

## The Potential for Underutilized Fruits of Northern India to Improve Food Security and their Role in Climate Resilient- A Review

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Received 18 January 2023, Accepted 15 May 2023, Published on 18 August 2023

### ABSTRACT

Underutilized fruits or less known fruits are the storehouse of nutrition and can play an important role in providing food security to people. As the name indicates underutilized fruits are those fruits which are neglected and rarely eaten. However, these fruits are rich in carbohydrates, fats, proteins, energy, vitamins, folic acids and dietary fibers. Since the dawn of time, these fruits have also been employed in Ayurvedic and Unani medicine for their medicinal properties. Due to the lack of outstanding flavor and attractive color, their consumption is quite low. The majority of these fruits have not gone through any domestication or selection processes. Their cultivation is extremely limited, and they primarily grow in the wild. These fruit species are appropriate for cultivation in disaster and drought-prone locations because of their resistance to biotic and abiotic challenges. The resistance genes present in these fruits can be utilized for the

crop improvement program. In India, these fruits are mainly grown in a tropical wet and dry climate and also has importance in marginal land. To meet the nutritional needs of the expanding population, these fruits need to be domesticated and commercially grown. The cultivation of these fruits, which are a significant source of medicinal benefits, might assist in returning to the Ayurveda approach of treating various illnesses.

**Keywords** Underutilized fruits, Nutritional values, Food security, Climate resilient.

### INTRODUCTION

Underutilized crops are a diverse group of species that are mainly ignored by researchers and financing organizations. The potential for these crops towards food and nutritional security as well as enhanced livelihood options for subsistence farmers, many of whom are women, are getting popular. Globally, deficiencies in key vitamins and minerals pose a very serious constraint to human health and economic development as detailed by the GLOPAN Foresight Report (GLOPAN 2016). Today, consumers are more conscious of the health and nutritional aspects of their food basket. People are preferring organic food without any use of chemicals (Ravani and Joshi 2014). The underutilized fruits like aonla, bael, jamun, karonda, passion fruit, phalsa, pomegranate, tamarind, wood apple are the main sources of livelihood for the poor and play an important role in overcoming the problem of malnutrition (Gajanana *et al.* 2010).

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India has a great diversity of naturally grown fruits and vegetables. Major fruits like mango, banana, guava, apple and citrus fruits are available in plenty due to their distinct flavor and taste. These fruits also remain under the focus of organic scientists and horticulturists, thus new researches further help to determine their quality. On other hand underutilized fruits always get neglected however, these fruits are inexpensive, locally grown and are easily available across the country and require less care. Some of them have distinct flavors and are easy to cultivate under harsh conditions as compared to exotic fruits like apples, mangoes, kiwifruit, cherries, grapes. These fruit plants are also naturally disease tolerant and are adapted to hot, hardy climate conditions. Some of them can thrive in unfriendly soils and climates that are unsuitable for the development of more typical staple crops. Seabuckthorn is a currently domesticated crop, which often yield on marginal soils and climates in India (Yadav *et al.* 2016). This is clearly advantageous in light of the projected changes in climate in the next decades.

In India, underutilized fruits are found basically in the dry regions of Rajasthan, Madhya Pradesh, Gujarat, Maharashtra, Chhattisgarh, Karnataka, Orissa and Tamil Nadu. These fruits have been used by the local tribes to cure various diseases and also been used in Indian system of medicine since time immemorial. Recently for Covid-19 average requirement of Vit-C 90 mg/day for men and 80 mg/day for women is to maintain a normal plasma level of 50  $\mu\text{mol/L}$  (Holford *et al.* 2020). Underutilized fruits are rich in carbohydrates, lipids, proteins, calories, vitamins, minerals (Ca, P, Fe), and dietary fibers. As a result, they have the nutritional ability to prevent and cure disorders such as anemia, cancer, diabetes, hidden hunger, hypertension, kwashiorkor, marasmus and night blindness (Nandal and Bhardwaj 2014). Furthermore, some fruits have outstanding flavor and taste and are employed in the preparation of delicacies at home.

Promotion of cultivation of underutilized fruits and their conservation is very essential. These fruits can be a donor of important genes for crop improvement due to their biotic and abiotic resistance. Lots of information is known about the excellence of the

underutilized fruits of India, but sadly very rare of these fruit crops have ended up in farmer's orchards. There is a need of crop improvement and development of an ideal propagation methods and agro-techniques. There is a lack of processing in these crops, thus setting up of processing industries for preparation of jams, jellies, fermented products, and industries for manufacturing of resins, gums should also be promoted. Underutilized crops production can go hand in hand with organic certification because of less external input requirements, thus opening niche market options to the producers (Hellin and Hignman 2009). In the present review, some important underutilized fruits of Northern India namely Aonla, Bael, Ber and Jharber, Jamun, Karonda, Lasora, Phalsa, Pomegranate, Loquat and Fig have been discussed regarding to climate change and nutritional importance (Vitamins and minerals as protective food) as seen in Covid-19 pandemic situation in worldwide (Holford *et al.* 2020).

#### Nutritional and medicinal benefits of underutilized fruit

Various fruits, including aonla, bael, lasora, fig, mulberry, pomegranate and ber have been suggested by the Ministry of AYUSH as potential treatments for COVID 19. Due to their demonstrated immunomodulatory, antiviral, anti-allergic/anti-inflammatory/anti-asthmatic and anti-allergic/anti-inflammatory action against COVID 19, these fruits have been prioritized based on prior reports Li *et al.* (2020), Nivetha *et al.* (2020), Abe (2020), Jung *et al.* (2019) and Pinheiro *et al.* (2019). Consuming basic foods along with underutilized fruits can diversify the diet and add nutrients and bioactive substances that are vital to health. These consist of :

Sl. No.	Fruit	Nutritional and medicinal values
1	Aonla ( <i>Emblica officinalis</i> )	The fruit has the highest concentration of antioxidant qualities and ascorbic acid (vitamin C), 445 mg/100 g. It aids in the treatment of haemorrhage, dysentery, diarrhoea, stomach problems, constipation, headache, jaundice and liver enlargement in diabetic patients (Goyal <i>et al.</i> 2007). Fruit is utilized to make a variety of

Sl. No.	Fruit	Nutritional and medicinal values
		ayurveda tonics like chayavanprash, triphala, because it is not widely consumed in fresh form or as table fruit due to its very acidic and astringent quality. However, aonla fruits are processed into a number of food products like jam, jelly, toffy candy, murabba (preserve), pickle, squash, juice, RTS beverage, cider, shreds, dried powder.
2	<b>Bael</b> ( <i>Aegle marmelos</i> )	Bael fruits contain, fat (0.3%), minerals (1.7%), protein (1.8%), fiber (2.9%), and carbohydrates (31.8%) per 100 g of edible portion. Thiamine, riboflavin, niacin, vitamin C, calcium, phosphorus, iron and beta-carotene are just a few of the vitamins and minerals it contains. Every part of this tree such as root, bark, leaf, flower and fruit can be utilized in different fields. Bael fruits are used as Ayurveda remedy against stomach problem, dysentery and diarrhea. It can be used for jam, jelly, squashes and other beverages.
3	<b>Ber</b> ( <i>Ziziphus species</i> )	Fruit are rich in calcium, phosphorus, protein, minerals, vitamin A and vitamin C. Ripe fruit is consumed as a popular dessert. It can also consumed in processed form such as murabba, candy, sharbat, squash and powdered fruits after drying. It is used widely in Ayurveda and Chinese medicine (Mishra <i>et al.</i> 2016).
4	<b>Jamun</b> ( <i>Syzygium cumini</i> )	Jamun is an important indigenous fruit and is tall growing in nature. Fruits are rich in carbohydrate, protein, iron, calcium, phosphorus, fat and fiber. It is used as a dessert fruit and is also processed to form beverages, squash, jam, jelly and wine. Jamun is used in blood purification, diabetes, diarrhoea, eczema and as an antidote for strychnine poisoning and also lowers the blood pressure. The jamun seed powder reduces the sugar content in urine (Mishra <i>et al.</i> 2016).
5	<b>Karonda</b> ( <i>Carrisa carandus</i> )	Karonda fruit is the richest natural source of iron. Seed powder is used in curing cracking of skin of foot and hand. Karonda its fruits are used for preparation of household delicacies like pickles, jam.
6	<b>Phalsa</b> ( <i>Grewia asiatica</i> )	Phalsa is indigenous to India and is known with different names in East and North India. The fruits are potential sources of vitamins and minerals. It contains high amount of vitamin A and has high antioxidant value. The phalsa fruits are rich sources of carotenoids, flavonoids and anthocyanins (Singh <i>et al.</i> 2008). Whole fruit is eaten along with the seeds.

Sl. No.	Fruit	Nutritional and medicinal values
7	<b>Pomegranate</b> ( <i>Punica granatum</i> )	An important source of bioactive substances such phenolics, organic acids, and anthocyanins is wild pomegranates. Because of its powerful health-promoting qualities, it is regarded as a functional food (Sharma and Thakur 2016). The fruit of the wild pomegranate is rich in organic acids, polyphenols and anthocyanins. Historically, wild pomegranate fruits were utilized to make an Indian market condiment known as anardana (Kingsley <i>et al.</i> 2006) and is used as an acidulant in many Asian cuisines and curries.
8	<b>Loquat</b> ( <i>Eriobotrya japonica</i> )	A functional fruit with a high market value, loquats contain specific nutrients such phenylacetaldehyde, hexanal and hexanoic acid (Liu <i>et al.</i> 2016). The most significant medicinal component of the loquat is its leaf, which contains the volatile oils nerolidol and farnesol as well as organic acids, amygdalin, and vitamin B.

### Genetic resources of underutilized fruits

India is the center of origin for many tropical fruit tree species, most of which are not commercially cultivated (underutilized) but provides livelihood support for many rural communities. Numerous universities and institutes started various programs to conserve underutilized fruits. One of such institute is NBPGR New Delhi where over 2552 accessions of 16 underutilized fruits has conserved which have been collected by various organizations in India and national identity (IC Numbers) have been obtained from the NBPGR since 1976. These underutilized fruits include *Aegle marmelos* (57), *Embllica officinalis* (159), *Ziziphus species* (342), *Syzygium cumini* (198), *Carissa species* (50), *Cordia species* (134), *Grewia species* (36), *Buchanania lanzan* (187), *Capparis decidua* (118), *Diospyros melanoxylon* (24), *Garcinia species* (541), *Madhuca indica* (153), *Manilkara hexandra* (74) and *Tamarindus indica* (248) (Malik *et al.* 2010).

**Aonla**: Germplasm variability of aonla is widespread in Uttar Pradesh, Gujarat, Rajasthan and Maharashtra. Surveys conducted in different areas resulted in the identification of promising selections like Banarasi,

Chakaiya, Francis (Hathi Jhool), Kanchan (NA-4), Krishna (NA-5), Neclam (NA-7), NA-6, NA-8 and Balwant. Cultivars Anand I, 2 and 3 have been released from Gujarat. Goma Aishwariya a selection released from CIAH Bikaner is an early and drought tolerant variety with low fiber content. Germplasm of aonla has been conserved in the field gene banks at various institutes namely CIAH Bikaner (50), ANDUAT Faizabad (22), SD Agricultural University Sardarkrushinagar (12), MPKV Rahuri (8), CCSHAU Regional Research Station, Bawal (6), and Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli.

**Bael :** In India the main bael growing states are Uttar Pradesh, Bihar, West Bengal, Rajasthan, Madhya Pradesh, Uttaranchal and Orissa. ND University of Agriculture and Technology, Faizabad has identified and collected twenty genotypes of bael, of which NB-4, NB-5, NB-7 and NB-9 are most promising. NB-5 was adjusted the best selection (Pareek and Nath 1996) on the basis of fruit characters and bearing behavior five promising genotypes of bael was identified from the germplasm collected from Jharkhand and Bihar (Nath *et al.* 2003). Collection of bael germplasm is being maintained at CISH, Lucknow (44), CCSHAU, Regional Research Station, Bawal (10), ANDUAT, Faizabad (22), CIAH, Bikaner (16), GBPUAT, Pantnagar (10), CAZRI, Jodhpur (5) and also at NBPGR Regional Station, Jodhpur. A large genetic diversity still remains unexplored and awaits proper identification and use.

**Ber :** *Z. nummularia* (Jharber) is indigenous to Indian sub-continent and commonly found throughout drier parts of India (Pandey *et al.* 2010). High genetic diversity of *Ziziphus* is present in India and about 20 species are found between 8.5° N to 32.5° N and 69 to 84°E (Awasthi and More 2008). There are two cultivated species, the Indian jujube or ber (*Z. mauritiana* Lam.) and Chinese jujube (*Z. jujube* Mill.). Status of ber germplasm at important centers is, IIHR Bangalore (32 accessions), PAU Ludhiana (34 accessions), IARI New Delhi (39 accessions), PAU Regional Station Bahadurgarh (41 accessions), CCSHAU Regional Research Station Bawal (47 accessions), CAZRI Jodhpur (68 accessions), GAU SK Nagar (75 accessions), CCSHAU Hisar (79 accessions), MPKV Rahuri (93 accessions), NBPGR

Jodhpur (146 accessions) and CIAH Bikaner (318 accessions) (Vashishtha *et al.* 2005).

**Jamun :** It is indigenous fruit tree grown as a wild and semi-wild and *S. cumini* is the cultivated species of jamun in India. Other important species is *S. jumbos* (Rose apple or safed jamun) which is found in South India, West Bengal and Assam. There are no standard cultivars available in jamun but one popular type natural selection grown in North India is 'RaJamun' (Singh *et al.* 2007) which produces big size, oblong, deep purple pink, juicy and sweet pulp and small seed. Singh and Singh (2005) collected 33 accessions from Gujarat.

**Karonda :** The genus *Carissa* has nearly 30 species in which *C. carandas* and *C. spinarum* are native to India. There are no well established varieties of karonda, although the cultivated types are classified according to fruit color as green, pink and white of which the pink and white are mainly ornamental types. Some of the known selections are PK-3, PK-4, Pant Dudarshan, Pant Manohar and Pant Suvarna. Major centers for germplasm conservation are CCSHAU, Regional Research Station Bawal (4), CIAH Bikaner (5), CAZRI Jodhpur (13), CISH Lucknow (25), College of Agriculture, Kolhapur (212) and NBPGR Regional Station Jodhpur.

**Lasora :** It is a native of Northwestern India and is found naturally wild. In cooperation with CCSHAU, Regional Research Station, Bawal, NBPGR New Delhi acquired 45 accessions of superior genetic material from the Haryana districts of Rewari, Mahendergarh, and Bhiwani. 57 accessions of *C. myxa*, *C. crenata* and *C. rothii* have been gathered at the NBPGR in New Delhi from different states. NBPGR Regional Station, Jodhpur (73), CIAH, Bikaner (65), CCSHAU, Regional Research Station, Bawal (30) and ANDUAT, Faizabad are lasora germplasm conservation centers.

**Phalsa :** Phalsa is cultivated in the semi-arid regions of Punjab, Haryana, Uttar Pradesh, Rajasthan, Andhra Pradesh, Gujarat and Maharashtra. The genus *Grewia* has 140 species, out of which 40 occur in India. However, *G. subinaequalis* is only of commercial importance. There are no known cultivars

in Phalsa. Tall (vigorous) and dwarf are two types of genotypes reported (Nehra *et al.* 1985). Two types of phalsa cultivars Local and Sharbati are also known.

**Pomegranate :** There is a lot of variability exists in India, with regard to size, weight, color of fruit, rind thickness, aril color and seed hardness. At CIAH, Bikaner 150 germplasm of pomegranate have been collected and maintained in field gene bank. Muskat, Bassein seedless, Dholka, Jolore seedless and Jodhpuri red are the traditional identified cultivars. The selections P-23 and P-26 from Muskat, Ganesh from Alandi, G-137 from Ganesh, Jyoti and IIHR selection from Bassein seedless and Yercaud-1 (Sayed *et al.* 1985) have been made.

### Impact of climate change on horticulture

There is a rapid progress in climate change than expected, creating a new environmental conditions for growing horticultural crops mainly fruit crops. Nowadays, extreme heat waves or frost are already showing their impacts in some regions and extended drought periods are becoming a serious threat elsewhere. The impact of climate change could be positive or negative; however, they directly affect the quality of the produce and total production. Being perennial in nature fruits crops are mostly affected due to climate change. There is a shifting of temperate fruits towards higher altitudes. According to one study, higher altitude orchards in Shimla district of Himachal Pradesh have been replaced from high chilling requiring apple cultivars to low-chilling requiring cultivars and other fruit crops like pear, peach, plum and kiwi. Whereas, mid hills of Shimla district is shifted totally from apple to potato cultivation. This happened due to the declining trend in snowfall. The production of apple has fallen from 10.8 to 5.8 tons/ ha (Awasthi *et al.* 2001). However the climate change brought the opportunity to grow tropical fruits at higher elevation also where the temperate fruits were grown previously. In tropical fruits also the negative effect of climate change has also been noticed. In perennial crops like mango and guava, temperature is reported to have influence on flowering. Low-chilling-temperature crops like peaches and plums are also exhibiting signs of declining production (Hazarika 2013). An increase in

temperature during fruit ripening causes mangos to ripen too soon and litchis to crack and burn (Kumar and Kumar 2007).

Greenhouse gas emissions are primarily linked to climate change. Carbon sequestration mitigation techniques aid in reducing the harmful effects of climate change. Despite their enormous contribution, little is known about fruit trees' ability to sequester carbon. In a study using PRO-COMAP model at IISC, Bangalore estimated the mitigation potential of farm forestry fruit orchard block planting with 75% of area proposed under mango, tamarind, sapota, jackfruit, guava and neem. For the 30 year period (2005-2035), the carbon stock change under the baseline and mitigation scenario (excluding harvested wood products) and the carbon increment per ha for various project activities came to be 47.42 t C/ha. Farm forestry has a total mitigation potential of 81,750 t C over a 5,381 ha area. Fruit orchard farms are reported to have the highest IRRs, at 29.92% (Laxman *et al.* 2010).

### Climate change and underutilized fruits

The issue of climate change and its effects on agricultural productivity currently affects the entire world. Fruit crops like ber, karonda, lasora and khejri have the capacity to flourish in arid and semi-arid environments when grown rainfed or with supplemental irrigation using captured rainwater during the establishment and other crucial stages (Meghwal and Singh 2016). Fruit crops have longer life cycles than other crops, which makes them more difficult to grow under stress and less able to adjust to changing environmental conditions. The inherent potential of underutilized fruits from environmental problems sustains a sustainable production chain including different tactics for plant management, including plant breeding operations that take advantage of variances. Numerous neglected fruit crops have the capacity to endure adverse agroclimatic conditions. Several fruit species, including aonla (*Emblica officinalis*), custard apple (*Annona squamosa*), ber (*Zizyphus mauritania*), and the tamarind (*Tamarindus indica*), are widely known for their drought tolerance and capacity to flourish in low soils and marginal lands (Hegde 2009).

### Scope of minor fruit production

**Utilization of neglected land :** In India total area under horticultural crop is very small and it is about 9% of total cropped area and fruit occupy 29% of total horticultural area. Large area is under fallow land. In such area there is a vast scope of minor fruit cultivation. So, this untapped fallow and degraded lands can be utilized for the cultivation of minor fruit crops and contribute to rural income.

**Hardy nature of plants :** Being hardy in nature and underutilized fruit crops are resistant to various diseases and pests. They are found in numerous agricultural ecosystems and often survive mainly in marginal areas.

**Tolerance to adverse soil and climate :** Fruit crops like ber, phalsa, date palm, bael, wood apple, are capable of growing on waste land where other crops fail to grow. Thus fruit cultivation has bright scope under waste land. In view of increasing population pressure, decline per capita land availability and escalating input cost, diversification of Indian Horticulture with hardy and high value indigenous fruit crops is necessary for boosting fruit production. Sustainability of some fruit crops under stress conditions are mentioned below :

Tolerance range	ESP	EC (dS m <sup>-1</sup> )	Fruit crops
High tolerance	40 – 50	12 – 15	Date palm, ber, wood apple
Medium tolerance	30 – 40	9 – 12	Aonla, tamarind, jamun, lasoda, karonda, mahua, phalsa, khirni and custard apple
Low tolerance	20–30	6 – 9	Guava, citrus, mango, bael
Susceptible	< 20	< 6	Banana, papaya and pineapple
Drought tolerant	–	–	Ber, sapota, aonla, phalsa, lasoda, kair custard apple, karonda, fig

**Minor fruit as ecological security and ecosystem stability :** Most of the underutilized/minor fruits can tolerate adverse ecological conditions (drought,

shallowness of profile, cold and wet soil). They can be grown in wasteland also. These crops has great potential to stand under difficult environments, climate changes, degradation of land and limited water resources. The dragon fruit (*Hylocereus* sp.) is a minor fruit that has recently attracted the attention of South Indian growers due to its abundance of functional food supplements, attractive fruit color (red or pink), and economic value as a fruit as well as its high antioxidant activity, vitamin C content, and fiber content. As a result, it qualifies as a “healthy fruit”. It is a perennial fruit that is frequently called red Pitaya.

### Reasons for unpopularity of underutilized horticultural crops

Farmers are unaware about the nutritional and medicinal value of these fruits.

The majorities of underutilized fruits are small in size and have several seeds.

Lack of improved cultivars and desirable planting material.

Due to the high quantities of tannins and glycosides in these fruits, most individuals do not appreciate them; instead, they choose fruits with a good flavor.

Lack of transportation, storage and processing facilities and inadequate marketing supports and poor recognition of these crops in horticulture promotion programs.

### Strategies for the development of underutilized horticultural crops

Homestead farming should be used to domesticate potential wild species in order to prevent over-exploitation from natural sources. Support of researchers is needed in terms of the multiplication of planting materials and their distribution besides providing market access through a marketing network for perishables.

Being nutritionally rich, more research and development efforts in these underutilized horticultural crops will add substantially to food security and nutrition.

National-level programs need to be started with a limited number of species for detailed research, development, and conservation. Both species and crops that are crucial for subsistence farming and those with the potential to become cash crops need more attention in research.

Local areas with traditional farming expertise are where most underutilized horticulture crops are grown, so it is important to record this indigenous knowledge about these crops.

Systematic local specific crop planning according to their agro-climatic conditions, need to be done. Proper transport and marketing systems need to be developed.

There is a need to develop criteria for commercial exploitation of underutilized crops to overcome the yield and quality issues. Hence, special research efforts are required to develop location specific package of practices of different horticultural crops including the development of superior varieties, and conservation of genetics resources.

Making the farming community aware of the nutritional value of underutilized horticulture crops, such as fruits, vegetables and medicinal plants, is essential from the beginning by arranging various awareness camps/campaigns, exhibitions, at the macro and micro levels, all with the theme of underutilized horticulture crops.

### Research and development issues

Underutilized fruits of the arid zone have remained neglected. Genetic resources of these crops are still available on farmers field. The germplasm of these crops needs to be collected, documented and conserved in field gene banks and there should be an exchange in information among researchers working on these fruit crops.

There is a need to establish *ex-situ* genetic conservation parks in the diversity rich regions as a backup for future research and development needs. Genetic improvement and development of new varieties are required.

Standardization of propagation techniques and timely supply of quality planting materials and development of location specific agro techniques to exploit these crops commercially.

Commercialization of processing, packaging and value addition in natural growing areas.

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