POLICY PAPER 140

Underutilized Fruits and Vegetables for Nutritional and Health Security

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Underutilized Fruits and Vegetables for Nutritional and Health Security

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Preface

The conservation and utilization of plant biodiversity have become increasingly critical for ensuring food, nutritional, and environmental security under changing climatic conditions. India's rich horticultural diversity includes a vast array of underutilized fruits and vegetables that possess high nutritional density, ecological adaptability, and genetic variability. However, despite their potential, these species remain largely neglected in mainstream research, development, and policy frameworks.

This policy paper on "Underutilized Fruits and Vegetables for Nutritional and Health Security" provides a comprehensive synthesis of the scientific, nutritional, and ecological importance of these crops. It emphasizes their roles as rich sources of micronutrients, vitamins, antioxidants, and bioactive phytochemicals, essential for combating malnutrition, hidden hunger, and diet-related non-communicable diseases. The document highlights their adaptability to marginal and stress-prone environments, where major crops often fail, making them strategic resources for climate-resilient and sustainable agricultural systems.

Drawing upon recent evidence, the paper identifies priority species of underutilized fruits as well as vegetables, which exhibit wide agro-ecological adaptability and high nutritive value. It outlines potential regions for their large-scale cultivation and underscores the need for genetic improvement, varietal development, and propagation standardization tailored to specific agro-climatic conditions. Furthermore, it calls for strengthening value chains, postharvest management, and product diversification to enhance marketability and rural income generation.

The Academy recognizes that the mainstreaming of underutilized horticultural crops requires coordinated Institutional action involving ICAR institutes, SAUs, CSIR, ICMR, and private stakeholders. The promotion of these crops through research, extension, and policy convergence will not only improve dietary diversity and public health, but also support sustainable livelihood opportunities for small and marginal farmers.

This policy paper is expected to serve as a valuable reference material for researchers, academicians, and policymakers engaged in building nutrition-sensitive and climate-resilient food systems. I take this opportunity to thank the Convener (Dr. T. K. Behera), Reviewers (Dr. Suman Kumar Pandey & Dr. Pritam Kalia) and Editors (Dr. V. K. Baranwal & Dr. R. K. Jain), whose insights and efforts have made this document possible.

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(Himanshu Pathak)
President, NAAS

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1. INTRODUCTION

Globally, there are more than 3,000 species of tropical and 2,400 species of temperate fruits and nuts. Despite this vast diversity, only 28 species (7 tropical, 7 subtropical, and 14 temperate) have been commercially developed, leaving more than 95% of fruit species largely underutilized. The situation is even more striking for vegetables. Of about 1,097 cultivated vegetable species worldwide, less than 150 are widely utilized and only about 20 dominate global production, leaving over 85% of vegetable species remain underutilized, despite their nutritional, medicinal, and climate-resilient attributes (FAO, 2021).

Fluctuations in climate, such as rising air temperatures, increased UV radiation, droughts or floods, soil salinity, mineral deficiencies or toxicities, and the prevalence of pests and diseases, threaten the sustainable production of major crops (FAO, 2019). In this context, underutilized fruit and vegetable species offer significant advantages, as they are resilient and adaptable to climate stresses, often easier to cultivate, and inherently rich in nutritional and therapeutic compounds. Their inclusion in diets can address the nutritional requirements of underserved populations while simultaneously expanding the global food supply and reducing food and nutritional insecurity (FAO, 2021).

These underutilized crops are often referred to as “crops of the future”. However, they remain localized, largely overlooked, and poorly integrated into mainstream agriculture or the commercial value chain, including post-harvest processing and value addition. Expanding their cultivation and utilization requires a well-structured strategy that combines genetic enhancement, agronomic optimization, and supply chain development.

2. GENETIC DIVERSITY

India’s diverse agro-climatic conditions provide vast opportunities for expanding the cultivation of underutilized fruits and vegetables. Conservation and utilization of their genetic diversity can support climate resilience, nutritional security, and sustainable farming systems. The most important underutilized fruits and vegetables with immense potential in different parts of India are as follows:

Top 10 Underutilized Fruits

(i) **Aonla (*Phyllanthus emblica*):** Extremely rich in vitamin C, antioxidants; highly drought tolerant.

(ii) **Bael (*Aegle marmelos*):** Hardy fruit of arid/semi-arid zones; valued for medicinal and nutritional benefits.

(iii) **Jamun (*Syzygium cumini*):** Source of anthocyanins and iron; used for diabetes management.

(iv) **Ber (*Ziziphus mauritiana*):** Adaptable to poor soils and drought; rich in vitamin C and iron.

(v) **Custard apple (*Annona squamosa*):** Grows in marginal soils; nutrient-rich pulp and seeds.

(vi) **Karonda (*Carissa carandas*):** Drought-hardy; high in iron and antioxidants, used in preserves and pickles.

(vii) **Phalsa (*Grewia subinaequalis*):** Rich in antioxidants; thrives in hot, dry conditions.

(viii) **Tamarind (*Tamarindus indica*):** Multi-purpose fruit; pulp rich in tartaric acid and minerals.

(ix) **Wood apple (*Limonia acidissima*):** Hardy, drought-resistant; rich in dietary fibre and micronutrients.

(x) **Mulberry (*Morus* spp.):** Nutrient-dense berries; also supports sericulture and diversified livelihoods.

Top 10 Underutilized Vegetables

(i) **Amaranth (*Amaranthus* spp.):** Leafy green with high iron, calcium, and vitamin A content.

(ii) **Moringa (*Moringa oleifera*):** Leaves, pods, and flowers rich in vitamins, minerals, and glucosinolates.

(iii) **Basella (*Basella alba/rubra*):** Rich in iron, calcium, and antioxidants; popular as leafy spinach substitute.

(iv) **Winged bean (*Psophocarpus tetragonolobus*):** High-protein multipurpose legume with edible pods, leaves, and seeds.

(v) **Faba bean (*Vicia faba*):** Source of protein, resistant starch; tolerates cool climates.

(vi) **Pointed gourd (*Trichosanthes dioica*):** Traditional cucurbit; valuable for digestion and gut health.

(vii) **Round melon/Tinda (*Praecitrullus fistulosus*):** Drought-hardy cucurbit; consumed widely in arid regions.

(viii) **Cluster bean (*Cyamopsis tetragonoloba*):** Source of guar gum; grows well in desert ecosystems.

(ix) **Yam bean (*Pachyrhizus erosus*):** Underground tuber rich in starch, water, and micronutrients.

(x) **Jute mallow (*Corchorus olitorius*):** Leafy vegetable rich in polyphenols, mucilage, and iron; important in traditional diets.

3. POTENTIAL AREAS OF CULTIVATION

Identifying region-specific crops based on adaptability, nutritional composition, consumer preference, and yield potential is crucial for mainstreaming these species (Box 1 & 2).

Box 1: Selected underutilized fruits and their potential areas of cultivation in India

Crop	Varieties	Potential Areas of Cultivation
Bael	Goma Yashi, Thar Divya, Thar Neelkanth, Thar Srishti, Thar Prakriti, Thar Shivangi, Thar Gauri, Thar Bhavya, NB-5, NB-7, NB-8, NB-9, NB-10, NB-11, NB-16, NB-17, CISHB-1, CISHB-2, CISHB-3, Pant Aparna, Pant Shivani, Pant Sujata, Pant Urvashi	North & Central India (Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar, Chhattisgarh, Jharkhand)
Aonla	Goma Aishwarya, NA-4, NA-5, NA-6, NA-7, NA-10, NA-25, NA-26, BSR-1, Laxmi 52, Anand-1, Anand-2	Uttar Pradesh, Gujarat, Madhya Pradesh, Rajasthan, Maharashtra
Ber	Umran, Gola, Seb, Koma Kirti, Thar Sevika, Thar Bhubhraj, Thar Malti, BanarasiKarka, Mehrun, Elaichi, Kaithali	Arid & Semi-arid regions (Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh, Maharashtra)
Jamun	Goma Priyanka, Thar Kranti, Konkan Bahadoli, Jamwant, Paras, Rajamun, Rajendra Jamun-1	Throughout India, especially Uttar Pradesh, Bihar, Maharashtra, Karnataka, Tamil Nadu
Custard Apple	Thar Amrit, Pink Mammoth, Balanagar, Mammoth, Red Sitaphal, Yellow Sitaphal, Phule Janki, NMK Gold, Sindhan	Maharashtra, Madhya Pradesh, Andhra Pradesh, Telangana, Rajasthan
Mulberry	Thar Lohit, Thar Harit, Saharanpur Local-1, Saharanpur Local-2, S-13, S-34, S-146, S-7999, S-1635, ChakMajra	Karnataka, West Bengal, Tamil Nadu, Andhra Pradesh, Uttar Pradesh (Sericulture belts)
Karonda	Pant Manohar, Pant Sudarshn, Pant Suverna, Konkan Bold, Thar Kamal	Arid & semi-arid regions (Rajasthan, Uttar Pradesh, Madhya Pradesh, Maharashtra, Gujarat)
Tamarind	Goma Prateek, Thar Rashmi, Prathisthan, PKM-1, T-263, Urigam, Ajanta, Yogeshwari, DTS-1, DTS-2, Anant Rudhira	Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, Chhattisgarh, Odisha
Phalsa	Thar Pragati	Northern & Central India (Punjab, Haryana, Uttar Pradesh, Rajasthan, Madhya Pradesh)
Wood Apple	Thar Gaurav, Thar Prabha	Dry regions of Central & Eastern India (Rajasthan, Madhya Pradesh, Chhattisgarh, Jharkhand, Bihar)

Source : Singh *et al*., 2023

Box 2: Selected underutilized vegetable crops and their potential areas of cultivation in India

Crop	Varieties	Potential Areas of Cultivation
Winged bean	Kashi Annapurna	North-eastern states, Kerala, Karnataka, Tamil Nadu (humid tropics)
Faba bean	Kashi Sampada, Pusa Sumeet, Pusa Udit, Swarna Suraksha, Swarna Gaurav	North India (Uttar Pradesh, Bihar, Punjab, Haryana, Madhya Pradesh, West Bengal)
Basella (Poi/ Indian spinach)	Kashi Poi-1, Kashi Poi-2	Eastern & Southern India (West Bengal, Odisha, Assam, Kerala, Karnataka, Tamil Nadu)
Vegetable Amaranth	Kashi Chaulai-1, Co-1, Co-2, Arka Arunima, Pusa Lal Chaulai	Throughout India, esp. West Bengal, Kerala, Tamil Nadu, Andhra Pradesh, Uttar Pradesh
Round melon (Tinda)	Kashi Hari, Arka Tinda, Pusa Raunak, Punjab Tinda	Arid & semi-arid regions (Rajasthan, Punjab, Haryana, Uttar Pradesh, Delhi)
Moringa (Drumstick)	PKM-1, PKM-2, Bhagya (Dhanraj), Coimbatore-1, Coimbatore-2	Tropical and subtropical India — Tamil Nadu, Andhra Pradesh, Karnataka, Kerala, Maharashtra, Gujarat, Odisha, Bihar, Telangana
Pointed Gourd (Parwal)	Rajendra Parwal-1, Rajendra Parwal-2, Swarna Alaukik, Swarna Rekha, Chhotanagpuri	Eastern and northeastern India (Bihar, West Bengal, Assam, Odisha, Jharkhand, Eastern Uttar Pradesh)
Cluster Bean (Guar)	HG 563, HG 2-20, HG 75, Pusa Navbahar, Pusa Sadabahar, Thar Bhadavi, Thar Maghi, RGC 936	Arid and semi-arid regions (Rajasthan, Gujarat, Haryana, Punjab, Madhya Pradesh, Maharashtra)
Yam Bean (Mishrikand / Pachyrhizus)	Rajendra Mishrikand-1, Rajendra Mishrikand-2	Eastern, northeastern & central India (Bihar, Jharkhand, Odisha, West Bengal, Assam, Chhattisgarh)
Jute Mallow (Nalta Jute / Tossa Pat)	JRO 524, JRO 7835, Bidhan Pat-1	Humid tropical and subtropical regions (West Bengal, Assam, Odisha, Bihar, Uttar Pradesh, Coastal Andhra Pradesh)

Source : Devi and Singh, 2023

4. PROSPECTS

4.1. Food Security and Sustainable Production

From a production perspective, underutilized fruits and vegetables exemplify resilient agriculture. They thrive in diverse agro-climatic zones, including arid, semi-arid, and rainfed ecosystems, where major crops often fail. Hardy species such as ber (*Ziziphus mauritiana*), karonda (*Carissa carandas*), lasoda (*Cordia myxa*), and khejri (*Prosopis cineraria*) flourish in low-input systems, surviving on minimal irrigation by capturing and conserving rainwater. Similarly, aonla (*Phyllanthus emblica*), tamarind (*Tamarindus indica*), custard apple (*Annona squamosa*), and bael (*Aegle marmelos*) tolerate drought and poor soils, making them ideal for wasteland horticulture. Their ability to withstand adverse climate conditions, coupled with inherent pest and disease resistance, reduces dependency on agrochemicals and supports environmentally sustainable farming systems.

Despite being cultivated on only 0.437 million hectares and contributing about 6.56% of total fruit production in India, underutilized fruits show relatively high productivity (11.47 t/ha) (NHB, 2019). By contrast, major fruits like mango, banana, apple, guava, and citrus occupy over 72% of area and production, leaving a vast untapped potential for diversification. Large tracts of fallow and degraded lands across India offer opportunities to expand the cultivation of these hardy crops, transforming unproductive landscapes into sources of food, nutrition, and rural livelihoods.

Underutilized fruits and vegetables represent a strategic pathway for achieving food security and sustainable production. Their cultivation in degraded and marginal lands enhances ecological sustainability, while their nutritional richness combats malnutrition and hidden hunger. Coupled with improved post-harvest management and value-chain development, these hardy species can provide triple benefits—better nutrition, sustainable farming systems, and enhanced rural incomes. Harnessing their potential requires focused research, policy support, and awareness creation, but the rewards in terms of resilient food systems and community well-being are substantial.

4.2. Nutritional Value

Underutilized fruits and vegetables, though neglected in mainstream agriculture, are gaining increasing attention for their nutritional richness and unique phytochemical composition. These crops, often adapted to marginal and stress-prone environments, thrive with minimal inputs and provide a wide range of essential nutrients and bioactive compounds. Their ability to combine resilience with high nutritional density positions them as important contributors to food and nutrition security, particularly in rural and resource-limited communities.

Underutilized fruits and vegetables represent a treasure of nutritional and therapeutic resources. Their regular inclusion in diets can combat malnutrition, anemia, hidden

hunger, and lifestyle-related disorders, while promoting sustainable agriculture and dietary diversification. By harnessing their rich composition of vitamins, minerals, fiber, proteins, and bioactive compounds, these crops can play a pivotal role in improving community nutrition and health, especially in vulnerable populations.

4.3. Income and Production Enhancement of Small-scale Producers

The underutilized fruits and vegetables have huge potential for livelihood enhancement and community development. They can help both in providing nutrient supplementary diet and added income to rural people. These lesser-known fruits and vegetables are currently processed to produce various value-added products by rural community employing traditional knowledge like sun drying, pickling etc. Fruits such as tamarind, custard apple, bael, khirni, karonda, phalsa mulberry, wild noni, and wood apple are excellent sources of vitamins, minerals, and dietary fibers, which are essential for numerous physiological functions in the body. However, they have a short shelf life, making marketing challenging, especially in years with abundant supply. Nevertheless, modern techniques can improve product quality, leading to higher market prices. Standardized methods have been established for the preparation of various products (Singh et al, 2023). A simple pre-treatment involving hormones and harmless chemicals can enhance the quality of many fruit products. Solar drying and electric tray dehydration methods help reduce dust contamination and maintain the natural color of fruits and vegetables. By implementing processing, adding value, and ensuring effective marketing, farmers can significantly improve their economic status, resulting in better health and nutrition security. Therefore, it is crucial to focus on incorporating modern techniques in processing, value addition, and marketing. This approach can contribute to alleviating malnutrition and dietary deficiencies among vulnerable populations in rural and tribal areas.

5. RECOMMENDATIONS

- **Mainstreaming underutilized fruits and vegetables:** Many underutilized horticultural crops exhibit wide agro-ecological adaptability, tolerance to drought, salinity, and poor soils, and resistance to several pests and diseases, making them ideal candidates for climate-resilient agriculture. Their nutritional richness—particularly in vitamins, minerals, dietary fiber, and bioactive compounds—offers a sustainable solution to hidden hunger, micronutrient deficiencies, and non-communicable diseases.
- **Research and policy interventions:** Comprehensive documentation and mapping of underutilized species should be prioritized to establish a national knowledge base covering distribution, agroclimatic suitability, genetic diversity, nutritional profiles, and ethnobotanical uses. Conservation strategies should adopt a complementary approach: *in-situ* conservation through custodian farmers and community seed banks, combined with *ex-situ* conservation in field gene banks,

biodiversity parks, and cryo-storage facilities. A "virtual gene bank" linking these resources would ensure broader accessibility and coordination among institutions.

- **Crop improvement:** Conventional breeding methods, including selection and hybridization, should be complemented with advanced biotechnological tools such as marker-assisted selection, genomic selection, and gene editing to accelerate the introgression of desirable traits. Equally important is the standardization of agro-techniques, propagation protocols, and Good Horticultural Practices (GHPs) tailored to specific species, ensuring that research outputs are transferable to farming communities.
- **Nutritional and functional food research:** Needs intensification to profile macro- and micronutrients, phytochemicals, and anti-nutritional factors. This knowledge base will allow the scientific validation of health claims associated with crops such as *Moringa oleifera*, *Amaranthus spp.*, *Momordica charantia*, and *Phyllanthus emblica*, thereby facilitating their integration into national health, nutrition, and school feeding programs. Linking underutilized crops with public health interventions will not only improve dietary diversity but also enhance their demand and cultivation.
- **Strengthening value chains:** Post-harvest management, processing technologies, and product development will increase the marketability of these crops. Value-added products such as aonla powder, bael squash, tamarind pulp, or moringa leaf powder can enhance shelf life and open domestic and export market opportunities. Empowering smallholder farmers, self-help groups, women's collectives, and farmer-producer organizations (FPOs) in value addition and branding will improve rural incomes and promote equitable benefit-sharing. Policies that incentivize production—through inclusion in Minimum Support Price frameworks, subsidies, and crop insurance—are necessary to encourage farmers to adopt these crops on a larger scale.
- **Strong institutional convergence and public awareness:** Collaboration between ICAR, NBPGR, PPVFRA, CSIR, ICMR, SAUs, and NGOs should be strengthened to coordinate research, conservation, and extension. Participation in initiatives promoting "Future Smart Foods" can position India as a leader in the conservation and utilization of neglected and underutilized species. Public awareness campaigns, nutritional rebranding (e.g., as "Amrit Fasal"), and integration into local and national markets will be vital to changing consumer perceptions and driving demand.

By combining conservation, genetic improvement, nutritional research, value-chain development, and supportive policy frameworks, underutilized horticultural crops can be transformed into key drivers of food and nutritional security, rural income generation, and climate-resilient sustainable agriculture.

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