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Prospects and practices of vanilla (*Vanilla planifolia*) cultivation in Assam: A scientific review

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Abstract

Vanilla (*Vanilla planifolia* Andrews), a tropical orchid prized for its aromatic pods, ranks as the second-most expensive spice globally after saffron. It finds extensive use in the food, pharmaceutical, and cosmetic industries. Despite its global demand and high market value, vanilla cultivation remains underexplored in India due to challenges such as manual pollination, long gestation period, and post-harvest curing complexities. However, Assam, with its humid subtropical climate, diffused light under natural forest canopies, organic-rich soils, and year-round rainfall, provides an ideal agro-ecological niche for vanilla cultivation. This review evaluates the scientific, agronomic, and economic feasibility of promoting vanilla as a commercial crop in Assam. Economically, vanilla offers high returns, with yields of 300 to 600 kilogram cured beans per hectare potentially generating Rs 15-25 lakh annually, while initial input costs range between Rs 3-5 lakh. Intercropping with banana, ginger, or turmeric improves resource use efficiency and provides income during the crop's non-bearing phase. Field trials in Karbi Anglong and Jorhat have demonstrated successful adaptation of vanilla cultivation under scientific management, including use of support trees, organic inputs, and community-led curing techniques. The scope for vanilla cultivation in Assam is significant, particularly in tribal, forest-adjacent, and agro-forestry based systems. Vanilla can diversify farm income, promote export-oriented horticulture, and enhance livelihoods, especially for smallholders. However, constraints such as unavailability of planting material, labor for pollination, and limited processing infrastructure must be addressed. With proper scientific guidance, market linkages, and policy integration under horticulture and tribal development programs, Assam can emerge as a promising vanilla producing region in India.

Keywords: Chhani, consumption, fuel-wood, households, Lanchaan

Introduction

Vanilla (*Vanilla planifolia* Andrews) is a tropical climbing orchid renowned for its aromatic pods, which yield vanillin, an essential flavoring compound extensively used in food, beverages, cosmetics, and pharmaceuticals (Krishnan, 2017) ^[13]. Globally, vanilla is the second-most expensive spice after saffron due to its labor-intensive pollination and curing processes. Originally native to Mexico, where it is pollinated by endemic *Melipona* bees, vanilla cultivation has expanded to regions like Madagascar, Indonesia, and India through manual pollination (Bory *et al.*, 2008) ^[3]. In India, commercial production has been limited to the southern states of Kerala, Karnataka, and Tamil Nadu. However, inconsistent prices, high labor demands, and lack of organized market channels have restricted large-scale adoption (Krishnan, 2017) ^[13]. Assam, with its humid subtropical climate, high rainfall, rich organic soils, and natural tree cover, offers promising conditions for vanilla cultivation (Figure 1) (Gogoi & Dutta, 2023) ^[8]. The region's biodiversity, coupled with the presence of agro-forestry systems in tribal and hill areas, makes it a suitable candidate for promoting vanilla as a niche, high-value crop. Vanilla can also be integrated into existing cropping systems for income diversification and sustainable land use. This review aims to assess the scientific basis, agro-ecological feasibility, and economic potential of vanilla cultivation in Assam, while highlighting key challenges, recent trials, and future opportunities for scaling up production in the region.



Fig 1: Vanilla Cultivation Photo Credit: (Camerina Rabha, Prog. Farmer, Goalpara, Assam)

Agroclimatic Suitability of Assam for Vanilla Cultivation

Assam's agroclimatic conditions are highly favorable for the scientific cultivation of *Vanilla planifolia*, a crop that thrives in warm, humid, and partially shaded environments. The state lies in the Eastern Himalayan foothills and experiences a humid subtropical climate, with annual rainfall ranging from 1,800 to 2,500 mm high relative humidity (70–90%), and an average temperature range of 18 °C to 35 °C all ideal for vanilla growth and flowering (Singh *et al.*, 2021) [20]. Vanilla requires filtered sunlight, which can be naturally provided under tree canopies, making Assam's forest-fringe and hill regions particularly suitable. Soils in Assam primarily loamy to sandy loam, rich in organic matter and well-drained further support the growth of vanilla vines. The use of live support trees like *Gliricidia*, *Erythrina*, *Areca* nut and banana within agroforestry systems can optimize space and microclimate (Gogoi & Dutta, 2023) [8]. Regions such as Karbi Anglong, Dima Hasao, and parts of Upper Assam (Jorhat, Golaghat etc) have shown promising microclimatic adaptability. The integration of vanilla in existing agroforestry and tribal farming models holds potential for sustainable, high-value cultivation in the state.

Botanical Aspects of Vanilla

Vanilla planifolia Andrews is a perennial, herbaceous, climbing orchid belonging to the family Orchidaceae. It is the most commercially cultivated species among over 100 vanilla species worldwide. The plant exhibits monopodial growth, characterized by a fleshy, green, photosynthetic stem with adventitious aerial roots emerging from each node. These roots anchor the vine to support structures such as living trees, wooden stakes, or trellises (Bory *et al.*, 2008; Sreedhar *et al.*, 2020) [21]. Leaves are thick, leathery, alternate, and oblong lanceolate, playing an essential role in photosynthesis and moisture retention. Vanilla flowers are hermaphroditic and borne in axillary racemes. Despite containing both male (anther) and female (stigma) reproductive parts, natural pollination rarely occurs outside its native range due to the presence of a physical barrier the rostellum. As a result, hand pollination is essential in regions like India (Krishnan, 2017; Saji *et al.*, 2014) [13, 17]. Flowering begins 2–3 years after planting, and pods (capsules) mature in 6–9 months post-pollination. Each vine

can support 20–30 flowers per season, though only selected flowers are pollinated to prevent plant stress. Mature pods are odorless and flavorless until cured, a process that chemically transforms glucovanillin into vanillin—the principal flavor compound (Hegde, 2018; Saini & Sharma, 2022) [10, 16].

Propagation and Planting Techniques

Vanilla (*Vanilla planifolia*) is propagated vegetatively using stem cuttings, as seed germination is slow, erratic, and dependent on specific mycorrhizal fungi (Sreedhar *et al.*, 2020) [21]. Vegetative propagation ensures uniformity and early flowering. Cuttings of 60–120 cm in length with at least 5–10 nodes are ideal. The basal 3–4 nodes are defoliated, treated with fungicide (e.g., carbendazim 0.1%) to prevent rot, and air-cured for 2–3 days before planting (Krishnan, 2017; Das *et al.*, 2023) [13, 5]. Propagation is done under 50% shade using polybags or raised nursery beds until rooting. Transplanting to the main field is ideally timed with the onset of monsoon (May–June), which ensures sufficient moisture. Cuttings are planted near live supports like *Gliricidia sepium*, *Erythrina indica*, *Areca* nut or Banana. These species provide filtered light, necessary for vine development, and assist in natural microclimate regulation. A spacing of 2.5 × 1.5 meters is recommended to facilitate vine training and airflow. Vines are allowed to climb up to 1.5–2 meters and then looped downward to stimulate flowering. Regular mulching, organic manure, and shade regulation (around 50%) are critical for successful establishment and early growth (Bory *et al.*, 2008; Das *et al.*, 2023) [3, 5]. This propagation method has shown promising results in recent field trials in Assam.

Nutrient and Water Management

Scientific cultivation of vanilla requires a balanced approach to nutrient and water management, particularly under the humid subtropical conditions of Assam. Vanilla thrives in fertile, well-drained soils rich in organic matter. Incorporating organic inputs like compost, vermicompost, neem cake, and poultry manure improves soil structure and microbial health. Application of biofertilizers such as *Azospirillum*, *Phosphobacteria*, and *Trichoderma* enhances nutrient uptake and disease resistance. Vanilla is responsive to foliar applications of micronutrients such as zinc (Zn), magnesium (Mg), and iron (Fe), especially during the vegetative and flowering stages. Foliar sprays with 0.5% ZnSO₄ and FeSO₄ at 30-day intervals have shown improved vine vigor and pod yield (Krishnan, 2017; Sharma & Sarmah, 2023). Apply 40 – 60: 20 – 30: 60 – 100 g of NPK per vine per year. It is given in 2 to 3 splits. Spray 1% solution of 17: 17: 17 NPK mixture once in a month for boosting growth and flower production. (TNAU, 2021). Irrigation should be light and frequent. Drip irrigation is ideal for maintaining consistent soil moisture without water logging. Organic mulching conserves soil moisture and reduces weed growth under shaded canopies.

Pollination and Flowering Management: Vanilla (*Vanilla planifolia*) requires manual pollination (Figure 2) outside its native range, as natural pollinators are absent. In Assam, flowering begins 2–3 years after planting and occurs from February to April, lasting about 6–8 weeks. Each flower blooms for a single day, necessitating timely pollination—ideally before 11 a.m. Trained workers use a needle or

toothpick to lift the rostellum and press the anther and stigma together. Successful pollination results in 80–90% pod set (Das *et al.*, 2024; Sharma & Sarmah, 2023) [5, 19]. Daily monitoring is critical during peak flowering. Proper shade (50%), pruning, and adequate nutrients promote synchronized flowering and pod uniformity.

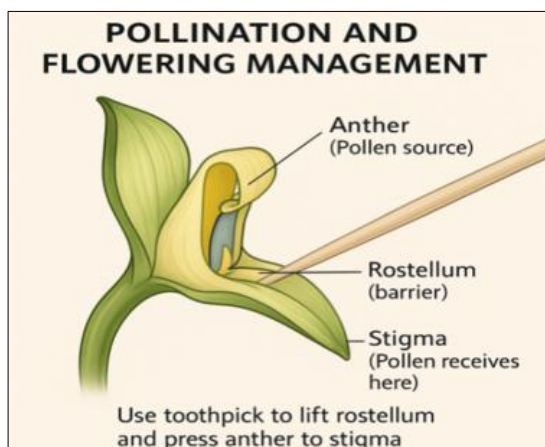


Fig 2: Diagram of Hand Pollination in Vanilla, Source: Internet

Table 1: Common Pests and Diseases of Vanilla and Their Control Measures

Problem	Causal Agent/Type	Symptoms	Control Measures
Aphids, Thrips	Sucking insects	Leaf curling, yellowing, stunted growth	Neem oil spray (3%), <i>B. bassiana</i> , yellow sticky traps
Flower Beetles	Insect pest	Feeding on buds and flowers	Hand collection, light traps, neem + soap spray
Root Rot	<i>Rhizoctonia solani</i>	Root decay, plant wilting	Good drainage, soil drenching with <i>Trichoderma viride</i>
Stem Rot	<i>Fusarium oxysporum</i>	Vine wilting, dark stem lesions	Fungicide dip (carbendazim 0.1%) for cuttings, <i>Trichoderma</i> bioagents
Anthrachnose	<i>Colletotrichum gloeosporioides</i>	Leaf/stem black lesions, defoliation	1% Bordeaux mixture, proper shade and sanitation

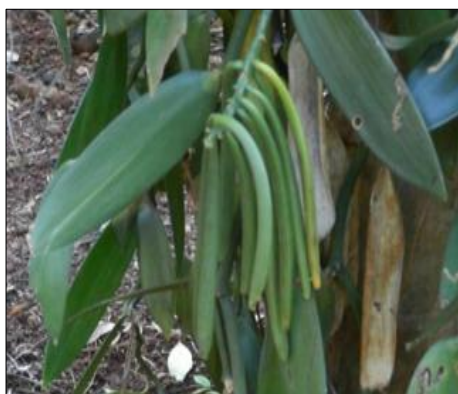


Fig 3: Vanilla Beans

Harvesting and Curing

Vanilla pods (Figure 3) are harvested 6–9 months after pollination, when the tips begin to yellow, indicating optimal maturity. Harvesting too early reduces vanillin content, while delayed harvesting increases the risk of pod splitting and microbial infestation (Kalita & Das, 2025) [12]. In Assam, harvesting typically occurs from October to December under protected shade-grown conditions.

The curing process is essential to transform raw, flavorless pods into aromatic vanilla. It comprises four key stages:

1. **Killing:** Pods are dipped in hot water (60–65 °C) for 2–3 minutes to arrest vegetative growth and initiate

Pests and Diseases

Vanilla cultivation in Assam is challenged by various pests and diseases that significantly impact vine health and pod yield. Among pests, sucking insects such as aphids and thrips are common, especially during dry months. These pests weaken the plant by extracting sap and act as vectors for viral infections. Vanilla flower beetles, a localized pest, feed on developing buds and flowers, reducing fruit set and marketable yield.

Diseases are primarily fungal in nature. Stem rot, caused by *Fusarium oxysporum*, leads to wilting and blackening of vines. Root rot, predominantly caused by *Rhizoctonia solani*, affects root systems in poorly drained soils. Anthracnose, caused by *Colletotrichum gloeosporioides*, results in leaf and stem lesions, particularly under high humidity.

Preventive and curative measures include the use of disease-free planting material, good drainage, and organic mulch to regulate soil moisture. Application of biofungicides like *Trichoderma harzianum* and entomopathogens like *Beauveria bassiana* and neem-based sprays effectively control early-stage infestations.

enzymatic conversion of glucovanillin to vanillin (Krishnan *et al.*, 2021) [13].

2. **Sweating:** Pods are wrapped in cotton and kept in wooden boxes for 36–48 hours to facilitate fermentation.
3. **Drying:** Gradual sun-drying for 2–3 hours/day followed by shade drying prevents case-hardening and mold growth (Sreedhar *et al.*, 2020) [21].
4. **Conditioning:** Pods are stored in airtight containers for 2–3 months to stabilize aroma and improve vanillin concentration.

Properly cured pods fetch 4–5 times more market value than green pods and exhibit a vanillin content of 1.5–2.5%, depending on cultivar and curing quality. Some value added products of Vanilla are Vanilla Extract, Vanilla Sugar, Vanilla Paste, Vanilla Essential Oil (Oleoresin) used widely in baking, confectionery, cosmetics, perfume, pharmaceutical and beverages industries. (ICAR-IISR, 2023)

Economics of Vanilla Cultivation

Vanilla is a high-value spice crop with potential returns of Rs 45 to 90 lakhs/ha from 300–600 kg/ha cured bean yield, depending on management and market price (Rs 15,000 to 25,000/kg). Initial investments of Rs 3 to 4 lakhs/ha cover shade structures, planting material, and labor-intensive operations like hand pollination and curing. Intercropping with Arecanut, turmeric, banana, or ginger can enhance

early-stage income. (Figure 4) Though vanilla has a long gestation period (3–4 years), its benefit-cost ratio ranges from 2.5 to 3.8, making it economically viable under Assam's agro-climatic conditions. (TNAU, 2021; ICAR-IISR, 2023).



Fig 4: Vanilla intercropped with Arecanut

Challenges and Constraints

Despite being a high-value crop, vanilla cultivation in Assam faces several significant constraints. A primary challenge is the lack of quality planting material and limited technical knowledge among farmers, which restricts its adoption (Baruah & Gogoi, 2025) ^[2]. Vanilla requires manual pollination, a highly labor-intensive and time-sensitive process that increases production costs and limits scalability (Sarma & Hussain, 2024) ^[18].

The long gestation period of 3–4 years before economic returns discourages small and marginal farmers seeking quicker income sources. Additionally, poor market linkages and the absence of organized procurement systems result in price volatility and reduced farmer confidence. Inadequate curing infrastructure and non-standardized processing techniques often produce substandard beans, affecting vanillin quality and marketability (Kalita & Das, 2025) ^[12].

To overcome these barriers, investment in farmer training, propagation units, cooperative marketing, and value-chain infrastructure is essential to support vanilla as a profitable, sustainable crop in Assam.

Recommendations and Way Forward

To promote vanilla cultivation in Assam, capacity building through Krishi Vigyan Kendras (KVKs) is essential, especially in manual pollination and curing. Establishing model demonstration plots will encourage wider adoption. Integration with National Horticulture Mission schemes and convergence with tribal development programs can offer financial and institutional support. Formation of vanilla growers' cooperatives is vital for curing, branding, and collective marketing. Promoting organic certification and developing export linkages can enhance market value. Finally, public-private partnerships must be encouraged for building essential post-harvest infrastructure, ensuring long-term sustainability and profitability for farmers in the region. (MoA&FW, 2023).

Conclusion

Assam holds immense potential for vanilla cultivation, owing to its favourable tropical climate, rich biodiversity, and growing focus on organic and high-value crops. The state's humid conditions and availability of natural shade trees provide an ideal environment for vanilla vines (Gogoi & Kalita, 2025) ^[2]. Scientific practices—such as shade regulation, organic fertilization, and manual pollination—can significantly improve productivity and bean quality (Sarma & Hussain, 2024) ^[18]. However, realizing this potential requires targeted interventions, including farmer training, demonstration plots, and investment in post-harvest infrastructure.

Strengthening market linkages, introducing price assurance mechanisms, and promoting organic certification will enhance economic viability. Government initiatives under the Mission Organic Value Chain Development (MOVCD) and National Horticulture Mission (NHM) should be harnessed to scale up production. With policy support, public-private partnerships, and institutional engagement, vanilla can emerge as a niche income-generating crop for small and marginal farmers in Assam's agro-economy.

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