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Study on the Cost of Cultivation, Returns, and Benefit-Cost Ratio of Betel Vine Farmers in Different Farm Groups in Bankura District, India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Agriculture is the backbone of the Indian economy and plays a crucial role in the social and economic fabric of the country. It not only contributes to national income, food security, and employment generation but also fosters cultural unity and economic cohesion within society. This study focuses on betel vine cultivation in the Taldangra Block of Bankura district, West Bengal, where commercial betel cultivation is prevalent. Hence the study area was selected using purposive and convenient sampling methods to ensure representation of the dominant betel cultivation practices. To minimize recall biases, researchers established personal rapports with farmers before conducting surveys and collecting data. The study was conducted during the agricultural year 2023-24, with primary data collected from 120 farmers in seven randomly selected villages. The data

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collected aimed to assess the cost of establishing and maintaining betel orchards, total cultivation costs, returns, and the benefit-cost ratio for farmers. A semi-structured and pretested schedule, utilizing Participatory Rural Appraisal (PRA) techniques, was employed for data collection and farm economic evaluation. The results revealed that the total cultivation costs for marginal, small, semi-medium, medium, and large farmers were ₹457,943 ; ₹441,850; ₹430,115; ₹425,828 and ₹419,168, respectively. The cost-benefit ratios for these categories of farmers were 2.4, 2.5, 2.44, 2.2, and 2.7, respectively. Large farmers had a higher benefit-cost ratio of 2.7, while semi-medium farmers had a lower ratio of 2.2.

Keywords: Purposive Sampling; convenient sampling; pretested schedule; recall biases; participatory rural appraisal; cost of cultivation; cost-benefit ratio; farm economic evaluation.

1. INTRODUCTION

In India, traditional medicinal plants like ghritokumari, pudina, adrak, sarpagandha, tulsi, brahmi, poppy, basak, thankuni, and pan are widely used for their medicinal properties. Some of these plants are commercially cultivated due to their importance in traditional medicine. Betel vine, also known as piper betel, is a significant medicinal plant, which is intricately woven into the fabric of our culture [1]. Its leaves are the most economically valuable part and its cultivation has been commercialized for a long time [2-4]. Betel vine is often referred to as the 'neglected green gold' of India [5]. Betel leaves are highly nutritious, containing vitamins B, C, carotene, and a phenolic alkaloid called 'Eugenol', which is also found in cinnamon, clove, and bay leaves (Mazumdar et al., 2016 & Gupta, 2022). These leaves aid in digestion, freshen breath, and have been used as an antiseptic for cuts and wounds [6,7]. They are beneficial for the respiratory system and are used in treating colds, coughs, bronchitis, and to soothe respiratory tract in the presence of any foreign body [8]. The juice of betel leaves is used as an adjunct to oral pills administrated in Ayurvedic medicines [9]. In the Indian subcontinent, there are around 40 popular varieties of betel vines, with 30 varieties found in West Bengal [10]. West Bengal is renowned for its betel nut cultivation and the diverse genetic varieties of betel vines. Some major varieties in West Bengal include Bangla Pan, Sanchi, Mitha pati, Kali bangla, and simarulibangla pan [11]. The important planting seasons for betel vines in India are as follows in Table 1.

Major betel-growing countries in the world include India, Thailand, Bangladesh, and Sri Lanka, which form the Southeast Asian belt. In India, betel leaf cultivation is prominent in states like Assam, Andhra Pradesh, Karnataka, Bihar, Gujarat, Madhya Pradesh, Odisha, Rajasthan, West Bengal, and Maharashtra. The country has over 50,000 hectares dedicated to betel vine cultivation, generating an annual turnover of nearly 1000 Crores. India exported 6,159.39 metric tons of betel leaves valued at Rs. 26.18 Crores in the fiscal year 2020-21. India is a significant exporter of betel leaves to countries such as Afghanistan, Australia, Germany, Hong Kong, Kenya, Nepal, Bangladesh, Canada, France, the United Kingdom, UAE, Saudi Arabia, Qatar, Yemen, Oman, Pakistan, USA, and the United Kingdom [12]. Betel leaf consumption in India is estimated to be around 15-20 million people, providing direct or indirect employment opportunities for nearly 20 million individuals. In addition to job creation, betel leaf cultivation contributes to the nation's foreign exchange earnings. India's export potential remains strong, with increasing global demand for betel leaves [13].

West Bengal is the largest betel-producing state in the country, with nearly 18,690 hectares dedicated to betel vine cultivation [14]. The state contributes two-thirds of the total betel production in India, producing around 4-5 lakhs of boroj [15]. West Bengal exports betel leaves worth 150 crores annually to other states, with a total production of about 1.39 crores of betel leaves per year [16]. The post-harvest products of betel grown in West Bengal are in high demand in Bihar and Uttar Pradesh. Key betel vine growing districts in West Bengal include East Midnapur, Howrah, West Medinipur, Bankura, East Medinipur, and Nadia. East Medinipur district leads in betel vine cultivation area, with Bankura known for producing high-quality betel leaves. The area under betel vine cultivation in Bankura has been increasing [17]. Betel cultivation supports livelihoods for 25 million families in India, with betel leaves worth Rs. 30-40 million exported to the Middle East and European countries [5].

Table 1. Different planting seasons in different states

State	Season
Andhra Pradesh	September-October
Assam	April-May and August-September
Bihar	June-July September and May-June
Karnataka	July-August
Odisha	May-June and September-November
Madhya Pradesh	January-March and September-November
Maharastra	July-August and October-November
West Bengal	June-July and September-October

2. LITERATURE REVIEW

Kumar et al. [18] A study was conducted on betel farming in Uttar Pradesh, revealing it to be a lucrative cash crop with a high benefit-cost ratio of 2.3. However, betel cultivation requires significant labor and capital investment, making it most suitable for small-scale farmers in the region. It provides a stable source of employment and income for these farmers.

Dey et al. [19] A study was conducted on the economic analysis of betel leaf production and marketing in the Balasore district of Odisha. The study found that in the first year, the one-time cost of constructing a boroj for betel growers was ₹289,300. The annual cost of cultivation was ₹90,007, and the net return was ₹146,072.

Sathya et al. (2022) A study was conducted on the economic analysis of betel vine production in Thanjavur district of Tamil Nadu. It was found that the cost and return of a betel vine farm per acre was estimated to be 37 lakh ₹/acre, with an average gross return of 8 lakh ₹/acre. The study concluded that betel vine cultivation is highly profitable compared to other crops, with a benefit-cost ratio of 2.3.

Palanichamy et al. (2022) A study was conducted in the Tanjavore District of Tamil Nadu, focusing on betel vine production and the challenges faced by betel growers. The study revealed that the cost of a betel vine farm was approximately ₹3.37 lakh per acre, while the average gross return was ₹8 lakh per acre. The findings suggest that betel vine cultivation is highly profitable, with a benefit-cost ratio of approximately 2.5.

Mondal et al. [17] A study was conducted on the rejuvenation of the betel farming economy in South Bengal after a cyclone. Primary data was collected from 51 betel farmers in Fingha Dhaowri village in South 24 Parganas, West Bengal. The construction of a boroj (betel leaf plantation) covering 10 decimals costs between 0.8 to 1.5 lakh ₹, including first-year maintenance. This cost is supported by the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGA) and the state government disaster relief fund.

Rahman et al. [20] A study in Bagerhat district, Bangladesh, examined the profitability and marketing channels of betel leaf. The results showed that farmers made the most profit in the 4th year with a B-C Ratio of 1.62. Market margin analysis revealed that small, medium, and large betel leaf farmers sold their produce at prices of ₹ 31.25, ₹ 210.43, and ₹ 331.56 respectively. This price difference was due to varying demand for different sizes of betel leaves [21].

Pavithra (2016) A study was conducted on the economic analysis of betel leaf farming in Tumkur district, Karnataka. The researchers found that betel vine cultivation was highly recommended for its economic feasibility. It resulted in an Internal Rate of Return (IRR) of 29% and 24% with benefit-cost ratios of 1.37 and 1.26 in Gubbi and Pavagada taluks, respectively. Farmers in Pavagada taluk had higher marketing costs (₹160 per Pindi) compared to Gubbi taluk farmers (₹83 per Pindi) (Pindi is the local unit used to count leaves) [22,23].

Mandal and Mandal (2016) The financial feasibility and constraints of betel vine cultivation in the coastal area of Sundarbans, West Bengal were studied. Sundarbans is an ecologically vulnerable region in the era of global warming, with coastal regions losing their mean sea level (MSL) height. The study was conducted in this area to assess its potential as a betel growing zone. The findings showed a payback period of 2.81 years, an internal rate of return (IRR) of 45%, a net present value (NPV) of ₹134, 614 and a benefit-cost ratio of 1.25.

Tholkappian (2014) A study was conducted in Thanjavur district of Tamil Nadu to compare the

economic viability of organic and conventional betel farming. Data was collected from 30 organic and 30 conventional farmers during the 2012-2013 agricultural seasons. The study found that net returns from betel leaf were higher in organic farms (45,212 ₹ per acre) compared to conventional farms (36,802 ₹ per acre). Similarly, gross returns were also higher in organic farms (78,100 ₹ per acre) compared to conventional farms (72,250 ₹ per acre).

Kandle (2013) A study was conducted on the economics of betel vine production in the Kelawe area of Thane district. It was found that each betel vine sett yielded approximately 52 to 55 cuttings, with each sett generating around ₹50. The entire betel vine orchard required drip irrigation, with an irrigation cost of ₹28,000. The net profit from a betel vine garden ranged from ₹1,00,000 to ₹1,50,000 per hectare.

Vinayak Rao (2013) A study in Amravati district examined the production and marketing of betel leaf. The research revealed that the production cost per hectare of the orchard was ₹237,603.86, while the bearing cost per hectare was ₹15,840.19 (based on a 15-year shelf life). The production per hectare was 400,777.96 lakh betel leaves, resulting in a net return of ₹106,848.36 per hectare. The input-output ratios at cost A, cost B, and cost C were 2.06, 1.43, and 1.36, respectively.

3. METHODOLOGY

In research, especially in Social Science, sampling is essential as it is impractical and also impossible to study an entire population. By following scientific principles, we can derive the sample regression function (SRF) from the population regression function (PRF). Sampling techniques allow us to collect data that accurately represents the population, enabling social scientists to conduct research and make observations. Analytical tools are then used to analyze the samples and draw conclusions. Samples provide a clear picture of the population, making it easier to make informed decisions. In economic analysis, it is not feasible to collect data from every individual, so sampling is necessary. Proper analytical tools are crucial for accurate data analysis and inference.

The methodology for the study includes the following sections:

1. Sampling framework
2. Data collection
3. Data analysis

3.1 Sampling Framework

3.1.1 Selection of study area

The state of West bengal has 23 districts, and Bankura district was chosen purposefully for this study. It is a well known area as betel producing zone.

3.1.2 Selection of block

Bankura district has 23 blocks, and Taldangra block was selected purposefully for its high betel vine cultivation and a large number of betel growers and orchard owners.

Table 2. Total no. of villages selected in Taldangra block

Sl. No.	Selected Villages
1	Taldangra
2	Phulmati
3	Jambedia
4	Khalgram
5	Lalbandh
6	Mandi
7	Nabagram

3.1.3 Selection of villages

A comprehensive list of all 143 villages in the block was compiled with the assistance of the block office. From this list, 5% of villages (i.e., total 7 villages) were randomly selected for the study.

Table 3. Type of respondents on the basis of Land Holding size

Type of Farmers	Land Holding Size
Marginal	< 1 ha.
Small	1-2 ha.
Semi-medium	2-4 ha.
Medium	4-10 ha.
Large	> 10 ha.

3.1.4 Selection of respondents (Farmers)

A comprehensive list of farmers was obtained from the chosen gram panchayats in the block. From the total villages, 10% of respondents were randomly selected. The chosen respondents were then categorized based on their landholding size into following categories.

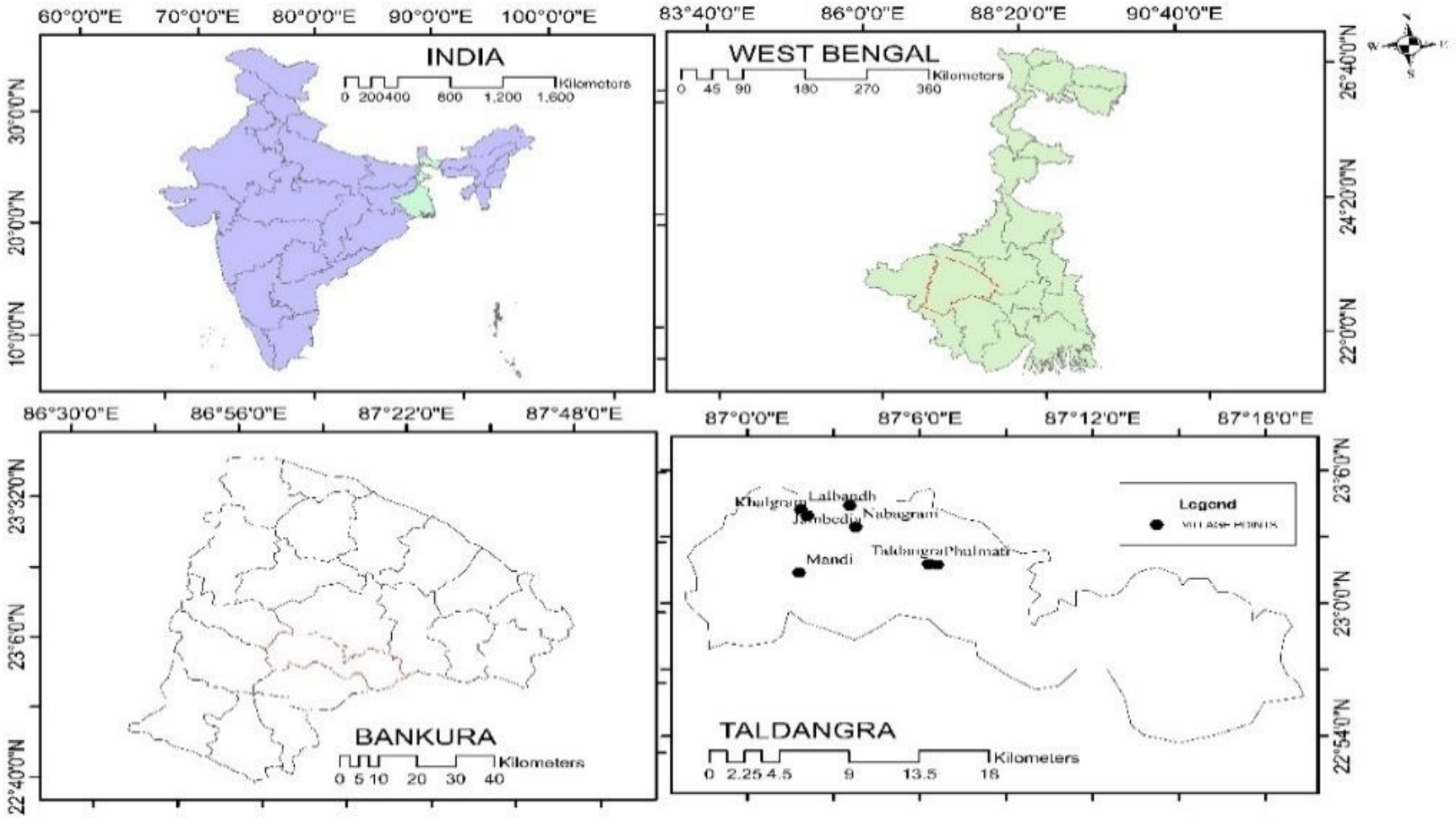

Fig. 1. Map of the Study Area (composed by Arc GIS Software)

Table 4. Selection of respondents

Sl. No.	Villages	Total no. of Betel farmers						Total no. of respondents					
		Marginal	Small	Semi-medium	Medium	Large	Total	Marginal	Small	Semi-medium	Medium	Large	Total
1	Taldangra	30	30	50	20	30	160	9	9	15	6	9	48
2	Phulmati	40	70	30	20	20	180	12	21	9	6	6	54
3	Jambedia	0	30	50	60	20	160	0	9	15	18	6	48
4	Khalgram	0	20	80	60	20	180	0	6	24	18	6	54
5	Lalbandh	40	40	60	40	0	180	12	12	18	12	0	54
6	Mandi	40	20	50	50	0	160	12	6	15	15	0	48
7	Nabagram	10	90	0	80	0	180	3	27	0	24	0	54
Total		160	300	320	330	90	1200	48	90	96	99	27	360

3.1.5 Market selection

The primary and secondary markets were chosen purposefully for this study.

3.1.6 Selection of market functionaries

A list of all market functionaries from both primary and secondary markets was compiled. 10% of the market functionaries were randomly selected for the study. These selected market functionaries were included in the data collection process.

Table. 5 Selection of Market Functionaries

Sl. No.	Market Functionaries	Total No.	Selected
1	Processing Unit	0	0
2	Commission Agents	40	4
Total		40	4

Period of Study: Data was collected during the Agricultural year 2023-2024

3.2 Analytical Tools

Following analytical tools were employed.

Cost A_1: Includes expenditures on value of owned human labour, owned bullock labours, tractors, hired bullock labours, owned and hired machineries, inputs like seeds, fertilisers, manures and fertilisers, agrochemicals, irrigation charges, interest and depreciation on working capitals, land revenue and other miscellaneous charges etc.

Cost A_2: Cost A_1 +rent paid for leased in land

Cost B: Cost A_2 + rental value of owned land + interest on owned fixed capital

Cost C: Cost B1 + imputed value of family labour

3.3 Measures of Farm Income

1. Farm business income = Gross income – Cost A_1
2. Family labour income = Gross income – Cost B
3. Net income = Gross income – Cost C
4. Farm investment income = Farm business income – Imputed value of family labor
5. Gross Income = No. of main products X Price of each product.

3.4 Benefit-Cost (B:C) Ratio

Benefit-cost ratio (BCR) is a measure that compares the economic yield to the biological yield and the present worth of gross return to the present worth of costs. It is calculated by dividing the discounted benefits of a project or policy by its discounted costs. If the BCR is greater than 1, it is advisable to proceed with the project or policy.

Formula:

$$\text{Benefit Cost Ratio} = \frac{Net\ Revenue}{Total\ Cost} = \frac{Gross\ Revenue - Total\ Cost}{Total\ Cost}$$

Total Cost = total Fixed Cost + Total Variable Cost

Gross Revenue = No. of items sold X price per item

3.5 Programming Language Applied

Arc GIS is an online Geographic Information System (GIS) software developed in 1999. It is highly used for creating study area maps for determining position at a global or geographical scale.

4. RESULTS AND DISCUSSIONS

The cost incurred in cultivation is typically classified into the following categories for better understanding:

- Establishment Cost (1st year)
- Maintenance Cost (2nd year)
- Total Cost of Cultivation (CoC)

Betel growers need to invest a certain amount before starting betel cultivation, especially in the initial years. This initial investment is crucial as it is the period where expenses are incurred before the actual harvest. The investments made by farmers in setting up the crop from pre-planting stages to the first cutting are considered establishment costs. These costs include field preparation, weeding, purchase of materials like bamboo, bricks, nylon, jute sticks, and farmyard manure. Nylon is essential to create a barrier to prevent grazing animals from damaging the crop. Manures and fungicides are also applied to the soil before constructing the betel leaf structure. When the establishment costs are combined with maintenance costs, which are the ongoing

variable expenses, the total cost of cultivation is calculated. Establishment costs are fixed, while maintenance costs are variable and necessary to sustain the farming operations.

Table 6 shows the average establishment cost of betel vine per hectare for farmers of different sizes. The establishment cost for a betel vine orchard was Rs. 959300 for marginal farmers, Rs. 929400 for small farmers, and Rs. 913300, Rs. 912950, and Rs. 891650 for semi-medium, medium, and large farmers respectively. This indicates that betel farming is typically conducted on a small scale.

Table 7 illustrates the annual maintenance cost of betel vine per hectare for farmers of various sizes. The maintenance cost for marginal farmers was Rs. 328,968, for small farmers it was Rs. 315,600, and for medium, semi-medium, and large farmers it was Rs. 304,600, Rs. 299,350, and Rs. 292,800 respectively.

The Table 8 shows the cost of betel leaf cultivation per hectare for different farm sizes. The costs for marginal, small, semi-medium, medium, and large farmers are as follows:

- Cost A: ₹ 395512, 380752, 368464, 364186, 355932
- Cost B: ₹ 415112, 400482, 389814, 385916, 379862
- Cost C (including family human labor): ₹ 416312, 401682, 391014, 387116, 381062
- Total cost (including 10% managerial costs): 457943, 441850, 430115, 425828, 419168.

These figures provide an overview of the cultivation costs for betel leaf farming across different farm sizes.

Table 6. Cost of establishing betel vines per hectare of betel leaf cultivation for various group sizes

Sl. No.	Particulars	Expenditure Variation by Farmers' Category [₹]				
		Marginal	Small	Semi-medium	Medium	Large
1	Field Preparation	98000	92000	88000	85000	82000
2	Labor for wedding & field preparation	58000	60000	61500	63000	63500
3	Purchase of small bamboo	28000	25000	25500	25300	25000
4	Purchase of large bamboo	170000	160000	155000	163000	150000
5	Jute sticks	90000	88000	86500	86300	86000
6	Nylon net	11500	11000	10750	10700	10600
7	Bricks	5000	4900	4900	4800	4750
8	Straw	2500	2500	2500	2500	2500
9	Iron wire	140000	138000	136000	135000	134500
10	Farmyard Manure	20000	20000	20000	20000	20000
11	Fungicide application	50000	50000	50000	50000	50000
12	Labor for fungicide preparation	55000	53000	52500	51000	50000
13	Labor for manure application	58000	56000	52500	51000	50000
14	Seedlings	80000	80000	80000	80000	80000
15	Water sprayer	4500	4500	4500	4500	4500
16	Irrigation	15000	13000	12500	12350	12000
17	Labor for Boroj construction	28000	27000	26500	25000	24000
18	Labor for vines plantation	3000	3000	3000	3000	3000
19	Lime	300	300	300	300	300
20	Rope	3500	3400	3350	3300	3200
21	Fertilisers	20000	20000	20000	20000	20000
22	Labor for fertilizer application	2000	1900	1700	1650	1600
23	Pesticides & Insecticides	5000	5000	5000	5000	5000
24	Labor for Pesticides &Insecticide application	2000	1900	1800	1750	1700
25	Others	10000	9000	9000	8500	7500
Total		959300.00	929400.00	913300.00	912950.00	891650.00

Table 7. Maintenance Cost of Betel Vine per Hectare of Betel Leaf Cultivation for Different Sizes

Sl. No.	Particulars	Expenditure Variation by Farmers' Category [₹]				
		Marginal	Small	Semi-medium	Medium	Large
1	Preparatory Tillage	38000	35500	34000	33500	33000
2	Ploughing	0	0	0	0	0
3	Manuring	58000	56000	53000	52500	52000
4	Fertilisers	3768	3700	3700	3600	3600
5	Weeding	6000	5500	5300	5100	5000
6	Pruning	80000	79000	77700	77100	77000
7	Chemicals	20000	20000	18000	18000	17500
8	Harvesting	28000	26000	25000	24000	23000
9	Packaging	28000	26000	25000	24000	23000
10	Total Hired Labour	42000	41700	41200	41000	40500
11	Total Family Labour	1200	1200	1200	1200	1200
12	Irrigation	15000	13000	12500	12350	10000
13	Others	9000	8000	8000	7000	7000
Total		328968.00	315600.00	304600.00	299350.00	292800.00

Table 8. Costs of betel leaf cultivation per hectare for different group sizes

Sl. No.	Particulars	Marginal [₹]	Small [₹]	Semi-medium [₹]	Medium [₹]	Large [₹]
1	Total Hired Labour	42000	41700	41200	41000	40500
2	Preparatory Tillage	38000	35500	34000	33500	33000
3	Ploughing	0	0	0	0	0
4	Manuring	58000	56000	53000	52500	52000
5	Fertilisers	3768	3700	3700	3600	3600
6	Weeding	6000	5500	5300	5100	5000
7	Pruning	80000	79000	77700	77100	77000
8	Chemicals	20000	20000	18000	18000	17500
9	Harvesting	28000	26000	25000	24000	23000
10	Packaging	28000	26000	25000	24000	23000
11	Irrigation	15000	13000	12500	12350	10000
12	8% of establishment cost	76744	74352	73064	73036	71332
13	Cost A (1-12)	395512	380752	368464	364186	355932
14	Rental value of owned land	12000	12000	13000	13000	15000
15	Land revenue	900	900	900	900	900
16	Depreciation on fixed capital	1680	1630	1780	1930	1980
17	Interest on fixed capital	5020	5200	5670	5900	6050
18	Cost B (13-17)	415112	400482	389814	385916	379862
19	Family human labour	1200	1200	1200	1200	1200
20	Cost C (18-19)	416312	401682	391014	387116	381062
21	Managerial Cost (@10% of Cost C)	41631	40168	39101	38712	38106
Total Cost (20-21)		**457943.00**	**441850.00**	**430115.00**	**425828.00**	**419168.00**

Table 9. Returns per hectare of betel leaf cultivation for different group sizes

Sl. No.	Particulars	Marginal	Small	Semi-medium	Medium	Large
1	Yield in 1st year [in panaa]	150	152	154	156	158
2	Yield 1st year onwards [in panaa]	310	304	308	312	316

Sl. No.	Particulars	Marginal	Small	Semi-medium	Medium	Large
3	Total Cost [₹]	**457943**	**441850**	**430115**	**425828**	**419168**
4	Total Establishment Cost [₹]	959300	929400	913300	912950	891650
5	Total Maintenance Cost [₹]	328968	315600	304600	299350	292800
6	Gross Revenue [₹]	1557006	1546475	1479596	1362649	1550922
7	Net returns (6-3)	1099063	1104625	1049481	936821	1131754
8	Cost A [₹]	**395512**	**380752**	**368464**	**364186**	**355932**
9	Cost B [₹]	**415112**	**400482**	**389814**	**385916**	**379862**
10	Cost C [₹]	**416312**	**401682**	**391014**	**387116**	**381062**
11	Farm Business Income [₹]	385432	401400	431300	436150	450100
12	Farm Labour Income [₹]	384452	398520	418320	440970	445020
13	Cost Benefit Ratio (7/3)	2.4	2.5	2.44	2.2	2.7

Table 9 shows the return and benefit-cost ratio for different farm sizes. Large farmers had a higher benefit-cost ratio of 2.7, while marginal farmers had a lower ratio of 2.2.

5. CONCLUSION

The study was conducted with 120 sample respondents, with an average farm size of 2.8 hectares per family. Despite the high establishment costs, many farmers are turning to betel farming due to its attractive benefit-cost ratio, which often yields double the initial investment. This provides a stable source of income for the farmers in the coming years. Betel farming is less affected by climate and price fluctuations compared to cereal crops. Marginal farmers, with smaller land holdings, have lower profitability compared to larger farmers who have the highest benefit-cost ratio.

6. RECOMMENDATION

Authors should establish a direct channel of communication between farmers and government agencies to facilitate subsidies for production costs such as raw materials, equipment, and agrochemicals. This would reduce production costs for farmers, increasing their profits.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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