

Review Article

Potential of arid fruits cultivation in Madhya Pradesh: A Comprehensive Review

Abstract

The arid and semi-arid regions of India cover a significant portion of the country, including parts of Madhya Pradesh, presents a unique set of agricultural challenges and opportunities. These regions are characterized by harsh climatic conditions, such as high temperatures, low and erratic rainfall, and poor soil quality. This review aims to explore the significance of arid and semi-arid fruit crops in enhancing food security, income generation, and sustainable agricultural practices in arid regions, with a particular focus on Madhya Pradesh. By analyzing the climatic conditions, soil types, production constraints, and the potential of horticultural crops, this paper highlights the critical role of these crops in the socio-economic development of these regions.

Key words : Arid fruits, value addition, sustainable agriculture, value addition, water saving

1. Introduction

The Indian arid zone is a vast expanse of land that covers around 31.8 million hectares, representing about 12% of India's total geographical area. This region includes parts of several states, namely Andhra Pradesh, Gujarat, Madhya Pradesh, Haryana, Karnataka, Maharashtra, Punjab, and Rajasthan. The climatic conditions in these areas are characterized by low and erratic rainfall, which ranges from 100 to 500 mm annually, with a coefficient of variation between 40% and 70%. The region experiences extreme temperatures, fluctuating between 1°C and 48°C, high wind velocities, and sandy soils, which collectively pose significant challenges to agricultural practices (Bhandari et.al, 2014)

Vegetation in the arid zone serves as a primary source of life support, with animal husbandry being a major vocation for the local population. This reliance on natural vegetation not only provides direct economic benefits but also stabilizes the sandy, friable surfaces that cover nearly two-thirds of the region [10-12]. The inhospitable climate, characterized by too deep or too shallow soils with low moisture and poor fertility, along with the presence of brackish or saline underground water, further complicates agricultural activities. Intense biotic pressure exacerbates these challenges, necessitating the cultivation of specialized plants that are well adapted to the climatic, edaphic, and biotic adversities present in the region. (Nath et.al, 2019)

2. Importance of Horticultural Crops

Horticulture-based production systems have emerged as an ideal strategy to provide food, nutrition, and income security for populations residing in arid regions [17,18]. The integration of annual crops with fruit trees yields multiple outputs, ensuring both production and income generation. The significance of horticulture in improving land productivity, generating employment opportunities, enhancing the economic conditions of farmers and entrepreneurs, boosting exports, and ultimately providing nutritional security to desert dwellers cannot be overstated [13,14].

In recent years, horticulture has gained substantial importance in crop diversification, which is essential for combating serious land degradation and enhancing farm income. The commercial viability of horticulture has also increased, contributing significantly to the regional economy. The transition from traditional land use, primarily characterized by cereal and legume-based cropping systems, to more productive and remunerative horticultural practices represents a crucial milestone for sustainable agricultural development [15,16]. Horticulture offers one of the few viable and attractive alternative land-use systems, providing not only a contribution to overall agricultural production but also the potential for significantly higher income for farmers [19,20].

3. About Madhya Pradesh

Madhya Pradesh, with its vast geographical area, enjoys diverse climatic and soil conditions that are suitable for a broad range of agricultural products. The agricultural sector in Madhya Pradesh forms the backbone of its economy, contributing nearly one-fourth of the Gross State Domestic Product (GSDP).

The state is one of the country's top producers of food grains, pulses, and oilseeds in the country. In the past two decades, Madhya Pradesh's agricultural sector has experienced rapid growth. It serves as the primary source of employment for over 70% of the population and constitutes approximately 60-75% of rural income.

Madhya Pradesh ranks first in country in the production of soybean, chickpea, urid, arhar, lentil, linseed; second in the production of maize, sesame, niger, green gram and third in the production of wheat, sorghum, barley. Although Madhya Pradesh is one of India's main food grain producing states and also having an ideal environment for the cultivation of fruit crops. State produces sustainable amount of orange, guava, mango, custard apple, aonla, ber, pomegranate, wood apple etc. These fruits not only contribute to food security but also have significant medicinal and economic value. In the horticulture industry, a number of initiatives have been put in place to encourage crop diversity and the adoption of new technology.

The state possesses large tracts of cultivable virgin wastelands and untapped irrigation potential, with the easy availability of land at reasonable prices being a significant advantage. The human

resources in Madhya Pradesh are well-regarded for their diligence, skills, and adaptability, while the state is known for its favorable industrial relations.

Madhya Pradesh is positioned to attract entrepreneurs with vision and commitment to harness the potential of its agricultural sector. The necessary political will and commitment are present, and the organizational setup is responsive to the needs of private partners. Attractive incentives are being offered to the private sector, matching those provided by other states. Entrepreneurs have ample opportunities to contribute to the growing agricultural sector, fulfilling their aspirations while promoting the prosperity of Madhya Pradesh. The ‘One District, One Product (ODOP)’ program has been operational in all the districts of Madhya Pradesh with aim to help districts foster economic and socio-cultural growth, and create employment opportunities, especially in rural areas through focus to encourage agro-processing and market development.

4. Agro-climatic conditions in Madhya Pradesh

Madhya Pradesh is strategically located in the very heart of India, offering logistical advantages for agricultural development. The climatic patterns across the state vary significantly, ranging from marginally semi-arid conditions in the north-western districts to dry winters and hot summers over the plateau regions of the Vindhyan and Satpura Ranges. The southern parts of the state experience a tropical climate with a distinct dry season during winter. The average annual rainfall in Madhya Pradesh varies considerably, ranging from 700 mm in the north-eastern regions to 1600 mm in the southern parts. Generally, the rainfall shows a declining trend from the south-east and eastern areas to the north-west and west. Most districts experience cool and prolonged winters, with temperatures dropping to about 14 degrees Celsius in the south-east and as low as 7 degrees Celsius in the north-west during the winter months.

5. Soils of Madhya Pradesh

Madhya Pradesh features four distinct types of soil, each contributing to the region's agricultural potential. The western and central regions are predominantly covered by medium and deep soils, which constitute approximately 53% of the total soil area. The eastern part of the state is primarily characterized by black soils, which comprise about 25-26% of the total geographical area.

The agricultural potential of Madhya Pradesh lies mainly in the central and western zones, which are rich in medium and deep soils. These zones contain several agricultural export zones, making them ideal for establishing industrial ventures.

Table 1 : Several agricultural export zones

Types of Soil	Districts	Percentage
Medium & Deep Soils	Narsinghpur, Narmadapuram, Harda, Shahdol, Umaria, Jabalpur, Katni, Sagar, Damoh, Vidisha, Raisen, Bhopal, Sehore, Rajgarh, Ujjain, Dewas, Shajapur, Mandsaur, Neemuch, Ratlam, Jhabua, Dhar, Indore, Khargone,	52.95%

	Barwani	
Alluvial Soils	Gwalior, Morena, Sheopurkala, Bhind	10.90%
Shallow & Medium Black Soils	Betul, Chhindwara and Seoni	9.86%
Black Soils	Mandla, Dindori, Balaghat, Rewa, Satna, Panna, Chhatarpur, Tikamgarh, Niwari, Shivpuri (Partly), Guna	26.39%

6. Underutilized Fruit Crops of Madhya Pradesh

Madhya Pradesh is home to a diverse range of underutilized fruit crops that are well-suited to the arid and semi-arid conditions of the state. Some of the prominent underutilized fruit crops include:

6.1 Indian Jujube (*Ziziphus mauritiana* Lamk.)

The Indian jujube (Ber) of family Rhamnaceae is one of the most ancient cultivated fruit trees in north Indian plains and can thrive in the harsh condition of Madhya Pradesh. It grows even on marginal lands or inferior soils where most other fruit trees either fail to grow or give very poor performance. It is regarded as the king of arid zone fruits and also as poor man's apple. There are three main species found in the country. The *Z. mauritiana* is the main species of commercial importance with its several varieties. *Z. nummularia* is prized for its leaves (rich in protein) which provide fodder for livestock. The third one, *Z. rotundifolia* also bears edible fruits but of smaller size. It is used as rootstock for commercial Indian jujube. The seeds contain saponins, jujubogenin (Kawai et al. 1974) and obelin lactone. Jujube fruits contain fairly high amount of vitamin C, besides vitamin A, B, protein, calcium and phosphorus (Jawanda and Bal 1978). It is a perennial hardy fruit tree which gives income from multiple products such as fruits, fodder and fuel wood even in severe drought conditions to the resource deficient farmers. It is the only fruit crop which can give good returns even under rainfed conditions and can be grown in a variety of soils and climatic conditions ranging from sub-tropical to tropical. Improved varieties and grafting techniques have significantly enhanced yield and fruit quality, making Ber a promising crop for these regions. It is commercially propagated by 'I' or 'T' (shield) budding and the major varieties are Gola, Thar Sevika, Thar Bhubhraj, Seb, Banarsi Kadaka, Umran. The Bhopal, Jabalpur, Chhindwara, Sagar, Dhar, Khandwa, Kargone, Ratlam, Mandsaur, Mandla, Dindori districts of the state recommended for its plantation.

6.2 Indian Gooseberry (*Emblica officinalis* Gaertn.)

The Indian gooseberry (Aonla) of family Euphorbiaceae is being cultivated in India since Vedic Era. As a result of intensive research and development, it has attained commercial status and also proved to be potential fruit crop for arid ecosystem. It is hardy, prolific bearer and highly remunerative even without much care and can be grown in variable agro-climatic and soil conditions. The fruits are recognized for their nutritive, medicinal and therapeutical values and

are rich source of vitamin C (4–9 mg/g), pectin, iron, calcium and phosphorus. The fruit is the main ingredient in Chayvanprash and triphala used in Ayurvedic medicine. In Madhya Pradesh, it grows well in semi-arid regions of Panna, Chhatarpur, Sagar and Satna districts. The patch budded plants of Kanchan (NA-4), Krishna (NA-5), NA-6, NA-7, NA-10 varieties give better yield over seeded plants.

6.3 Bengal Quince (*Aegle marmelos* (Linn.) Correa)

Bengal quince (Bael) of family Rutaceae is an indigenous hardy fruit crop and can be grown successfully in dry areas of the state. The major Bael growing districts are Jabalpur, Sagar, Damoh, Katni, Satna, Panna, Tikamgarh and Chhatarpur. It is well known for its nutritional and therapeutic properties. The ripe fruits are laxative and unripe ones are prescribed for diarrhea and dysentery and are in great demand for native system of medicine such as Ayurvedic. Various chemical constituents, viz. alkaloids, coumarins and steroids have been isolated and identified from different parts of bael tree such as leaves, wood, root and bark by various workers (Singh et.al. 2018). The marmelosin content of fruit is known as the panacea of the stomach ailments. The patch budded plants of varieties like Narendra Bael-1, Narendra Bael-2, Narendra Bael-5, Narendra Bael-9, CISH B-1, CISH B-2, Goma Yashi, Pant Shivani, Pant Sujata etc can be grown successfully in the state.

6.4 Custard apple (*Annona squamosa* L.)

Custard apple is one of the most delicious arid fruits known mostly for its dessert and confectionery values. It belongs to the family Annonaceae. Being rich in carbohydrate (23.0g/100g) and possessing pleasant flavour, custard apple fruits are utilized for ice cream. Custard apple prefers dry climate and can withstand mild frost. The root system is confined to relatively shallow layers and therefore, these do not require deep soils. However, it needs well-drained soil. The trees withstand high amounts of lime found in calcareous soils. It is one of the most drought tolerant fruit trees in India. It is cultivated in several parts of Madhya Pradesh, especially in areas with poor soils. The recommended districts for plantation are Chhindwara, Raisen, Sagar, Dhar, Khandwa, Khargone, Jhabua, Dindori, Sehore, Mandla, Harda, Seoni and Betul. The varieties like Arka sahan, Balanagar, NMK-1 along with locally available plants can be commercially cultivated.

6.5 Tamarind (*Tamarindus indica* L.)

Tamarind is a multi-use tree and it belongs to the family Leguminosae. It is a source of timber, fruit, seeds, fodder, medicinal extracts and potential industrial components, so in terms of the rural farmer the tree can provide seasonal income in periods of potential hardship. Tamarind trees are able to compensate farmers in seasons after subsistence crops have generally been harvested (pods are harvested in the dry season), thereby giving a potential economic return in

local markets when food is scarce. It is known for their drought resistance and services as insurance trees for the marginal and poor farmers in dry tracts. Tamarind is a fair source of vitamin C, which, like the B vitamins, helps to provide a healthy immune system. Vitamin C also helps to provide strong bones, teeth and skin. Tamarind is rich in the minerals, potassium, phosphorus, calcium and magnesium, which help to keep the body in balance. Calcium, magnesium and potassium help to protect the bones and teeth, and all have a role in providing strong muscles and general health. Tamarind can also provide smaller amounts of iron and vitamin A. Tamarind also contains a high level of protein, with many essential amino acids, which help to build strong and efficient muscles. Tamarind is also high in carbohydrate, which provides energy. In Madhya Pradesh, the trees are found in Vindhyan region and in some part of Bundelkhand. The major varieties like Goma Prateek, PKM 1, CISH T-5, Pratishtan, No. 263, Yogeshwari, Urigam, Cumbum, DT-1, DT-28 etc are suitable for commercial farming of tamarind.

6.6 Jamun (*Syzygium cumini* (L.) Skeels.)

The black plum or Indian black berry, commonly known as Jamun is an important indigenous fruit tree of India belonging to family Myrtaceae. The tasty, pleasant flavoured Jamun fruit is mostly used for dessert purpose. Apart from eating fresh, it can also be used for making delicious beverages, juice, jam, squash, wine, vinegar and pickles (Ochse *et al.*, 1996). The fruits & leaves extract of Jamun showed good efficacy to control nematode infestation in plants (Saxena and Singh, 2001). Seed contain an alkaloid jambosin and a glycoside, jambolin or antimallin, which reduces or stop diastatic conversion of starch into sugars. The volatile oil from the Jamun seeds can be extracted and used as an effective medicine against diabetes, heart & liver trouble (Vijayanand *et al.*, 2001.). In Madhya Pradesh, Jamun grow well in Jabalpur, Mandla, Shahdol, Betul, Katni, Chhindwara etc districts. The plant raised from softwood grafting or patch budding are suitable for commercial plantation. The suitable varieties are CISH J-37, CISH J-42 , Goma Priyanka, Narendra Jamun-6, Rajamun, Paras, Konkan Bahdoli

6.7 Pomegranate (*Punica granatum* L.)

Pomegranate (Anar) of family Punicaceae is an economically important commercial fruit crop of arid and semi-arid regions. Commercial plantations of Pomegranate exist in Maharashtra, Gujarat, Rajasthan, Madhya Pradesh, Andhra Pradesh and Karnataka owing to its preference for arid climate. Its xerophytic characteristics and hardy nature makes it suitable crop for dry, rainfed, pasture and undulating land, where other fruit crops cannot grow successfully (Nath *et al.* 2016). Besides, being a favorite table fruit it is also used for preparation of juice and squash. Dried seeds give an important condiment coined as Anardana. It also has medicinal value and rind is being used for dyeing cloths. The Mridula, Aarakta, Jyoti, Ruby and Bhagwa, Bhagwa super are the varieties grown commercially in different parts of the state. The semi hard wood cutting and air layering are the prominent methods of plant propagation but to overcome the disease occurrence, famers prefer tissue cultured plants. Madhya Pradesh has seen an increase in

pomegranate cultivation, particularly in the Malwa and Nimar regions. The Indore, Dhar, Khandwa, Khargone, Bardwani, Jhabua, Burhanpur, Ujjain, Shajapur, Ratlam, Mandasaur, Dewas etc. districts are recommended for its plantation. The introduction of improved cultivars and modern irrigation techniques, such as drip irrigation, has further enhanced pomegranate production in the state.

7. Value Addition and Marketing Opportunities

The potential of arid and semi-arid fruits extends beyond fresh consumption. There is a growing demand for processed products such as dried fruits, juices, jams, confectionary items and herbal products. Value addition can significantly increase the profitability of fruit cultivation by creating new market opportunities and reducing post-harvest losses. Establishing processing units and developing supply chains for these fruits can enhance the income of farmers and contribute to the overall economic development of arid and semi-arid regions. The government is providing ample support through various central and state sector schemes for setting-up of processing and value chain infrastructures to boost the economy.

8. Conservation and Utilization Strategies

To promote the cultivation of underutilized fruit crops in Madhya Pradesh, it is essential to adopt conservation and utilization strategies. Efforts should be made to collect and conserve the genetic diversity of underutilized fruit crops found in Madhya Pradesh. More research is needed to develop improved varieties, propagation techniques, and cultivation practices for underutilized fruit crops. Farmers should be made aware of the potential benefits of underutilized fruit crops and trained in their cultivation and management.

9. Challenges and Constraints

Despite the potential, several challenges hinder the widespread adoption of arid and semi-arid fruit cultivation in Madhya Pradesh. These includes :

- Poor-quality planting materials derived from inferior genetic stocks and inadequate management practices.
- Inferior Quality of Produce due to Poor post-harvest management practices along with absence of adequate infrastructural facilities for handling and storing produce.
- The significant capital costs associated with establishing orchards and plantations, as well as setting up necessary infrastructure and irrigation systems, represent a serious constraint on expanding the area under many horticultural crops and improving existing orchards.
- The long gestation periods for many horticultural crops result in wide variations in credit availability across different regions of the country.

- The high incidence of pests and diseases remains a persistent challenge for horticultural production.
- There is a lack of technologies aimed at improving wastelands, which represent potential future expansion areas for horticulture.
- There are currently no standard improved technologies available for the large-scale production of arid fruit crops, which are best suited for wastelands and poor, marginal soils.

10. Policy Implications and Future Prospects

To realize the full potential of arid and semi-arid fruit cultivation in Madhya Pradesh, supportive policies and initiatives are essential. These include providing subsidies for the adoption of water-saving technologies, promoting research and extension services, facilitating access to credit and insurance, and developing market infrastructure. Public-private partnerships can play a crucial role in scaling up the cultivation and processing of these fruits. The future prospects for arid and semi-arid fruit cultivation are promising, with opportunities for expanding acreage, improving yields, and increasing farmer incomes.

11. Conclusion

In conclusion, the cultivation of arid and semi-arid fruits in Madhya Pradesh presents a viable option for enhancing agricultural productivity and improving the livelihoods of rural communities in harsh climatic regions. By adopting appropriate agronomic practices, leveraging value addition opportunities, and addressing key challenges through policy support, the state can harness the potential of these crops for sustainable agricultural development of Madhya Pradesh.

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