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# CROP ECOLOGY, CULTIVATION AND USES OF CACTUS PEAR

Final Version





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# Marketing and communication constraints and strategies

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## INTRODUCTION

The aim of this chapter is to analyse agribusiness strategies applied to cactus pear and derived products and to examine business issues affecting their development. The records reviewed are from various sources, but are mainly of Mexican, Italian and Chilean origin. However, it should be noted that the product information is scarce, and moreover, it is not up to date, as indicated by Inglese *et al.* (2002a). Consequently, Chile is the main focus of this chapter, and the analysis is supplemented and discussed with literature associated with the major producer countries, Mexico and Italy.

According to the Foundation for Agrarian Innovation (FIA, 2010), many countries throughout the world produce cactus pear, and Mexico is the world's largest producer (currently close to 70 000 ha). Other important cactus-pear-producing countries are Italy, South Africa, Argentina, Chile, Bolivia, Peru, Colombia, United States of America, Morocco, Algeria, Libya, Tunisia, Egypt, Jordan, Pakistan, Israel, Greece, Spain and Portugal. However, in a significant number of these countries, especially in Africa, cactus pear fruits are considered a by-product, as the plant is mainly used for the conservation of degraded soils. There is potential for development of cactus pear through a wide range of applications, including:

- cultivation as forage complement, of which Brazil is the main producer (Callejas *et al.*, 2009);
- consumption as vegetable (cladodes) and fresh fruit;
- medicinal uses;
- industrialization for processed food (e.g. cladode flour, jams and juices);
- non-food industrialization (e.g. bioenergy and cosmetics); and
- carmine production.

Cactus pear also plays an important role in subsistence agriculture in many areas of the world. Whether cultivated on a small scale or in natural stands, cactus pear is a crucial source of food (fruits and its derivatives) for the rural poor, as well as fodder or forage for their livestock. This is the case, not only in North Africa and the Horn of Africa (Eritrea, Ethiopia), but in Mexico, the Near East and the Americas. While it is not possible to give an economic dimension to this phenomenon, northern Tigray (Ethiopia) conveys the

importance of cactus pear: natural cactus pear stands give subsistence to an entire population in months or years of food scarcity.

In most producing countries, cactus pear has developed in arid and semi-arid zones (Inglese *et al.*, 1995b; Russell and Felker, 1987b). It is a marginal crop in the fruit market, but in Mexico it produces employment and income in areas where few other crops can be produced (Timpanaro *et al.*, 2015b). The crop is often located in areas of high "rurality", cultivated by small and micro-farmers; this makes it attractive from a strategic point of view and it should be seriously considered in public policy development actions.

Moreover, with regard to sales and marketing, the fresh fruit is marketed mainly in the domestic fresh market with small and isolated incursions into export markets. Italy, the second producer worldwide, is the leading exporter of cactus pear. In the Italian island of Sicily, numerous festivals take place around harvest time (October-November) in villages, including San Cono, Biancavilla, S. Margherita Belice and Roccapalumba (Sáenz *et al.*, eds, 2006).

## PRODUCTION AND MARKETING BACKGROUND

Mexico is the largest producer, accounting for about 80% of world production of cactus pear, estimated at about 500 000 tonnes. Italy (12.2%) is the second largest producer, and South Africa (3.7%) ranks third. These three countries account for approximately 96% of world production. Average yields of cactus pear vary enormously: from 6.5 tonnes ha<sup>-1</sup> (García *et al.*, 2003) in Mexico to 20 tonnes ha<sup>-1</sup> in Italy and 25 tonnes ha<sup>-1</sup> in the United States of America and Israel. In Chile, cactus pear is traditionally cultivated between Arica and Parinacota and the Bío-Bío regions; however, more recently it has also been grown between Atacama and Maule, mainly to meet domestic consumption demand. There is a strong concentration of the crop in the central zone of Chile. The area covered by cactus pear in Chile has declined to 800 ha and according to the Office of Agricultural Studies and Policies (ODEPA, 2015a) and Franck (2010), it is concentrated in regions close to large cities, such as Santiago, Viña del Mar and Valparaíso (Table 1), and in Atacama and Maule. Sicily accounts for over 96%





of the total Italian cactus pear harvest, with 8 300 ha producing about 87 000 tonnes annually (Timpanaro *et al.*, 2015b).

The value addition and creation of derivatives for commercial purposes is minimal. Nevertheless, there has been some important research with the development of agro-industrial products from cactus pear (Sáenz *et al.*, eds, 2006). On the other hand, a quite different dynamic is present in Italy with cultivation increasing over the past 20 years. Nevertheless, development is limited for various reasons, including limited supply, lack of coordination throughout the value chain supply and scarcity of resources to boost research, innovation and cultivation techniques (Timpanaro *et al.*, 2015b). The average yield of a cactus pear plantation in Chile is around 10 tonnes ha<sup>-1</sup>. However, with modern cultivation practices, yields could more than double.

The most popular cactus pear ecotype is a local selection with yellow-green flesh (CEZA, 2011). There are, however, other coloured *Opuntia ficus-indica* genotypes with purple, orange, yellow, red and white fruits (Aquino *et al.*, 2012). These ecotypes are only produced at experimental level in Chile (Sáenz and Sepúlveda, 2001b). Marketing of cactus pear is atomized at producer level and oligopsonic/oligopolistic at wholesale level; this generates information asymmetries between producers and buyers and increases the market power of buyers, hindering the development of producers in Chile. In many cases, it means producers cannot sell directly or establish business contacts with other buyers. Consequently, producers wait for the same buyers to come every year, bringing their own workers for the harvest. A decade ago, the same situation existed in Italy (Inglese *et al.*, 2002a): most of the crop was sold by the farmer in the field, with limited participation of the producer in the value chain. Nowadays, farmers' organizations are more sophisticated; farmers get higher incomes and make a greater impact in the market. One of the most efficient examples is Euroagrumi s.c.c., a consortium operating in Sicily and trading 1 500 tonnes year<sup>-1</sup> of cactus pears to a value of €2.5 million.

Fruit production is from late July to late November in the Northern Hemisphere, plus a small winter production in Israel in January-March, mostly destined to the home market. Italy concentrates its production in October-November, with > 60% of the market con-

centrated in Sicily, 15-20% exported within Europe and a very small fraction exported to Canada (Timpanaro *et al.*, 2015b). North Africa fails to reach the European markets in early summer (June-July), when no fruits are available in Italy and high temperatures during the summer harvest affect post-harvest management and exports. Mexico produces fruits from June to October, with very modest exports to the United States of America and Canada. In the Southern Hemisphere, Argentina and South Africa produce from January until March and only for local markets. Rarely do they adopt the Italian practice of *scozzolatura* (removal of the first flush of flowers and cladodes) to obtain a second, out-of-season harvest. Chile, on the other hand, produces two crops with no technical help, the second one in June-September. Overall, cactus fruit comes on the market seasonally; however, with better coordination among the producing countries and accurate post-harvest management, cactus fruit could be supplied to markets at almost any time during the year, as is the case with kiwi fruit.

In Chile, the main market for cactus pear is represented by wholesale traders (Lo Valledor and Mapocho Fair), who then sell to retailers. According to Mora *et al.* (2013), wholesalers account for about 60% of cactus fruit sales. Another important outlet, accounting for approximately 18% of produce, are informal shops located on street corners and at traffic lights. Finally, supermarkets account for a mere 2%. Prices have a slightly upwards trend generally. During the year, prices rise when smaller volumes reach the wholesale markets and vice versa. There is also a direct relationship between size and price. It should be noted that during winter (June-September in the Southern Hemisphere), a small quantity of cactus pear tends to reach prices well above the seasonal average (**Figure 1**).

**Table 2** shows the unit value per kg of cactus pears for export by air – around US\$1.9 in 2011. If export costs (approximately US\$0.6 kg<sup>-1</sup>) are subtracted (free on board, FOB), the unit value is around US\$1.3 kg<sup>-1</sup> (based on the September 2015 exchange rate of 685.6 Chilean pesos = US\$1). While this is an attractive figure, it is difficult to bring together large volumes of export quality cactus pears, since only a very small fraction reaches this quality. In contrast, the domestic market pays an equivalent of about US\$0.6 kg<sup>-1</sup>, i.e. almost half the export price.

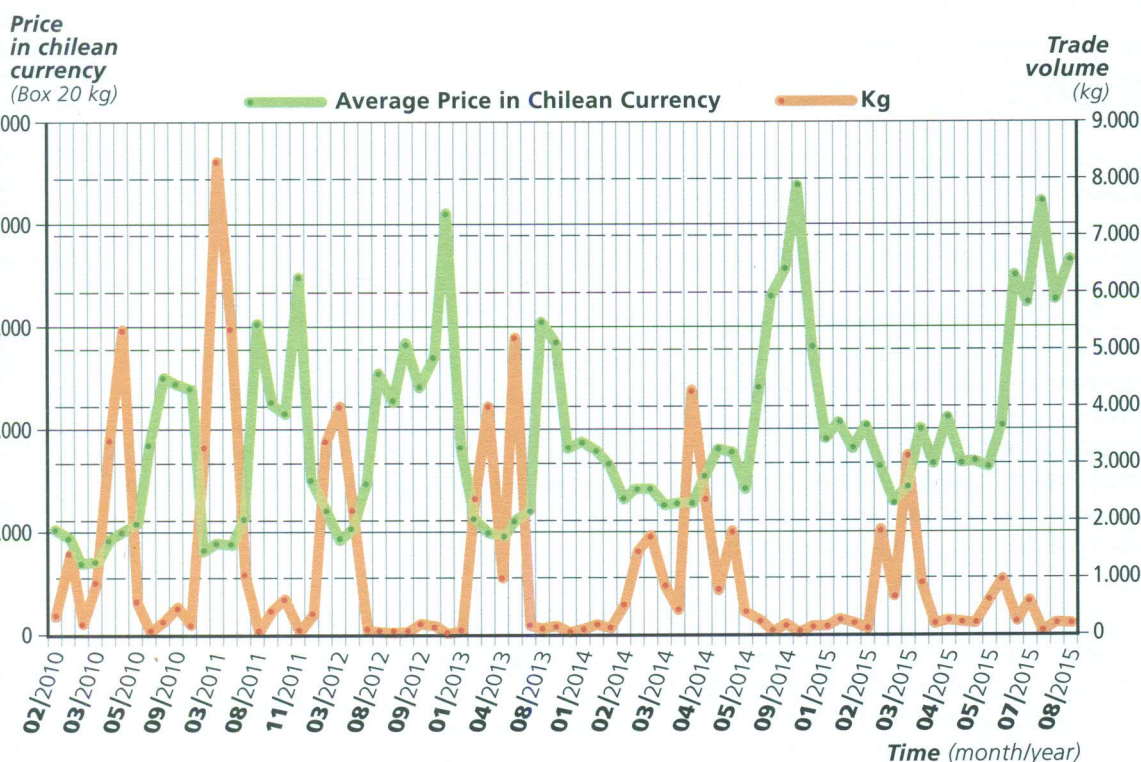




**TABLE 1** Chile: Producer number and cactus pear area

Region/Variety	Number	Total (ha)
<b>Atacama Region</b>		
'Chilena'	2	5.18
<b>Total</b>	<b>2</b>	<b>5.18</b>
<b>Coquimbo Region</b>		
'Blanca'	1	14.09
'Chilena'	7	69.01
No information	2	2.57
'Til-Til'	1	3.91
<b>Total</b>	<b>11</b>	<b>89.58</b>
<b>Valparaíso Region</b>		
'Blanca'	3	1.73
'Chilena'	58	65.75
No information	6	6.32
'Til-Til'	2	8.72
<b>Total</b>	<b>69</b>	<b>82.52</b>
<b>Metropolitana Region</b>		
'Chilena'	22	228.11
'Nopal De Castilla'	4	29.30
No information	6	20.60
'Til-Til'	50	306.22
'Undulatta Griffiths'	1	2.84
<b>Total</b>		<b>587.07</b>
<b>L.B. O'Higgins Region</b>		
'Chilena'	1	0.20
No information	1	7.00
'Til-Til'	1	18.00
<b>Total</b>	<b>3</b>	<b>25.20</b>
<b>Maule Region</b>		
'Chilena'	1	5.00
'Til-Til'	1	5.00
<b>Total</b>	<b>2</b>	<b>10.00</b>
<b>Total country</b>		<b>799.55</b>

Source: ODEPA-CIREN, 2015a, b, c; ODEPA-CIREN, 2014, 2013.



**Figure 1**  
Price and trade of cactus pear (high quality) in principal wholesale markets, Chile  
Source: ODEPA (2015b).

**TABLE 2** Fresh cactus pear exports by air from Chile

Year	FOB	Volume (kg)	FOB/US\$	Country for export and transport type
2002	53 795	23 641	2.3	Canada, USA
2003	37 829	18 766	2.0	Japan, USA
2004	24 252	12 423	2.0	Saudi Arabia, USA
2005	29 497	17 152	1.7	Canada, USA
2006	54 626	17 168	3.2	Saudi Arabia, USA rest
2007	75 963	20 172	3.8	Spain, USA rest
2008	42 173	12 138	3.5	Spain, UK, USA rest
2009	28 779	11 201	2.6	Spain, USA rest
2010	0	0	–	
2011	21 738	11 362	1.9	USA
2012	0	0	–	
2013	0	0	–	
2014	0	0	–	

Source: ODEPA (2015b).



## PERCEIVED QUALITY IN CACTUS PEARS: FROM INTRINSIC TO EXTRINSIC ATTRIBUTES

According to Olson and Jacoby (1972), quality attributes may be described as: either extrinsic – related to the product (e.g. price, colour, labelling and packaging); or intrinsic – tied to the physical attributes of the product (e.g. nutrient composition and flavour). As Grunert *et al.* (1996) asserts, quality is a multidimensional phenomenon, described by a set of attributes that are subjectively perceived by consumers before (quality expectation) and after (quality experience) the purchase. Credence attributes, however, increasingly influence consumer preferences in response to rising concerns about safety, health, convenience, locality, ethical factors and the environmental. (Migliore *et al.*, 2012, 2015a; Bernués *et al.*, 2003).



The marketing of cactus pears in Chile and the main producing countries has focused on the fresh fruit, highlighting its essentially intrinsic characteristics. Chile has seen the commercial development of containers, labels, brands or denominations of origin, but none have succeeded as formal commercial agents. In Italy, two protected designation of origin (PDO) labels are active:

- “Ficodindia dell’Etna” refers to production in the area of the Etna volcano, where the white flesh ‘Trunzara Bianca’ is the most important Italian cultivar, because of its firm flesh and early ripening time in summer (July-August).
- “Ficodindia di San Cono” refers to the most important cactus pear cultivation area in Italy where the three main cultivars grow (‘Gialla’, ‘Rossa’ and ‘Bianca’).

According to FIA (2010), the agro-industrial potential of countries such as Mexico and Italy has enabled the development of a variety of alternatives for the agrifood sector, for example, flour, tortillas, jams, supplements, confectionery, snacks, frozen products and juice. In Italy, however, the sector is limited to some liqueurs and – on a very small scale – jams, while the interest in and commerce of by-products for nutraceutical and medicinal uses is undergoing rapid expansion. Sáenz *et al.*, eds (2006) point out that there are a significant number of products that can be obtained from the various parts of the plant, and even more by exploiting the coloured fruit ecotypes. The fruit can be used to prepare a large number of products, including jams, liqueurs and vinegars, sauces, juice concentrates and canned products. Cladode powders, on the other hand, can be used as functional foods and colouring ingredients, while other encapsulated bioactive compounds act as colouring agents (Sáenz *et al.*, 2009). More specifically, many functional ingredients are characterized by their potential beneficial effects on health, thanks to the

fibre, hydrocolloids (mucilage), pigments (betalains and carotenoid), minerals (calcium, potassium) and vitamins (e.g. vitamin C), which are present in the fruit and the cladodes (Piga, 2004; CEZA, 2011).

Most consumers of fresh cactus pear fruit focus on the intrinsic attributes, because there has been practically no development of the extrinsic attributes. Intrinsic signals are related to the physical aspects of a product, such as colour, size, texture, shape and appearance (Mora *et al.*, 2011; Sulé *et al.*, 2002).

Extrinsic signals are related to the product, but are not part of its essence, for example: brand, packaging, seal of quality, price, PDO, shop, sales force and production information. Migliore *et al.* (2015a) report that important attributes of credibility for the Italian market are environmental sustainability, healthiness and Italian origin.

## VALUE ATTRIBUTES AND CONSUMER PREFERENCES

In Chile, there are 17 ecotypes of the genus *Opuntia*, probably introduced from Mexico by the Spaniards; the green variety (*Opuntia ficus-indica*) is the most commercialized at present (Sudzuki *et al.*, 1993). In this context, a study of cactus pear preferences developed by our group (Matamala *et al.*, 2015) focused on the study of six ecotypes of different colours, and evaluated intrinsic attributes, such as weight, number of seeds, peel thickness, internal and external colour, and sweetness. According to Mokoboki *et al.* (2009), a weight of around 120 g is a positive attribute on the market. The thickness of the peel and the seeds also have commercial impact (FIA, 2010). Green fruits are preferred by the Chilean population, while yellow cactus pear is the most consumed worldwide and red is the most attractive to first-time consumers (Migliore *et al.*, 2015a).

Matamala *et al.* (2015) identify three preliminary market segments: i) traditional, regular consumption of cactus pear; ii) sporadic, occasional consumption; and iii) skeptical about the characteristics of the product. Esparza (2015), on the other hand, identifies three consumer market segments: i) “practical” (48.8% of the surveyed population); ii) “essential” (18.5%); and iii) “healthy” (13.5%). In general, price was the most important attribute, followed by place of origin and lastly, by the colour of the flesh. There also exists a potential market segment attracted to the purchase of minimally processed cactus pear.

Migliore *et al.* (2015a, b) report similar findings in the Italian market. Inglese *et al.* (1995b) indicate that the challenge for researchers is related to reduced fruit size and the high number of seeds, together with poor promotion and issues of quality standardization. Moreover,



there are other attributes related on an emotional level: moods and emotions are factors that constitute the motivational bases of the purchasing process. With regard to cactus pear, Chironi and Ingrassia (2015) report three consumer profiles. The first analyses cactus pear, not only for the qualitative and sensory elements, but also in relation to new hedonistic needs. The second associates the image of the fruit with the territory. The third allows consumers to develop secondary needs, increasing the chances of overcoming the limitations related to this fruit.

## PROPOSED COMMERCIAL DEVELOPMENT STRATEGY FOR FRESH CACTUS PEAR AND ITS PRODUCTS

Callejas *et al.* (2009) provide guidelines for a better product in terms of aspects, quality, added value and competitive price.

### Price

This variable depends a lot on doing things the right way; however, in a competitive value chain, cactus pear prices are potentially attractive. Increasing competitiveness through improved performance quality (based on a yield of around 12 tonnes ha<sup>-1</sup>, i.e. 600 boxes – 20% more than current production in a plantation in central Chile) would result in an estimated average price of 6000 Chilean pesos (US\$8.75) per box premium (lowest wholesale price offer is projected). This would generate an income of 3.6 million Chilean pesos (US\$5 251) ha<sup>-1</sup>.

The Italian experience indicates that fruit of the best size (classified as A or AA) may reach prices of €1.5-3.0 at farm level, while smaller sizes show a sharp decrease in price, down to 30-40% for class B fruits and even less for class C fruits. Therefore, only with proper crop management is it possible to reach the best results in the market, by cultivating class A size cactus pear fruits, totally without glochids and defects, harvested at the appropriate ripening stage and with an adequate proportion (55-65%) of flesh (Inglese *et al.*, 2002a).

### Product

Quality as perceived by consumers depends mainly on the intrinsic attributes of the fruit. Certain aspects require improvement to achieve, for example, uniform size, thin epidermis and fewer seeds. For fresh cactus pear fruit in Chile, the preference is for green and yellow cultivars. Yellow (Inglese *et al.*, 2002a) and red cactus pears (Migliore *et al.*, 2015a) are the most appreciated in the Italian market. Moreover, there is a growing market space for minimally processed cactus pears,

particularly in public catering and in the refrigerated section of supermarkets. Research is required to explore the market potential of other cactus pear derivatives, such as jams, flour, juices, concentrates and functional products. Finally, for a quality product preferred by consumers, innovation of the primary activities in the value chain is required: it is necessary to improve cultivation techniques, with particular attention to organic practices (Timpanaro *et al.*, 2015b; Migliore *et al.*, 2015a).

### Promotion and advertising

In general, the cactus pear is a product known and consumed by a specific part of the market. A communications strategy must, therefore, present the intrinsic attributes – functional ingredients with beneficial effects on health, such as fibre, pigments (betalains and carotenoids), minerals (calcium, potassium) and vitamins (e.g. vitamin C) – and make them known to a wider public. Communication actions associated with public policy are essential and are recommended for cactus pear and its derived products.

## CONCLUSIONS

Cactus pear producers throughout the world face similar challenges with regard to improving the value chain. The main issues are outlined below:

- Irrigation systems are required at production level, as cactus pear grows in places characterized by water shortages.
- Fruit quality must be improved, with particular attention to the intrinsic attributes associated with homogeneity.
- Marketing strategies are needed. As cactus pear producers are generally small and lack the resources to access modern technologies, it is recommended that they develop associations to improve organization, optimize resources and deal with the significant asymmetries and failures inherent in markets.
- More up-to-date information needs to be made available, especially with regard to markets, costs, prices and quality. Major producing countries could develop a joint project for the generation of a database with standardized information and economic and business updates.
- The social role played by cactus pear in its production areas must be recognized. Public policies should be implemented to help associations improve productive and economic results and to generate innovation throughout the value chain, in both primary and secondary activities. The aim is to improve the level of competitiveness and welfare of the people living in those territories.

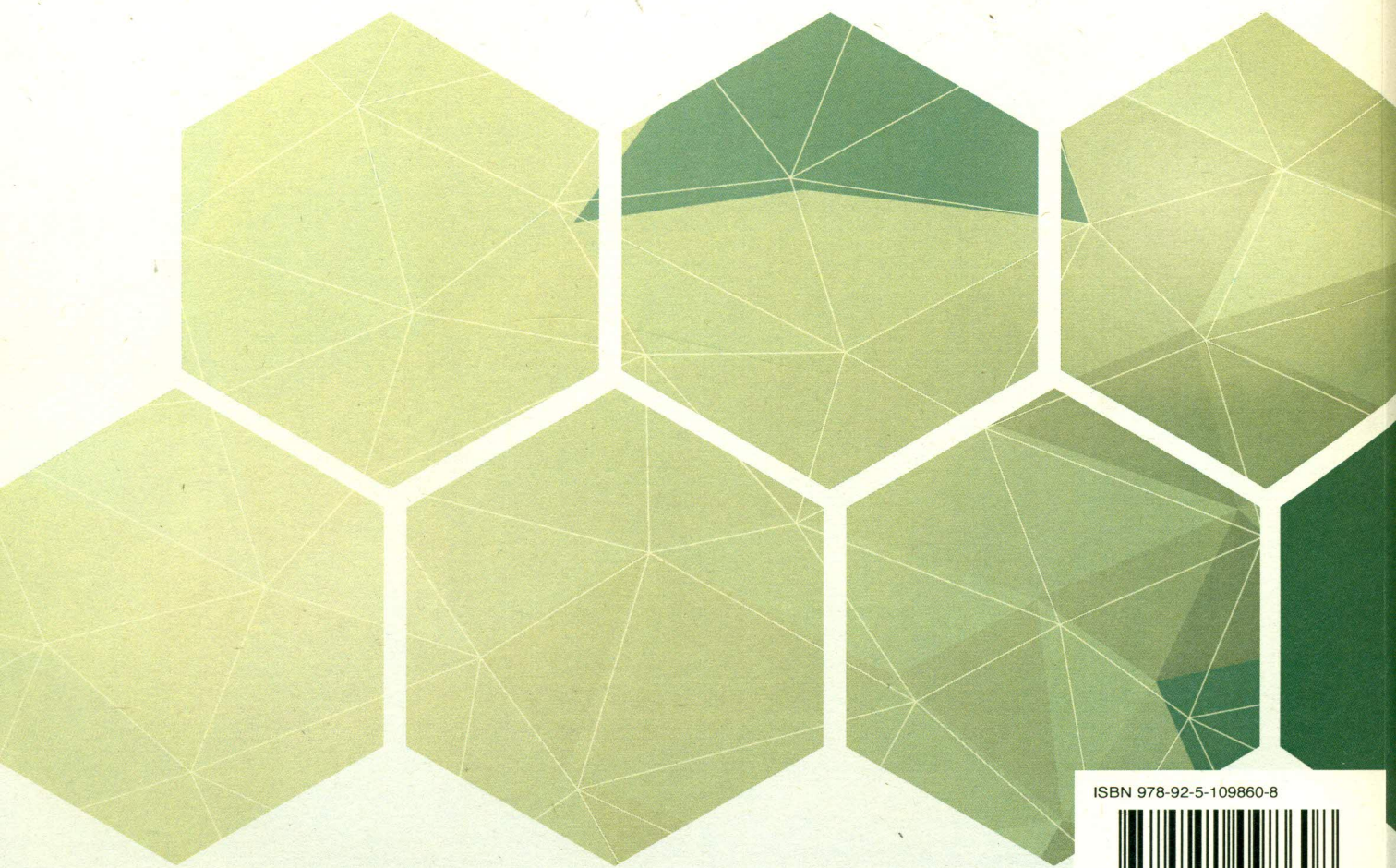




- Market research is required to understand the potential interest in products prepared from cactus pear and cladodes. Many interesting attributes could be well received in the market. Quality assurance systems must be installed for processed products, as they are essential tools for dealers selling such products.
- Development of the **intrinsic attributes** of cactus pear is at the centre of any marketing strategy:
  - Improve current systems of production (productivity and quality).
  - Carry out economic and technical feasibility studies to assess the production and trade potential of both domestic and international markets.
  - Explore consumer receptivity for new products developed by research centres (mainly agro-industrial), bring them to prototype stage and continue testing and market validation.
- Communicate the intrinsic attributes that create value but which the average consumer is not aware of.
- Explore new commercialization channels, *such as* speciality shops, catering businesses, *pharmaceutical* companies and the Internet.
- Continue research to decrease the number of seeds.
- Develop minimally processed cactus pears.
- Elaborate and communicate credence attributes with labelling of food safety, quality, nutritional and environmental aspects.
- Development of the **extrinsic attributes** (packaging and labelling) is also essential for added value.







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