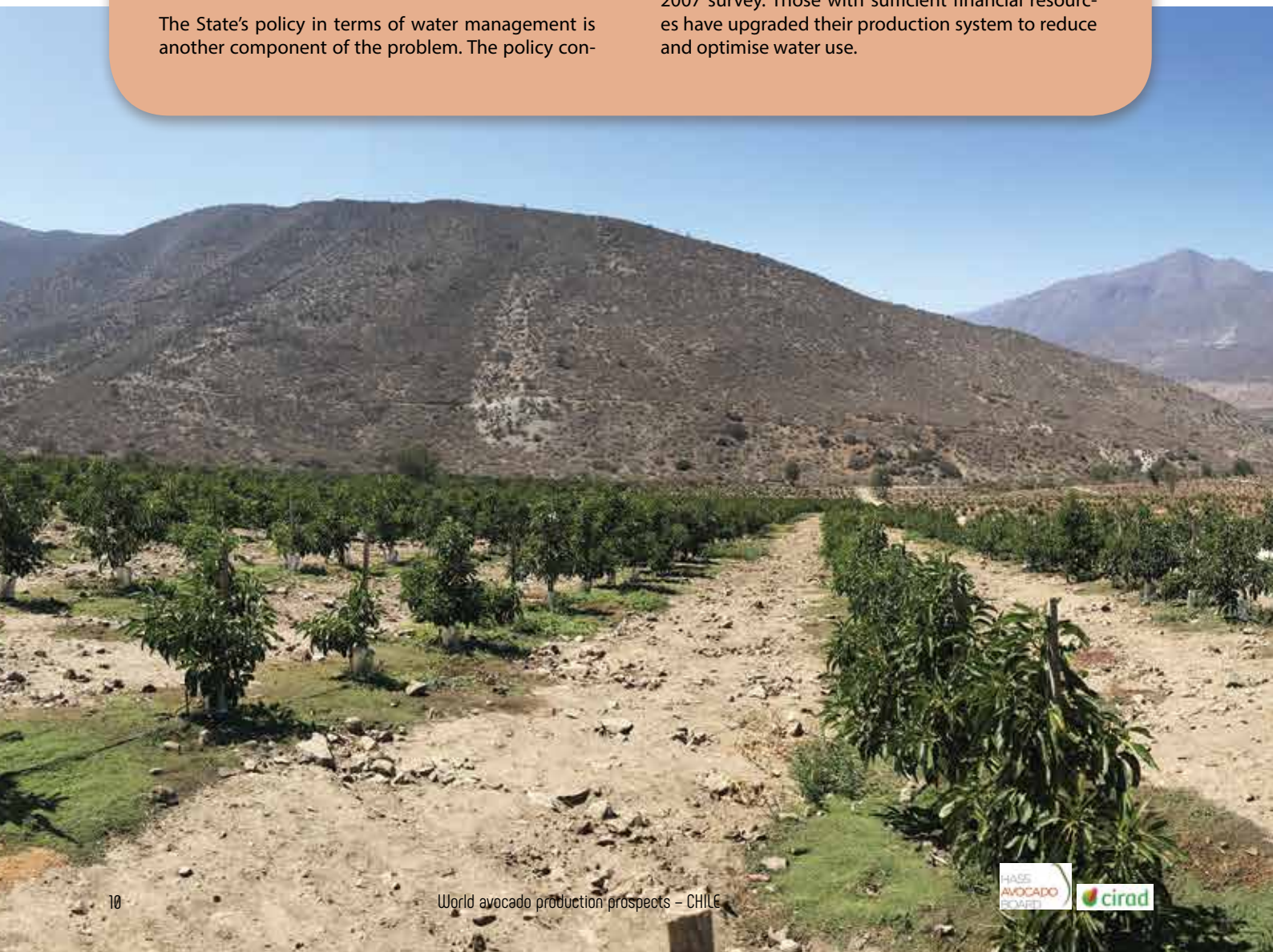


Agricultural water: an underlying problem, which has become a societal problem in the La Ligua/Petorca region

Agricultural water availability is a recurrent problem. While nationally water is an abundant resource, some zones with a climate favourable for agriculture are short of it. First of all, the rainfall level is low, from 450 mm to less than 100 mm in most avocado zones, with the exception of Region VI. Furthermore, the rainy season falls at a period of low requirements in the vegetative cycle. The main water resource from the centre to the north of the country is water drawn from the enormous reservoir provided by snow meltwater from the Cordillera, which feeds the groundwater and rivers which flow down from it and cross the country from east to west. However, their flow speed is highly variable: rivers with a catchment area situated at altitude have more of this precious resource than those with a lower source (especially the Rivers Petorca and La Ligua). There is a lack of accumulation infrastructures, despite the structural nature of the problem and the snow resources available at altitude. Only Region IV has suitable facilities; in the other regions works projects, sometimes dating back a long time, have never been executed (though some have been approved). The drought, practically uninterrupted since the start of the 2010s, and which culminated in 2019, has further aggravated the situation.

The State's policy in terms of water management is another component of the problem. The policy conducted under the Pinochet military government from the 1970s onward has led to commodification of water: usage rights are separate from land ownership, and can be sold independently. The absence of rigorous State management has led to over-allocation and concentration of these rights, and to illegal use of the resource.

Use of water has become a controversial subject, in particular in certain poorly endowed rural or semi-urbanised zones (La Ligua/Petorca in particular), where the public water supply is a problem. In this context fingers have been pointed at agriculture, and primarily the avocado, the zone's number one crop, even though other economic sectors such as the very powerful mining industry are also big consumers. However, a policy of stricter control of use of water allocations is now in place in zones under strain, and will gradually take effect in all regions of the country (compliance with quotas, redistribution of unused rights). Furthermore, avocado industry professionals have drastically scaled back cultivation areas, by uprooting or mothballing plantations. Hence there are only approximately 2 500 ha in production of the 8 700 ha recorded in the Petorca/La Ligua zone in the 2007 survey. Those with sufficient financial resources have upgraded their production system to reduce and optimise water use.



An enviable phytosanitary status

Pressure from diseases and pests is very low in this "phytosanitary island" thanks on the one hand to its dry climate, and on the other hand, to the presence of natural barriers such as the Cordillera to the East, the Atacama Desert to the north, and the Pacific Ocean to the west, which safeguard it from the arrival of invasive species.

The main pests present are red spiders (*Oligonychus yothersi* and *Oligonychus punicae*), several species of thrips (*Frankliniella australis*, *Frankliniella gemina*, *Frankliniella occidentalis*) and a mealybug (*Pseudococcus maritimus*). They are generally managed using natural products (oils, sulfur, soap) and integrated pest management. Synthetic pesticides are used only in rare cases of serious infestation. The country has been free from fruit fly since 1995, a status which has opened up a number of markets, with no sanitary protocols. SAG is a State body in charge of maintaining this status (entry point controls, trapping network for detecting any infestations at an early stage, etc.).

Avocado diseases are also rare. *Phytophthora* is present in the soil, but is non-virulent in the vast majority of the production zones, with their very dry climate. Some specialists also point to the protective role played by copper, reported to be naturally present in the irrigation waters. Chile is the world's leading producer of this metal, which is the country's main economic resource. Other fungal problems are also very limited: canker (*Dothiorella* spp) and root rot (*Cylindrocarpon destructans*) are occasionally present, as well as some cases of anthracnose in the few high-rainfall years.

Varieties and calendar: a wide calendar, thanks to great climate diversity

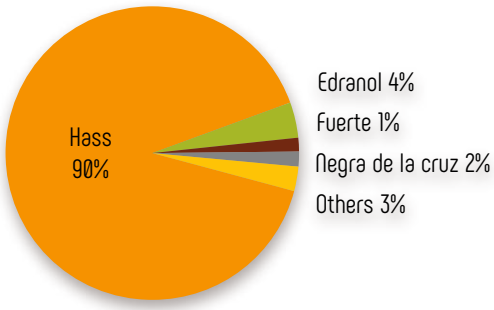
Introduced in the 1940s, Hass now represents nearly all surface areas planted in the country. Hass-like varieties (early such as Carmen and Maluma, or late such as Lamb), which can expand the production window, do not present any particular advantage. The Hass production calendar already covers a wide period, from early August to early April, thanks to the heterogeneous distribution of the orchards in terms of altitude and latitude. The zones situated furthest inland and at the highest altitude are the earliest, with coastal zones being the latest (maturity up to 55 days later on the coast than in the medium to high valleys). Furthermore, the orchards in the hotter zones in the north of the country are earlier than in the south.

The rest of the cultivation area comprises a wide varietal range. The main variety encountered is Edranol (5 % of surface areas), and to a lesser degree Zutano or Fuerte, primarily used as Hass pollinators. The numerous Chilean varieties, predominant in the 1970s, are now in a small minority, and aimed at the local market. The main one, Negra de la Cruz, represents barely 2 % of surface areas. Some Gem trials are in progress, though they too remain marginal.

The dominant rootstock is Mexicola. However, other more salinity-resistant varieties (derived from West Indian or Nabal races) are in common use in zones irrigated from the Rivers Maipo and Mapocho, and are reported to be on the increase too in certain plantations in the Aconcagua Valley. Use of clonal rootstocks remains fairly limited, except for replanting. The high unit cost of clonal plants (more than 10 USD/plant as opposed to 3 to 4 USD/plant for traditional plants), and their properties in terms of vigour, represent a handicap in the high-density systems commonly used in this country.

Most big growers have their own nurseries, and produce certified plants.

Avocado - Chile - Planted varieties
(source: CIREN 2017-2018)



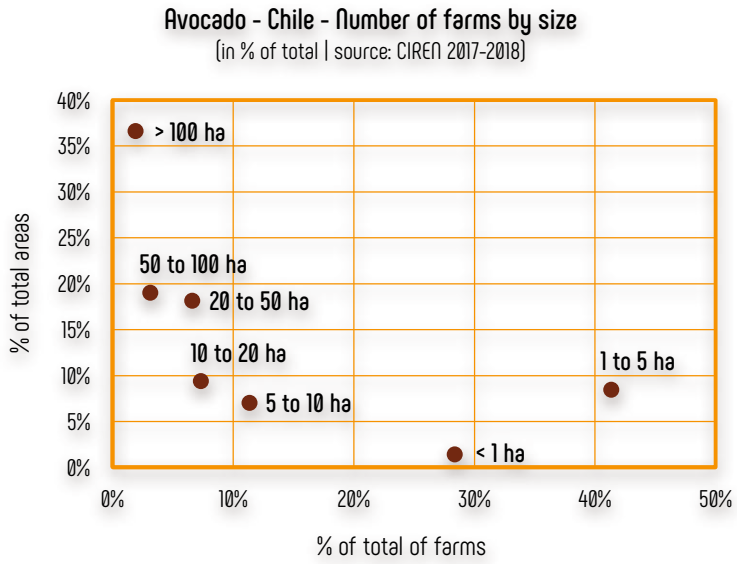
Avocado – Chile – Production calendar by region and production zone

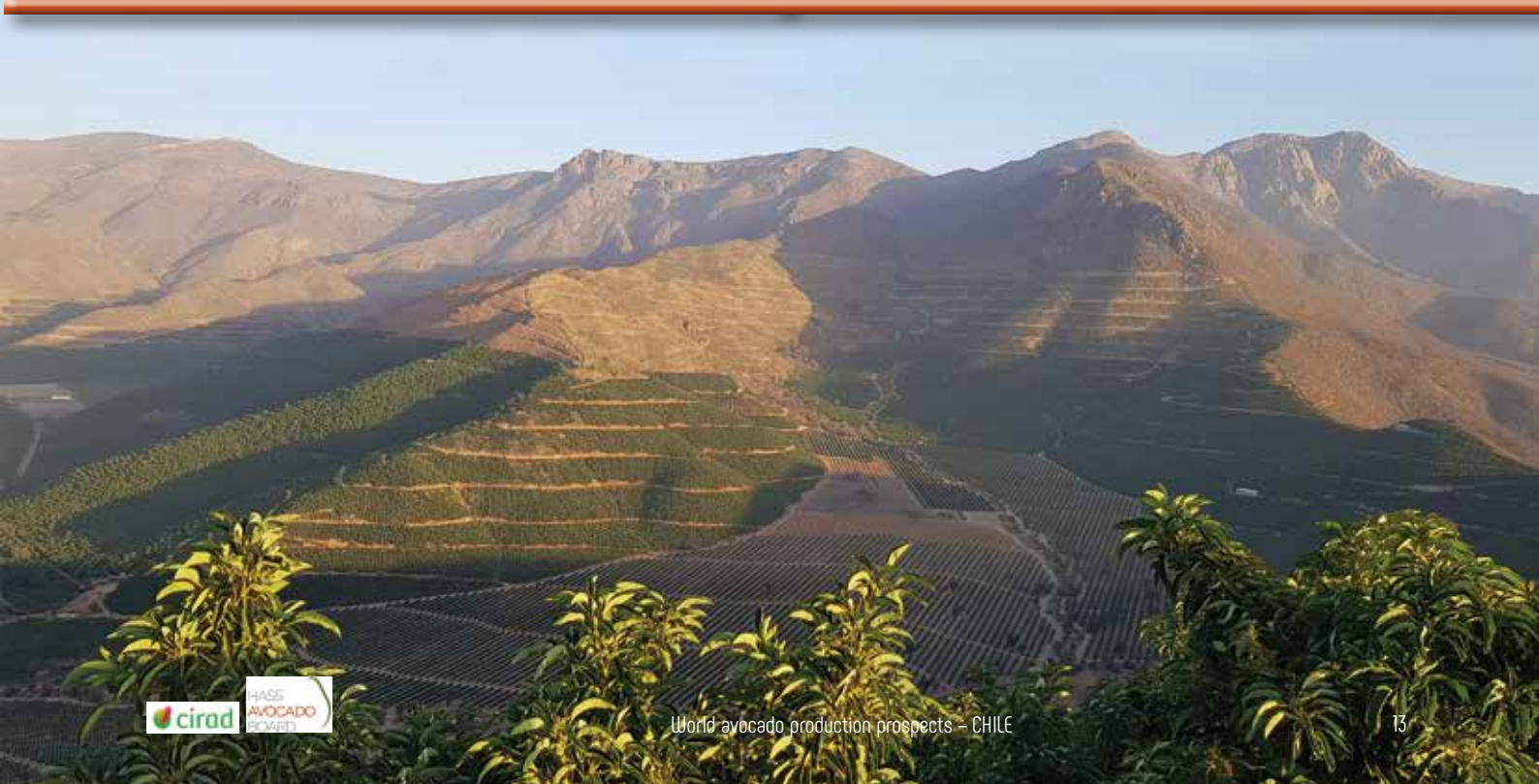
	Region	Zone	Number of hours >13°C	Sizing potential
VERY EARLY Harvest starts June/July	Region IV Region V	Vicuña, upper valleys of the Rivers Choapa and Illapel Petorca, Upper Aconcagua valley	>1 800	medium to large
EARLY Harvest starts mid-July/August	Region IV Region V Metropolitan region	Ovalle Cabildo, Panquehue, Llay Llay Maria Pinto	1 400 to 1 700	large
MID-SEASON - LATE Late August	Region IV Region V Metropolitan region Region VI	Illapel, Paloma La Ligua, Quillota, Limache Melipilla Peumo, Rapel	1 100 to 1 300	medium
VERY LATE Late October	Region IV Region V	La Serena Santo Domingo	900 to 1 000	medium to small

According to F. Gardiazabal

Production structure: medium to large plantations

The sector has nearly 2 700 avocado growers, according to the latest available agricultural surveys (2017-2018). The plantation size is medium to large: 75 % of the total cultivation area is concentrated in large facilities covering more than 10 ha (with 56 % of the total cultivation area within facilities covering more than 50 ha). There are many small growers with less than 5 ha (70 % of personnel), yet they represent less than 10 % of total surface areas.





Yield: marked diversity

Nationally, the average yield is estimated at 11 tonnes/ha, with marked extremes varying according to the production system, and the pedoclimatic quality of the location. Low-tech small growers have low yields, of around 6 to 8 tonnes/ha, while the yields of the high-tech orchards are on average around 15 to 17 tonnes/ha, under favourable production conditions, and can reach peaks of 20 to 25 tonnes/ha. Conversely, despite good management, yields are levelling out at 10 to 13 tonnes/ha in orchards where water salinity is high. There is a marked alternate bearing effect, especially in high-density orchards and late zone orchards.

Production costs among the highest in Latin America

Production costs are homogeneous between regions, but vary greatly according to the altitude of the orchard. They range from 8 000 to 9 000 USD/ha in the valley bottoms, and can be as high as 12 000 or even 13 000 USD/ha in the steepest zones. Hence they are considerably higher than in other South American countries such as Peru, Mexico and Colombia. Thanks to the favourable phytosanitary conditions and the free water (excluding any access rights purchases, and any desalination treatment required), the two main cost items are the energy required for pumping (approximately an additional 800 to 900 USD/ha per 100 metres altitude difference, i.e. up to 4 000 USD/ha), and labour. The cost of this latter item is rising, and is around 25 to 30 USD/day, or 440 USD/month including fringe benefits. The minimum wages set by the State are regularly revised, and are rising. The problem of labour availability, due to competition from other more lucrative economic sectors such as mining or construction, is less acute than in the past. On the one hand, personnel management has been improved with the launch of synergies with other crops with a complementary production calendar, thereby providing continuous work for the personnel, especially at the packing stations. On the other hand, use of immigrant labour has been considerable, particularly from Peru and Bolivia, since the 2010s. However, the absence of a genuine policy for receiving foreign labour raises questions over its long-term future. The biggest growers bring in contractors for harvesting, and sometimes also for pruning and irrigation systems maintenance.

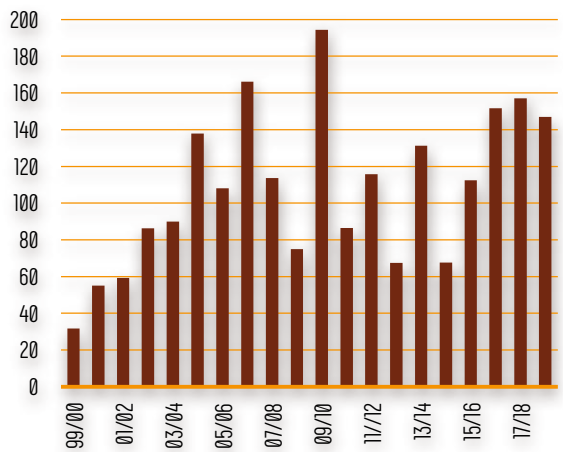
Outlets

Production quality ensuring high commercial adaptability

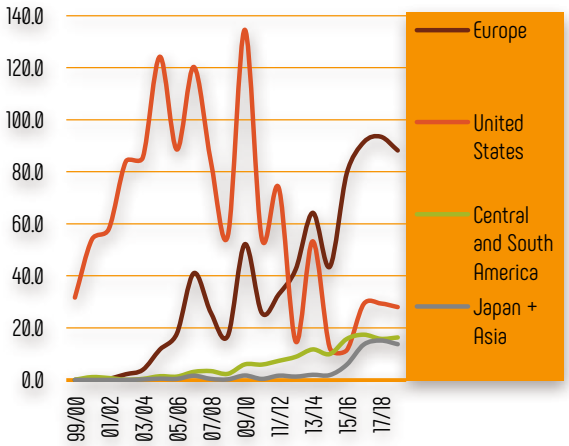
Practically all of the production is intended for fresh consumption, on the export or local markets. The industry outlet is practically non-existent since the very good sanitary level of production due to the dry climate, which helps limit sorting rejects, and fruit with cosmetic problems sells readily on the domestic market.

The export sector was built on a rationale of supplying the US market, with the Comité de Paltas and the California Growers Association operating jointly from a very early stage in terms of marketing. Volumes took off in exemplary fashion in the late 1990s, going from less than 20 000 t in 1997-1998 to nearly 200 000 t in 2009-2010. However, the dazzling rise of the Mexican competition in the USA, as well as adverse weather, altered the export landscape. Exports across all destinations, in freefall throughout the first half of the 2010s (fluctuating between 70 000 and 130 000 t per season), have climbed back to around 150 000 t in recent seasons. The European Union, initially a diversification market since it was less lucrative and harder to work (controlled atmosphere mandatory to extend the life to 45 days), has become the Chilean avocado's top destination since the 2012-2013 campaign (approximately 60 % of shipments). Chile is now the number one supplier to the EU market during the winter season, with volumes of around 90 000 t in recent seasons. The USA remains a major outlet, though volumes have topped out at just under 30 000 tonnes in recent years, sold mainly over a short period at the very beginning of the season (August-September), before Michoacán's production comes to the fore. Thanks to the country's excellent phytosanitary status, and the very high post-harvest quality of the production, Chilean exporters have developed a very wide range of customer countries, both regional and more distant destinations. Exports to neighbouring Latin American markets have increased considerably: 16 000 to 17 000 t per season, primarily aimed at Argentina, which has become the country's number three export outlet in terms of volume. Efforts in recent years have been turned to Asia, with volumes on the increase, reaching 15 000 t in 2017-2018, aimed above all at the Chinese market, which was opened up in 2014.

Avocado - Chile - Exports
(in 000 tonnes | source: Chilean Customs)



Avocado - Chile - Exports by destination
(in 000 tonnes | source: Chilean Customs)



The Chilean domestic market is now a major outlet for its production. The share of production aimed at local consumption is estimated at 30 to 35 %, i.e. a record for Chilean export fruits. It became of prime importance toward the 2010s, a period when Chilean growers had to face shrinking exports to the USA. The promotion campaigns conducted by the Comité de Paltas have made a big contribution to its development (in-store events, setting up a "día de la palta", etc.). As a staple of local diet, among the favourite options as a snack (bread with avocado or cheese), the avocado is the flagship sales leader of the Chilean supermarket sector, where it is available loose or in net bags at prices which can range, for loose,

from 3 800 pesos/kg (i.e. 4.60 USD/kg) to 5 000 pesos/kg (6 USD/kg), and 2 800 pesos/kg for net bags (3.5 USD/kg). Hence this highly lucrative outlet is, at certain times of year, in direct competition with the export markets. Local production is topped up by imports from Mexico and Peru in the counter-season, taking the Chilean consumption dynamic to more than 7 kg/capita. The price elasticity of consumption remains high, as does the profitability on the retail segment: so the local market probably remains an under-used consumption pool.

Players

A highly concentrated export sector

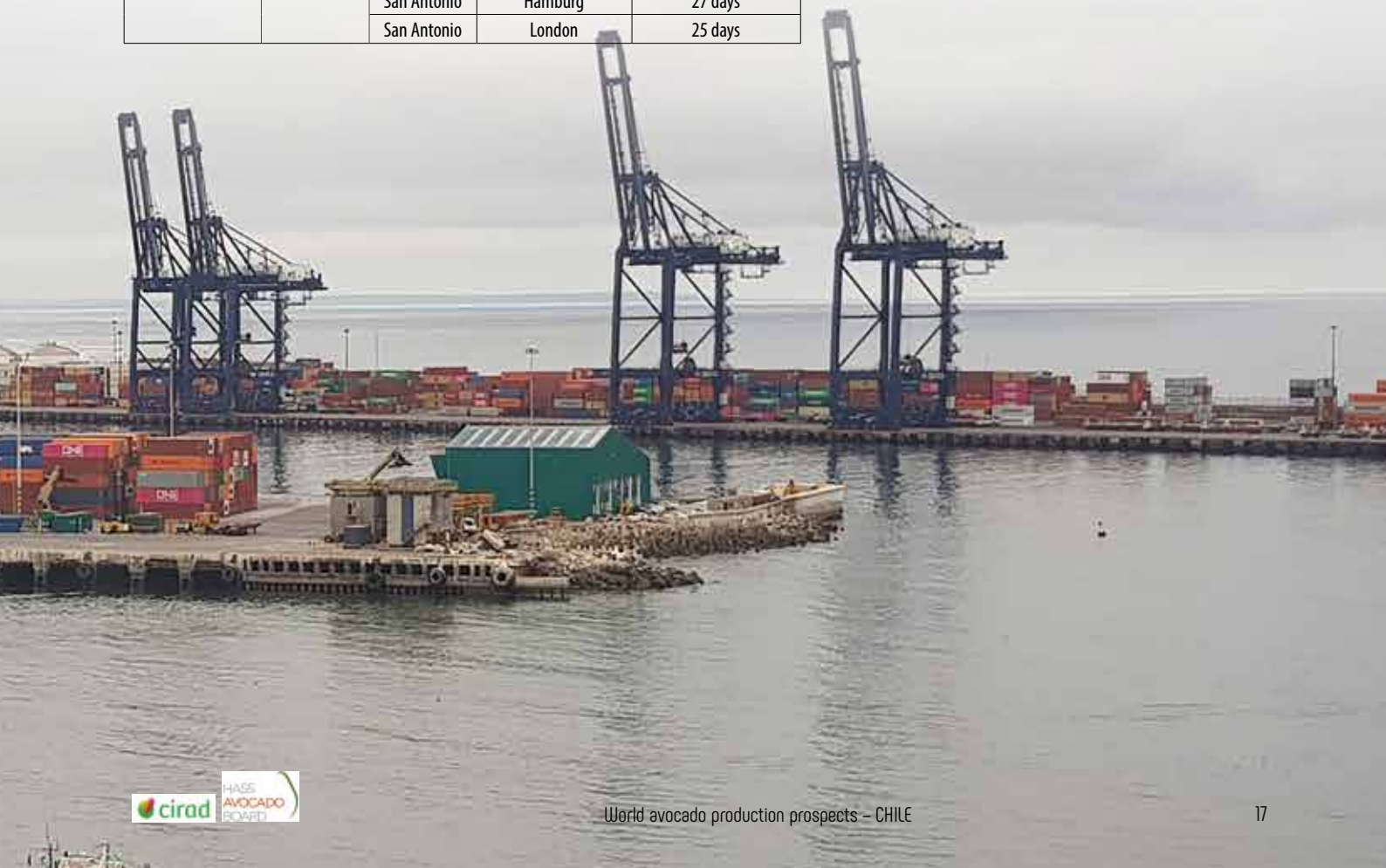
The export sector is highly concentrated, with the top five operators alone selling 80 % of volumes.

Avocado – Chile – Sea logistics

Main lines	Market	Port of departure	Port of arrival	Transit time
Maersk	Asia	San Antonio	Hong Kong	26 days
		San Antonio	Shanghai	36 days
	United States	Valparaiso	Philadelphia	17 days
	Europe	San Antonio	Antwerp	22 days
		San Antonio	Rotterdam	24 days
		San Antonio	Hamburg	27 days
Hapag-Lloyd	Asia	Valparaiso	Hong Kong	22 days *Cherry Express*
		Valparaiso	Shanghai	27 days *Cherry Express*
	Europe	San Antonio	Rotterdam	25 days
		San Antonio	Hamburg	29 days
		San Antonio	Antwerp	31 days
CMA CGM	United States	San Antonio	Ensenada (California)	-
	Europe	San Antonio	Hamburg	28 days
		San Antonio	Antwerp	31 days
Hamburg Süd	United States	San Antonio	Los Angeles	28 days
	Europe	San Antonio	Antwerp	22 days
		San Antonio	Hamburg	27 days
		San Antonio	London	25 days

Logistics

Most merchandise is transported by road-freight to the ports of Valparaiso and San Antonio, which are situated near the production zones (no more than 2 hours by road between the production zones and the ports), and which have an SAG-USDA inspection station. Controlled atmosphere is systematically employed for shipments to all destinations. The freight cost is around 7 000 to 7 500 USD/container for all destinations (including controlled atmosphere).



Prospects

Methodology

We combined two approaches: one quantitative, based on using the CIREN survey data, and the other qualitative, using the information gathered from professionals. The information gathered enabled us to pinpoint and analyse the various variables influencing the evolution of cultivation areas and productivity. We then selected the most relevant hypotheses to put together an evolution scenario up to 2025. We opted for an approach based on production valleys, as the constraints vary greatly between zones, especially in terms of water availability.

1. Estimated evolution of surface areas

1.1. Cultivation area size in 2020

The initial step was to estimate the actual size of the cultivation area in 2020. While the CIREN survey data are very precise in geographic terms, they go back to 2018 for Region IV and Region VI, and to 2017 for the Metropolitan and Valparaiso regions, and some major changes have taken place in recent years. To make this estimate, we opted to extend the trend known between the last two surveys, and adjust this result according to reports from the professionals.

The results figure in the table below. They are used in the "Location" section (see page 7).

Avocado – Chile – Cultivation area by region

Production zones	2020 estimated cultivation area (ha)
Region IV	**3 400**
River Elqui valley (Vicuña)	**300**
River Limari valley (Ovalle)	**1 800**
River Choapa valley (Illapel)	**1 300**
Region V	**13 000**
La Ligua/Petorca valley	**2 500**
Aconcagua valley	**10 500**
Quillota/Marga Marga	*6 000*
San Felipe/Andes	*4 500*
Regions V/VI	**7 500**
Maipo/Mapocho valley	**7 500**
Talagante/Melipilla/Maipo	*4 000*
San Antonio	*3 500*
Region VI	**2 500**
Total	**26 400**

Sources: CIREN, professionals

1.2. Evolution of cultivation area over the period 2020-2025

This factor should be closely monitored in the case of Chile, despite the relative proximity of 2025. The production system, which is based on high-density planting or other techniques for increasing productivity (girdling and sometimes clonal rootstocks), makes for a rapid entry into production. Furthermore, any ongoing plantation uprooting and felling could also have an immediate impact on production. There too, we used a combined qualitative and quantitative approach. The crucial points which will govern investments are:

Climate context

Since 2010, Chile has gone through the worst drought ever since the meteorological data survey ("mega drought", as it is dubbed locally). The evolution of the climate situation will go a long way to determining the dynamic of the sector in the coming years. If it eases up, the felled orchards will be reactivated, and the planting rate could pick up. However, the climate models consulted reckon on a long-term increase in water stress instead, with rainfall decreasing by approximately 15 % by 2050. Similarly, the warming phenomenon should continue, with a temperature increase of 1.5°C to 2.5°C in certain zones. Maximum summer temperatures could become problematic in certain zones (more than 30°C in all zones, except for Aconcagua Valley and San Antonio). Conversely, the frost risk appears less marked, in particular in Region VI.

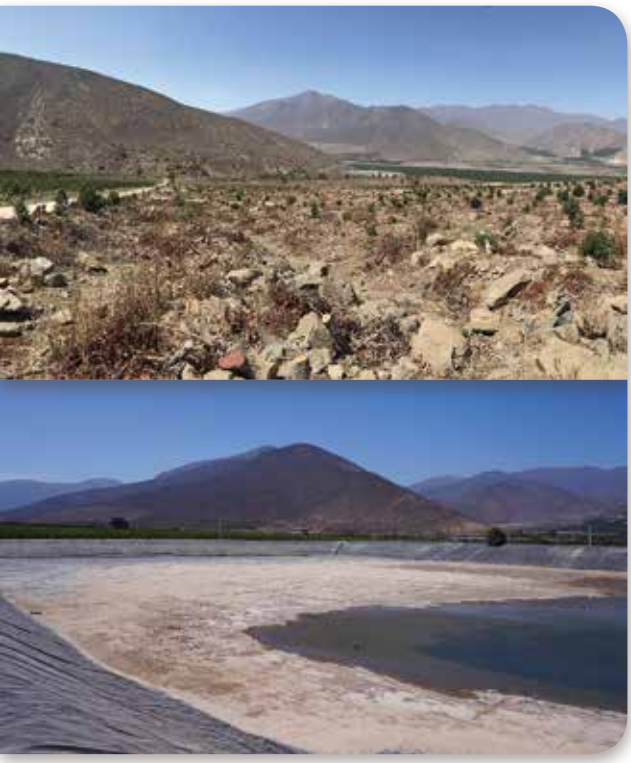
Two huge water infrastructure projects are under study. They are both aimed at carrying water, abundant in the cold zones in the south of the country, to regions of high agricultural potential in the centre and north (coastal undersea aqueduct or high-altitude aqueduct running over the Cordillera). These projects are not incorporated into this study, as the consequences of their potential execution would not be felt until after the 2025 deadline.

Increased competition and evolution of profitability

The evolution of the sector's profitability will be crucial in investment choices. While prospects of growth in world demand remain exceptional for the avocado, Chile will have to continue to face increasingly tough competition on its two main markets, namely the European Union and the USA. On the one hand, highly competitive new direct competitors are appearing in Europe (Jalisco and Colombia), while Michoacán is continuing its rise in the USA. On the other hand, the production boom from European counter-season market suppliers is tending to significantly limit the trading window for the winter origins, especially in September and during part of October. The evolution of the country's competitiveness will be crucial (production cost and productivity). The price of energy, a major cost item in the Chilean slope cultivation system, as well as labour availability in the medium term, will need to be monitored.

Evolution of brand image

The quality of Chilean fruit is currently recognised by downstream professionals, such as importers and marketers, thanks to the excellent technical level of the growers and to the dry climate. It is a powerful differentiating asset, especially compared to more competitive origins. Conversely, recent controversies around water use have tarnished the brand image of Chile as an origin, both internationally and locally. Social pressure is high, and is contributing to curbing investment, even in zones where agricultural water availability is good.



2. Estimated evolution of productivity

The margins for progress appear relatively limited. In medium and large-sized plantations, the very high-tech production system already harnesses a great deal of the potential given the country's relatively restrictive pedoclimatic conditions. A larger water supply could change the hand, but it should remain restricted in the coming years. Marginal rises could come in zones where the water pressure is highest, and where certain big growers are replanting on better technical standards (clonal rootstocks, techniques to optimise water use, such as mulching, etc.). Conversely, the increasingly acute problem of salinity in other zones (Rivers Maipo and Mapocho in particular) could have a more pronounced depressive effect on yields.

Furthermore, it is also important to note that there could be a natural fall in productivity due to ageing of the stock in the next few years. The majority of the Chilean cultivation area was planted between 1992 and 2002 (1 400 ha/year on average during this period). A major need for replanting should appear in the very short term (2022-2027), with high productivity required given the country's high production costs. This is an additional challenge, which will increasingly raise the issue of investment in the Chilean avocado sector.

3. Overall and zonal scenario

The 2000s were a dark period for the Chilean avocado industry, with the cultivation area probably losing nearly 10 000 ha. According to our scenario, the period 2020-2025 could be a time of stabilisation. Agricultural water availability remains the main constraint, and a major brake on development. Nonetheless, the hypothesis of an ongoing large-scale reduction in surface areas seems unlikely, since professionals are seeking a balance between availability and requirements in the zones with the highest stress, even at the price of significant uprooting. Furthermore, the desire to invest is also being curbed by the steep increase in land prices, by the prospect of more uncertain economic returns in a country where production costs are high, and by social pressure, especially at local level given the water issue. At present extension programmes are limited, and concentrated in the southern zones best endowed with water. Furthermore, a significant proportion of the country's producer groups has diversified their investments in recent years, completely or partially targeting countries other than Chile, such as Peru, and then more recently Colombia, with Brazil also a potential target.

In the coming years, the country will need to face an additional challenge. The majority of the Chilean cultivation area was planted between 1992 and 2002 (1 400 ha/year on average during this period). If we assume a natural productivity fall after 30-35 years, and an economic balance based on a good yield level, given the country's relatively high production costs, a major replanting requirement should appear in the very short term (2022-2027).

To face these challenges, increasing productivity and maintaining an excellent quality level will remain crucial lines of work. Chilean professionals will also continue to be able to count on their adaptability to new climate or commercial realities, which they have demonstrated in the past.

Region IV

The climate is semi-arid, or even desert, but it is the country's only region equipped with large-scale waterworks in some zones. Hence we opted for a scenario of stability in the River Elqui valley (La Laguna and Puclaro dams – retention capacity 240 million m^3) and River Limari valley (La Paloma, Cogoti and Recoleta dams – retention capacity 1 000 million m^3). Conversely, we have reckoned on ongoing shrinkage of the production zones situated on the River Choapa, because of a higher water pressure (two dams in place, but a much more limited retention capacity).

La Ligua and Petorca valleys

There is major pressure on the water resource, and growers have had to accept uprooting and mothballing of approximately 6 000 ha in recent years (approximately 70 % of the cultivation area). We opted for a scenario of stability, since the surface areas currently in cultivation are seemingly in balance with water availability. Furthermore, we assume that productivity could increase slightly thanks to the new production systems which can optimise water use set up by some large-scale players (using clonal rootstocks, techniques for saving more water, such as mulching, etc.).

Aconcagua valley

This zone, the historic heartland of the Chilean avocado industry, enjoys very good pedoclimatic conditions for the crop. We opted to extend the trends from recent years, i.e. a slight drop in the valley bottoms (Quillota zone), offset by slight growth in the part situated further upstream and better endowed with surface water and groundwater (San Felipe). A similar scenario is adopted for yields: the slight increase in productivity arising from improved cropping practices would be cancelled out by a fall in downstream zones due to the appearance of salinity problems.

Maipo and Mapocho valleys

We opted to extend the slight downward trend in surface areas in the Melipilla and Maipo zones, where tension on the water resource is on the increase. Conversely, the increasing problem of water salinity, already high, has led us to assume a fall in productivity. Conversely, growth could continue in the San Antonio zone, where the water issue has less impact. Nonetheless the planting rate could slow down. Salinity is another issue that could affect this zone's yield, although it remains considerably lower than in zones situated further upstream.

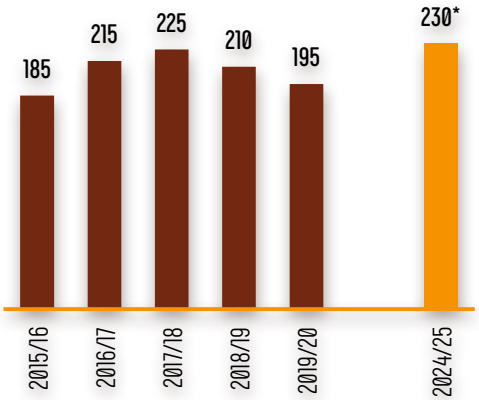
Region VI

The dynamic should remain strong. However, while the zone has major assets in terms of agricultural water availability, it is also subject to much more intense frost risks. So growth will remain restrained in zones with the necessary microclimate, taking into account the constraints relating to biodiversity protection (Peumo, Pichidegua, La Estrella and Las Cabras in particular). This region will considerably increase the Chilean supply in the late-season slot, though with probably acute alternate bearing effects.

4. Results (see table below)

According to our hypotheses, the overall extent of the cultivation area should not see much change (approximately 25 600 ha of Hass in 2025). Conversely, its centre of gravity could shift toward the slightly wetter but also cooler zones in the south. Hass production should also see little change, with around 230 000 t.

Hass avocado - Chile - Production
(in 000 tonnes | sources: Comité de Palta, CIRAD*)



Avocado – Chile – Evolution of cultivation area by production zone (across all varieties)

Production zones	Cultivation areas in 2020 (ha)	Past annual evolution* (ha/year)	Hypothesis for 2025		Yield** (t/ha)	2025 production (t)
			Total cultivation areas (ha)	of which young orchards (up to 48 months) (ha)		
Region IV	**3 400**	**- 320**	**2 900**		**10.5**	**30 450**
River Elqui valley (Vicuña)	**300**	**- 30**	**300**			
River Limari valley (Ovalle)	**1 800**	**- 200**	**1 800**			
River Choapa valley (Illapel)	**1 300**	**- 100**	**800**			
Region V	**13 000**	**- 220**	**13 000**	**800**		**130 900**
La Ligua/Petorca valley	**2 500**	**- 270**	**2 500**		**9**	**22 500**
Aconcagua valley	**10 500**	**+ 50**	**10 500**	**800**	**10.5**	**108 400**
Quillota/Marga Marga	*6 000*	*- 200*	*5 000*			
San Felipe/Andes	*4 500*	*+ 250*	*5 500*	*800*		
Regions V/VI	**7 500**	**+ 320**	**7 700**			**65 700**
Maipo/Mapocho valley	**7 500**	**+ 320**	**7 700**		**9**	**65 700**
Talagante/Melipilla/Maipo	*4 000*	*- 130*	*3 200*			
San Antonio	*3 500*	*+ 450*	*4 500*	*800*		
Region VI	**2 500**	**+ 300**	**4 000**	**1 200**	**10.5**	**35 700**
Total	**26 400**		**27 600**			**262 750**
		of which HASS (89 %)	**25 600**			**230 000**

* calculated between the last two surveys (2018/2015 or 2017/2014)
** Yields of young orchards before maturity were smoothed: they correspond to 50 % of adult trees' yields

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