Chapter 15
Date Palm Status and Perspective in South American Countries: Chile and Peru

Hugo A. Escobar and Rafael G.J. Valdivia

Abstract Date palm was introduced to South America, probably from Morocco, by Spanish colonialists to the central coast of Peru, from where it spread to Mexico and North America. Currently, date palm is little known as an agronomic crop; its cultivation in South America is limited to specific areas of Peru, Chile, Argentina, and Brazil. Excellent climatic conditions for date palm cultivation are present in northern Chile from Arica to Copiapó, as well as in areas of central and northern Peru such as Ica, Zaña, and Pisco. Important germplasm has developed from seed propagation which has produced all the named cultivars such as Medjool, Zahidi, and Deglet Noor. The importance of seedling-derived material lies in its adaptation to edaphic and climatic conditions different from those found in its area of origin, including acquisition of tolerance to high levels of salinity and boron in soil and irrigation water. It is interesting that there are date palms cultivated in locations at 1,500 m elevation such as the valleys of Pisco and Ingenio in Peru and Codpa in Chile. Currently, date production in Chile and Peru is all consumed locally. As well as having areas with optimal climate for the cultivation of date palms, Chile and Peru have important strengths and opportunities for the development of this crop, such as internationally recognized prestige in the production and exportation of fruit, government support of innovation, and multiple free trade agreements. There are also weaknesses, mainly the absence of local agronomic researchers familiar with the crop, lack of trained workers, insufficient knowledge about this fruit, and limited consumption. Date palm has an important potential in South America due to favorable agricultural and economic conditions as well as an expanding international demand.

Keywords Arica • Azapa • Chile • Date palm • Esmeralda • Ica • Lluta • Peru • Pica • Pisco • Zaña

---

H.A. Escobar (✉)
Facultad de Ciencias Agronómicas, Universidad de Tarapacá, Arica, Chile
e-mail: hescobar@uta.cl

R.G.J. Valdivia
Agronomist, Private Consultant, Santiago, Chile
e-mail: rafaelvaldiviaurra@gmail.com

J.M. Al-Khayri et al. (eds.), *Date Palm Genetic Resources and Utilization: Volume 1: Africa and the Americas*, DOI 10.1007/978-94-017-9694-1_15

15.1 Introduction

Although the date palm is known as a fruit tree linked to Arabian countries, its cultivation has spread into the Americas, introduced and disseminated during Spanish colonization. In certain American countries, the date palm adapted to favorable climates; however, it has been little developed as a crop. Chile and Peru have agroclimatic conditions which would allow date palm cultivation with high-quality fruit, such as those currently produced in family orchards but not in commercial quantities. In locations such as Ica, Zaña, and Pisco in Peru, and in the oasis of Pica in Chile, dates are produced which are highly sought after locally. The initial efforts to develop this fruit in Chile are still present, represented mainly by those in the former Esmeralda Experimental Station inland from Iquique, in a part of the Atacama Desert currently dedicated to growing tropical and subtropical fruit. There are larger plantations in Peru, from where it is thought that date palms were spread to North America and other South American countries. The importance that dates have attained in countries of North Africa and the Middle East, coupled with the similarity of their climate to the warm deserts of Chile and Peru, opens the possibility of developing this fruit in South America, where there are large unexploited desert areas of saline soils which only support cultivation of the most tolerant species such as the date palm. There is almost no precipitation in these deserts, an important factor for the cultivation of date palms, especially in the ripening period. Although there is limited published information available, the objective of this study is to present what is known about the history of the date palm in Chile and Peru, along with the geographic locations where plantations have been established, the agricultural and climatic characteristics, and an analysis of future possibilities of date palm cultivation in these two countries.

15.2 Historical and Current Agricultural Aspects

The first introduction of the date palm to the New World has not been documented, although it is likely that it was Spanish colonizers who carried seeds to South America and Spanish religious congregations who propagated it in the sixteenth and seventeenth centuries. Date palm seeds presumably reached America from Morocco; their initial propagation appears to have been on the coast of central Peru. The Jesuit Bernabé Cobo wrote in 1612 about the date palms in the Viceroyalty of Peru (Mateos 1956), indicating that "…the dates from palms born in the same valley (Pisco) mature as well as those which are brought from Berberia" (Barbary Coast, North Africa).

During the Spanish colonial period in Peru, the Jesuits mention the establishment of date palms in Peruvian farms. The interest in establishing date palms may not have been just for their fruit, but also associated with traditional Spanish religious ceremonies such as Palm Sunday, which begins the Catholic Holy Week and which requires palm fronds, ideally from the date palm. The production of dates

Fig. 15.1 *Phoenix dactylifera* in Esmeralda, Iquique, Chile

Fig. 15.2 Date palms introduced to Arica, Chile, from California in 1965–1970

as edible fruit was only important in specific areas where the fruit can mature, such as Zaña, Pisco, and Ica in Peru. This crop was an important activity for at least 200 years; however, currently these palms are surviving without appropriate crop management. The importance that Peru may have had in this crop is also reflected in its being an important possible distribution center of date palm seeds to Mexico and the Baja California Peninsula in North America, due to the abundant commerce between these regions in the seventeenth and eighteenth centuries; this also generated an interchange of crop management practices (Aschmann 1957). Date palms were present during the colonial epoch; however, the commercial interest in this crop only began in 1965–1970, when the Chilean government introduced offshoots from California to the Tarapacá Region. Most of the 240 plants brought in were planted in the Esmeralda Experimental Station (Fig. 15.1), inland from Iquique, and a few in the Lluta Valley in the Arica and Parinacota Region (Fig. 15.2). The cultivars introduced were Medjool, Zahidi, and Deglet Noor, which have been the progenitors of an abundant quantity of plants, mainly

Fig. 15.3 Date palm ecotype in the Lluta Valley, Arica, Chile (*Source*: Universidad de Tarapacá)

Fig. 15.4 Date palm ecotype in the Lluta Valley, Arica, Chile (*Source*: Universidad de Tarapacá)

propagated by seed (Figs. 15.3, 15.4, and 15.5), which have been distributed in the cities of Arica, Pica, and Iquique. However, the project originated from the Public Works Ministry (Fernández 2006), beginning in 1957 with a study of the ground waters in Esmeralda and Canchones, inland from Iquique, followed in 1968 by the establishment of the Esmeralda Experimental Station of CORFO (Corporación de Fomento de la Producción), on which 6 ha of date palms was established (Pavez et al. 2007). This station has been under private ownership since 1997. In 1995, the University of Tarapacá established a small plantation of 25 date palms and a row of approximately 50 of the plants in the Lluta Valley, Arica, all from seed. In the Villa Frontera section of the city of Arica, at the mouth of the Lluta River, there are two orchards of 1,400 and 380 palms, of 3 and 2 ha, respectively. These were planted between 1995 and 1998 and constitute the plantations closest to the coast, at a distance of about 6 km from the ocean.

Fig. 15.5 Date palm ecotype in the Lluta Valley, Arica, Chile (*Source*: Universidad de Tarapacá)

Fig. 15.6 Date palm ecotype in the Azapa Valley, Arica, Chile

15.3 Agricultural Importance

Although date production is concentrated mainly in the Northern Hemisphere, it is important to consider as well the presence of date palms in the Southern Hemisphere. Here, Peru is important; it has 50,000–80,000 plants of productive age, with a potential to produce about 4,000 mt of fruit annually (Robles 2006). These are possibly the descendants of oldest plantings in South America; however, the industry so far has not had been efficiently developed and fruit is only commercialized locally (Azañero et al. 2000). In Chile, date palms are mostly found in the extreme north of the country and do not constitute an important industry; most are isolated family plantings. The most important concentration of date palms in Chile is the orchard in Esmeralda, community of Pica, with 6 ha. Other important localities with date palms are the valleys of Lluta and Azapa (Fig. 15.6) in the community of Arica.

Fig. 15.7 Date-growing locations in Chile and Peru

Both in Chile and Peru, date palms are an important potential agricultural crop in regions where irrigation water and soil have high concentrations of salt and boron and an advantageous climate for its cultivation.

Along the Pacific Coast in the desert of Peru and Chile, date palms are found from Zaña in Peru (6°55′ S) to Pica in Chile (20°30′ S), a distance of 2,300 km (Fig. 15.7). This north-south latitudinal distribution is the most extended in the world for *Phoenix dactylifera*. It is important to note that in this zone, flowering and fruiting of date palms may be obtained at elevations from sea level to 1,500 m in the valleys of the western slope of the Andes (Pisco and Ingenio in Peru and Codpa, Pica, and Tarapacá in Chile). This distribution provides the date palm with one of the largest ranges of geographic adaptation to elevation in the world.

An increase in the area planted with date palms in Chile would allow expanding the use of this plant not only for fruit production, but also to use its leaves as a subproduct for the preparation of biochar. This would minimize the liberation of CO_2 to the atmosphere and serve as a product to improve the physical and chemical conditions of the soil and make possible increased horticultural production. The first experimental trial of this technique in Chile was published by Lara (2011), with biochar from date palm leaves used to cultivate beets in highly saline soils with excess boron. In this study, the yield of edible roots and the fresh weight and area of leaves were greater when plant biochar was added to the soil at a concentration of 1 % (v/v).

Table 15.1 Reported locations of date palm growth in Peru and Chile

Country	Location/city	Latitude (°S)	Elevation (m)	Distance from the ocean (km)
Peru	Zaña/Chiclayo	6° 55′	120	16
Peru	Paracas/Pisco	13° 51′	5	0
Peru	Cachiche/Ica	14° 10′	400	45
Peru	Ocucaje/Ica	14° 22′	330	60
Peru	Río Grande/Nazca	14° 32′	265	55
Peru	Camaná/Arequipa	16° 40′	5	5
Peru	Ilo /Moquegua	17° 42′	35	8
Chile	Azapa/Arica	18° 32′	250	15
Chile	Lluta/Arica	18° 32′	300	20
Chile	Villa Frontera/Arica	18° 32′	20	6
Chile	Tarapacá/Iquique	19° 55′	1,500	70
Chile	Esmeralda/Pica	20° 30′	1,180	110

Source: Modified from Pavez et al. (2007)

As well as in the zones indicated in Table 15.1, date palms could be cultivated in Chile up to 1,000 km south of the city of Iquique; climatic conditions would allow the establishment of date palms in the Taltal and El Salado valleys (26° 30′ S), the Copiapó valley (28° S), and San Félix in the community of Vallenar (29° S, at 1,600 m elevation and 125 km from the ocean).

The main date production zone in Peru is the Department of Ica, 300 km south of Lima, including the Paracas district in Pisco, Villacurí, Cachiche, and Ocucaje in Ica and Río Grande in Nazca. This area is recognized as the most important in South America due to the density of date palms established there; its peak was reached in the eighteenth and nineteenth centuries. In this zone, there are 50,000 adult female palms, although 90 % of them are abandoned and surviving in a natural state. Only about 4,000 palms are managed under rustic conditions, while another 1,000 are in industrial plantations with adequate technical management and irrigation. The potential for new plant production by offshoot separation is approximately 300,000 trees; however, the parent plants were propagated from seed and provide little incentive to increase the planted surface (Letts and Pavez 2000). Earlier information (INIA-CONAFRUT 1998) reported 60,000–80,000 productive date palms in all of Peru, which makes it the largest in South America. These palms are located in the coastal valleys of Zaña, Chilca, Palpa-Río Grande, Nazca, Acarí, Yauca, Camaná, Tambo, Ilo, and La Yarada/Tacna.

The low yields obtained in Peru, equivalent to 3,000 kg/ha and 20–30 kg/plant, are the result of deficient management of the plantations, most of which do not receive irrigation, pollination, or sanitary treatments. Thus, as Table 15.2 illustrates, there has been a decrease of commercial date production in Peru, mainly affected by the decrease in the cultivated area. This production is consumed almost completely in the area of cultivation; there is only one company in Peru (Huerto Alamein S.A.) which packages and sells dates in Lima. There are also some locally important artisanal preparations such as candied dates at Zaña in Chiclayo and Camaná in

Table 15.2 Commercial date production in Peru

Year	Surface (ha)	Production (mt)	Yield (kg/ha)
1966	150	808	5,386
1986	270	777	2,877
2004	97	260	2,680
2011	104	379	3,644

Source: FAOSTAT (2014), Pavez et al. (2007)

Table 15.3 Average monthly temperatures (°C) at locations where date palms are grown

Location and country	Maximum (warmest month)	Minimum (coolest month)	Annual average
Paracas, Peru	29.4	9.8	18.7
Ica, Peru	33.3	6.6	21.2
Ocucaje, Peru	35.6	5.9	20.6
Azapa, Chile	28.5	11.5	19.0
Esmeralda, Chile	34.1	1.0	18.8

Source: Pavez et al. (2007)

Arequipa. The fruit and its possibilities of processing and incorporation into the food industry are almost completely unknown in the internal market.

15.4 Climatic Conditions

15.4.1 Temperature

In Chile, the optimum isotherm of 18 °C for cultivation of the date palm occurs only around the city of Arica; however, there are other locations in the country where good-quality dates are produced with the 15 °C isotherm, such as Pica and Esmeralda. Other localities with the same characteristics extend along the entire littoral from Arica (18° S lat.) to Carrizal Bajo (28° S lat.) and inland of Iquique and Arica (Valdivia 2012).

The subtropical climate of this area is modified by marine influence, with thermal seasonality. The highest temperatures (28.5–35.6 °C) occur from December to March, the lowest (1.0–11.5 °C) from June to August (Table 15.3). Mean minimum temperatures are rarely below 8 °C near the coast, and it never freezes. However, temperature differences increase in the interior of the continent at intermediate elevations; day-night oscillation may reach 30 °C, as in Esmeralda, at 1,180 m elevation, 110 km from the coast. Table 15.4 presents the average maximum daily temperatures in some localities of Chile and Peru.

Earlier research by Munier (1973) and Rebour (1971) indicated that date palm needs an isotherm of at least 18 °C to produce quality dates; this isotherm is present in Chile only round the city of Arica, and there are no higher isotherms in the country. However, inland from Iquique, specifically in Pica, high-quality dates are produced

Table 15.4 Average maximum daily temperatures during the year (°C)

Month	Paracas, Peru	Ica, Peru	Ocucaje, Peru	Azapa, Chile	Esmeralda, Chile
January	28.9	31.7	33.1	28.0	34.0
February	28.8	33.3	35.4	28.5	34.0
March	29.4	32.6	35.6	27.7	33.3
April	26.9	30.9	34.8	24.1	31.7
May	26.1	28.2	33.7	22.7	29.9
June	23.5	24.0	27.0	20.3	28.5
July	22.7	23.6	24.1	19.3	29.5
August	21.9	24.1	26.3	19.5	31.1
September	22.4	24.5	29.2	20.7	32.3
October	22.4	27.1	29.1	22.1	34.0
November	23.5	27.8	31.3	23.9	34.1
December	24.9	30.4	32.4	26.0	33.9
Average	24.2	28.3	31.1	23.7	32.2

Source: Pavez et al. (2007)

Table 15.5 Heat units at various date-growing areas in Chile and Peru (base 18 °C)

Months	Paracas, Peru	Ica, Peru	Ocucaje, Peru	Azapa, Chile	Esmeralda, Chile
January	337.9	424.7	468.1	310.0	496.0
February	302.4	428.4	487.2	294.0	449.2
March	353.4	452.6	545.6	300.7	474.3
April	267.0	387.0	504.0	213.0	411.0
May	251.1	316.2	486.7	145.7	368.9
June	165.0	210.0	270.0	69.0	315.0
July	145.7	173.6	220.1	40.3	356.5
August	120.9	189.1	257.3	46.5	406.1
September	132.0	224.0	336.0	81.0	429.0
October	136.4	282.1	344.1	127.1	496.0
November	165.0	294.0	399.0	177.0	483.0
December	244.9	384.4	446.4	248.0	492.9
Annual total	2,621.7	3,767.1	4,764.5	2,052.3	5,177.9

Source: Pavez et al. (2007)

although the annual isotherm is below 15 °C. Thus, in spite of the opinion of Rebour (1971) that there are few places in Chile where date palms could produce quality fruit, early-bearing cultivars such as Medjool should have no trouble producing fruit, at least in areas with an annual isotherm of 15 °C or greater, which includes the entire littoral from Arica to Carrizal Bajo. This concurs with the opinion of Pavez et al. (2007) who indicated that the date palm may be cultivated in the coastal area from Arica to 1,000 km south of Iquique and only inland of Iquique and Arica up to 1,500 m.

Table 15.5 presents the accumulated heat units in certain localities of Chile and Peru, confirming the feasibility of date production since the heat units are considerably above

Table 15.6 Flowering period and heat units of tree date palm cultivars in Esmeralda, Chile

Cultivar	Flowering period[a]	Heat units (base 18 °C)
Deglet Noor	July–August	356.5–406.1
Medjool	September–October	429.0–496.0
Zahidi	July–August	356.5–406.1

[a]Alexander Cáceres, administrator of the Fundo Esmeralda (personal communication 2011) and Enrique Arroyo, date producer of Pica, Region I (personal communication 2011)

Table 15.7 Rainfall at various date-growing areas in Chile and Peru

Location	Rainfall (total annual, mm)	Monthly rainfall (rainiest month)	Rainiest month
Paracas, Peru	1.6	0.5	August
Ica, Peru	4.4	1.2	January
Ocucaje, Peru	0.3	0.2	December
Azapa, Chile	0.5	0.3	January
Esmeralda, Chile	0.6	0.3	February

Source: Pavez et al. (2007)

1,000 °C (base temperature 18 °C) which is the lower limit for quality date production established by Munier (1973) cited by Zaid and Wet (2002). Table 15.6 shows the heat units and flowering periods of three date palm cultivars in the Esmeralda Station in Chile.

15.4.2 Precipitation

Precipitation amounts are minimal and rainfall sporadic in the zones where the temperature would allow date production in Chile. According to the Dirección Meteorológica de Chile (2001), rainfall is usually around 1 mm per year, although inland from the cities of Arica and Iquique totals reach nearly 20 mm/year.

The coastal desert of Peru and Chile is considered the driest area of the world; it almost never rains. Only short (hours) and very sporadic rains occur, followed by long, dry sunny periods. However, in northern Peru in Zaña, Chiclayo, summer precipitation is influenced by the El Niño effect, a periodic climatic event associated with warmer than normal offshore waters, which alters stability and produces rainfall of considerable magnitude and duration in the months of fruit formation, between December and April (Table 15.7).

15.4.3 Relative Humidity

Humidity is another climatic factor which significantly affects the date palm; according to Klein and Zaid (2002), in the areas where the relative humidity is high, date palm plantations should adopt a lower planting density (125 palms or less per ha), and they should not be intercropped with other fruit trees since this increases the effect of high humidity on the dates. High relative humidity occurs in the

Table 15.8 Average daily relative humidity at selected locations in Peru and Chile

Location	Maximum relative humidity (%)	Minimum relative humidity (%)	Annual average (%)
Paracas, Peru	87.0	77.0	81.5
Ica, Peru	99.0	39.0	69.3
Azapa, Chile	97.0	41.2	72.0
Esmeralda, Chile	85.0	20.0	31.4

Source: Pavez et al. (2007)

Table 15.9 Average monthly relative humidity (%) at selected locations

Months	Paracas, Peru	Ica, Peru	Azapa, Chile	Esmeralda, Chile
January	82.0	67.5	68.9	40.8
February	80.5	67.0	70.1	42.6
March	80.5	68.0	72.1	43.5
April	80.5	68.0	72.9	36.9
May	82.5	69.5	74.1	28.1
June	83.0	73.0	75.8	28.0
July	81.0	74.5	75.2	23.7
August	81.0	71.5	74.2	25.0
September	82.5	69.5	72.3	23.7
October	81.5	67.0	70.4	23.3
November	81.5	68.5	69.4	28.6
December	81.0	68.0	68.4	32.7
Annual average	81.5	69.3	72.0	31.4

Source: Pavez et al. (2007)

northern coastal desert of Chile (Dirección Meteorológica de Chile 2001) during the night and early morning in the coastal desert of Chile and Peru (Tables 15.8 and 15.9), but decreases during the day due to high solar radiation. Above 1,200 m elevation, humidity is less because of the dry warm air which descends from the Andes. This low humidity may dry dates excessively; plants also transpire more and thus have higher water requirements (Pavez et al. 2007).

High relative humidity and high cloud cover reduce the commercial production of quality dates in a large part of the littoral area of central Peru between Chiclayo in the north and Chincha to the south, including the capital, Lima. Thus, it must be mentioned that the ideal conditions of relative humidity for *Phoenix dactylifera* are found in the hot, dry sunny valleys in the departments of Ica, Arequipa, Moquegua, and Tacna, and in interior valleys north of Lima, but at greater elevation and distance from the ocean (Pavez et al. 2007).

15.4.4 Hours of Sunlight

The coastal zone of Peru and Chile enjoys many hours of sunlight during the year, which reaches a maximum in the interior desert and at higher elevations such as in Esmeralda, Chile (Table 15.10). The coasts of Peru and northern Chile are located

Table 15.10 Average hours of sunshine in selected locations

Months	Paracas, Peru	Ica, Peru	Azapa, Chile	Esmeralda, Chile
January	217	223	261.8	350.3
February	199	177	252.8	299.6
March	213	217	265.4	322.4
April	211	223	247.8	312.0
May	177	235	215.4	257.3
June	136	196	177.0	243.0
July	119	184	198.8	313.1
August	153	205	193.7	313.1
September	168	221	217.5	333.0
October	198	260	246.7	334.8
November	197	235	249.5	348.0
December	201	218	269.4	356.5
Annual total	2,189	2,594	2,795.8	3,783.1

Source: Pavez et al. (2007)

between 7° and 20° S latitude. For this reason they receive more solar radiation than the traditional areas of date production in the Northern Hemisphere, which are located in subtropical areas between 18° and 39° N latitude.

Considering the exceptional levels of heat accumulation, an absence of cold temperatures and precipitation, there are exceptional natural conditions for the development of date palm cultivation.

15.4.5 Soil Conditions

The soils in the zone with isotherms of 15 °C or greater usually have depths greater than 2 m; however, they have high salt and boron concentrations which would affect the productivity of dates when the electrical conductivity (EC) is above 5.3 dS*m^{-1}. According to Pavez et al. (2007), in the valleys of Lluta, Azapa, Chiza, and Miñi-Miñe in Chile, the production of this species would not be limited by this factor, while in the valleys of Suca, Taltal, and Copiapó, the plants would not produce dates, since these areas have EC above 27 dS*m^{-1} (Table 15.11). However, this study also concluded that the levels of boron in the water and soil in these valleys would not affect the establishment or productivity of the species. Date palms adapt well to soil with salt and boron concentrations, which favor its introduction in a wide variety of soils. In Peru, the main concentrations of date palms in the *pampas* (plains) of Pisco and Ica valley are located in desert areas with an elevated concentration of salts, but have good-quality ground water at depths of 2–10 m, originating from the rivers descending the western slopes of the Andes.

The locations in Table 15.11 represent a variety of local agricultural and ecological conditions found in the Atacama Desert. The valleys of Copiapó, Taltal, Liga, and Suca have extreme salinity, while Taltal, Suca, and Lluta have extreme levels of

Table 15.11 Chemical analysis of the soil in selected valleys of northern Chile (in saturation extracts)

Parameter	Lluta	Azapa	Chiza	Suca	Liga	Miñi-Miñe	Taltal	Copiapó
pH	7.6	7.6	8.5	7.4	6.9	8.1	7.1	8.2
EC (dS/m)	3.07	5.25	2.38	40.6	16.19	0.84	27.1	62.1
Ca (meq/l)	10.1	30.4	6.3	70.2	75.3	3.7	59.0	41.6
Mg (meq/l)	4.8	4.6	2.0	26.2	19.2	1.0	39.8	135.0
Na (meq/l)	14.1	14.63	14.5	315.2	66.4	3.4	157.0	265.2
K (meq/l)	1.5	1.05	0.8	4.2	1.4	0.3	13.0	7.0
HCO_3 (meq/l)	2.8	2.7	9.4	7.5	4.2	2.8	3.8	10.8
Cl (meq/l)	18.3	29.63	11.0	317.2	140.3	5.2	228.8	388.9
SO_4 (meq/l)	6.9	27.5	3.7	52.4	14.8	0	0	165.0
B (mg/l)	13.2	7.82	3.1	17.6	8.8	1.8	24.5	6.4

Source: Escobar et al. (1995), Figueroa et al. (1993)

boron. The Lluta and Camarones valleys are typically saline, with serious limitations for agriculture. The main crops in these valleys are local cultivars of alfalfa and maize which are highly resistant to salinity and boron. The Azapa, Chaca, and Miñi-Miñe valleys have the best soil and water conditions, almost without restrictions for cultivation of a number of fruits and vegetables, including olives, citrus, guavas, mangoes, tomatoes, and green beans. The Miñi-Miñe valley has ideal conditions for all types of subtropical agriculture, thanks to a microclimate at 2,000 m elevation which allows the growth of mangoes, bananas, and citrus fruits.

15.4.6 Water Conditions

Irrigation water in this zone presents limitations for many crops, due to its high concentration of salts and boron. However, Pavez et al. (2007) indicated that irrigation water usually has EC values which allow the production of dates, since in the Lluta, Azapa, Chiza, Suca, Miñi-Miñe, and Copiapó valleys, EC values are below 3.5 $dS*m^{-1}$ (maximum value in which dates do not lose productive potential); in Taltal, EC reaches 5.34 $dS*m^{-1}$, which would produce a decrease in the allowable yield of the plant (Table 15.12).

Thus, we conclude that the date palm may be cultivated in any zone of the littoral from Arica to Carrizal Bajo, extending 120 km inland from Iquique and Arica especially in the transverse valleys where other fruits which are much less tolerant to salts than date palm (e.g., olives, pomegranates, citrus, mangoes) have been cultivated for many years. Dates can also be grown in areas with isotherms greater than 15 °C where other crops are not cultivated due to the high concentration of salts and boron in the water and soil, keeping in mind that the date palm may grow and establish, but will decrease its potential production according to the differential concentration of these elements in each locality and availability of water; this is the situation in Suca, Taltal, and Copiapó, which have high concentrations of salts in the soil.

Table 15.12 Chemical analysis of irrigation water in different valleys in northern Chile

	Lluta	Azapa	Chiza	Suca	Miñi-Miñe	Taltal	Copiapó
pH	7.0	8.6	7.6	6.8	8.2	7.0	7.0
EC (mS/cm)	3.15	0.66	1.83	2.01	0.94	5.43	2.06
Ca (meq/l)	5.4	0.9	1.3	16.6	3.2	24.0	9.0
Mg (meq/l)	5.3	0.5	1.5	2.2	1.1	10.7	5.5
Na (meq/l)	20.4	3.1	13.0	4.1	5.3	18.2	6.1
K (meq/l)	1.1	0.3	0.2	0.3	0.2	1.0	0.4
HCO_3 (meq/l)	2.3	3.38	7.7	3.2	4.9	3.5	4.5
Cl (meq/l)	22.0	1.62	8.5	6.7	0.94	45.4	3.7
SO_4 (meq/l)	6.5	3.7	2.8	11.8	0.8	5.2	11.2
B (mg/l)	16.6	0.8	2.2	1.9	1.3	1.2	1.4
R.A.S.	8.8	2.9	11.1	1.3	3.6	4.4	2.3

Source: Escobar et al. (1995), Figueroa et al. (1993)

15.5 Propagation and Crop Management

The small plantations of date palms in northern Chile suffer from traditional management practices. The technicians and laborers of the plantations work without specific knowledge about this species, acquiring information as the plants developed. To the present, professional consultants on irrigation, nutrition, harvest, and postharvest for the most advanced plantations must be contracted from outside the country.

The main center of propagation and dispersion of seeds and plantlets of date palms in Chile has been the Esmeralda Station, inland from Iquique, which has the main group of cultivars Medjool, Zahidi, and Deglet Noor. Its seeds have been used to establish small plantations in Pica, the Azapa and Lluta Valleys and Villa Frontera. Later, other plants were propagated from these materials. Palms of these cultivars have been maintained in the area of Pica, adjacent to Esmeralda. In northern Chile, there is currently the potential to develop in vitro propagation in the Plant Tissue Culture Laboratory, University of Tarapacá, Arica. This modern laboratory would also allow importation of plants from other producer countries, as well as the micropropagation of local genotypes.

These small date palm plantations are generally drip irrigated with fertilizers added to the water or to the wells. Irrigation flow is applied without a specific methodology with respect to the variables involved, such as soil type, climate, and the plant needs. The irrigation criterion is mainly determined by the available water. The presence of sandy soils and salts is an important factor to consider in northern Chile. Other practices are unknown or there is no record of their application; thus, there is haphazard management of pollination, leaf and stem trimming, sanitary management, fruit thinning, and harvest, which are important factors that limit the production of dates. It is also important to note the maturation problem of the Deglet Noor cv., whose fruits do not fully mature; they are left on the tree until the next epoch of flowering and fruit set of the following year in the hope that they will finish ripening. This results in dehydrated and extremely hard fruits with almost no commercial value and generates cycles of alternate bearing in these plants.

The lack of industry in northern Chile does not allow a greater level of investment in these small family orchards and plantations. This affects processes such as the harvest, which is inefficient for the lack of appropriate machinery; harvesting is done by ladder, which increases production costs due to increased labor cost. The main postharvest problems are due to the lack of efficient storage, resulting in fruit damage by insects, birds, and rodents.

15.6 Production, Consumption, Importation, and Exportation of Dates in Chile

According to Valdivia (2012), Chile has no reported date production and no statistics of production, yield, or area harvested, according to FAOSTAT. However, according to the records of the Fundo Esmeralda for 2011, approximately 5 mt was harvested, with a yield of at least 10 kg per palm. Most of the production was of the Deglet Noor cultivar; local prices were Deglet Noor USD 3/kg, Medjool USD 6/kg, and Zahidi USD 4/kg (Cáceres A, Administrator of the Fundo Esmeralda, 2011, personal communication).

Date consumption in Chile between 2001 and 2007 averaged about 11 mt, less than 1 g per person per year, but increased 5 % per year (Valdivia 2012). Importations between 2001 and 2009 averaged USD 28,000 (CIF); this was variable, but increased by 32 % per year. The mean volume of fruit imported of 20 mt per year had a mean value of USD 1,462 (CIF)/mt. Most of the imports came from Iran and the USA (69 and 26 %, respectively), with small amounts from Tunisia and Syria. The monthly distribution of importation shows none in the months of March, April, October, and November and peak values in December and January. The unitary value followed almost the same pattern as the total of importations, while the volume was variable, increasing frequently in the summer months and with a small increase in May.

Reexportation of dates from Chile in the period 2001–2009 averaged USD 14,000 (FOB) per year in value, decreasing at a 12 % annual rate. The volume of reexportation declined even more rapidly (21 %/year) with an average of 10 mt/year; the mean unitary value of this fruit was USD 1,911 (FOB)/mt, decreasing by 8.3 %/year. Chile reexported dates mainly to Brazil, Colombia, and Costa Rica, 28, 27, and 20 %, respectively, with occasional shipments to Japan, the USA, and Venezuela. Reexportation decreased from October to December, revealing two patterns; one, dates were not exported in January and, two, the value and volume of reexportations showed similar behavior, reaching their maximum in June. The unitary value decreased continuously during the year beginning in February; it was above USD 3/kg in October and December, but less than USD 2/kg in March, April, July, and August.

Table 15.13 Detail of variable cost and variable unit cost

Component	Variable cost (USD/ha/year)	Variable unit cost (USD/mt)	Relative importance (%)
Consultants	774	62	3.08
Fertilizer	804	64	3.20
Electricity	1,586	127	6.31
Maintenance of irrigation system	95	8	0.38
Rent of equipment	534	43	2.12
Total labor costs	2,134	171	8.49
Agricultural and security implements	342	27	1.36
Storage	193	15	0.77
Packing Materials	6,250	500	24.85
Subtotal (Preshipment)	12,712	1,017	50.55
Shipment to port	1,934	155	7.69
Shipment (Maritime Europe)	10,500	840	41.76
Total variable costs	25,146	2,012	100.00

Source: Valdivia (2012)

15.6.1 Costs of Date Production in Chile

There are no official statistics on the production costs of dates in Chile, because it is a little-cultivated species, and because the producers do not have complete records. Thus, in order to estimate the variable unit costs and get an idea of the competitiveness of Chile in the international market for dates, it was necessary to use price quotes and earlier experience (Fernández 2006; SACOR 1986), decoupling the variation in fixed costs in date palm cultivation in different places. Table 15.13 shows that among the component of this variable cost, the most important are preshipment items that were packing costs, labor, and electricity, which represented 49, 16, and 12 %, respectively, of the variable unit cost before shipping. This cost is half of the total variable unit cost, almost all the remainder was the cost of surface shipment to Europe (USD 840/mt).

Thus, the total variable unit cost of exporting dates to Europe was USD 2,012 (CIF)/mt, noting that the unit variable FOB to ship dates to the closest port (Iquique) was USD 1,172/mt. Thus, we may conclude that according to the calculated total variable unit cost, Chile would have the opportunity to insert itself into the world market for this fruit; however, the success of individual producers will depend on their own fixed costs and the market price obtained.

15.6.2 SWOT Analysis for Chile

To understand and evaluate the real possibility of Chile entering the world date market, we performed an analysis of the strengths, weaknesses, opportunities, and threats (SWOT) of the present and future development of this area, supported by the opinions of qualified informants and previous experience, ordering them as appropriate for this tool, which is shown below.

15.6.2.1 Strengths

The absence of serious date palm pests and diseases in Chile creates a great advantage both in the production and commercialization of this fruit, since it means almost zero cost to control of outbreaks except for rodent and bird control, minimizing the entrance requirements of many markets.

According to qualified informants and Fernández (2006), the dates produced in northern Chile are larger than those in the world market, which would generate a competitive advantage. According to Pavez et al. (2007), some climatic conditions in Chile favor a reduction in the cost of production, since, for example, the absence of rainfall avoids the repetition of manual pollination which is necessary after a rain, increasing the labor requirement for the development of this crop.

The proximity of an embarkation port to the production zone would also generate a cost reduction, giving Chile an advantage compared to other producers. Chile has a very good reputation as a fruit exporter in many markets where dates fetch a good price, as in most European countries; it also has a good exportation infrastructure for foods and fruits, along with many free trade agreements which facilitate the entrance of Chilean products into European, US, and Latin American markets.

The promotion of the introduction and diversification of new alternatives for agricultural development in northern Chile, the generation of new jobs, and control of desertification may generate benefits appreciated by the government and/or private institutions, facilitating the initial development of this crop in Chile. The sale of offshoots and larger palms for ornamental use in the cities of northern Chile should also be considered, which would generate a scrap value of senescent date palm that may aid in the formation of new plantations or recovery of old ones.

Of course, the possibility exists of intercropping date palms with other fruits, vegetables, and fodder, increasing the productivity of the fields in northern Chile with an acceptable availability of workers, machinery, and agricultural inputs.

Finally, the establishment of immigrant Moslem communities in Chile and neighboring countries such as Brazil may help to promote the initial sales and exportation of dates.

15.6.2.2 Weaknesses

The small number of qualified workers with technical knowledge; the lack of specialized equipment; the limited experience with packing, processing, and commercialization of dates; the low local availability of offshoots; and an absence of micropropagation techniques in date palms are all factors which limit the development of this product in Chile and increase production costs. The greater distance to the main markets and/or consumer countries also limits the insertion of Chile into them.

Lack of knowledge of the date palm may influence the farmers of northern Chile to continue to grow crops better known to them. Also, the level of investment necessary to establish new plantations may limit the development of this crop, since the cost of water rights and electricity and their accessibility often implies high costs and investment which farmers cannot or do not want to incur without the certainty that the returns will justify the investment. This is especially true in the areas which have suitable conditions to cultivate this crop, since agriculture must compete with local mining activities for water and labor.

The lack of accumulation of heat units, in some areas, for the maturation of the late-bearing cultivars, could limit cultivation to early-bearing cultivars, such as Medjool and other selected local ecotypes.

The high concentration of salts and boron in water and soil is common in northern Chile, which may limit the development and yield of date palm; this may increase production costs, losing competitiveness in the market and to alternative crop productions. However, it must be taken into account that the date palm is the most tolerant fruit to these conditions.

15.6.2.3 Opportunities

The scarcity of pests and serious disease which affect this crop in Chile represents a real possibility of producing organic dates, generating higher prices and better acceptance by consumers. The deep cultural and religious association between dates and the Moslem people insures consistent commerce and consumption of this fruit, which extends to new Islamic communities established in other countries, indirectly making the fruit known to the world. Chile has greater political and economic stability than that shown by some of the large producers of this fruit in the Middle East, fostering greater consumer confidence. Also, there are government grants and other economic incentives supporting agricultural research and development and innovative initiatives for production. Between 2001 and 2009, both the unit value and the volume of importations of this fruit grew at an annual rate close to 6 %.

15.6.2.4 Threats

One threat, which may be interpreted as competition, is that represented by other South American countries having natural potential for date palm cultivation and the production of good-quality dates. Also, there may be poor acceptance of dates produced in Chile by Moslem consumers, due to an emotional attachment linked to the origin or place of production of the fruit.

15.7 Conclusions and Recommendations

Based on the analyses in this chapter, it is concluded that the coastal desert from Zaña in Peru (7° S) to Pica in Chile (20° S), a distance of 2,300 km, has optimum agroclimatic conditions for date palm development; it could also be grown up to 1,000 km farther south in specific areas, to the city of Vallenar (29° S). It is important to note that the presence of old and new date palm plantings in Chile and Peru demonstrates the technical feasibility of producing quality fruit. Most of the palms in these countries are propagated from seed, representing valuable germplasm which has been grown in and adapted to areas with high levels of salinity and boron. These genotypes are important to keep in mind for the improvement and selection of palms for an agriculture limited by an excess of salts and desert characteristics such as high solar radiation and extreme drought. The strengths described for this crop in the warm deserts of the Chilean and Peruvian coasts, as well as their high prestige as fruit producers and exporters, government support for agricultural research and innovation, free trade agreements, and growing demand for dates, combine to create the basis to predict a high probability of success for the development of the date palm. However, the weaknesses should also be considered, mainly the minimal technical experience with this crop in South America, lack of familiarity with and low consumption of dates, and the current small area of cultivation which does not yet produce enough to export. Conventional and in vitro propagation, agronomic management, importation of the main cultivars, and the establishment of agreements and support networks with the major producing countries are the main needs to provide incentives for the cultivation of date palm in South America.

References

Aschmann H (1957) The introduction of date palms into Baja California. Econ Bot 11(2):174–177

Azañero M, Figueroa U, Mendoza N (2000) Dátiles. Seminario de Agro Negocios. Sección Administración. Universidad del Pacifico, Facultad de Administración y Contabilidad, Lima

Dirección Meteorológica de Chile (2001) Climatología regional. Departamento de Climatología y Meteorología. http://164.77.222.61/climatologia/

Escobar H, Bastías E, Tapia L et al (1995) Análisis del comportamiento de frutales tropicales y subtropicales en el valle de Azapa; selección y micropropagación de clones sobresalientes. Informe Final de Proyecto. Fondo Nacional de Ciencias, Universidad de Tarapacá, Arica

FAOSTAT (2014) Date crop production. FAO, Rome

Fernández F (2006) Prospección económica de la palma datilera, *Phoenix dactylifera,* y evaluación de localidades de la región de Tarapacá para su cultivo. Taller de Licenciatura, Pontificia Universidad Católica de Valparaíso, Facultad de Agronomía, Quillota

Figueroa L, Tapia L, Bastías E et al (1993) Selección y evaluación de portainjertos de olivos (*Olea europaea* L.) resistentes a las condiciones de salinidad y toxicidad específica para el norte de Chile. Informe Final de Proyecto, Fondo Nacional de Ciencias, Universidad de Tarapacá, Arica

INIA-CONAFRUT (1998) Cultivo del datilero. Bol Téc 17. Comisión Nacional de Fruticultura, Ministerio de Agricultura, Lima

Klein P, Zaid A (2002) Land preparation, planting operation and fertilisation requirements. In: Zaid A (ed) Date palm cultivation. FAO Plant Production and Protection Paper 156. Food and Agriculture Organization of the United Nations, Rome, pp 107–129

Lara R (2011) Efecto del biochar de maíz y palma datilera en el crecimiento, relaciones hídricas, contenidos iónicos foliares y rendimiento de la planta de betarraga (*Beta vulgaris* var. *Detroit Dark Red*) en el Valle de Lluta, XV Región de Arica y Parinacota. Tesis Ingeniero Agrónomo, Universidad de Tarapacá, Arica

Letts R, Pavez A (2000) Peru in South America: excellent conditions for commercial date cultivation. In: Proceedings of the Date Palm international symposium, Windhoek, pp 349–350

Mateos F (1956) Obras del P. Bernabé Cobo (1580-1657). Historia del Nuevo Mundo. Biblioteca de autores españoles. Madrid

Munier P (1973) Le palmier dattier. Maison Neuve et Larose, París

Pavez A, Escobar H, Johnson D (2007) Date palm cultivation in Chile and Peru (South America): current status and future prospects for development. Acta Hort 736:71–85

Rebour H (1971) Frutales mediterráneos. Mundi Prensa, Madrid

Robles F (2006) Dátil, tesoro del desierto. http://www.a-campo.com.ar/espanol/fruticultura/fruticult10.htm

SACOR (1986) Evaluación técnico económica de la hortofruticultura del área de Esmeralda. I Región. Sociedad Agrícola CORFO Ltda, Santiago

Valdivia R (2012) El mercado mundial del dátil: evaluación de posibilidades de inserción para Chile. Memoria de Título. Facultad de Ciencias Agronómicas, Universidad de Chile, Santiago

Zaid A, de Wet P (2002) Climatic requirements of date palm. In: Zaid A (ed) Date palm cultivation. FAO Plant Production and Protection Paper 156. Food and Agriculture Organization of the United Nations, Rome, pp 58–73