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Underutilized Vegetables: Enhancing Nutrition and Livelihood Sustainability

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The global nutrition crisis, characterized by widespread hunger and malnutrition, has gained significant attention. Currently, one in eight people worldwide faces hunger, with more than double that number suffering from hidden hunger. With a projected global population increase of 40 % by 2050, agricultural production must rise by 70 % to meet the demand. However, limited land and resource constraints put immense pressure on agriculture to produce sufficient food, feed and biofuels.

A promising solution to these challenges lies in utilizing underutilized vegetables, which possess rich nutritional and medicinal qualities. These include minor grains, pulses, root crops, fruits, vegetables and non-timber forest products, all of which can improve food security, mitigate market instability and contribute to sustainability.

Traditional and indigenous vegetables often offer superior nutritional value compared to widely consumed crops like tomatoes and cabbage. Packed with essential vitamins, micronutrients, proteins and phytonutrients, these crops can play a key role in addressing nutritional gaps. Vegetables such as amaranth, African nightshade, eggplants, drumstick, water spinach, Malabar spinach, winged bean and gourds are excellent examples of crops that promote sustainable agriculture. Their cultivation requires minimal inputs, can grow in marginal soils and adapts to various climatic conditions, reducing the environmental impact of food production.

To fully unlock their potential, substantial investment in research, breeding and crop development is necessary. This would facilitate the transformation of local landraces into high-yield, adaptable and commercially viable varieties, ultimately enhancing food security and promoting sustainable agriculture.

Underutilized crops, defined as those with significant untapped potential to improve food security, health, income generation and environmental sustainability, often meet the following criteria:

1. Scientifically or ethnobotanically recognized food value
2. Grown in specific regions, with limited cultivation compared to common crops
3. Lack of formal seed supply systems
4. Indigenous uses in local communities
5. Minimal attention from researchers, policymakers and technology developers
6. High nutritional and medicinal value

These crops are rich in micronutrients, antioxidants and antimicrobial phytochemicals and their benefits could drive large-scale conservation, promotion and sustainable use.

Many of these lesser-known vegetables have been traditionally consumed, with local communities recognizing their nutritional and medicinal benefits. The ICAR-Indian Institute of Vegetable Research in Varanasi maintains significant genetic diversity of these crops in its gene bank, proving their potential for wider adoption and commercial success.

By investing in research and supporting their cultivation, underutilized vegetables can play a transformative role in addressing global food and nutrition challenges.

Table 1. List of significant underutilised vegetables

Name	Botanical name	Family
Asparagus	<i>Asparagus officinalis</i>	Liliaceae
Agathi	<i>Sesbania grandiflora</i>	Fabaceae
Baby corn	<i>Zea mays</i>	Poaceae
Cluster bean	<i>Cyamopsis tetragonoloba</i>	Leguminaceae
Chinese cabbage	<i>Brassica rapa var. pekinensis</i>	Brassicaceae
Curry leaf	<i>Murraya koenigii</i>	Rutaceae
Chekurmanis	<i>Sauropus androgynus</i>	Euphorbiaceae
Chow-Chow	<i>Sechium edule</i>	Cucurbitaceae
Elephant foot yam	<i>Amorphophallus paeoniifolius</i>	Araceae
Gherkin	<i>Cucumis anguria</i>	Cucurbitaceae
Globe artichoke	<i>Cynara cardunculus</i>	Asteraceae
Garlic Chives	<i>Allium tuberosum</i>	Alliaceae
Hooker chives	<i>Allium hokkeri</i>	Alliaceae
Indian hemp	<i>Crotalaria juncea</i>	Fabaceae
Kachnar	<i>Bauhinia variegata</i> L	Fabaceae
Kale	<i>Brassica oleracea var. acephala</i> L	Brassicaceae
Lettuce	<i>Lactuca sativa</i>	Asteraceae
Oriental pickling melon	<i>Cucumis melo var. conomon</i>	Cucurbitaceae
Round gourd	<i>Praecitrullus fistulosus</i>	Cucurbitaceae
Rice bean	<i>Vigna umbellata</i>	Leguminosae
Snake gourd	<i>Trichosanthes cucumerina</i>	Cucurbitaceae
Snampelon	<i>Cucumis melo var. momordica</i>	Cucurbitaceae
Spiny coriander	<i>Eryngium foetidum</i>	Apiaceae
Tree bean	<i>Parkia roxburghii</i>	Leguminosae
Winged bean	<i>Psophocarpus tetragonolobus</i>	Leguminaceae
Water chestnut	<i>Trapa natans</i>	Lythraceae

Nutritional and Medicinal Benefits of Select Underutilized Vegetables

Amaranth (*Amaranthus spp.*): Amaranth is a versatile plant, thriving in warm, humid climates. Its leaves provide a substantial source of protein (17.5–18.3%), rich in lysine, an amino acid often lacking in cereal-based diets. Amaranth is high in essential vitamins and minerals such as pro-vitamin A, C, K and folate, surpassing spinach and lettuce in calcium, iron and niacin content. It also contains antioxidant-rich compounds like phenolic compounds and quercetin, which help prevent diseases like cancer and heart conditions. Amaranth's high fiber content is beneficial for digestive health.

Basella (*Basella alba*): This tropical leafy vegetable is high in vitamins A, C and B and minerals like calcium, magnesium and iron. *Basella* is also rich in essential amino acids and contains low levels of soluble oxalates. It offers multiple health benefits such as anti-diabetic, anti-inflammatory and antioxidant properties, thanks to phytochemicals like β -sitosterol and lupeol.

Cluster Bean (*Cyamopsis tetragonoloba*): Cluster bean is a drought-tolerant legume with deep-rooted growth, playing a key role in soil enrichment due to its nitrogen-fixing abilities. It has a short life cycle (90-110 days) and provides industrial value, including its use in the shale gas industry. Cluster beans are low input, requiring minimal resources for cultivation and yield higher in irrigated fields (12-15 quintals/ha).

Moringa (*Moringa oleifera*): Moringa, or drumstick, is a tropical tree known for its nutritional richness and medicinal properties. Its leaves are consumed fresh, cooked, or powdered, maintaining high nutrient levels. Moringa is used in traditional medicine for treating various ailments, including skin infections, asthma and digestive disorders. It also boasts antioxidant, anti-diabetic and anti-hypertensive properties.

Ivy Gourd (*Coccinia grandis*): Ivy gourd, also known as kundru, is a rich source of lycopene and β -carotene. It is recognized for its antioxidant properties and is commonly used in Ayurveda to treat skin issues and earaches. Its leaves contain protein and vitamin A, supporting its role as a health-boosting vegetable.

Vegetable Soybean (*Glycine max*): Vegetable soybean, also called green soybean, is gaining popularity for its protein, fiber and omega-3 fatty acid content. Known as a functional food, it supports heart health and reduces cancer risks. It is a complete protein, offering all essential amino acids, making it comparable to meat, dairy and eggs.

Winged Bean (*Psophocarpus tetragonolobus*): Widely grown in tropical regions, winged bean is a nutritious legume that is entirely edible, from its leaves to its seeds. It is rich in protein (up to 35% in seeds) and fat (18%). Its high niacin content helps reduce cardiovascular disease risks. Winged bean is particularly valued for its versatility and high nutritional value.

Tree Tomato (*Cyphomandra betacea*): Tree tomato is a perennial shrub grown in regions like Meghalaya and Sikkim. It produces egg-shaped berries in various colors, with a distinct flavor. Often consumed in chutneys or as roasted fruit, it is appreciated for its unique taste and high nutritional value.

Chow-Chow (*Sechium edule*): Chow-chow, or squash, is a versatile vegetable grown in the Northeastern Hill regions of India. It has starchy roots and edible fruits, thriving in high-altitude areas. This vegetable is known for its crisp texture and minimal care requirements.

Kakrol and Kartoli: These vegetables are rich in nutrients and medicinal properties. Their immature fruits are commonly cooked and their leaves, flowers and seeds are also edible. Known for their astringent properties, they are used in treating chest ailments and promoting urinary discharge, particularly in the Northeastern regions.

Jack Bean (*Canavalia ensiformis*): Primarily cultivated in the Northeastern region, jack bean is a bushy herb known for its nutrient-rich green pods, which are cooked as a vegetable. Its seeds are highly nutritious and provide significant protein.

Sword Bean (*Canavalia gladiata*): Sword bean is both a vegetable and a medicinal plant, with its red and black varieties being particularly high in antioxidants due to their phenolic content. The beans are used for their health benefits, including promoting digestion and combating oxidative stress.

Tree Bean (*Parkia roxburghii*) Tree bean is widely cultivated in the Northeastern region, producing pods with a high nutritional value. These pods are consumed fresh or processed and are commonly used in local cuisines.

Yard Long Bean (*Vigna unguiculata*): This climbing legume is widely cultivated in the NEH region and is consumed for both its immature pods and tender leaves. Its long, fleshy pods are a popular addition to various dishes.

Lai Sag (Mustard Leaves) (*Brassica juncea*): Mustard leaves, or Lai Sag, are rich in vitamins E, C and beta-carotene. These leaves are commonly consumed and dried for use during the rainy season, offering a significant nutritional boost with minerals such as calcium, iron and magnesium.

Snake Gourd (*Trichosanthes cucumerina*): This tropical and subtropical vine is cultivated for culinary and medicinal purposes. Snake gourd's soft, mucilaginous fruit is used in various dishes and it offers health benefits due to its high content of fiber and antioxidants.

Rice Bean (*Vigna umbellata*): Rice bean is a leguminous vine with yellow flowers and is grown as a minor crop or fodder. Rich in protein and essential amino acids, it is mainly harvested for its pulses and also used for vegetables.

Pigeon Pea (*Cajanus cajan*): Pigeon pea is a drought-tolerant legume commonly grown across India. It is a hardy plant that thrives in hot, acidic soils and is known for its high yield of green pods, which are used in a variety of dishes.

Bamboo Shoots: Bamboo shoots are harvested from fast-growing bamboo species and are widely used as a vegetable. Rich in nutrients, they are especially popular in the NEH region for their tender texture and are used in soups and stir-fries.

Water Chestnut (*Trapa bicornis*): Water chestnut, also known as Singhara, is a submersed plant with edible nuts rich in protein, starch and fiber. It is cultivated in waterlogged areas and provides income to local farmers through its harvest.

Indian Lotus (*Nelumbo nucifera*): The rhizomes of the Indian lotus are consumed after boiling or frying and are sold as vegetables. Rich in moisture, protein and minerals, they are used in traditional dishes and contribute to various health benefits.

Water Spinach (*Ipomoea aquatica*): Water spinach, or Kalmi Sag, is an aquatic plant consumed for its high nutrient content, including carotene and vitamins. It is also used as feed for fish and poultry and provides significant antioxidant properties.

Leafy Chenopod (*Chenopodium album*): Leafy chenopod is a nutritious leafy vegetable rich in dietary fiber, protein and essential minerals. It is gaining popularity for its potential to address nutritional deficiencies and support sustainable agriculture.

Challenges in Developing Underutilized Vegetable Crops

Lack of Awareness: Many farmers are unaware of the nutritional and medicinal advantages offered by underutilized vegetable crops.

Limited Research: There is a shortage of focused research on these crops, hindering their potential.

Inadequate Seeds and Planting Materials: A lack of appropriate seeds and quality planting materials is a major challenge in cultivating these crops.

Outdated Farming Methods: The use of traditional farming techniques limits the efficient production of underutilized vegetables.

Limited Adoption of Modern Technologies: Innovative farming technologies, such as biotechnology and plasticulture, are underutilized, restricting productivity growth.

Inadequate Post-Harvest Management Knowledge: Farmers often lack knowledge on effective post-harvest techniques, leading to spoilage and waste.

Weak Marketing and Infrastructure: There is insufficient infrastructure for transportation, storage and processing, limiting the reach of these crops to broader markets.

Low Recognition in Horticultural Programs: These crops often fail to receive attention in government and horticultural promotion programs.

Weak Institutional Support: The lack of strong institutional frameworks and minimal involvement from financial institutions impedes the development of agro-industries and horticultural units for underutilized vegetables.

Strategies for Advancing Underutilized Vegetable Crops

The absence of comprehensive documentation on these crops restricts the development of effective strategies and policies. A multifaceted approach is essential, viewing these crops as both agricultural commodities and valuable components of agro-ecosystem diversity.

Historically, agricultural modernization involved shifting preferences for crops based on farmers' needs, like the replacement of small millets with maize. Future research should prioritize crop improvement through modern breeding methods and biotechnological innovations, similar to the approach used for staple crops. Advances in plant genomics and molecular tools, such as genome sequencing, can facilitate faster crop breeding processes.

Research efforts should focus on sequencing the genomes of important underutilized crops, applying cutting-edge techniques to enhance their commercial viability. The development of these crops should focus on the intersection of agriculture, environmental sustainability and human health, where their potential impact is the highest. Most of the current understanding of these crops' benefits is based on anecdotal evidence, so robust scientific research is needed to investigate their nutrient content, yield, water productivity and nutrient bioavailability.

Research Challenges and Opportunities

To address the challenges of research and development, it is crucial to focus on how conservation and utilization can work together to preserve the genetic diversity of these crops. This approach will vary depending on the propagation method and breeding traits of each crop, but there are key questions to explore: What is the minimum size needed for ex situ conservation to preserve genetic diversity and how can this be maintained cost-effectively? Additionally, how can we monitor and sustain diversity within production systems? Securing resources through collaborations among farmers, consumers and various sectors will be essential to ensure long-term sustainability.

The use of modern technologies, such as molecular genetics and Geographic Information Systems (GIS), will play a critical role in developing effective conservation strategies. Engaging local communities in managing and utilizing these crops is vital for addressing production-related challenges and supporting the integration of new materials and techniques.

Conclusion

Underutilized vegetable crops have significant potential to address nutritional deficiencies and promote health, especially in combating lifestyle-related diseases. Focused research on their domestication and use is essential to unlock their nutritional benefits. Expanding the cultivation of these crops will enhance food security, reduce the need for imports and open up opportunities for export, contributing positively to local economies. Additionally, these crops can generate jobs in the agro-industry, including in sectors such as packaging, storage, preservation, canning and transportation. Investing in their development can lead to a more sustainable and diversified agricultural landscape.