



From Root to Pod: The All-in-One Power of Winged Bean

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INTRODUCTION

Winged bean [*Psophocarpus tetragonolobus* (L.) DC.] in the contemporary landscape of agriculture shaped by climate variability, resource constraints and nutritional insecurity the need for resilient, multifunctional crops has never been more urgent. Among the lesser-known yet highly promising legumes, Winged bean has emerged as a remarkable candidate capable of addressing multiple challenges simultaneously. Often described as a “complete plant,” winged bean is unique in that every part of it roots, leaves, flowers, pods and seeds is edible and nutritionally valuable. Despite its extraordinary potential and remains underutilized and largely confined to traditional farming systems in tropical regions and its role as a nutrient-dense, climate-resilient and agronomically versatile crop, making it highly relevant for sustainable agriculture and diversified food systems.

Botanical Description and Growth Characteristics

Winged bean [*Psophocarpus tetragonolobus* (L.) DC.] is a vigorous, climbing legume belonging to the family Fabaceae, typically grown as an annual in tropical and subtropical regions. The plant exhibits a twining growth habit, often reaching 2-4 meters in length and requires staking or support for optimal development. It bears trifoliolate leaves resembling those of soybean, and produces attractive blue, purple, or white flowers that are largely self-pollinated. The most distinctive feature of winged bean is its quadrangular pods with frilled “wings” along the margins, which are harvested at a tender stage for vegetable use. The seeds are round, oil- and protein-rich, while the plant also develops underground tuberous roots that store carbohydrates and appreciable amounts of protein.

Nutritional Profile: A Functional Food Crop

Winged bean is often referred to as a “supermarket on a stalk” due to its exceptional nutritional composition. Each plant part contributes uniquely to dietary requirements. The tender pods are rich in vitamins A and C, calcium, iron and dietary fiber consumed as a green vegetable. The young leaves and flowers also contribute significant amounts of protein, minerals, and antioxidants, enhancing their value in human diets. The seeds are particularly noteworthy, containing about 30–40% protein and 15–20% oil, with a favorable amino acid profile similar to soybean. Uniquely, the crop produces tuberous roots that contain around 15–20% protein along with carbohydrates and essential nutrients, a rare feature among root crops. Winged bean as an important crop for addressing protein-energy malnutrition and improving dietary diversity, especially in tropical and resource-limited regions.

Agroecological Adaptation and Climate Resilience

Winged bean is well adapted to tropical and subtropical agroecosystems, demonstrating remarkable resilience under diverse environmental conditions. It thrives best at temperatures between 25–35°C. The crop grows successfully in a wide range of soils, including sandy, loamy and moderately acidic soils, provided drainage is adequate and its ability to fix atmospheric nitrogen through symbiosis with *Rhizobium*, thereby improving soil fertility. Its vigorous vegetative growth and high biomass production contribute to soil organic matter and erosion control and enhancing its potential as a climate-resilient crop suitable for sustainable and low-input farming systems.

Agronomic Practices for Farmers

- **Land Preparation and Sowing** -Well-drained soils with good tilth are ideal. Seeds are sown directly at a spacing of 60–75 cm between rows and 30–45 cm between plants.
- **Support System** -Trellising or staking is essential to support vine growth, improve aeration and facilitate harvesting.
- **Nutrient Management** -Although winged bean fixes atmospheric nitrogen, the application of 40–60 kg phosphorus per hectare enhances nodulation and root development

- **Irrigation** -The crop responds positively to irrigation during flowering and pod formation, though it can withstand intermittent drought.
- **Weed and Pest Management** -Early weeding is crucial. Common pests include aphids and pod borers, which can be managed through integrated pest management (IPM) practices.

From Root to Pod: Multifunctional Utility

Winged bean exemplifies a truly multifunctional crop, offering valuable outputs from nearly every part of the plant from root to pod. The tender, four-winged pods are consumed as a nutritious vegetable, while the young leaves and shoots serve as protein-rich leafy greens. Its flowers are also edible and used in traditional dishes, adding both color and nutrition. The mature seeds, comparable to soybean in composition, provide a rich source of protein and oil, making them suitable for pulse and processed food uses. Uniquely among legumes, winged bean also produces underground tubers that are edible and contain appreciable amounts of protein along with carbohydrates. In addition to its role in human nutrition, the crop serves as excellent fodder for livestock and functions as a green manure, enhancing soil fertility through biological nitrogen fixation. This remarkable versatility allows farmers to derive multiple benefits from a single crop cycle, making winged bean an ideal component of sustainable and diversified farming systems. This “all-in-one” utility makes winged bean an ideal crop for nutritional gardens, smallholder farms, and diversified cropping systems.

Economic Potential and Farming System Integration

Winged bean holds considerable economic potential owing to its multipurpose nature and suitability for low-input agriculture. Farmers can derive income from multiple harvestable components tender pods, leaves, seeds and even protein-rich tubers ensuring diversified returns throughout the crop cycle. In farming systems, winged bean integrates seamlessly as an intercrop with cereals, fruit crops, and plantation systems, efficiently utilizing vertical space through its climbing habit. It also fits well into kitchen gardens, organic farming and agroforestry models, contributing to soil fertility, improved nutrient cycling and

sustainable land use. Its integration into farming systems can improve resource-use efficiency, farm income stability and resilience to climate shocks.

Constraints and Challenges

- Limited availability of improved and uniform varieties
- Photoperiod sensitivity affecting yield stability
- Lack of awareness among farmers and consumers
- Inadequate seed systems and market linkages
- Limited mechanization for cultivation and harvesting

Future Prospects

With increasing emphasis on sustainable agriculture, nutritional security and climate resilience, winged bean holds immense promise. Its ability to produce multiple nutrient-rich products from a single crop aligns well with modern agricultural goals. The

development of improved varieties, promotion through extension programs and inclusion in value-added food products can significantly enhance its adoption. Additionally, its potential role in urban agriculture, agroforestry and climate-smart farming systems opens new avenues for expansion.

CONCLUSION

Winged bean exemplifies the concept of a multifunctional, resource-efficient crop capable of addressing diverse agricultural and nutritional challenges. Its unique ability to provide edible products from root to pod, combined with its adaptability to low-input conditions, makes it a valuable asset for sustainable farming systems. For farmers, it offers a pathway to diversified income and improved food security. As the global agricultural community seeks resilient and nutritious crops for the future, winged bean stands poised to transition from an underutilized species to a cornerstone of next-generation farming systems.