Moth Bean: The Resilient Orphan Legume Promoting Sustainability in Arid Regions

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Moth bean, scientifically known as *Vigna aconitifolia*, is a lesser-known legume valued for its protein-rich seeds and versatility in various agricultural roles. It is native to the Indian subcontinent and has adapted well to regions with low and erratic rainfall. Moth bean is grown extensively in India, particularly in states like Rajasthan, Gujarat, and Maharashtra, where arid conditions prevail. The crop is also cultivated in parts of Africa, Southeast Asia, and Australia. In India, moth bean is cultivated on approximately 0.98 million hectares, with Rajasthan being the largest producer followed by Gujarat and Maharashtra. Globally, India is the leading producer of moth bean, accounting for a significant portion of the world's production. Moth bean is known for its ability to thrive under adverse environmental conditions. Average yield varies but can reach up to 600 kg per hectare under optimal management practices. Its short duration of 70-90 days from sowing to harvest makes it an attractive crop for farmers in areas with limited water availability and short growing seasons.

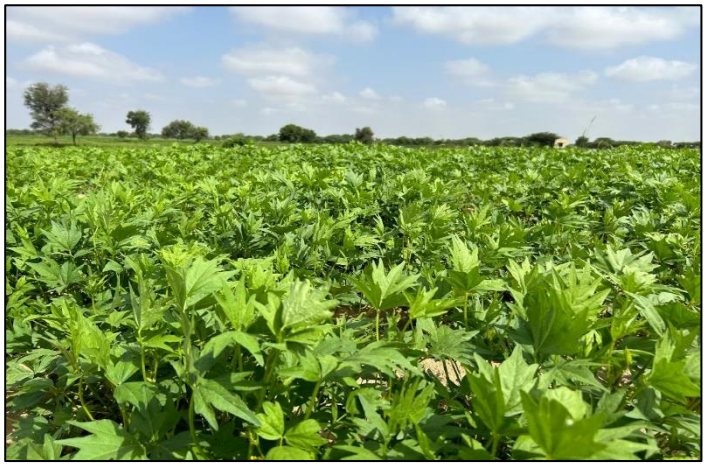

Fig 1 Harvest of Resilience: Moth Bean Crop Stands Strong on Sand Dunes

Moth bean is not only consumed as a nutritious food in the form of seeds, sprouts, and vegetable pods but also serves as crucial feed for livestock and as a cover crop for improving soil fertility. Its ability to grow under harsh conditions, with minimal water and in high temperatures up to 40°C, makes it exceptionally resilient against drought and heat stress. Despite these advantages, moth bean is underutilized and its cultivation has decreased in recent years due to challenges like low yield, slow growth, and limited genetic variability. This article highlights the potential of moth bean in sustainable agriculture and emphasizes the need for further research and development to fully exploit its agronomic, genetic, and nutritional benefits amidst global agricultural challenges.

Nutritional profile of Moth bean

Moth bean is a versatile legume primarily consumed in arid and semi-arid regions of South Asia, especially in India. Its seeds are used in various culinary preparations such as dal (stew), bhujia (snack), papad, mangori, rabri, and vada (fritters). The seeds can also be ground into flour for making bread and are valued for their medicinal properties in treating fevers. Moth bean seeds are rich in protein (20-24%), particularly lysine and leucine, which are essential amino acids often lacking in cereals, thus complementing vegetarian diets. They are also a good source of carbohydrates, fats, fiber, and essential minerals and vitamins like calcium, iron, phosphorus, potassium, niacin, thiamine, and riboflavin. However, moth bean contains anti-nutritional factors such as phytic acid, trypsin inhibitors, and saponins, which can affect nutrient absorption and digestibility. Techniques like soaking, sprouting, and cooking help mitigate these factors and improve nutrient bioavailability. Despite its nutritional benefits, moth bean remains underutilized, and more research is needed to explore its potential health benefits and promote its consumption to combat malnutrition in developing nations.

Moth bean: An excellent fodder for animals

Moth bean is a valuable fodder crop, particularly suited to arid and semi-arid regions. One of the key advantages of moth bean as a fodder crop is its high nutritional value. The forage contains moderate protein levels (9-17% dry matter), comparable to other leguminous forages like cowpea and black gram. Additionally, it has high ash content (13-18% dry matter), which is beneficial for livestock nutrition. The palatability of moth bean forage is generally high, ensuring its readily consumption by

livestock, which can lead to improved health and productivity. The digestibility of moth bean forage is comparable to that of alfalfa hay, which is a standard high-quality forage. For instance, the in vitro organic matter digestibility of moth bean forage is slightly lower but nearly equivalent to that of alfalfa, making it a valuable feed option for animals (Sherasia et al., 2017). Moth bean forage is highly palatable, ensuring high feed intake levels, which correlates with better growth performance. Livestock fed with moth bean forage have shown a positive nitrogen, calcium, and phosphorus balance, crucial for overall health, exhibited higher dry matter intake and live weight gain along with efficient nutrient utilization and enhanced growth (Mathur et al., 2005; Nehra et al., 2018). These studies highlight the significant benefits of incorporating moth bean forage into livestock diets, demonstrating its potential to enhance animal performance and support sustainable agricultural practices.

Table1: Nutritional composition of moth bean fodder (adapted from feedipedia)

Main analysis	Unit	
Dry matter	% as fed	89.6-96.2
Crude protein	% DM	21.3-28.4
Crude fibre	% DM	4.3-5.6
Neutral detergent fibre	% DM	13.1
Acid detergent fibre	% DM	6.5
Ether extract	% DM	0.6-5.3
Ash	% DM	2.8-5.6
Starch (polarimetry)	% DM	47.9
Total sugars	% DM	7.5
Gross energy	MJ/kg DM	18.4
Minerals		
Calcium	g/kg DM	2.3-3.6
Phosphorus	g/kg DM	1.4-4.7
Potassium	g/kg DM	3.4-24.5
Sodium	g/kg DM	0.25-0.37
Magnesium	g/kg DM	1.4-2.6
Manganese	mg/kg DM	9.0-32.0
Zinc	mg/kg DM	12.0-75.0
Copper	mg/kg DM	5.0-18.0
Iron	mg/kg DM	65-203

Moth Bean: A crop for soil conservation

Moth bean is a resilient legume known for its adaptability to arid and semi-arid environments. This crop not only serves as an excellent fodder but also plays a significant role in soil conservation and enhancement of soil fertility, making it an invaluable asset for sustainable agriculture, particularly in regions with poor soil quality. Moth bean has a dense, mat-like leaf cover that effectively protects the soil from erosion. The coverage provided by the plant helps in reducing the velocity of surface runoff, thus minimizing the loss of topsoil during heavy rains. The low-lying, dense foliage of moth bean helps in keeping the soil cool and moist by reducing direct exposure to sunlight. This microclimate effect not only benefits the moth bean crop itself but also aids in maintaining soil structure and moisture levels, which are crucial for the growth of subsequent crops (Harsh et al., 2016). The natural BNF process enriches the soil with nitrogen, an essential nutrient for plant growth. Studies have shown that fields cultivated with moth bean exhibit higher nitrogen content, improving soil fertility for future planting cycles (Gupta et al., 2016). The incorporation of moth bean residue or its green manure into the soil enhances its organic carbon content, which improves soil structure, water retention, and microbial activity.

Fig 2 Golden Maturity: Moth Beans Ready for Harvest in the Heart of the Desert

This practice has been documented to enhance soil fertility, particularly in marginal lands with low organic matter (Brink et al., 2006). The deep root system of moth bean improves soil aeration and facilitates better water infiltration. This reduces soil compaction and promotes a healthy root environment for other crops. Enhanced soil aeration and water movement are critical for maintaining soil health and promoting sustainable agricultural practices (Sherasia et al., 2017). These physical improvements reduce soil compaction, fostering a more favorable environment for root growth. Biologically, moth bean enhances soil microbial activity by increasing organic matter content through its biomass when used as green manure. This organic matter serves as a substrate for soil microorganisms, boosting microbial

diversity and activity, which are crucial for nutrient cycling and soil health (Brink et al., 2006). Furthermore, the improved soil structure and moisture conditions support a more vibrant soil ecosystem, enhancing overall soil fertility and productivity (Harsh et al., 2016).

Fig. 3. Nature's Balance: Moth Bean and Pearl millet Intercropping, a Sustainable Duo

Conclusions

The cultivation of Moth bean represents a significant opportunity for enhancing agricultural sustainability in arid and semi-arid regions. As a hardy and resilient legume, Moth bean thrives under extreme conditions where other crops struggle, making it an invaluable asset for food security and soil health. Its ability to fix nitrogen improves soil fertility, reducing the need for chemical fertilizers and promoting eco-friendly farming practices. Moreover, the high nutritional value of Moth bean supports local diets and provides a reliable source of protein for communities. By integrating Moth bean into crop rotations and promoting its widespread adoption, we can foster resilient agricultural systems, conserve natural resources, and contribute to the global effort against climate change. In conclusion, Moth bean is not only a crop for today but a strategic investment in the sustainable future of agriculture in arid regions.

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Table 2: List of moth bean varieties with salient characteristics

Varieties	Maturity (days)	Yield (kg/ha)	Salient features
Type-1	120	200-300	It is medium-sized brownish-red seed with an average forage production of 10-14 q per ha
Type3	120	370-375	It produces 22-25 q/ha of green forage, has narrowly lobed leaves, and has a canopy that extends outward and trails horizontally.
Baleshwar-12	110-115	400-475	Plants are taller; green fodder yields 15–17 q/ha; seeds are brown and medium size; extremely vulnerable to YMV.
Jadia	85-90	450-500	It has a spreading growth habit, dark brown, medium bold seeds (l00-seed weight of 2.5-2.5g), is prone to YMV, and 10–12 q/ha of green fodder production.
Jawala	80-90	500-550	Resistant to YMV, with an average fodder yield of 17-18 q/ha.

RMO-257	80-90	500-550	Popular in Gujarat and Maharashtra for its good yield under rainfed conditions and moderate resistance to diseases.
ML-365	80-90	500-550	Developed by IARI, suitable for intercropping with other cereals and pulses
IC-01007	80-90	500-550	Known for its tolerance to high temperatures and water stress, making it suitable for hot arid regions.
FMM-96	58-60	500-700	Extra early variety, short statured, erect growth habit with synchronous maturity.
RMO-225	62-65	600-700	Semi-erect type, grain colour light brown, arid regions escapes drought and YMV infection, fodder yield 17-20 q ha^{-1}.
RMO-435	64-67	600-700	Escapes drought, resistance to YMV in field conditions, semi spreading growth habit, may yield 10-12% higher over RMO-2S7
Maru moth	80-85	500-550	Semi-spreading type, less affected by the *Cercospora* leaf spot disease, also suitable for intercropping
IPCMO-800	80-85	450-500	Vining type; has broad, deeply lobed leaves; seed protein is 22–24 percent; harvest index is 20–25
IPCMO 880	80-85	450-500	90-100 days duration; produces 3-4 pods per cluster with medium to bold seed (2.8-3.1 g/100 seeds); seed yield: 4-5 q/ha.
IPCMO-912	75-85	400-500	Field tolerance to YMV and bacterial blight, narrow leaflets.
RMO-423	67-70	550-600	Short duration high-yielding variety maturing in 67 to 70 days, resistant to YMV, has good fodder value
RMB-25	67-70	600-700	Early maturing, multi-clustered, semi spreading, field resistance against YMV, root rot, leaf crinkle virus and bacterial lead spot as well as distinct resistance against jassids and white flies
RMB-2251	63-67	500-600	Erect with 3 to 5 branches, suitable for mixed cropping, fodder remains green upto maturity, early maturity escapes terminal drought
CAZRI Moth-1	72-75	400-500	It is semi-spreading and dual-purpose variety, field resistance to YMV, bold grain with 25% protein
CAZRI Moth-2	75-85	1000-1200	This is the first variety produced through hybridization (RMO-40 x Jadia); erect plant habit and profuse podding.
CAZRI Moth-3	60-62	800-900	Very drought hardy, erect, bears pods heavily and early maturing, drought tolerant and escapes YMV

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