

MULTI-PURPOSE DROUGHT-TOLERANT CACTUS PEAR can provide livelihood opportunities for farmers and nutrition for people and livestock in dryland areas

KEY MESSAGES

The cactus pear is a remarkably **resilient** species and can thrive in extremely harsh environments. It is **easy to establish and maintain**, requiring **minimum inputs** and can grow in areas where no other crops can make use of poor-quality, shallow soils.

The **multi-purpose** cactus pear plant offers valuable products, including **fodder** for livestock, and food for humans. Furthermore, its high water content reduces the need for watering livestock, especially in dry environments. The diverse range of products derived from the plant can increase the **economic viability** of low-income farmers and the rural poor.

Cactus pear provides valuable **environmental goods and services** including soil and water erosion control, regulation of climate through carbon sequestration, biodiversity conservation and habitat for wildlife.

There is increasing **global interest and uptake**, especially under expected ongoing climate change, prolonged droughts, land degradation and desertification, particularly in dry and arid areas.

EXECUTIVE SUMMARY

The International Center for Agricultural Research in the Dry Areas (ICARDA) has conducted extensive research and developed best agronomic practices to maximise the productivity of a multifunctional crop that millions of farmers in semi-arid and dry areas can cultivate. This plant can grow in harsh environments and on otherwise unproductive land where very few other crops will grow. This crop is the *Opuntia ficus-indica*, better known as the cactus pear, and is said to be the most important economic cactus species worldwide.

Against the backdrop of ongoing climate change, prolonged droughts, land degradation and desertification, this hardy crop demonstrates significant social, environmental and socio-economic benefits. Coupled with its ability to reduce soil erosion and enhance the capacity of soil to store water, there is growing appreciation of the versatility of cactus pear as a source of livelihoods, as fodder for livestock and as a nutritional source of food for humans.

Distributing cactus pear cladodes to farmers as part of a pilot in Bawarli, Jodhpur, India.
(Photo on right) Photo CAZRI/Suresh Kumar



INTRODUCTION

The cactus pear, which originates from Mexico, has drawn extensive attention and is gaining increasing interest worldwide because of its remarkable resilience in the face of extreme conditions. Often referred to as 'green gold', the perennial, evergreen cactus pear plant is easy to establish, has very low water demands, is highly productive and can grow in poor and shallow soils that would not normally support other crops.

The cactus pear has the potential to secure a place in future sustainable food production systems. The cultivation of this crop can increase the economic viability of low-income farmers and the rural poor through the production of nutrient-rich fruit and cladodes (the cactus plant's flat stem-like leaves), which can be consumed by livestock and humans alike.

ICARDA's research into the sustainable and efficient cultivation of the cactus pear plant has led to a more in-depth understanding and promotion of the plant's wide range of uses, benefits and commercial opportunities, particularly in dryland areas. This research has expanded into adapted plant materials for each agro-ecology, which have now been screened and determined. For instance, in West Asia, the plant needed to tolerate cold and even frost as temperature may fall below zero during the winter season. In India, a map was generated showing where cactus can be planted in each state based on land potential, climate conditions and requirements of the plant. Through the suite of best-bet agronomic practices and training initiatives developed by ICARDA and partners, cactus plantations have been expanding in Tunisia, India, Pakistan, Jordan, Gulf states and Syria, benefiting thousands of people.

It has been fascinating to discover the multipurpose, hardy cactus pear plant, which is transforming the economic opportunities of rural communities through the utilisation of otherwise marginal and unproductive land with minimum input.

Mounir Louhaichi, Research Team Leader at ICARDA



Photo ICARDA/Sawsan Hassan

An international training course in Jordan on cactus pear best agronomic practices at Muchaqqer Research Station in Madaba, Jordan.



Photo ICARDA/Mounir Louhaichi

Cows eating cactus-based feed ration in Jhansi city, in the state of Uttar Pradesh in India.

VALUABLE FODDER FOR LIVESTOCK

Up to 44% of all the world's cultivated systems are in the drylands, according to the UN Sustainable Development Group, and are home to half of the world's livestock (*UN Decade for Deserts and the Fight Against Desertification, 2010-2020*). However, higher temperatures, erratic rainfall patterns and nutrient-poor soils are resulting in fewer farming opportunities for rural farmers and reduced pasture for livestock.

The cactus pear has the potential to replace upwards of 40% of the feed ration of livestock. It is easily digestible and high in soluble sugars. Furthermore, it can be up to 40% more profitable than other conventional fodder crops such as sorghum, green and black gram.

Although low in crude protein (CP: 3-5%) and fibre, the cactus pear cladodes are high in water, sugars, ash and vitamins A and C. The cladodes are palatable and have a favourable calcium:phosphorous ratio. The carbohydrate content is approximately 60% dry matter, the Beta carotene level is approximately 0.0065g dry matter, and mucilage is 6-18% of fresh material.

Cactus pear is also a natural water reserve, thanks to its ability to efficiently use and retain water. It therefore provides the dual service of addressing shortages of green fodder and reducing livestock watering, particularly during the dry months when high temperatures and water scarcity threaten food security. In Brazil's north-eastern dryland region, for example, a 600,000 hectare cactus pear plantation is providing an average of 180 tonnes of fresh water for livestock per year.

A NUTRITIOUS FOOD SOURCE

As food for humans, the cactus pear plant offers sweet and juicy fruit, which is characterised by its high sugar content (12-17%) and low acidity (0.03-0.12%), with pH values between 5 and 7. The pulp offers high potassium and low sodium content, is rich in minerals such as calcium and magnesium, and contains twice the antioxidants found in apples, pears, tomatoes, bananas and white grapes. The fruit can be processed into juices, jams, marmalades, and jellies.

Eaten as a vegetable, the cladodes are rich in vitamins, minerals and antioxidants and offer a valuable source of greens year-round. Dehydrated cladodes can be transformed into powder as a food supplement.

Another notable and potentially lucrative by-product is cactus pear seed oil extract. Rich in unsaturated fatty acids, it is being adopted by pharmaceutical and cosmetic industries for use in anti-ageing products.

BARRIERS TO UPTAKE

Although there is much interest in the cultivation of cactus pear, a newly planted cactus cladode requires two years to fully establish and start producing enough to enable the plant to enter the production cycle. Some farmers have found it a challenge to commit to this amount of time. Furthermore, the plant needs to be protected against livestock or wildlife grazing as well as other possible attacks such as birds and rabbits and even cochineal for which there is a lack of explicit treatment methodology. Once in production, fruit collection and cladode harvesting require manual labour, which can be costly. And finally, Material Transfer Agreements regulations severely affect the expansion of cactus planting materials exchange between countries, added to a lack of resources and suitable economic policies in terms of technical and financial support hinder its adoption.



Cactus pear fruit in Bloemfontein, South Africa.

ENCOURAGING ADOPTION

Since 2010, ICARDA has held nearly 100 training events and practical field days (see box) aimed at raising awareness of the versatility and benefits of cactus pear and demonstrating how the crop is planted and farmed.

The success of these various training initiatives and field days has led to a substantial increase in national and international demand for the cactus pear crop in southern Asia, North Africa, Gulf states and the Middle East and the demand for further ICARDA research and development initiatives. This has, in turn, resulted in the development of adapted varieties of the crop.

These variations feature different phenotypic and genetic characteristics in terms of resilience, productivity and use (fodder and/or fruit production), which can be adapted to better serve specific agro-ecological zones.

From the work done by ICARDA on the cactus pear, significant interest has been seen across various stakeholders in India for cactus as green fodder supply, in Jordan for fruit production, and in Tunisia for fruit and fodder. Requests for more information, plants materials and technical advice from farmers, communities, the private sector, NGOs, research centres, governments, universities continue to drive the expansion of this crop. Further awareness campaigns, however, are still required to bring further attention and increase the adoption rate globally.



Photo ICARDA/Sawsan Hassan

Different varieties of cactus pear fruit on display at the Muchaqqer research station, Madaba, Jordan.

GLOBAL AND LOCAL PARTNERSHIPS

In response to rising international interest in the cactus pear, ICARDA, in collaboration with the FAO, established the International Technical Cooperation Network on Cactus (CactusNet) to support the promotion and proliferation of this underutilised crop. Since its conception in 1993, an immense body of knowledge has been generated from contributing members from 55 countries worldwide. It is through CactusNet that ICARDA and partners can share experiences and lessons learned concerning all commercial aspects of the cactus pear in its efforts to foster business development and support young farmers and entrepreneurs. Through this partnership, ICARDA is able to further broaden awareness of cactus pear importance, organise international events, and build and strengthen the link between science and development.

Other global partners include the Arab Fund for Economic and Social Development (AFESD), and the German Society for International Cooperation (GIZ). Local partners include development agencies, research institutes (National Agricultural Research Systems), farmer unions, local non-governmental organisations, universities and extension services.

CASE STUDY : CHANGING PERCEPTIONS AND ENCOURAGING ADOPTION

From the outset of ICARDA's research, it was important to understand and contextualise certain prevailing perceptions and a lack of knowledge held by some farming communities relating to cactus cultivation. This informed the most effective approach when sharing knowledge, changing perceptions, and encouraging the adoption of the evergreen cactus pear. To this end, a targeted series of campaigns, training events and practical field days were implemented in different countries: India, Pakistan, Jordan, Syria, Sudan, Afghanistan, Gulf states,

Yemen and Tunisia during the last decade or so to share ICARDA's research findings with farmers in the MENA (the Middle East and North African) and South Asia (India and Pakistan) regions.

One study in India and Pakistan aimed to change the perception held by smallholder farmers regarding the cactus pear plant and showed an adoption rate of 78%. Studies with farmers in India and Pakistan showed 90% of responders eager to begin growing the plant. In India, several nurseries have now been launched, and an awareness outreach programme has been established.

Results from Jordan and India since 2017 are summarised in the table below:

Country	India	Jordan
Area (km ²)	3,287,000	89,342
Population	1,366,000,000	10,100,000
Number of cladodes planted	350,000	3,000
Number of beneficiaries/farmers	11,000	500
Number of group training events	42	3
Number of participants at the training events	2,000	50
Number of field days	41	3
Number of participants at field days	3,600	200

“ I have been involved in cactus since 2011... I am completely convinced that the cactus is the most underutilised and potential-filled crop that you can think of for dry land areas. ”

**Makiko Taguchi, Agronomist
and Agricultural Officer at FAO**

CONCLUSION

The results from ICARDA's peer-reviewed research and awareness campaigns have served to shine a spotlight on the incredible potential the cactus pear holds in combatting the challenges posed by ongoing climate change. The socio-economic and environmental benefits, which the cultivation of this multifunctional crop can provide to vulnerable, low-income farming communities in dry areas inspire hope and excitement from communities, researchers, and policy decision-makers worldwide. Continued research and development initiatives will further pave the way to further understand, promote and appreciate the 'green gold' cactus pear.



Photo ICARDA/Chandira Sekhar Routray

Women farmers at the launch of their cactus pear community nursery in Balangir, Odisha state in India.



Photo ICARDA/Mounir Louhaichi

Farmers taste the red cactus pear fruit at the Muchaqqer Research Station in Madaba, Jordan.



Photo ICARDA/Muhammad Islam

Chopped cactus pear cladodes are a nutritious and water dense livestock feed (Islamabad, Pakistan).



Photo ICARDA/Muhammad Islam

Sheep feeding on chopped cactus pear cladodes.

IMPLICATIONS AND RECOMMENDATIONS

- It is imperative to raise the importance of the cactus pear as a multipurpose crop, especially in 2021, which coincides with the international year of fruits and vegetables (<http://www.fao.org/fruits-vegetables-2021/en/>). The cactus pear is considered a neglected and under-utilised crop, and more work needs to be done to change this perception.
- Alongside the technical know-how, we need to conduct research to estimate cactus valuation (economic studies) to determine the return on investment when a young farmer decides to begin a new business. This is currently being undertaken by ICARDA under the CGIAR Research Program on Livestock, but more in-depth studies are needed.
- We must allow more flexibility for the exchange of *Opuntia ficus-indica* genetic materials (germplasm) between countries. The current international procedure applied for crops (e.g., wheat and maize) under the Material Transfer Agreement (MTA) is too strict as we do not know the exact origin of each "elite" cactus accessions.
- We are witnessing a surge in the invasive cochineal insect, particularly in the MENA region. This insect can quickly destroy cactus plantations. Efforts must be strengthened to protect the cactus pear from this insect and develop plant materials resistant to this disease.

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Special mention must be made for the following contributing team members, whose work has significantly contributed to the body of knowledge available today on the cactus pear:

- **Dr Mounir Louhaichi** (ICARDA, Tunisia): Principal Scientist, Research Team Leader of Rangeland Ecology and Forages Unit (m.louhaichi@cgiar.org)

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Related publications and further reading

- *Adoption and Utilization of Cactus Pear in South Asia - Smallholder Farmers' Perceptions.* Sustainability, 10 (10). Journal article <https://hdl.handle.net/20.500.11766/8521>
- *Finding a Suitable Niche for Cultivating Cactus Pear (Opuntia ficus-indica) as an Integrated Crop in Resilient Dryland Agroecosystems of India.* Sustainability, 11 (21). Journal article <https://hdl.handle.net/20.500.11766/10737>
- *Crop Ecology, Cultivation and Uses of Cactus Pear.* Rome, Italy: FAO. Book. <https://hdl.handle.net/20.500.11766/8263>
- *Cactus Pear*, Innovation. <https://www.icarda.org/research/innovations/cactus-pear>
- *Cactus Pear, a Drought-tolerant Crop Grown by Millions of Farmers in Dry Areas for Nutritional and Income Generating Purposes.* Panorama Solutions portal. <https://panorama.solutions/en/solution/cactus-pear-drought-tolerant-crop-grown-millions-farmers-dry-areas-nutritional-and-income>
- *Cactus Pear.* WOCAT. <https://qcat.wocat.net/en/summary/5882/?as=html>

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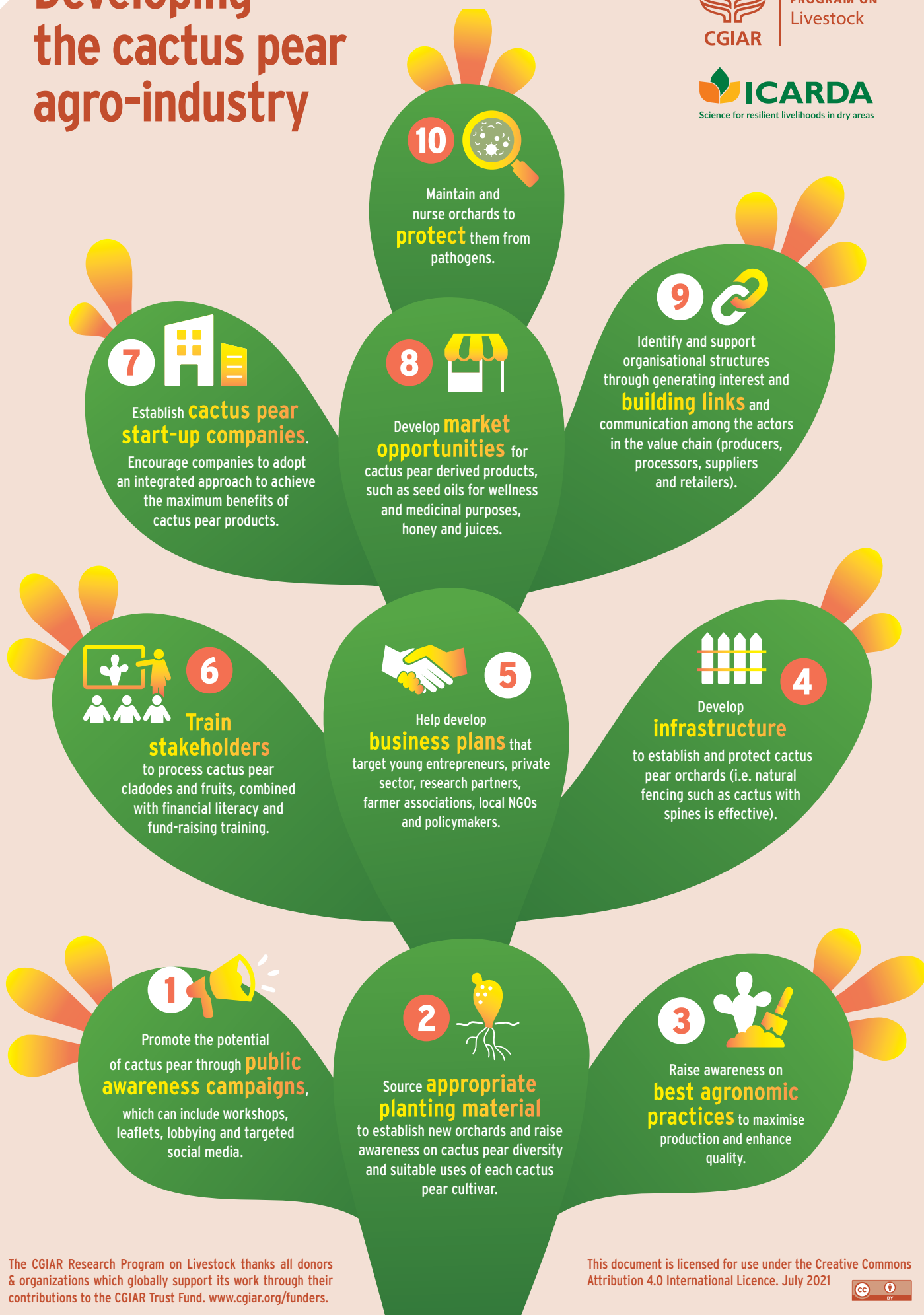
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Developing the cactus pear agro-industry



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