

Winged Bean (*Psophocarpus tetragonolobus*): An Underutilized Vegetable Crop with High Nutritional Potential

*Anitha S, Sreeja S, Anto Jeya Priya P and JeySri P

Department of Horticulture, Faculty of Agriculture, Annamalai University,
Chidambaram, Cuddalore, Tamil Nadu, India

*Corresponding Author's email: anithashanmugavel23@gmail.com

Winged bean (*Psophocarpus tetragonolobus* (L.) DC.) is a nutritious yet underexploited leguminous vegetable belonging to the family Fabaceae. It is considered native to the tropical regions of Papua New Guinea or the Indo-Malayan region and is now grown in many tropical countries, including India, Sri Lanka, Malaysia, Indonesia, Thailand, and the Philippines. The crop is unique because almost every part of the plant can be consumed. Its young pods, tender leaves, flowers, immature and mature seeds, as well as tuberous roots, are edible, making it one of the most versatile vegetable crops. Owing to this exceptional usefulness, winged bean is often described as a "one-species supermarket." Winged bean is recognised for its excellent nutritional quality. It provides high levels of protein, dietary fibre, essential vitamins such as A and C, and minerals including calcium, iron, and phosphorus. The mature seeds contain substantial amounts of protein and edible oil, with a nutritional composition similar to soybean, making the crop an important alternative source of plant-based protein. The crop performs well in warm and humid tropical environments. Like other legumes, winged bean establishes a symbiotic relationship with *Rhizobium* bacteria that enables atmospheric nitrogen fixation.



This natural process enhances soil fertility, lowers the requirement for nitrogen fertilisers, and supports environmentally sustainable farming systems. Although winged bean possesses remarkable nutritional, agricultural, and economic value, it continues to receive limited attention in commercial cultivation. Low public awareness, insufficient research and breeding efforts, limited availability of improved cultivars, and weak market development have restricted its wider adoption. Increasing the cultivation and utilisation of winged bean can contribute significantly to sustainable agriculture, crop diversification, improved nutritional security, and enhanced livelihoods for smallholder farmers.

Botanical Description

Winged bean (*Psophocarpus tetragonolobus*) is a vigorous, climbing leguminous plant grown mainly in tropical regions. It is valued because almost every part of the plant is edible and nutritious.

Growth habit: It is an annual, herbaceous vine that grows rapidly and may reach a height of 3–4 metres when provided with suitable support such as stakes, trellises, or fences.

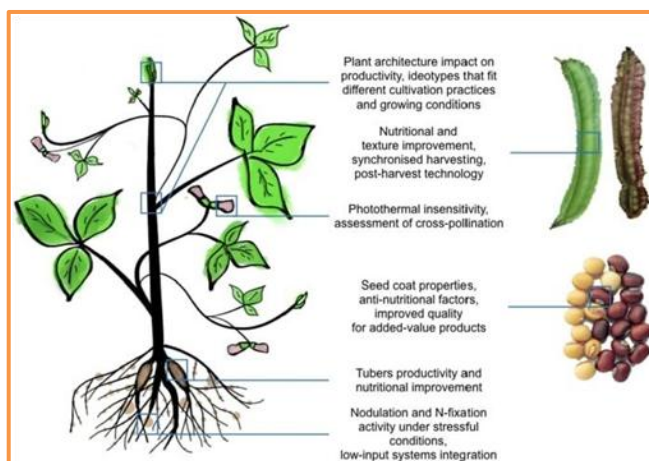
Stem: The stem is slender, green, and twining in nature, allowing the plant to climb by wrapping around nearby supports.

Leaves: The leaves are trifoliate, with each leaf consisting of three broad, green leaflets that are generally triangular to ovate in shape.

Flowers: The flowers are attractive and resemble those of other legumes. They are butterfly-shaped and are usually pale blue, light purple, or occasionally white.

Pods: The immature pods are long, tender, and green, with four prominent wavy ridges or wing-like extensions running along their length, which give the crop its common name, "winged bean."

Seeds and roots: Mature pods contain several rounded seeds that vary in colour depending on the variety. The plant also develops swollen, tuberous roots that are edible and serve as an additional source of nutrients.



Agronomic Characteristics

Growth habit

Winged bean is a vigorous, herbaceous climbing legume with a twining growth habit. It is generally cultivated as an annual crop, although it can behave as a perennial under favourable tropical conditions. With proper support, the vines can grow up to 2–4 m in length.

Climate requirement

The crop is well adapted to warm and humid tropical environments. It performs best under high temperature conditions with adequate rainfall and does not tolerate frost or extended periods of low temperature. It is commonly grown in tropical regions of Asia, Africa, and other humid areas.

Soil requirement

Winged bean can be cultivated in different soil types, ranging from light sandy loam to heavier soils. However, it grows optimally in fertile, well-drained soils with sufficient moisture and a slightly acidic to neutral pH. Poor drainage and prolonged water stress negatively affect plant growth and productivity.

Photoperiod and flowering behaviour

Many traditional winged bean varieties are short-day plants, requiring shorter day lengths for flowering. This photoperiod sensitivity limits cultivation in certain regions. Improved day-neutral varieties have been developed that can flower under a wider range of environmental conditions.

Root system and tuber development

The plant develops a relatively shallow root system mainly for support and nutrient absorption. It also produces a swollen tuberous root that stores carbohydrates and proteins. These edible tubers increase the crop's value as a multipurpose food source.

Nitrogen fixation and fertilizer requirement

Being a leguminous crop, winged bean forms root nodules with *Rhizobium* bacteria and fixes atmospheric nitrogen. This improves soil fertility and reduces dependence on nitrogen

fertilizers. Application of phosphorus and potassium may be beneficial depending on soil nutrient status.

Yield potential

Winged bean has high productivity potential and provides multiple edible products, including pods, leaves, flowers, seeds, and tubers. Tender pods are usually ready for harvesting around 70–90 days after sowing, and harvesting can continue for an extended period under suitable management.

Pest and disease tolerance

Winged bean is considered a hardy crop with comparatively fewer major pest and disease problems. However, insect pests such as pod borers and other local pests may affect production. Regular field monitoring and proper crop management help reduce damage.

Cropping system suitability

The climbing nature of winged bean makes it suitable for small farms, kitchen gardens, and mixed cropping systems. It can be trained on supports such as poles, fences, or trees. Its ability to fix nitrogen and provide food products for a long duration makes it a valuable component of sustainable farming systems.

Uses

Winged bean is a highly versatile tropical leguminous crop with several edible and agricultural uses. The young tender pods are commonly consumed as a vegetable in various preparations such as curries, stir-fries, soups, salads, and traditional dishes. Immature seeds can be used as a substitute for green peas, while fully matured seeds serve as a valuable pulse and can be processed into products like flour, plant-based milk, tofu, fermented foods, and roasted snacks. The young leaves and shoots are used as leafy vegetables, and the attractive flowers can be consumed or utilized as a natural colouring source. The underground tuberous roots are also edible and can be cooked similarly to other root vegetables, providing additional nutritional value due to their protein content. Besides human food uses, the crop residues, foliage, and seed by-products can be used as animal feed. As a nitrogen-fixing legume, winged bean contributes to soil fertility improvement and is suitable for sustainable farming practices, including intercropping and small-scale agricultural systems.

Why it is underutilized

Winged bean is considered an underutilized crop because, despite its excellent nutritional value and ability to provide multiple food products, its cultivation and consumption remain limited compared with major legume crops. Several factors contribute to its lower adoption, including inadequate awareness among farmers, consumers, and stakeholders regarding its nutritional benefits and diverse uses. The crop has received limited attention in breeding programmes, resulting in fewer improved varieties with desirable traits such as high yield, better adaptation, and reduced sensitivity to day length. Traditional varieties often require specific photoperiod conditions for flowering, which restricts their cultivation in some regions. In addition, the presence of certain anti-nutritional compounds in raw seeds requires appropriate processing methods before consumption, creating challenges for wider acceptance and commercialization. Poor market development, limited processing facilities, lack of value-added products, and weak supply chains further reduce its economic importance. Compared with widely cultivated legumes such as soybean and common bean, winged bean has received less research support, extension services, and promotion, resulting in its continued status as an overlooked but valuable crop.

Constraints in Cultivation

The cultivation of winged bean is limited by several environmental, biological, and management-related challenges that restrict its large-scale adoption. The crop requires warm and humid climatic conditions with adequate rainfall, making it less suitable for dry areas and regions with low temperatures. Many traditional varieties show sensitivity to day length, particularly short-day flowering behaviour, which affects their adaptation and productivity in

different locations. The crop also has a long growth period and a vigorous climbing nature, requiring proper support systems such as staking or trellising, which increases labour requirements and makes mechanical operations and uniform harvesting difficult. The seeds contain certain anti-nutritional compounds that require suitable processing methods before consumption. Early plant growth may be affected by drought stress, poor establishment, and pests such as pod borers and nematodes. Furthermore, limited availability of improved varieties, insufficient production technologies, weak market networks, and inadequate processing facilities reduce farmer acceptance and restrict the commercial cultivation of winged bean.

Future Scope

Winged bean has considerable potential for future development, particularly in tropical and subtropical regions where conditions are favourable for its growth. Due to its rich nutritional composition, including high-quality protein, vitamins, minerals, and dietary fibre, it can play an important role in improving food and nutritional security. The ability of the crop to produce edible pods, leaves, seeds, and tubers makes it a valuable multipurpose vegetable and protein source. Its nitrogen-fixing capacity and adaptability to warm climates make it suitable for sustainable agriculture, organic farming, home gardens, intercropping, and low-input production systems while also contributing to soil fertility improvement. The existing genetic diversity of winged bean provides opportunities for developing improved varieties with early maturity, higher yield, wider adaptability, reduced anti-nutritional factors, and better suitability for commercial cultivation. There is also great potential for processing and utilization of winged bean in the production of value-added products such as flour, plant-based milk, tofu, snacks, and functional food products. With increased research efforts, farmer awareness, improved cultivation practices, and stronger market support, winged bean can become an important crop for sustainable food production and nutritional improvement in tropical regions.

Research Needs

To enhance the cultivation and utilization of winged bean, comprehensive research efforts are required in various areas. Development of superior varieties with improved yield, early harvestability, broad environmental adaptation, day-neutral flowering, and lower levels of anti-nutritional compounds should be given importance. Genetic improvement through breeding programmes and advanced biotechnological tools can help in developing cultivars with better nutritional quality and tolerance to pests and diseases. Research on crop production techniques, including suitable planting time, spacing, nutrient requirements, irrigation management, and cropping systems, is essential to increase productivity and profitability. Greater attention is also needed towards post-harvest handling, preservation, and processing methods to reduce losses and improve utilization of pods, seeds, and tubers. Studies on value addition and development of innovative products such as protein supplements, flour-based foods, plant-derived beverages, and functional food products can create new market opportunities. Further investigation into its nutritional properties, bioactive components, and health-promoting effects will support consumer acceptance. Establishing effective seed supply systems, improving farmer awareness through extension programmes, and developing strong marketing channels are important steps for promoting wider cultivation and commercialization of winged bean.

Conclusion

Winged bean (*Psophocarpus tetragonolobus*) is an important yet neglected tropical legume that has significant potential as a versatile and nutritious crop. Since different parts of the plant, including young pods, leaves, flowers, seeds, and roots, can be utilized as food, it can contribute greatly to dietary improvement and food security. Its ability to fix atmospheric nitrogen, grow well under tropical conditions, and support sustainable agricultural practices adds to its importance in farming systems. Despite these advantages, its cultivation remains

limited due to insufficient awareness, limited availability of improved cultivars, production challenges, poor market development, and inadequate research attention. Promoting crop improvement programmes, refining cultivation practices, encouraging value addition, and creating awareness among farmers and consumers are essential for wider adoption. With continued research and proper promotion, winged bean has the potential to become a valuable crop for sustainable production and future nutritional needs.

References

1. National Research Council. (1981). *The Winged Bean: A High-Protein Crop for the Tropics*. National Academy Press, Washington, D.C., USA.
2. Khan, T. N. (1976). Winged bean (*Psophocarpus tetragonolobus*): A high protein crop for the tropics. *Economic Botany*, 30, 169–174.
3. Vietmeyer, N. D. (1986). *Lesser-Known Plants of Potential Use in Agriculture and Forestry*. National Academy Press, Washington, D.C.
4. Claydon, A. (1978). The winged bean (*Psophocarpus tetragonolobus*): A review of its potential as a food crop. *Plant Foods for Human Nutrition*, 28, 273–280.
5. Nwokolo, E. (1987). A nutritional assessment of the winged bean (*Psophocarpus tetragonolobus*). *Food Chemistry*, 25, 295–304.
6. Mohanty, S. N., & Das, P. (1988). Nutritional quality and utilization of winged bean seeds. *Journal of Agricultural and Food Chemistry*, 36, 1026–1029.
7. Lawn, R. J., & Imrie, B. C. (1991). The importance of winged bean in tropical agriculture and its potential for improvement. *Field Crops Research*, 26, 1–14.
8. Khan, T. N., & Young, G. (1989). Winged bean production and utilization in tropical regions. *FAO Plant Production and Protection Paper*.
9. Maxted, N., & Bennett, S. J. (2001). *Plant Genetic Resources of Legumes in the Tropics*. International Plant Genetic Resources Institute (IPGRI).
10. Prosea (1997). *Plant Resources of South-East Asia No. 11: Auxiliary Plants*. Backhuys Publishers, Leiden, Netherlands.