

Can the Ayurvedic pippali plant (*Piper longum* L.) be a good option for livelihood and socio-economic development for Indian farmers?

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The pippali of Ayurveda botanically known as Piper longum L. is one of the economically valued plants, the fruits and roots of which are used widely in the preparation of traditional herbal medicines as well as in various modern drugs. The Ayurvedic medicine system has been heavily dependent on its use since time immemorial. Dried or powdered forms of the fruits and roots are sold at Rs 350 to 3000 per kg, at the national and international markets. Supply of the raw materials is still dependent on the wild source as the existing cultivation and management practices are not adequate to fulfill the demand. If utilized, it may become one of the most important components of agroforestry systems in the tropical and subtropical warm humid climate of the country that may generate up to approximately Rs 130,000 as an additional income to the farmers.

Keywords: Agroforestry, cultivation techniques, livelihood, market demand, pippali.

WITH the fast-paced development worldwide, there is an increase in the outbreak of many diseases. As humans continue to depend on synthetic drugs, there has been a realization and renewed interest in plant-based medicines. With the recent spurt in demand for medicinal plants worldwide, more farmers are entering into this potential sector. India, with its diverse biogeographic area has a vast potential for the export of medicinal plants. The forests of the country are abound with important medicinal plants which are used widely by the traditional healers. About 22% of the herbal raw drugs in the country are produced through cultivation¹. India with its centuries' old Ayurvedic–Unani history is home to about 7000 species of medicinal plants, of which only about 1178 species are used in trade¹. *Piper longum*, commonly called as pipili, pippali, or long pepper belonging to the family Piperaceae is one such important medicinal plant. The dried female spikes (pippali) and roots (pippalimula) are the commercial parts of the plant which have been used in various formulations for treating different ailments like common cold, fever, indigestion, asthma, bronchitis, leprosy, cancer, etc. The species is known to contain more than 50 alkaloids and various other essential oils^{2,3}. Additionally, the species is used in household cooking as a spice and for seasoning foods. Despite its

wide range of medicinal values and high potentiality of industrial application, the species has not been managed properly. The climatic conditions of the Northeast and Southern plateau of India provide the best habitats for the luxuriant growth of the species. Hence its extensive domestication in various agroforestry systems could become one of the best options for livelihood enhancement. In view of its promotion for cultivation and management in the country, the commercial capability, present trading status and agro-techniques are discussed here.

Pippali plant and its distribution

Piper longum L. is a perennial low creeping root climber. It is a dioecious species with separate male and female individuals. The branches are dimorphic in nature where vegetative branches are creeping and rooting at nodes, and the fertile branches are erect with swollen nodes and without adventitious roots. The flowers are unisexual and borne on erect spikes. Fruiting spikes elongate up to 5 cm. Drupes are densely aggregated, globose, black on maturing and characterized by aromatic smell and pungent taste (Figure 1).

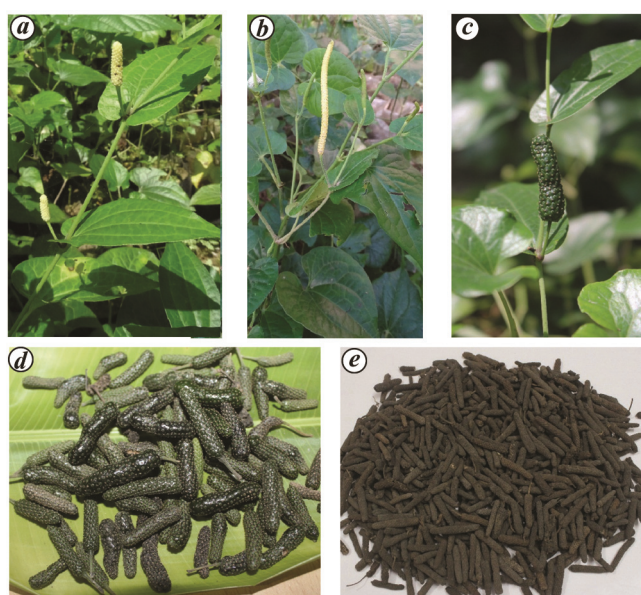
The species is naturally distributed in the wild in the tropical and subtropical regions of the world such as Bangladesh, Bhutan, India, Indonesia, Myanmar, Nepal and Sri Lanka⁴. In India, the natural distribution is restricted to the hotter regions from Central Himalayas, to Assam, Arunachal Pradesh, Meghalaya, Sikkim, lower

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Table 1. Traditional medicinal uses of *Piper longum* in different Asian countries

Country	Parts used	Uses	Selected references
India (Indian Systems of Medicine)	Fruits	Colds, asthma, arthritis, rheumatism, lumbago, sciatica, epilepsy, indigestion, flatulence, improves decongestion, antibiotic and analgesic effects, toothache, gynaecological diseases chronic bronchitis, intestinal distress	8, 21–23
	Roots	Diuretic, stimulant, sudorific, antidote against snakebite and scorpion stings	24
	Leaves, young shoots	Body/joint ache	25
Nepal	Fruits	Rheumatic pain, cough, indigestion, bronchitis, fever	26, 27
Thailand	Dried unripe fruits	Carminative, tonic, diarrhoea, expectorant, oxytotic for postlabor, alleviate pain, fever and piles	28, 29
China	Fruits	Stomach chills, vomiting, acid regurgitation, headache and rhinitis	24

**Figure 1.** *a*, Female flowering spike; *b*, Male flowering spike; *c*, Fruiting spike; *d* and *e*, Fresh and dried fruits.

hills of West Bengal, Andhra Pradesh, parts of Western Ghats and Andaman & Nicobar Islands^{4,5}.

The species is reported to be cultivated at low elevations in some areas of Assam, Meghalaya, West Bengal, Uttar Pradesh, Madhya Pradesh, Maharashtra, Kerala, Karnataka and Tamil Nadu^{4,5}. The species typically thrives well in areas with high rainfall and humidity and prefers well-drained sandy soil of pH range 5.5 to 8.5 with rich humus in shady areas.

Traditional uses

Apart from being used as a spice for flavouring foods, *Piper longum* is also used extensively throughout the world in various traditional medical practices. The importance of *P. longum* in the Indian traditional medicinal system has been described in ancient texts such as *Cha-*

raka Samhita, *Susruta Samhita*, *Vagbhata's Astangya Hrdayam*, etc.^{6,7}. The entire plant parts including the stem, roots, leaves, and fruits are reported to be used in the treatment of numerous ailments Table 1.

P. longum forms a significant part of the Ayurveda, Siddha and Unani system of medicines and is used for treating various ailments. It is one of the most preferred in the *Indian Ayurvedic System*, where the fruits and roots are used in more than 100 crude drug formulations which include cold (*kaas*), asthma, bronchitis, colic (*shool*), catarrhal fever (*jwar*), liver and spleen ailments (*pleeha*), piles (*arsha*), urinary tract diseases (*prameh*), leprosy (*kushta*), rheumatism (*amavata*), gastritis, dyspepsia, menstrual problems, haemorrhage during child birth, anorexia, gout, paralysis, epilepsy, antidote against snake and scorpion bites⁸.

Phytochemical properties and pharmaceutical values

The plant contains a large number of alkaloids and other related compounds like volatile oil, starch, gums, resins, fatty oils and inorganic matter^{3,9}. More than 50 various alkaloids are already reported from this plant. The most abundant alkaloids present is piperine, followed by methyl piperine, piperonaline, piperettine, asarinine, pellitorine, etc.^{3,10}. Important lignans and esters contents of the plant include sesamin, pulvuatilon, tridecyl-dihydro-pcoumaarate, etc.^{11,12}. The essential oil present in the fruits constitutes three major components, i.e. caryophyllene (17%), pentadecane (15.8%) and bisabolone (11.2%)². Major organic acids present comprise palmitic acid and tetrahydropiperic acid¹³.

Because of the occurrence of important bioactive principle and secondary metabolites, *P. longum* has gained worldwide attention for its various therapeutic uses. Some of its major pharmaceutical activities reported are anti-tumor activity, anti-diabetic activity, cardioprotective, hepatoprotective activity, antioxidant activity,

immunomodulatory activity, anti-fertility activity, anti-venom activity, etc.

Market demand and supply of pippali in India

Due to its diversified ethnomedicinal, ayurvedic and pharmaceutical applications, the market demand for pippali is rapidly rising both in national and international markets. The supply of traded pippali in India is mostly from the wild, collected from forests of Assam, West Bengal, Uttar Pradesh and Nepal. Additionally, a small proportion of the material is also contributed from small scale cultivated areas of Meghalaya, Madhya Pradesh, Maharashtra, Kerala, Karnataka and Tamil Nadu^{5,10}. Our own field and market survey also revealed that collections and marketing of the fruits are mostly made from the wild collection from Arunachal Pradesh (foothills of Western parts of the state), Assam (bordering to Bhutan), Meghalaya, Bhutan and Bangladesh. All these collections from the wild are traded to the South Indian markets. Some companies that are engaged in trading of the species in India include Sathvabioactives Pvt Ltd, Enjay Marketing Services Pvt Ltd, BIOPREX/LABS, Mother Herbs Pvt Ltd, Nutramine Life Sciences, Alchemy Chemicals, M/S World Wide Enterprise, Genia Nature Herbs Pvt Ltd, Mazzy Exports, etc.

The domestic price of long pepper fruits varies from place to place and also suppliers. The products of the species mostly the fruits are sold at the rate of Rs 800–1500 per kg in Indian markets. The fresh, dried or powdered form of fruits and roots are exported to other countries with prices varying from Rs 350 to 3000 or more per kg (ref. 5). Some of the processed pippali products found in the Indian market include Chuturushana, Sragyada Churna, Ashta Churnam, Pulmoflex, Tabut Azaraqi, Tablet Munish, Majoon Lana, Majoon Falasefa, Jawarish Kamooni, Jawarish Bishasa, etc.

International demand and supply

Currently, Vietnam is the largest exporter of *P. longum* in the world with a 22.7% share in export followed by Brazil with 7.3% and Indonesia with 5.6%. India ranks 4th among the countries exporting *P. longum* with a 1.9% share¹⁴. USA, Austria, Australia, Africa, Canada, Russia, Philippines, Singapore, etc., are some of the countries where *P. longum* is being exported regularly. With proper cultivation technology and export mechanism, our country can aim to rise as a major global market for long pepper and other herbal products based industry.

Adulterants

Although *P. longum* is the major source of pippali, it has been found that the dried marketed fruits are a mixture of

various other species of *Piper*. The most commonly used adulterant is the *P. sylvaticum* Roxb. and *P. peepuloides* Roxb., both of which are also grown in the habitats of *P. longum*.

Potential of commercial cultivation and management of *P. longum*

The above discussion clearly revealed that *P. longum* has a high market demand. However, at present, the species is cultivated and managed only in some selected regions in the country. Despite the suitable climatic requirements and availability of land, particularly in the northeastern region, *P. longum* is not found under large scale cultivation. An integrated effort from communities and government departments may boost its commercial cultivation in different parts of the country. Govt agencies like National Medicinal Plant Board offer support for large scale cultivation of various *Piper* species to Indian farmers. As the companies like Sathvabioactives Pvt Ltd, BIOPREX/LABS, Nutramine Life Sciences, M/S World Wide Enterprise, Mazzy Exports, etc. directly buy the raw harvested products from the farmers, the cultivation may be promoted through buyback policies with these firms. Adoption of proper cultivation techniques selecting suitable habitats certainly leads to sufficient production of these raw materials that may fulfill the growing demands. The northeastern region of the country has a large volume of degraded forest lands where the species can be managed by the forest department involving the local communities to improve the productivity of the forest land.

Excessive collection of pippali from the wild has also resulted in the population reduction in the wild. There is an increasing demand in both the international and domestic markets promoting its systematic cultivation.

Cultivation of *P. longum* as an understory crop in forest and agroforestry systems

Presently, Non Timber Forest Produces (NTFPs) have gained importance in the management of forest, and particularly, medicinal plants with high commercial demands are being preferred. As per the Indian Forest Policy (1988), NTFPs which provide sustenance to the tribal population and other communities residing in and around forests should be managed to enhance their production with due regard to employment and income generation. *P. longum* as a highly valuable medicinal plant falls under such category. It is a shade-loving species with its creeping habit, easy to grow and manage, and having high market demand, could be one of the best choices for the forest department to introduce in the forest management schemes including Joint Forest Management (JFM). A vast volume of forest land in the region specifically as

per the habitat preference (up to 1000 mean sea level) of the species, is available in the northeastern states without any countable productivity. They are either being simply left barren or covered with unwanted invasive species like *Lantana camara*, *Mikania micrantha*, *Cuscuta reflexa*, *Pueraria* spp., etc. On the other hand, these lands are capable of growing of various understorey crops with minimum soil and nutrient management. The total forest cover in the northeastern states of India is about 65.05% of the total geographical area. The rest of the land cover comes under crops, non-agricultural use or uncultivated lands¹⁵. The majority of the tribal communities of the region are mostly engaged in farming activities. However, due to the undulating topography and inaccessible terrain, there is less area under settled agricultural systems. To overcome these problems, people of the region have evolved their own traditional approaches to agricultural systems to facilitate and sustain themselves. With their diverse nature, the agroforestry practices have the potential to improve the livelihood of farmers by providing both economic production and ecological protection. Home gardens, *jhum* cultivation, cardamom and alder based farming system¹⁶, *Zabo* system of Kohima¹⁷, *Bun* system in Meghalaya and Apatani wetland rice cultivation integrated with fish culture¹⁸, are some of the examples of indigenous agroforestry systems widely practiced in the region. This shows that through some adjustments in the land-use strategies and cropping pattern, the farmers can adapt through changes in socio-economic and environmental conditions.

As *P. longum* is found growing in the wild in northeastern states, it can be cultivated on a small to large scale in the foothills of Arunachal Pradesh, Mizoram, Nagaland and Meghalaya. It can be cultivated either as a monoculture crop or mixed crop with multipurpose trees such as *Artocarpus heterophyllus*, *Albizia procera*, *Cinnamomum* spp., *Glyricidia sepium*, *Moringa oleifera*, etc. Eventually, income from the multipurpose trees will provide extra profit to the farmers. If practiced with suitable cultivation practices, it can also be introduced in the secondary forests, degraded forests, etc. This plant has already been raised successfully as an intercrop with coffee and coconut plantation in some parts of Western Ghats¹⁹.

Cultivation technology

Seeds of pippali have very low germination capacity, and therefore the species is mainly cultivated through vegetative propagation. Usually stem cuttings with 3–5 nodes, or root tillers are used as propagation material (Figure 2). Propagation of the cuttings is usually carried out during March–April and plantation before the onset of monsoon.

Experimentation on propagation through stem cuttings of the plant conducted by us in Arunachal Pradesh showed a good result. Three distinct types of cuttings

were made from the stem, i.e. cutting with one node, two nodes, and three nodes. The cuttings were raised in the nursery using poly bags with sand, soil and cow dung at a ratio of 2 : 1 : 1. The planted cuttings were watered and monitored regularly. The emergence of new buds began after one month in all the three types of cuttings and grew successfully. The observation after 2 months revealed that the stem cuttings showed a good survival percentage with at least 70% in all the three types of cuttings indicating regeneration potentiality through the stem as in other *Piper* species. Though all the three cutting types showed good results, it would be recommendable to use the three-node cutting for commercial cultivation as this will promote the production of higher number of shoots capable of producing good number of fruiting spikes. However, during selection, one must select the female plant. Production of fruits without male counterpart is already reported in *Piper* and had also been observed in *P. longum* by us. However, for ascertaining healthy fruits, at least 5% of male plants should be raised.

The well established seedlings are transplanted in the field at 1 × 1 m under mono-cropping or 2 × 2 m distance in mixed cropping. Manuring of the plantation area with Farm Yard Manure (FYM) or any other organic manure can be done during the first year of the plantation before the onset of monsoon. Irrigation is usually done 2–3 times a week depending on soil quality and weather conditions. Growth of weeds must be avoided in the plantation. Raising of cuttings should be initiated between March and April which can then be transplanted in the field during May–July.

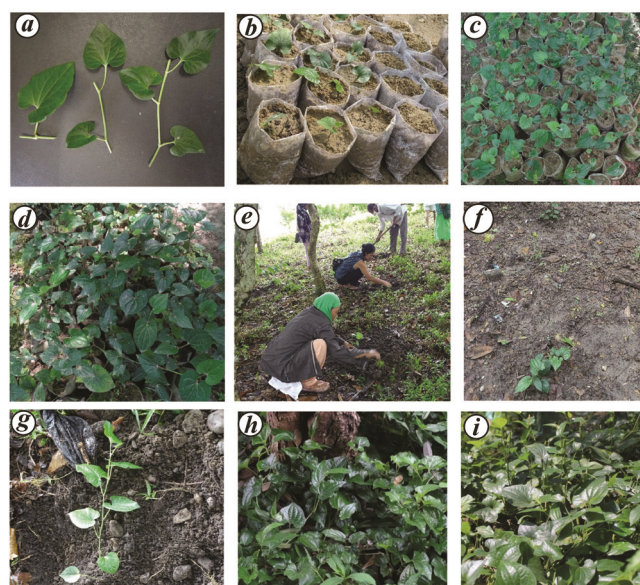


Figure 2. *a*, Cuttings with 1, 2 and 3 nodes; *b*, Cuttings in polybags; *c*, Two months old cuttings; *d*, Three months old and ready for plantation cuttings; *e*, Transplantation of cuttings in North Eastern Regional Institute of Science and Technology (NERIST) campus; *f*, Transplanted cuttings at 2 × 2 m distance; *g*, Transplanted cuttings; *h* and *i*, Established flowering and fruiting plants in NERIST campus.

Harvesting and yield

The flowering of the plant starts after 2 to 3 months from the cuttings raised from fertile shoots. Generally, *P. longum* produces flowers from August to October, after 4–5 months of planting, and fruits are ready to be harvested 2–3 months after spike formation, which would be mostly from December to February. The fruits are preferably harvested just before ripening to retain the best quality.

In mixed cropping patterns, about 66 kg/ha dried spikes can be harvested during the first year which will rise to about 166 kg/ha from the second year onwards. The yield eventually decreases after the fourth year and by the fifth year it becomes economically unfeasible, therefore the plants need to be replanted. The stem and roots can also be harvested for producing a product called ‘pippalimula’ or ‘piplamool’. The root is traded based on their grading. Grade I comprises of thick roots and underground stem which are sold at a higher price as compared to Grade II and Grade III which are composed of thin roots, stem and broken fragments²⁰.

Economy and employment generation

In mixed cropping of introducing the species in any agroforestry system, the farmer can earn a minimum of about Rs 50,000 per hectare as additional income per year. Combining with other crops in the agroforestry farming system, the profit may increase as per the nature of the intermixed crop. Unlike most other commercial crops, farmers can reap the benefits right from the first year of planting as the plant starts producing fruits within 6–7 months of its planting. An estimation of the net income per hectare is as shown below.

Net income from fruiting spikes (@Rs 800/kg) in an agroforestry system

Total plants that can be accumulated = 2500 per hectare

Income in first year = Rs 52,800

[2500 × 8 spikes = 20,000 spikes (approx. 8 spikes/plant) = 66 kg (1 kg = 300 spikes)]

Income from second year to fourth year = Rs 132,800

[2500 × 20 spikes = 50,000 spikes (approx. 20 spikes/plant) = 166 kg].

It is also estimated that through monocropping with reducing the spacing below 1 m × 1 m, a farmer may also earn a net income of Rs 100,000 to 150,000 per hectare⁵.

Large scale plantation of *P. longum* will play a considerable and increasing role in fulfilling the supply gap for industrial demands. It will also provide employment opportunities that can make a difference in rural areas with weak labour markets. The various activities required

in the nurturing of the plants like nursery management, plantation, plant management, harvesting, grading and drying and marketing will thereby play a vital role in economy and manpower generation.

Conclusion

Medicinal plants with regular market demands always provide better livelihood options for the farmers. However, due to the lack of understanding of their marketing demand and cultivation techniques, many of the potential medicinal herbs are yet to be recognized for large scale farming. *P. longum* is one of the best crops that can be cultivated easily with minimum efforts for generation of good revenue. Due to its shade-loving nature and warm humid climatic requirement, it can be introduced as one of the understorey crops in different agroforestry systems where a farmer may earn about Rs 50,000–150,000 per hectare as an additional income along with various other crops of silvicultural and horticultural importance. Once large scale cultivations are targeted, it may also promote self-employment opportunities for the farmers through processing and marketing of the products. Various Govt departments can take an integrated approach for promotion of the commercial cultivation of this crop involving the local mass, particularly in the northeastern region of the country.

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