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Challenges and Economic Feasibility of Betelvine Cultivation in Uttar Pradesh

Ajay Kumar[1*], Sudheer Kumar Yadav[2], Rakesh Jangid[1], A. K. Gupta[3], Amit Kumar[4], Deepak Kumar[5] and Kripa Shankar[6]

[1]Division of Fruit Crops, ICAR-Indian Institute of Horticultural Research, Hessarghatta, Bengaluru, Karnataka (560 089), India
[2]Dept. of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh (226 025), India
[3]Division of Post-harvest Management, ICAR-Central Institute for Subtropical Horticulture, Lucknow, Uttar Pradesh (226 101), India
[4]Dept. of Horticulture, Sardar Vallabh Bhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh (250 110), India
[5]Dept. of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh (208 002), India
[6] Division of Fruits and Horticultural Technology, ICAR - Indian Agricultural Research Institute, Pusa, New Delhi (110 012), India

Corresponding Author

Ajay Kumar
e-mail: ajayaadihorti@gmail.com

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Abstract

Betel vine (*Piper betel* L.) is referred to as “Paan” in India. It is the most significant and profitable commercial crop and is cultivated as a significant cash crop due to its high benefit cost ratio (2.3). Fresh betel leaves found rich source of phyto-nutrients and vitamins *viz.,* proteins, minerals, fibre, carbohydrates, vitamin A and vitamin B1. Uttar Pradesh region is favourable for better cultivation of betel vine. There are a few areas in Uttar Pradesh that are well-known for growing betel leaves, such as Bundelkhand, Varanasi, and Unnao. Betel vine farming is labour and capital intensive and best suited to small-scale farmers with a stable source of work and income. The main challenges associated with betel vine cultivation are lack of quality planting material, disease and pest infestation, lack of market, and natural calamities. Leaf rot, wilt, and leaf spot are the major diseases that significantly affect the quality and productivity of betel leaves. But due to its perishable nature and price fluctuations, this is one of the biggest marketing challenges faced by betel vine farmers. Establishing a market intelligence system to forecast prices in advance and simultaneously exploring the export market may be beneficial for realising a higher return on betel vine cultivation. Young farmers are excited to cultivate the betel vine and promote it as a cash crop for gainful employment in Uttar Pradesh. The Government of Uttar Pradesh has launched a scheme to promote the quality production of betel vine leaves.

Keywords: Betel vine, phytonutrients, challenges, farming, government schemes, marketing, post-harvest, pests, diseases

1. Introduction

Betel vine (*Piper betel* L.) is a dioecious perennial creeper grown in India. It is a member of the Piperaceae family (Dikshit et al., 2021, Chakrabarty, 2018). According to Ahuja and Ahuja (2011), the betel vine is not indigenous to India. It is indigenous to central and eastern Peninsular Malaysia and is found in East Africa and tropical Asian countries. The betel vine is referred to as the “green gold of India” because it provides a means of livelihood for about 20 million people in India through the production, handling, transportation, preparation, and processing of betel leaves (Guha, 2006). It is an evergreen root climber that prefers shade and has glossy heart-shaped leaves (Jana, 2016). The leaf is simple, alternating, glabrous, fleshy, greenish to yellowish, lustrous, broadly ovate, cordate at the base, and acuminate at the apex, with an entire, narrowly recurved edge and reticulate venation (Preethy et al., 2018, Rahman et al., 2020). The inflorescence consists of an axillary spike that develops into a cylindrical, pendulous catkin. Flowers are small and unisexual, with only a few stamens and stigmas placed in each bract’s axil (Biswas et al., 2022), and fruits are globose berries (Jana, 2016). It is mostly cultivated as a commercial cash crop in India, Bangladesh, Sri Lanka, Thailand, Taiwan, Malaysia, and a few other Southeast Asian countries. In India, it is cultivated in Bengal, Bihar, Orissa, Andhra Pradesh, Karnataka, Uttar Pradesh and Tamil Nadu. Betel vine is grown on about 1,000 ha of land in Uttar Pradesh. In the state of Uttar Pradesh, betel vine is grown in the following 21 districts: Mahoba, Banda, Lalitpur, Sonebhadra, Mirzapur, Varanasi, Azamgarh, Jaunpur, Ballia, Ghazipur, Barabanki, Sultanpur, Pratapgarh, Prayagraj, Amethi, Hardoi, Sitapur, Unnao, Kanpur, Rae Bareli, and Lucknow (Dept. of Horticulture and Food Processing, Govt. of U.P.). Mahoba, Lalitpur and Banda are the major production areas under Bundelkhand region of Uttar Pradesh (Dikshit et al., 2021).

Betel vine is one of the most significant horticultural cash crops. The cultivation of betel vines has a wide-ranging socioeconomic impact on the grower's community. It is characterised by several issues, including low crop yield and low returns. Most of the farmers are reliant on natural resources and can only produce one crop during the rainy season (Mandal, 2013, Mandal and Mandal, 2016). However, the betel vine is vulnerable to insect, rain, wind, and frost damage. The growth of the betel vine may also be hampered by inadequate irrigation. Farmers suffer significant losses due to high fertilizer and pesticide costs, unpredictable prices, a large number of intermediaries, insufficient finance, and a lack of transportation and storage facilities (Chandra and Sagar, 2004, Mandal and Mandal, 2016). Due to perishability, storage, and transportation, a considerable amount of leaf waste occurs yearly, ranging from 35 to 70% (Sathya et al., 2022). Despite betel vine production being profitable, many farmers were switching to other crops due to price volatility in the local market and a lack of financial support (Absar, 2015, Kumar et al., 2021). However, the production of betel leaves varied throughout the year. When compared to the months of July to December, it sold for a relatively higher market price from January to March (Das et al., 2016). This review article is mainly concentrated on the cultivation and the challenges of betel vines that farmers encountered in Uttar Pradesh.

2. Nutritional Composition and Uses

Fresh betel leaves are mostly composed of water (85–90%), followed by proteins (3–3.5%), fats (0.4–1.0%), essential oils (0.08–0.2%), minerals (2.3–3.3%), fibre (2.3%), carbohydrates (0.5–6.10%), nitrogen (2.0–7.0%), phosphorus (0.05–0.6%), potassium (1.1–4.6%), calcium (0.2–0.5%), and tannins (0.1–1.3%) (Madhumita et al., 2020). It contains a good amount of vitamins such as vitamin A (1.9–2.9 mg), B1 (10–70 g), B2 (1.9–30 g), and B3 (0.6–8.9 mg) 100 g^{-1} of fresh leaves. In addition, each 100 g of leaves has a good amount of iodine (3.4 g) and calories (44 kcal) (Guha, 2006). The leaves also have high levels of all essential amino acids except lysine, histidine, and arginine, which help in fat breakdown and reduce muscle development. Betel leaves contain high levels of asparagines as well as glycine and proline. Additionally, it is also abundant in enzymes like catalase and diastase (Madhumita et al., 2019).

It is used in various traditional medicines, including traditional Chinese medicine, the Indian Ayurvedic medical system, and the folk medicine of the West Indies and Latin America (Taukoorah et al., 2016). It has a strong, pungent, and unique taste, as well as a strong clove-like flavour, due to the presence of phenols and terpenes. In the past, consumers used betel leaves as a chewing agent to avoid halitosis and acquire numerous health benefits. The plant is traditionally used to treat a wide range of illnesses, including colds, bronchial asthma, coughs, stomachaches, rheumatism, boils, bad breath, constipation, conjunctivitis, gum swelling, abscesses, wounds, and cuts (Guha, 2006, Biswas et al., 2022). Along with treating skin disorders, endoparasites, and problems of the ear, nose, and throat, it is also used to treat physiological function disorders. Betel leaves are used for a variety of therapeutic and preventative purposes and have cooling and analgesic qualities. There are substances in betel leaves that are advantageous for patients with diabetes and various forms of glycosuria (Madhumita et al., 2020). Additionally, betel leaf has properties such as antibacterial (Lubis and Wahyuni, 2020), antimicrobial (Datta et al., 2011), antioxidant (Sarma et al., 2018), antimutagen (Amonkar et al., 1986) anticarcinogenic (Chen et al., 1999), antiallergic, antiprotozoal, anti-diabetic, hepatoprotective, anti-inflammatory, antitumor, cardioprotective, and respiratory antidepressant effects (Fazal et al., 2014). Other applications for this plant include fish poisoning, fish bait, insecticide, oil, perfumes, and hallucinogens. No religious ceremony is complete in the Hindu religion without the usage of betel leaf (Dikshit et al., 2021).

3. Climate and Soil

The betel vine prefers a tropical climate with cool humid weather. Both wetlands and uplands are suitable for its cultivation. Highlands and especially fertile sandy or sandy clay or sandy loam soil with a well drainage system and a pH range of 5.6-8.2 are the best choices for betel cultivation while, saline and alkali soils where water logging is a problem are not suitable (Biswas et al., 2022). The congenial weather require for optimum cultivation 2250-4750 mm rainfall, relative humidity 40-80%, and temperature range 15-40°C (Biswas et al., 2022). To successfully cultivate this crop, adequate irrigation and shade are required. It can tolerate temperatures ranging from -10°C to 40°C. Leaf fall is caused by abnormally low air temperatures and hot dry winds are also dangerous for its cultivation (Jana et al., 2016, Chandra and Sagar, 2004).

4. Cultivars

The most popular cultivars in India are Magadhi, Salem, Mysore, Bangla, Kauri, Venmony, Meetha, Kapoori, Sanchi, Banarasi, Desavari, Kasi, Ghanagete, and Bagerhati which are characterized by mostly their colour, flavour, taste, and size. In Uttar Pradesh, the cultivars Deswari, Kapoori, Maghai, and Bangla are extensively cultivated (Chandra and Sagar, 2004, Jana et al., 2016, Das et al., 2016). The characteristic features of the extensively grown cultivars was given below:

4.1. Bangla

It is moderately vigorous and the leaf is thick, green to dark green, cordate in shape with broad lamina, rough to touch, and very pungent in taste. Because of the longer internodes, the petiole, or leaf stalk, is long, thin, and widely spaced. There are few or no laterals or vines and it is also grown in Bihar, Maharashtra, West Bengal, and south India (Chandra and Sagar, 2004).

4.2. Kapoori

The leaf is greenish-yellow, smooth, ovate with an acute tip, juicy, and non-pungent. It produces a large number of laterals vine^{-1}, and the yield is higher than other cultivars (Chandra and Sagar, 2004).

4.3. Maghai

The leaves of this cultivar are smaller than those of other varieties. The leaves are tasty and sweet. It is known for its premium leaves throughout India (Chandra and Sagar, 2004).

4.4. Deswari

It has large cordate leaves with short, pointed, acuminate tips and a distinctively curved apex. It has low anethole content with mild sweet taste (http://ecoursesonline.iasri.res.in).

5. Cultivation Methods

Two types of cultivation are being practiced in India, open systems using support plants and closed systems using bareja, which are man-made rectangular structures (Jana et al., 2016). The bareja system is mainly practiced in Uttar Pradesh (Dikshit et al., 2021). Bareja is a hut-like structure that is square or rectangular in shape and 7–8 ft in height. The inner side of the enclosure commonly has a path left around the garden that is about one meter wide. The next beds have a distance of about 30 cm between them and are 100-125 cm wide. Bamboo poles inside the bareja are used to reinforce and strengthen the side wall. It is roughly 20–25 cm between each horizontal pole. Usually, sticks, paddy straw, coconut or sugarcane leaves, etc. are used to cover the roof and side walls (Chandra and Sagar, 2004, Jana et al., 2016) (Figure 1a, 1b and 1c). The followimg advantages of bareja system of training over the open system of cultivation are (Mandal and Mandal, 2016):

i.The production of good quality betel leaves.

ii.To protect the vines from desiccation in summer and cold in winter.

iii. Maintenance ought to be easy because they have small structure and their cost of frame work erection is low.

6. Propagation and Planting

Terminal stem cuttings or setts, having 3–5 nodes about 30–45 cm long, are used for propagation and these are planted in such a manner that 2–3 nodes are buried in the soil (Jana et al., 2016, Chandra and Sagar, 2004). Setts taken from the tops of the vines are the easiest to root and are therefore ideal for planting. A single node cutting with a mother leaf is also planted. For planting one hectare, 100000 setts are generally required. In general, an open method of cultivation requires 40000–75000 (Jana et al., 2016), 50000 (Chandra and Sagar, 2004) cuttings ha^{-1}, but bareja (closed) method requires 100000–120000 cuttings ha^{-1} (Jana et al., 2016). Because of the deep dormancy of the adventitious roots, the lower nodes of the vines take longer to sprout or even fail to sprout. The planting distance varies from region to region, such as 12–15 cm×75–80 cm in north India and 100×20 cm in south India. The planting season in north India is March or April, while it is June–July in south India (Chandra and Sagar, 2004).

7. Irrigation and Manuring

Irrigation should be done shortly after planting and then once a week after that (Jana et al., 2016). Betelvine yard required NPK @160:80:40 Kg ha^{-1} (Chandra and Sagar, 2004). Use neem cake (75 kg N) and urea (75 kg N) to apply 150 kg N ha^{-1} year^{-1}. A total of 37.5 kg of nitrogen should be used as basal dressing during vine planting. The remaining 112.5 kg N should be applied in three separate top dressing doses, the first 15 days after vine removal, and the second and third doses 40–45 days apart. As a basal dressing, apply 30 kg ha^{-1} year^{-1} of muriate of potash (MOP) and 100 kg P_2O_5 ha^{-1} year^{-1} (Jana et al., 2016).

7.1. Training and lowering of vines

With the use of banana fibre, the vine is loosely fixed at intervals of 15–20 cm along the standards to perform training. Depending on the growth of the vines, training is done at every

Figure 1: a and b : Training of betel vine on bareja system; c: Leaves

15–20 days interval. In a year, the vines can reach a height of 3 m under normal conditions. They require rejuvenation by being lowered in March and April because once they reach this height, their ability to produce normal-sized leaves is diminished. After lowering, the tillers emerge from the nodes at the bends of the coiled vines at the ground level and produce numerous primary vines. After each lowering, irrigation should be done (Jana et al., 2016, Chandra and Sagar, 2004).

7.2. Harvesting, Yield and Marketing

The market situation and vine growth are key factors to decide the harvesting of betel leaves. Once harvesting begins, it almost always continues every day. Harvesting of mature leaves is done by twisting the peduncle of leaves at age of 3 months. Harvesting is done during March–April in Uttar Pradesh, Madhya Pradesh and Bihar, during May–June in Andhra Pradesh; during January–February or April–May in Tamil Nadu (http://niftem.ac.in). On average, a hectare can produce approximately 75 to 100 lakh leaves year^{-1}. The traditional unit of measurement for paan is “Dholi” (1 Dholi equals 2 kg or 200 betel leaves). Two important paan markets, where trading occurs every day, are in Varanasi (Uttar Pradesh) and Gaya (Bihar) (Das et al., 2016).

7.3. Post-harvest management

Harvested leaves are cleaned, washed, and graded based on size, colour, texture, and maturity. They are packed after removing a portion of the petiole and discarding the injured, dead, and diseased or pest-infected leaves. Bamboo baskets are commonly used for packaging, and straw, fresh or dried banana leaves, moist cloth, and other materials are used for the inside lining in many places.

8. Techniques for Reducing Betel Leaf Post-harvest Losses

8.1. Depetiolation

The removal of the petioles from the leaves is known as depetiolation. It reduces the weight of leaves by roughly 10–25% due to a 10–40% reduction in leaf length. It plays a significant role in the postponement of senescence (Mishra and Gaur, 1972). Depetiolated conditions have always been preferable over petiolated conditions for extending storage life. In comparison to the depetiolated condition, chlorophyll degradation was reported to be lowest in the petiolated betel leaves, whether packed with banana leaves or treated with BA (benzylaminopurine), at 30 ppm (Imam and Pariari, 2012). Senescence can be delayed by demidribing, but when depetiolation is coupled with partial or complete demidribing, senescence is delayed to a significantly higher extent than when depetiolation is used alone (Madan et al., 2014).

8.2. Dehydration

Drying is a technique that preserves any product by lowering the moisture level of the raw ingredients. There are various methods of drying, including solar drying, shading drying, mechanical drying, microwave drying, and hot air drying (Vernekar and Vijayalaxmi, 2019). The shade drying of betel leaves in dark rooms is a time consuming method that results in a low quality product. Although sun drying is common, extended direct exposure to the sun rays causes undesirable changes in colour, texture, and flavour as well as contamination with sand, mud, and other outside material (Midilli 2001, Adom et al., 1997). Therefore, modern drying or microwave drying should be emphasized for better results because this method results in a substantial reduction of volatile oil, which is responsible for enhancing the organoleptic properties of the leaves (Midilli 2001, Pin et al., 2009). The thin-layer drying of betel leaves was carried out in a cabinet dryer and a cross-flow tunnel dryer. The significant chemical content increased with temperature from 40 to 70°C but began to decompose when the leaves dried at 80°C (Pin et al., 2009).

8.3. Bleaching and curing

It is usually done in a bhatti, or closed chamber. The curing procedure for betel leaves was most likely originated in Varanasi (Uttar Pradesh), where the techniques were traditionally used to make Banarasi paan. The basic principle in curing process is that the green leaves are treated with smoke, high temperature, and pressure in a bhatti, or closed chamber, with little or no ventilation in order to regulate the temperature inside the chamber for enhancing the organoleptic properties, and eventually the green leaves are transformed into white or yellowish-white leaves. It is alternating heating for 6 h at 50–60°C and cooling for 12 h two to three times, followed by aeration of leaves by turning and storage in the dark. It takes about 15–20 days for green betel leaves to turn completely white or yellowish (Dastane et al., 1958, Madan et al., 2014, Pandey et al., 2018). This process extends the shelf life up to one month, and the top-grade bleached leaves are very soft and uniformly green-yellow in color. This technique enhances flavour and organoleptic qualities because of the presence of volatile oils such as eugenol. Except for fibre content, all physiological parameters were linked in different degrees with improved organoleptic aspects of betel leaves due to curing (Guha, 2010) . An unsaturated aromatic phenol with a strong pungent odour reminiscent of cloves and a harsh spicy taste has antiseptic and local properties (Sadhukhan and Guha, 2011).

8.4. Chemical treatments

The storage life of betel leaves can be prolonged by adding a mixture of tartaric acid and sodium bicarbonate to the storage container (Pandey et al., 2018). To reduce spore load and yellow colour development, the packing material could be cleaned with sodium hypochlorite prior to packaging. Ventilation was proven to be the most essential factor since no aeration results in moist discolouration and fermentation, while excessive aeration results in dry discolouration. The shelf life of betel vine leaves is significantly extended by dipping them for 6 h in solutions of benzyl adenine (25 ppm) and kinetin (50 ppm) and packing them in vented polythene bags stored in the refrigerator. Leaves placed in baskets at room temperature can last up to 40 days (Pandey et al., 2018).

8.5. Combined effects of de-petiolation, de-midribbing, and chemical treatment

An extra 10 days of shelf life were obtained by combining de-petioling, de-midribbling, and dipping for 6 h in BA (25 ppm). Yellowing spoilage was negligible in these treatments. From a commercial standpoint, matured harvested leaves treated with BA at 5 mg L^{-1} for 6 h and stored in conventional packing were found to be most suitable for extending the storage life (Bhuvaneswari and Narayana, 2014, Pandey et al., 2018).

9. Pest and Diseases

9.1. Pests

9.1.1. Aphid (Aphis gossypii)

Both nymphs and adults desap the new shoots and leaves, resulting in yellowing, curling, and crinkling of leaves. Honeydew secreted by the aphids, on betel leaves leads to the development of sooty mould which appears as black spots. To minimized the aphid population from field by remove all the infested leaves and spray chlorpyriphos @ 2 ml L^{-1} of water.

9.1.2. Scales (Lepidosaphes cornutus)

Adults and nymphs both infest the leaves, petioles, and major veins. The scale-infested leaves lose their colour, develop warts, crinkle, and eventually dry up. The damaged vines appear sticky, and they will ultimately wilt. Select scale-free seed vines. Spray 50 g L^{-1} of NSKE (5%), 2 ml of chlorpyriphos (20 EC), or 1 ml of Malathion (50 EC) per liter of water.

9.1.3. White flies (Aleurocanthus nubilans and Dialeurodes pallid)

The development of yellowing, chlorotic patches, and shooty mould on leaves is caused by nymphs and adults sucking the sap from the delicate leaves. Spray neem seed kernel extracts @ 5% or tobacco decoction @ 2% to control it (Das et al., 2004).

9.1.4. Mealy bug (Geococcus citrinus)

Adults and nymphs both reside on the root region and sap the roots. Spray 2 ml L^{-1} of chlorpyriphos 20 EC or dimethoate on the collar region.

9.1.5. Shoot bug (Pachypeltis politus)

Leaf blotches are caused by both nymphs and adults sucking the sap from tender leaves, which eventually leads to drying. This pest is prevalent from June through October. Spray 2% tobacco decoction, 0.5% neem oil, 0.05% chlorpyriphos, or 2.0 ml L^{-1} Malathion 50 EC after leaf harvesting.

9.2. Diseases

9.2.1. Foot rot or Leaf rot or wilt (Phytophthora parasitica var. piperina)

The months of September through February are extremely favourable for this disease because of the high atmospheric humidity and cool night temperatures (23°C or less). The first sign is sudden vine wilting. The damaged vines have yellowing and drooping leaves from the tops downward, and the affected plants die within 2 or 3 days. The fungus causes "leaf rot" symptoms in the young crop. The leaves near the soil region have round to irregular shaped water-soaked patches that often start from the edge. The spots spread quickly, covering a portion or the entire leaf blade (Dasgupta et al., 2008). To effectively control this disease, soak seedling vines for 30 m in a solution of streptocycline (500 ppm) and Bordeaux mixture (0.05%). Collect and destroy diseased vines and leaves. Irrigation should be controlled during cold weather. During the cool weather season (October–January), drench the soil with a 0.5% Bordeaux mixture at 500 ml $hill^{-1}$ at monthly intervals (Mohanty et al., 2011, Yadav, 2013).

9.2.2. Sclerotium foot rot and wilt (Sclerotium rolfsii)

The disease can affect vines at any stage of development, and the infection commonly begins in the collar region. On the stem and roots, white cottony mycelium is apparent. The stem shows rotting tissues at the point of attack, and the plants show leaf drop and wilting before drying up. The months of May–July, with warm temperature (28–30°C), is favourable for this disease. Remove the diseased vines and roots, and subsequently burn them. Apply more soil amendments, such as neem cake, mustard cake, or farmyard manure, and then drench the soil with 0.1% carbendazim (Parvin et al., 2016).

9.2.3. Powdery mildew (Oidium piperis)

The most favourable conditions for this disease are dry and humid weather during the months of May to July. The disease affects the crop at all stages of development, with infection most visible on young shoots and leaves. A whitish powdery growth appears on both the surface and underside of the leaves, which eventually enlarges and covers the majority of the leaves. Tender shoots and buds are damaged and shrivelled, and leaf margins curl inward. Defoliation and yellowing of the leaves occur in severe cases. Collect diseased leaves and burn them. After plucking the leaves, spray 0.2% wettable sulphur or dust sulphur at a rate of 25 kg ha^{-1} (Maiti and Sen, 1979, Chhetri et al., 2021).

9.2.4. Anthracnose (Colletotrichum piperis)

The leaves initially have little black circular spots that spread and develop to a size of 2 cm, become concentric, and are surrounded by a yellow halo. The damaged leaves turn pale yellow and dry up, with huge black dots in the centre of the spots. Collect diseased vines and leaves and destroy them. Spray 0.2% Ziram or a 0.5% Bordeaux mixture after plucking the leaves (Maiti and Sen, 1979, Kumar et al., 2016).

9.2.5. Bacterial leaf spot or stem rot (Xanthomonas campestris p.v. betlicola)

The disease begins as tiny, brown, water-soaked spots on the leaves surrounded by a yellow halo, which develop later and become necrotic and angular, generally confined to interveinal areas. Infected leaves turn yellow, wither, and die. The stem tissues weaken and break easily at infected nodes, and the vine withers and dries. Cloudy weather with intermittent rains and high relative humidity are favourable conditions for this disease. Vines that are two to three years old are highly susceptible. Remove diseased vines and stubbles from the field and burn them. During the cold weather season, regulate irrigation. After plucking the leaves, spray streptomycin at 400 ppm plus the Bordeaux mixture (0.25%) at 20-day intervals (Kumar et al., 2016) (Figure 2).

Figure 2: Infestation of different major pests and diseases in betel vine (Source: www.bckv.edu.in, www.drysrhu.edu.in)

10. Government Schemes

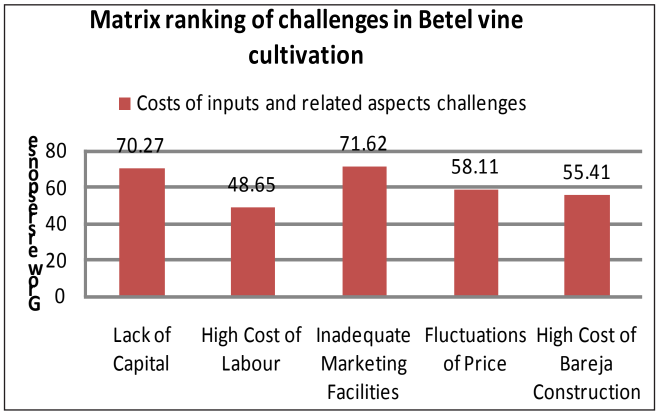
In 2012, the Uttar Pradesh government announced a scheme to promote betel vine farming. The government has allocated ₹ 1 crore for the scheme (Paan Utpadan Yojan, Cluster Based Scheme), wherein betel farmers would be provided grants. Recently, the state government has launched “Betel Bareja construction work” under a scheme to promote quality betel production in the state. Twelve districts would benefit from this scheme: Unnao, Raibarely, Lucknow, Jaunpur, Pratapgarh, Allahabad, Kanpur, Azamgarh, Balia, Barabanki, Mirzapur, and Sonbhadra (Dept. of Horti. and Food Processing, Govt. of U.P.). A total of 63 barejas will be constructed. According to U.P. Govt. the cost of bareja^{-1} construction (1500 m^{2}) is ₹ 1,51,360.00, out of which 50% amount will be paid in advance to the beneficiary farmer and the rest 50% amount will be of farmer.

11. Challenges for Farmers

Betel leaf is an extremely weather-sensitive crop. Among the agro-biological constraints, hailstorms, frost, fire, drought, and rain, etc. cause 89.10% of crop loss, followed by insect pest and disease infestations (77.02%) and the highly perishable (41.89%) nature of the produce (Dikshit et al., 2021). The crop were completely destroyed by winter rain and frost. Lack of quality planting material, inadequate marketing facilities, lack of capital, and fluctuations of price are major issues associated with betel leaf grower (Mandal and Mandal, 2016, Dikshit et al., 2021, Patil, 2016). In addition, farmers are facing major challenges due to lack of storage facilities, lack of information about the market, high commission fees, and high transportation costs (Mandal and Mandal, 2016). Because it is a horticultural crop, the government does not provide crop insurance in case of natural disasters, which is a major issue for farmers (Dikshit et al., 2021). Additionally, the demand for Betelvine leaves was also decreasing year by year (Patil, 2016) (Figur 3).

12. Economics of Betel Vine Cultivation

This crop has enormous economic potential, as evidenced by the fact that around 15–20 million people in India regularly consume betel leaves. Not only is that, but over 2 billion people from many other countries are known to be the main consumers of betel leaves around the world (Guha, 2006). Most significantly, the economic status of betel leaves on the global market is determined by the physical characteristics of the end products. The betel leaf and its products, which include powder, capsules, liquid, and various types of value-added products, are widely available in the market as



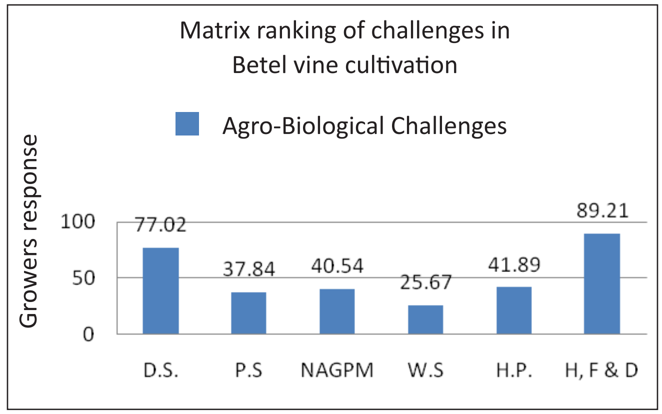


Figure 3: Matrix ranking of challenges faced by Betel vine growers in Uttar Pradesh.D.S. (Disease severity), P.S. (Pest severity), NAGPM (Non-availability of good planting materials), H.P (High Perishability of leaves), H, F&D (Hailstorm, Frost and Drought) (Data Source: Dikshit et al., 2021)

beverages, oral care items, pharmaceutical products, and cosmetics. The national income is worth between ₹ 7,000 and 10,000 million year^{-1}. The leaves were exported to different parts of the world where the plant is not naturally grown or where local supplies are insufficient. Betel leaves are widely exported to Hong Kong, Pakistan, Italy, Bahrain, Canada, the United Kingdom, Kuwait, Saudi Arabia, Nepal, and several other European nations (Biswas et al., 2022). In 2021–2022, India exported 6517.26 MT of betel leaves to other countries resulting in aearning of ₹ 45.97 crores (Anonymous, 2022).

The average annual production of betel leaves from an average area of 0.15 ha is around 42 dholi pari^{-1} of bareja (1 pari yields 42 dholi, and 1 dholi=2 kg or 200 betel leaves). During the first year, the average annual gross return and net return were calculated to be ₹ 344,300 and ₹ 147,428 for an average area of 0.15 ha. As income generation continued to rise in the subsequent years, the cost of cultivation gradually decreased. At a cost of ₹ 60,000, the gross income increased to ₹ 6–7 lakhs in the third year (Dikshit et al., 2021) (Table 1).

Table 1: Cost of Bareja construction and cultivation of Betel vine for 1500 m^2 (0.15 ha) area (Source: Dept. of Horti. and Food Processing, Govt. of Uttar Pradesh).

Sl. No.	Particulars	Total quantity	₹ item^{-1}	Total cost (₹)
1.	Bamboo Number-01 (05 m long 05 cm thick)	800	30	24000
2.	Bamboo Number -02 (04 m long 04 cm thick)	600	25	15000
3.	Sanaua (04 cm diameter)	200	50	10000
4.	Grass (For medicine 25 cm diameter)	60	50	3000
5.	Sugarcane leaf	1.5	500	750
6.	Bakoda	10	600	6000
7.	Teak Balli	20	600	12000
8.	G.I. wire 12 Gauge	15	90	1350
9.	G.I. wire 20 Gauge	20	85	1700
10.	Spray machine	1	2500	2500
11.	Betel buell cutting (Dholi)	64	365	23360
12.	Fertilizers / Pomace (Kg)	100	25	2500
13.	Black soil of pond (in trolley)	5	400	2000
14.	Greaves Engine for Irrigation (set)	1	2300	2300
15.	Other Expense: Agronet for Bareja construction (set)	1	20000	20000
16.	Chemical/ Growth regulator		24900	24900
	Total Cost			151360

13. Way Forward

To promote area expansion, incentives and schemes are to be formulated and implemented as in the case of other horticulture crops through NHM/RKVY. Betel vine should also be included in the list of priority crops and be covered under the Crop Insurance claim. The government should also implement a policy to provide 80% of the construction costs as a subsidy to support farmers in replacing traditional bareja with modern bareja. The government has launched a scheme to promote quality betel production in the state. The government contributes 50% of the cost of construction for an area of 1500 m^2 under this scheme. Previously, this range was between 500 and 1500 m^2. As a result, most farmers will be unable to benefit from the scheme because most paan cultivation takes place on pieces of land about 500 m^2 or less. It is necessary to design a low-cost technique for the construction of the Bareja. It is critical to fill the void left by the shortage of high-quality planting material (terminal stem cutting or setts) he government should build at least two or more cold storage facilities and warehouses for each block of the district to store betel leaves during periods of high production. It is also vital to standardise the proper betel leaf packing process. It is necessary to organize the growers by creating federations and betel vine growers associations for improved marketing and negotiation strategies. The government should organize regular training and skill development programmes for betel growers in order to improve the industry and encourage young growers to enter the industry. The federal and state governments should work together to implement effective pest and disease management measures in betel farms, especially for wilt. They should also create a Betel Research and Development Board to improve export-oriented activities by following international standards, cut down on middlemen in the marketing process, stabilizes the price of betel leaves, expand the area under betel vine cultivation, and raise awareness among betel vine growers. These activities will enable India's betel vine production to hopefully make up a considerable share of the country's gross domestic product in the near future.

14. Conclusion

A larger section of farmers in Uttar Pradesh are regular growers of betel leaves. An economic study showed that the cultivation of betel vines is very profitable to the growers. However, high perishability, price fluctuations, unauthorised deductions, lack of storage facilities, lack of market knowledge, high commission charges, and high transport costs are influencing the decline of cultivation. Recently, the Uttar Pradesh government has launched "Betel Bareja Construction Work" under a scheme to promote quality betel production in the state.

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