ISSN: 2347-4688, Vol. 14, No.(2) 2026, Pg. 362-369

Current Agriculture Research Journal

www.agriculturejournal.org

Assessing Economic Viability of Woody Pepper (*Piper pendulispicum* C.DC) Nursery Production using Serpentine Layering in Remote Areas of Andaman Islands, India

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Abstract

Woody pepper (*Piper pendulispicum* C.DC) is a novel spice reported to occur in the Andaman and Nicobar Islands in the Bay of Bengal. This underutilized species has a great potential for agricultural diversification in these islands. However, the scarcity of quality planting material prevents its widespread adoption in other parts of the islands, which are remotely located but have good demand for these plants. In order to promote production of quality planting material locally in these far-flung islands, understanding the economic feasibility of the nursery venture is desired. Recently, serpentine layering was standardized for mass multiplication of woody pepper and the present study describes its economic feasibility in an inexpensive bamboo polyhouse. An estimated 6,916 rooted cuttings were produced each year in a model low-cost nursery with 260 mother plants housed in a 50 m² set up. Gross profits were ₹2.76 lakh, while the total cost of production (Cost C3) was ₹93,978.33. With a net present value of ₹1.82 lakh, it was clearly financially feasible. Profitability was further supported by the benefit-cost ratio of 2.94. Thus, serpentine layering of woody pepper was found to be a feasible and resource-efficient enterprise, which could improve access to planting material, reduce shipping costs, and create revenue opportunities under decentralized nursery production system in the Andaman Islands. The results are indicative estimates based on assumed conditions and should be interpreted with caution.

Article History
Received: 08 June 2026
Accepted: 08 July 2026

Keywords
Benefit Cost Ratio;
Bamboo Polyhouse;
Choi Jhaal;
Entrepreneurship;
Novel Spice.

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Doi: http://dx.doi.org/10.12944/CARJ.14.2.7

Introduction

Andaman & Nicobar Islands in the Bay of Bengal are one of India's top tourist destinations. In 2023–24, 3,57,000 tourists visited these islands, while the total population of the islands was 3,80,581 as per 2011 census.[1] Tourism will continue to be a major driver of the Island economy due to these islands, exceptional scenic beauty, improved infrastructure and connectivity. This has resulted into increased competition for land among agricultural, infrastructure, and service-sector endeavours. Therefore, providing farmers with remunerative agricultural ventures is of great importance for keeping the island agriculture profitable. In fact, the authors propose that with rich biodiversity of various native flora, it would be more pragmatic if agriculture is considered as a complimentary sector to the tourism rather than its competitor sector. For this, identification and systematic promotion of unique crops from the native biodiversity is of utmost importance. The incoming tourists in the islands could offer good opportunity to the island farmers to market their unique produce as lack of marketing opportunity has often been cited as a major impediment in farmer’s welfare elsewhere.[2]

Woody pepper (*Piper pendulispicum* C.DC), locally referred to as *Choi Jhaal*, is a unique species reported from the Andaman Islands.[3] The stem pieces of this species have been identified as a source of antioxidants including phenolic compounds and piperine,[4] and is being promoted as a novel spice crop in these islands. Traditionally, woody pepper is being grown using various live standards *viz.* mango, jackfruit, forest trees, coconut, drumstick *etc.,* while it has been identified as a potential crop for cultivation as intercrop in the arecanut plantations.[5] Of the 36,759 ha of arable land available in the Union Territory, 4,757 ha is under arecanut, and the area has shown an increasing trend in the recent past.[6] Extensive research in arecanut growing regions has shown that systematic intercropping within arecanut plantations has improved land-use efficiency and farm profitability, rendering these systems more resilient and economically appealing to the smallholders.[5, 7-11] Cultivation of this unique species would not only help in getting better profits to the island farmers but would also offer new flavours for tourists thereby complimenting the tourism industry.

From an economic perspective, the limited availability of quality planting material represents a critical constraint in scaling up woody pepper cultivation, reflecting a form of input market inefficiency. To overcome this bottleneck, productivity enhancement strategies should focus on ensuring timely access to quality planting materials, implementing disease control measures, and assured irrigation.[12] Moreover, the conventional vine cutting propagation techniques have attained merely 20% success.[13] This reflects an input supply inefficiency that restricts crop expansion. Authors’ Institute standardised and promoted serpentine layering (Fig. 1) as an efficient propagation method, facilitating more dependable multiplication of woody pepper for both monoculture and intercropping systems.[14] Although planting material is being produced and supplied to farmers in South Andaman Island, growers in remote islands face considerable difficulty in accessing these inputs due to geographical isolation. High inter-island transportation and associated transaction costs further inflate the price of propagules, reducing affordability and adoption. This underscores the importance of developing low-cost and location-specific models, as highlighted by Prabhakar *et al.*[15] In this context, decentralized nursery production through island-based entrepreneurs can play a crucial role in strengthening backward linkages in the value chain by improving local availability of quality planting material, reducing transaction costs, and ensuring timely access to inputs. Such localized production systems can enhance economic efficiency while supporting wider adoption of woody pepper cultivation among smallholders. Since there is virtually no study on economic viability of low-cost nursery production of woody pepper, this study was taken up with objective of assessing the economic feasibility of a suggested nursery production technique for woody pepper utilising serpentine layering within a low-cost polyhouse system.

Fig. 1: A view of serpentine layering in woody pepper at authors' institute

Materials and Methods

A low-cost bamboo polyhouse structure measuring 50 m² was used for calculation in this study (Fig. 2). The total construction cost of polyhouse was estimated to be ₹20,000/- with an estimated lifespan of four years. The planting layout, number of mother plants, and expected output of cuttings were estimated based on published literature[13] and authors' experience in the institute's nursery. Each mother plant was assumed to produce an average number of cuttings annually under optimal management conditions.

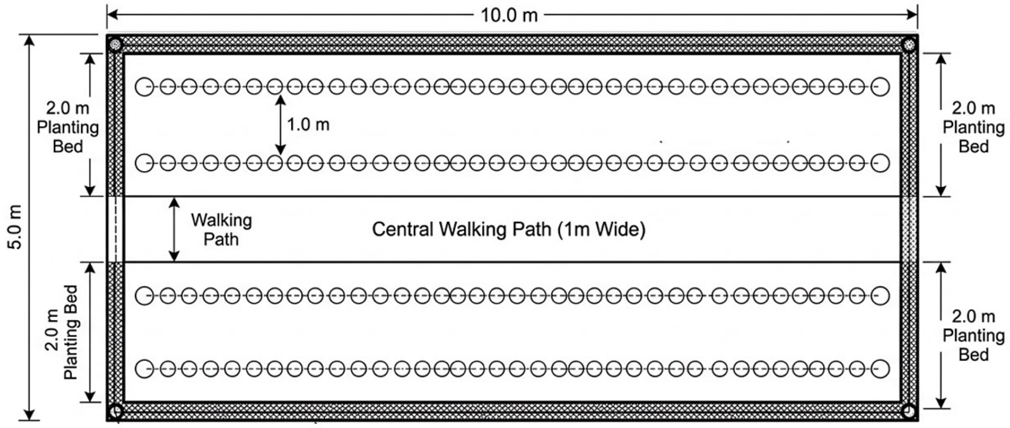

Fig. 2: Technical layout of a low-cost polyhouse structure- Top-Down View

(The image is generated with the help of AI tool-Perplexity and technically validated by authors)

The planting arrangement was planned such that the polyhouse had four rows, each containing 65 plants, culminating in a total of 260 mother plants inside the structure. Standardized procedure for serpentine layering described by Waman *et al.*[14] was followed. Equal ratios of farmyard manure (FYM) and soil were utilised for the formulation of the substrate. Observations have suggested that each mother plant could produce an average of 26.6 cuttings each year, totalling 6,916 cuttings from the planned structure. A demand of 2,766 kg of FYM and soil was calculated based on the intended operational scale. The unit cost of FYM was deemed ₹ 1.00 per kg, whereas the cost of soil was set at ₹ 0.50 per kg, according to prevailing market prices. The labour needed for maintenance and operating tasks was estimated at two hours daily. For economic assessment, the Andaman and Nicobar Administration set wages for unskilled workers at ₹ 641 per day for an 8-hour workday were used, with a standard workforce utilisation of 91.25 working days yearly. Cost A1 included miscellaneous expenses such as minor repairs, consumables, and incidental charges at 5% of the total paid-out cost, a common approximation in farm management studies. The fixed capital investment in the polyhouse structure was subject to an annual interest rate of 10%, determined by the average value of the asset throughout its anticipated useful life.

Table 1: Components of Cost analysis

Cost	Items included
A1	Planting material of mother plants Planting bags Farmyard manure Soil Plant Protection Chemicals Depreciation of polyhouse Miscellaneous
B1	A1+ Interest of fixed capital assets (Polyhouse) at 10%
B2	B1+ Rental value of owned land
C1	B1 + Imputed value of family labour
C2	B2 + Imputed value of family labour
C3	C2 + 10 % C2

Source: Adapted from Directorate of Economics and Statistics (2021), *Cost Concept*.[16]

Economic analysis was carried out using standard cost ideas offered by Commission on Agricultural Costs and Prices (CACP) as per requirement of the study (Cost A1, B1, B2, C1, C2, and C3) to estimate total cost of production (Table 1). Rent for land in the Islands is paid either half-yearly or annually depending on the terms of the landowner's agreement, which ranged from ₹ 17,500/- to ₹ 26,500/- in 2019.[17] The annual rent for agricultural land was calculated to be Rs 30,000/- based on secondary data from public reports and conversations with farmers. This amount was then added at a 10% interest rate to determine Cost B2. Returns were calculated based on assumed survival rate and prevailing market price of planting material. Indicators such as Net Present Worth (NPW), Benefit–Cost Ratio (BCR), and Operational Efficiency were used to assess the economic viability of the proposed model. Since the study is based on a proposed model, the results represent indicative estimates under assumed optimal conditions and may vary under actual field situations.

Results

Economics of Woody Pepper Nursery Production Under Low-Cost Bamboo Polyhouse

The economic analysis of the low-cost bamboo polyhouse structure revealed promising financial returns from woody pepper nursery production (Table 2). In the experiment, a total of 260 mother plants produced 6,916 rooted cuttings annually, corresponding to an average output of 26.6 cuttings per mother plant. The operational cost (Cost A1) was estimated at ₹25,794, while Cost B1 and Cost B2 were ₹26,793.60 and ₹26,943.60, respectively. The comprehensive costs C1, C2, and C3 were estimated at ₹85,284, ₹85,435, and ₹93,978, respectively. Among the cost components, planting material (₹6,500), polythene bags for cuttings (₹6,916), and depreciation of the polyhouse (₹5,000) constituted the major expenditure items.

The gross receipts from nursery production were estimated at ₹2.76 lakh based on a sale price of

₹40 per rooted cutting (Farm Gate Price). The Net Present Worth (NPW) was calculated as ₹1.82 lakh. The Benefit-Cost Ratio (BCR), estimated using Cost C3, was 2.944, while the operational efficiency (Gross Returns/Cost B2) was 10.267, indicating favourable economic returns from the enterprise.

Table 2: Economics for woody pepper nursery production for a year

Costs	Values (₹)
Planting material cost	6,500
Cost of polythene for cuttings @ ₹1 per cutting	6,916
FYM cost @ ₹ 1 per kg	2,766
Soil cost @ ₹ 0.5 per kg	1,383
Plant protection cost	2,000
Depreciation of polyhouse	5,000
Miscellaneous cost	1,228
Cost A1	25,794
Interest of fixed capital assets at 10%	1,000
Cost B1	26,794
Rental Value of 50 m^2 land	150
Cost B2	26,944
Cost C1	85,284
Cost C2	85,435
Cost C3	93,978
Gross receipts @ ₹ 40/- per rooted cutting	2,76,640
Ratios	
Net Present Worth (GR-Cost C3)	1,82,662
Benefit cost ratio (GR/C3)	2.944
Operational Efficiency (GR/B2)	10.267

Source: Authors' calculation based on the study data

Table 3: Sensitivity analysis of the economics of woody pepper nursery production under selected production and market scenarios

Scenario	Gross Returns (₹)	Cost C3 (₹)	Net Returns (₹)	B:C Ratio
Base scenario	276,640	93,978.33	182,661.67	2.94
Market price ₹36 per cutting (-10%)	248,976	93,978.33	154,997.67	2.65
Market price ₹44 per cutting (+10%)	304,304	93,978.33	210,325.67	3.24
Productivity −10% (23.94 cuttings/mother plant)	248,960	93,978.33	154,981.67	2.65
Productivity +10% (29.26 cuttings/mother plant)	304,320	93,978.33	210,341.67	3.24
Labour cost −10%	276,640	88,129.20	188,510.80	3.14
Labour cost +10%	276,640	99,827.46	176,812.54	2.77

Source: Authors' calculation based on the study data

Sensitivity analysis indicated that the profitability of woody pepper nursery production was robust under plausible variations in key economic parameters. A ±10% change in the market price of rooted cuttings or in the average number of rooted cuttings produced per mother plant (26.6 ± 10%) resulted in B:C ratios ranging from 2.65 to 3.24. Similarly, a ±10% variation in labour cost changed the B:C ratio from 2.77 to 3.14. In all scenarios, the B:C ratio remained well above unity, indicating that woody pepper nursery production is economically viable under moderate fluctuations in production and market conditions.

Discussion

The positive NPW obtained in the present study indicates that the low-cost bamboo polyhouse nursery model is economically viable, with returns substantially exceeding the total investment cost. The estimated BCR of 2.944 suggests that every rupee invested in the nursery enterprise could generate nearly three rupees in return, demonstrating the profitability of woody pepper propagation under protected conditions. Similar observations were reported by Kumar *et al.*,[18] who attributed higher profitability in protected cultivation systems to improved productivity and efficient resource utilization. The BCR estimated in the present study is comparable to values reported for black pepper nursery production of Panniyur-1 in Karnataka (2.95), supporting the economic feasibility of nursery-based enterprises.[19] Plantation-level studies in Karnataka have also reported BCR values ranging from 2.35 to 4.52, indicating that spice crop nurseries can provide attractive economic returns.[20] In contrast, lower input-output ratios (1.76–1.94) reported for field-level black pepper cultivation in Kerala suggest that nursery enterprises may offer greater profitability than conventional cultivation systems.[21] The operational efficiency value of 10.267 further indicates efficient utilization of resources within the production system. Despite the relatively high cost of agricultural inputs in island ecosystems due to transportation and logistical constraints, the nursery model maintained strong economic performance. These findings are in agreement with observations reported under polyhouse-based cultivation systems, where protected structures enhanced resource-use efficiency and economic returns.[22] Although the estimates are based on assumed production and price parameters, the results highlight the substantial economic potential of low-cost bamboo polyhouse nurseries for woody pepper multiplication. The sensitivity analysis demonstrated that woody pepper nursery production remained economically viable under ±10% variations in market price, productivity, and labour cost, indicating the robustness of the enterprise against moderate production and market uncertainties. The authors recommend pilot-scale adoption of the nursery to validate the underlying assumptions and findings under local conditions before scaling up to commercial production. The technology appears particularly suitable for small and resource-constrained farmers in the Middle Andaman, North Andaman, and Little Andaman regions. Furthermore, the model may also provide opportunities for entrepreneurs in other warm and humid regions of mainland India interested in commercial woody pepper propagation.

Conclusion

Recent research indicates that the proposed nursery production method for woody pepper, employing serpentine layering within a cost-effective bamboo polyhouse, holds considerable potential for economic feasibility in the Andaman and Nicobar Islands. The economic forecasts, based on assumed optimal conditions, provide a favourable Net Present Worth of ₹1.82 lakh and a Benefit–Cost Ratio of 2.94, indicating efficient resource allocation and potential financial benefits, even for small landholdings. The adoption of advanced propagation techniques, such as serpentine layering, may alleviate the scarcity of high-quality planting material and promote cultivation. However, since the research is based on a proposed framework, the results are only suggestive and may vary in practical applications. Therefore, it is recommended to do field-level validation before extensive implementation. The methodology demonstrates considerable promise for enhancing sustainable horticultural entrepreneurship in the region.

Acknowledgement

The authors are thankful to the Director, ICAR-Central Island Agricultural Research Institute, Sri Vijaya Puram, Andaman and Nicobar Islands for providing necessary facilities for the study.

Funding Sources

Indian Council of Agricultural Research provided financial assistance in the form of inhouse project (Project Code: HORTCIARISIL202400700251) to the first author.

Conflict of Interest

AAW is a member of the Editorial cum Advisory Board of Current Agriculture Research Journal. To ensure impartiality, the author had no role in the editorial review or decision-making process for this manuscript. The submission was handled independently by other editors.

Data Availability Statement

The supporting data are available in the public domain and the data are obtained from the web sites of Government of India.

Ethics Statement

This research did not involve human participants, animal subjects, or any material that requires ethical approval and therefore, informed consent was not required.

Clinical Trial Registration

This research does not involve any clinical trials.

Permission to reproduce material from other sources

Not Applicable.

Author Contributions

- **Sharath Yeligar:** Calculation and Data Analysis, Writing of First Draft.
- **Ajit Arun Waman:** Conceptualization, Development of Method and Editing of the Draft.

Both the authors read and agreed to the final version of the draft.

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