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Profitability of exotic fruit crop: rambutan (*Nephelium lappaceum* L.) – A study from Kerala

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Abstract

Kerala has been witnessing a rapid increase in area under exotic fruits. The study was undertaken to evaluate the economic feasibility of rambutan cultivation, emphasising on cost and returns and major production constraints in Kerala. Primary data were collected from 120 farmers cultivating rambutan from the leading rambutan growing districts of the state. Multistage sampling technique and field survey using semi-structured interview schedule were employed for data collection. The amortisation technique was used to estimate annual establishment cost. Findings of the study indicated that rambutan cultivation involves high initial investment during the establishment phase as well as high labour costs during the maintenance phase. Amortised establishment cost was estimated to be Rs. 88325/ha/yr, accounting for about 37% of the total cost of cultivation (Rs. 2.4 lakh/ha/yr). Farm level average yield was found to be 6.5 t/ha. Gross income and net profit were found to be Rs. 8.45 lakh/ha and Rs. 6 lakh/ha, respectively. Unfavourable weather, high establishment cost, and wild animal attack were perceived to be the major constraints in cultivating rambutan, suggesting the need for evolving climate and cost-effective cultivation techniques. Though rambutan cultivation involves higher cost, its relatively higher yield and returns makes the crop a preferred crop among the exotic fruits.

Key words: Cost of cultivation, economic analysis, establishment cost, exotic fruits, rambutan, Kerala, farm economics, cost-return analysis, production constraints

Introduction

India is the second largest producer of fruits in the world after China, accounting for about 12% of the world's fruit production with an annual output of 110.21 million tonnes (APEDA, 2024). The growing significance of horticulture is evident from the increasing share of fruit crops in total horticultural output, which rose from 29.5 per cent in 2001–02 to 31.5 per cent in 2015–16. (Keerthika *et al*., 2024). Exotic fruits are becoming prevalent in Indian horticulture owing to their high market demand and profitability. The country witnessed a steady increase in the cultivation of exotic fruits during recent years and it could produce about 11.39 million metric tonnes of exotic fruits during the year 2024 (FAO, 2024). Studies have confirmed their economic feasibility and reported profitable cultivation across the states (Vasuki and Soundariyan, 2022; Akhil *et al.,* 2024)

Kerala, known for its high value horticulture crops has been witnessing a shift from existing rubber cultivation to exotic fruits like rambutan. Exotic fruits such as rambutan, passion fruit, dragon fruit, avocado, and mangosteen were the most preferred in this order of importance (Chacko and Sulaja, 2024). The success stories of early rambutan adopters encouraged the widespread conversion of rubber plantations to rambutan orchards (Hindu Business Line, 2016; Singh *et al*., 2022).

Although the state once accounted for about 88% of the rubber cultivation of the country, its share had declined from 84.3% in 2000-01 to 75.1% in 2010-11 (Rajesh, 2015). Rubber cultivation requires a consistent and skilled labour force throughout its productive period, as tapping is a specialised and labour-demanding activity (Philip and Shantamani, 2016). These challenges, along with adverse scenarios like unstable market prices, rising production costs, and declining profitability, led to shift from rubber crops to rambutan in the regions, mainly in the midlands of Central Kerala (Sree *et al*., 2024). The Travancore region including Kottayam, Pathanamthitta and Ernakulam had witnessed introduction of rubber during 1790s. The cutivators in the region foster agricultural commercialisation and innovation through introducing new crops and developing commercial cultivation practices and mass propagation methods. The cultivators from these regions had migrated to the less populated North Kerala during 1950s spreading agricultural commercialisation and intensive cultivation throughout the state.

Rambutan (*Nephelium lappaceum*), a tropical fruit native to South-East Asia and a member of the *Sapindaceae* family, has agro-climatic suitability to the midland and highland regions of the state. Kerala now covers about 839.12 ha of land under rambutan cultivation (GoK, 2023). Muhammed and Kurien (2018) investigated on the phenological stages of rambutan under Kerala's environmental conditions and reported that the crop has emerged as one of the most valued courtyard fruits in the state. The study conducted by Gaddafi (2025) provides key baseline data to guide future crop-improvement efforts and marker-assisted breeding initiatives for rambutan in Kerala. The role of varietal improvement in enhancing productivity, fruit quality, and operational efficiency has been well-documented in perennial horticultural crops, such as apple (Bhat *et al*., 2022). Availability of budded varieties like N18 and support by providing technical advice on production technology from nurseries like *Homegrown Biotech* have resulted in its widespread adoption. N18 variety has higher fruit quality, yield, palatability and enhanced shelf life in

contrast to traditional rambutan called Mullanpazham (Alex and Alex, 2024). As the crop is being introduced in different parts of the state, it has its importance in the cropping system of the state, especially as a fruit crop in the home gardens.

As rambutan is a newly introduced crop gaining momentum in the state, the pros and cons of shifting to this crop has to be understood. Even though studies are available either on agronomic performance and varietal characteristics, detailed economic evaluation of rambutan cultivation under Kerala conditions has been least attempted. Considering growing interest among the farmers about the crop and consistently increasing area under the crop in the state, there is a need to empirically evaluate profitability of the crop in terms of economic parameteRs. The perceived constraints in crop cultivation by the existing growers will throw insight into the future prospects of crop cultivation. Therefore, this study attempts to narrow down the research gap and aims to quantify the profitability of rambutan by estimating the cost of cultivation, gross and net returns and to provide insights about constraints faced by the groweRs.

Materials and methods

The state of Kerala (India) has been classified into 5 agroclimatic zones. These zones are subdivided into 23 agro-ecological units (AEU). The AEU-12, Southern and Central foothills spreading over Ernakulam, Kottayam, Pathanamthitta and Thrissur districts is suitable for rambutan cultivation. The first three districts account for about 70% of total area under rambutan cultivation in Kerala (Table 1). One block each with highest area under the crop were purposively chosen from each district for the study. The CD blocks chosen were Ranni (58 ha), Kothamangalam (65 ha) and Eratupetta (54 ha) from Pathanamthitta, Ernakulam, and Kottayam districts respectively. Thus, multistage sampling was employed for the study. The respondents (40 each) from these blocks were randomly selected for the field survey and data collection. Farms with atleast 15 bearing trees of age above 5 years were only selected to ensure availability of data regarding last three years yield. The lists of rambutan farmers provided from the *Krishi Bhavans* (KBs) of the selected blocks were used as the sampling frame. The survey was carried out during 2025 and data was collected using a pretested semi-structured interview schedule. Yield was taken as average of three years 2022-2025.

Table 1. Area under rambutan cultivation in Kerala (2023-24)

Districts	Area (ha)
Pathanamthitta	229.37
Ernakulam	220.37
Kottayam	141.70
Thrissur	50.30
Others	197.38
State total	839.12

Source: Directorate of Economics & Statistics (DES), 2023-24

Cost of cultivation: Rambutan is a perennial crop which starts yielding from third year of planting onwards and hence initial 2 years were considered as the establishment phase and rest as maintenance phase. The buds were planted at 2-year-old stage and an average yield of 2355 kg/ha was observed at third year. Cost of establishment was amortised and added to the maintenance cost for obtaining the annual cost of cultivation. We have used the formulae given below:

$$\text{Amortised establishment cost} = \frac{y[i(1+i)^n]}{[1-(1+i)^n]}$$

Where, y= total establishment cost, i = interest rate (7%), n = productive life span of rambutan (15 yrs) (Orwa *et al*., 2009)

Interest on working capital = m * i

m = annual maintenance cost, i = interest rate (7%)

Cost of cultivation = Amortised maintenance cost + Annual maintenance cost + Interest on working capital. For calculating cost of irrigation, amortised cost of irrigation given as:

$$\text{Amortised cost} = \text{Compounded investment} * \frac{[(1+i)^{EL} * i]}{[(1+i)^{(A)} - 1]}$$

Compounded investment = Historical cost$*$ $(1 + i)^{(A)}$

A= Age of the item

EL= Economic life of the item

Interest rate = 2%

Gross returns = Average yield * Average price of the output

Average yield was three-year average during 2022-23, 23-24 and 24-25. Price was average price received by the farmers during 2025 (Rs. 130/kg)

Net returns = Gross returns – Total cost of cultivation.

Production constraints: Constraints were identified and ranked using the Garrett ranking technique (Garrett and Woodworth, 1969), and the formula used is given below:

$$\text{Percent position} = \frac{100*(Rij-0.5)}{Nij}$$

where:

Rij = Rank given for the ith factor by the jth individual

Nij = Number of factors ranked by the jth individual

Results and discussion

Capital investment for irrigation: Since rambutan is an irrigated crop, it requires considerable capital investment in irrigation. The major water sources used in the rambutan farms were ponds followed by borewells or wells, and the cost of establishing each of these structures was estimated. Farmers in the study used either micro-sprinkler systems or conventional hose irrigation, and their capital costs was also estimated. The overall capital investment in irrigation across farms was Rs. 1,02,675/ha (Table 2).

Table 2. Capital investment (Rs/ha) and amortised cost for irrigation (Rs/ha/yr)

Particulars	Cost
Pond/well/borewell	35890
Motor pump	16610
Irrigation structure	
Micro-sprinkler	80317 (n=70)
Conventional (hose)	7975 (n=50)
Weighted average	50175
Total irrigation capital investment Rs/ha)	102675
Total amortised irrigation cost (Rs/ha/yr)	21138

(Figures in parenthesis indicates percentage)

Operation -wise establishment cost: The cost incurred during the first two years of the crop was considered as establishment cost. The planting of the crop was done in the land under senile and abandoned crops like rubber. These crops were uprooted and land was cleared and levelled using machines like JCB. Thus, machine labour was one of the major inputs during establishment

phase. About 99% of rambutan farmers shifted from rubber to rambutan cultivation due to decline in rubber tapping labour, single annual harvest, less pest and disease incidence, and better profitability of rambutan crop. Farmers used buds as planting material sourced from Homegrown nursery, Kanjirappally and it was observed that they prefer buds of N18 due to early yielding and good fruiting quality. Total orchard establishment cost was found to be Rs. 6,11,931/ha, comprising Rs. 5,22,654/ha in first year and Rs. 89,277/ha in second year. Major cost incurred was for fencing which accounted for about Rs. 3,16,886/ha (52 %). Strong fencing was provided around rambutan orchards to protect young plants from wild animals like wild boar and to safeguard long-term orchard investment, which accounted to major share of establishment cost (Table 3). Other major operations were manure application at 13 per cent (Rs. 76,908/ha) and weeding at 11 per cent (Rs. 64,222/ha). Both organic manures and compost were used heavily, particularly to improve the fertility of lateritic soil in the region. The crop is trained during the establishment phase (first 2 years) to maintain a balanced canopy. Training is an important operation to maintain plant shape and strong single stem. Among the blocks, cost was found to be highest in Ranni block (Rs. 6,66,866/ha), followed by Kothamangalam (Rs. 6,29,131/ha) and Eratupetta (Rs. 5,39,796/ha). Ranni block incurred the highest fencing cost (Rs. 3,77,642/ha), due to larger area coverage and steeper terrain conditions.

Table 3. Operation and year-wise establishment cost (Rs/ha)

Particulars	Year1	Year2	Total
Land preparation	56612	0	56612 (9.25)
Digging and planting	48299	0	48299 (7.88)
Fencing	316885	0	316886 (51.7)
Shade regulation	15395	0	15395 (2.51)
Manure and fertiliser application	41163	41639	82802 (13.56)
Soil ameliorant application	2135	2793	4927 (0.80)
Irrigation	8432	8432	16865 (2.75)
Weeding	31249	32973	64222 (10.5)
Training	2484	3440	5924 (0.96)
Total	522654	89277	6,11,931 (100)

(Figures in parenthesis indicates percentage)

Input-wise establishment cost: Fencing material, machine labour, human labour and organic inputs accounted for the major share of establishment cost (Table 4). Expenditure on fencing material formed the largest share (52%) of the total establishment cost. Farmers used durable chain-link or barbed wire fencing with concrete pillars, which though capital-intensive, ensures long-term orchard security. High machine labour cost (20%), reflected dependence on mechanisation for land preparation and weeding. Manure and fertiliser (12.3%) and human labour (14.17%) were the other major inputs. Expenditures on planting material (5.63%) were moderate but indispensable.

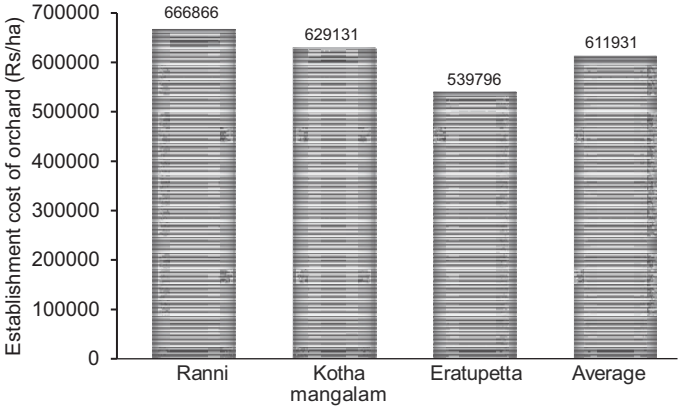

Fig. 1. Block-wise establishment cost of orchard (Rs/ha)

Establishment cost of rambutan was found to be higher than that of other perennial crops. In case of peach, a perennial crop, the establishment cost of Rs. 52,817/ha was amortised for 25 years, resulting in annual costs of Rs. 6,734/ha (Gangwar *et al.*, 2008). High expenses for land clearing and fencing and relatively shorter economic life taken for the amortisation caused higher amortised establishment cost.

Table 4. Input and year-wise establishment cost (Rs/ha)

Particulars	Year1	Year2	Total
Planting material	34460	0	34460 (5.63)
Fencing material	290834	0	290834 (47.52)
Shade net	2094	0	2094 (0.34)
Manure and fertiliser	37524	37698	75222 (12.29)
Soil ameliorant	621	1149	1770 (0.28)
Human labour	69260	17457	86717 (14.17)
Machine labour	87861	32973	120834 (19.74)
Total	522654	89277	611931 (100)

(Figures in parenthesis indicates percentage)

The total establishment cost was Rs. 714623/ha. When amortised, the annual establishment and irrigation costs together come to Rs. 88,325/ha/yr (Table 5).

Table 5. Establishment cost of orchard and amortised establishment cost (Rs/ha)

Particulars	Cost
Total orchard establishment cost (Rs/ha)	611931
Irrigation capital investment (Rs/ha)	102692
Total capital cost (Rs/ha)	714623
Amortised orchard establishment cost (Rs/ha/yr)	67187
Amortised irrigation cost (Rs/ha/yr)	21138
Total amortised establishment cost (Rs/ha/yr)	88325

(Figures in parenthesis indicates percentage)

Maintenance cost

Operation-wise maintenance cost: Rambutan is a shallow-rooted crop and hence disturbance of the land for fertiliser application and weeding is discouraged. Farmers usually do machine weeding and fertiliser is applied on topsoil. Manure application (including cost of manure (Rs. 32,552/ha) and cost of labour (Rs. 5899/ha)) was found to be the highest contributor to the total maintenance cost (27%) followed by weeding (26.53%). Other major operations include irrigation, fertiliser application and pruning. Pruning was done once a year by cutting excess branches, which helped to optimise sunlight penetration into canopy, hence increasing the yield. Total maintenance cost was

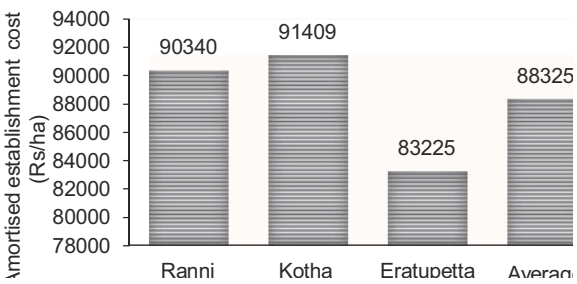

Fig. 2. Amortised establishment cost (Rs/ha/yr)

found to be Rs. 1,41,746/ha (Table 6). Kothamangalam block had highest maintenance cost (Fig. 3)

Table 6. Operation -wise maintenance cost (Rs/ha/yr)

Particulars/items	Cost (Rs/ha/yr)
Manure application	38451 (27.12)
Fertiliser application	11639 (8.21)
Soil ameliorant application	3897 (2.74)
Plant protection application	7052 (4.97)
Irrigation	31153 (21.90)
Pruning	11052 (7.79)
Weeding	37615 (26.53)
Land cess Depreciation Total	786 (0.55) 102 (0.07) 1,41,746 (100)

(Figures in parenthesis indicates percentage)

Input-wise maintenance cost: The major input components in rambutan maintenance were machine labour (26.7%) and organic inputs like cow dung (23%). Similar pattern of labour charges and manure and fertiliser costs accounting for a major share of maintenance costs was reported in mango farming in Varanasi (Kumar, 2024). Both machine and manual labour together accounted for about 51 per cent of the total maintenance cost. This shows that rambutan cultivation is highly labour-intensive. This is due to the high labour requirement for weeding and pruning (Fig. 4). Labour cost will further increase upon adding the labour cost for harvesting (Rs. 57,804/ha) which was usually carried out by pre-harvest contractoRs. The costs incurred for fertiliser (6%), plant protection chemicals (2%), and soil ameliorants like dolomite (1.1%) were relatively low, indicating that farmers followed organic practices (Table 7).

Total cost of cultivation: Total cost of rambutan cultivation was estimated to be Rs. 2,39,993/ha/yr, including amortised establishment cost (Rs. 88325/ha/yr) and maintenance cost (Rs.

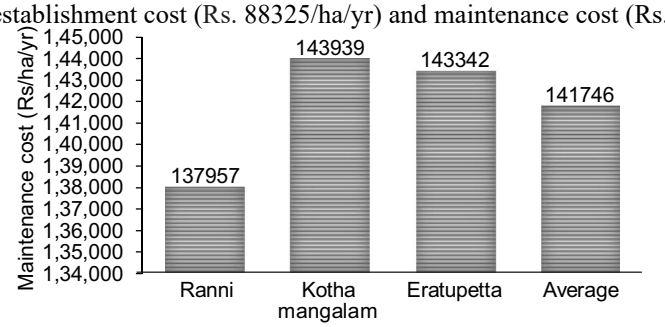

Fig. 3. Block-wise maintenance cost (Rs/ha/yr)

Table 7. Input- wise maintenance cost per year (Rs/ha/yr)

Particulars/Items	Cost (Rs/ha/year)
Manure	32552 (23)
Fertiliser	8559 (6)
Soil ameliorant	1550 (1.1)
Irrigation	24593 (17.40)
Plant protection chemical	2874 (2.04)
Human labour	33115 (23.36)
Machine labour	37615 (26.53)
Land cess Depreciation Total	786 (0.55) 102 (0.1) 1,41,746 (100)

(Figures in parenthesis indicates percentage)

1,41,746/ha/yr) (Table 8). The amortisation was followed by annualising the establishment cost over the economic life of the crop. Fig 5. shows inter-block variation, highlighting similar management practices across the three blocks.

Yield and returns: The average age of orchards was 8 yeaRs. Three-year averaging was carried out to avoid fluctuations in yield due to weather variation and also to account for the steady increase in yield of young orchards. Average yield of rambutan was 6.5 t/ha with average age of orchards being 8 yeaRs. The yield

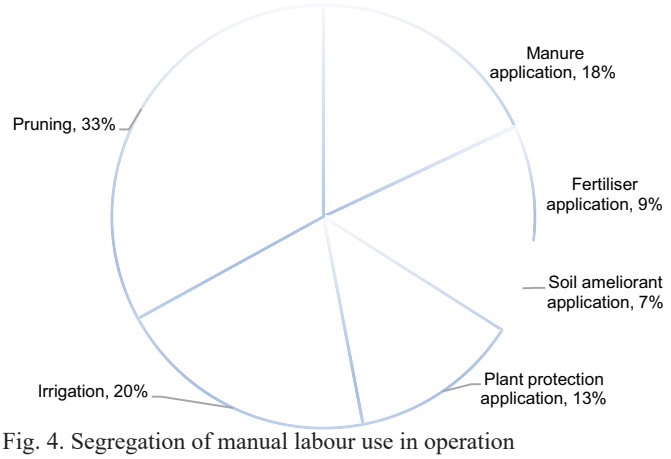

Fig. 4. Segregation of manual labour use in operation

Table 8. Total cost of cultivation (Rs/ha/yr)

Particulars	Cost (Rs/ha/yr)
Total establishment cost (Rs/ha/yr)	7,14,623
Amortised establishment cost	88,325
Maintenance cost (Rs/ha/yr)	1,41,746
Interest on working capital (7%)	9922
Total cost of cultivation (Rs/ha/yr)	2,39,993

(Figures in parenthesis indicates percentage)

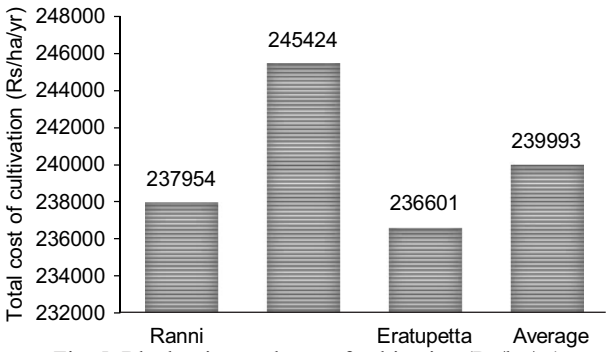

Fig. 5. Block-wise total cost of cultivation (Rs/ha/yr)

was found to be increasing till 15 years of age. Kothamangalam block had higher average yield than other two blocks (Fig 6).

Average price received by farmers in 2025 harvesting season was Rs 130/kg, yielding a gross return of Rs 8.4 lakh/ha/yr and a net profit of Rs 6 lakh/ha/yr. BCR was found to be 3.52, confirming that rambutan is a viable fruit crop in the study area. The observed BCR of 3.52 is comparable to the range reported by Preecha *et al.* (2016) in Thailand, who reported BCR values ranging from 2 (in-season production) to 6.3 (off-season production). A well-managed one-hectare rambutan orchard can give 8–10 tons of yield per year in Karnataka (Mohith and Kavana, 2025). The results demonstrate that rambutan cultivation is a highly remunerative perennial crop, with relatively stable returns across

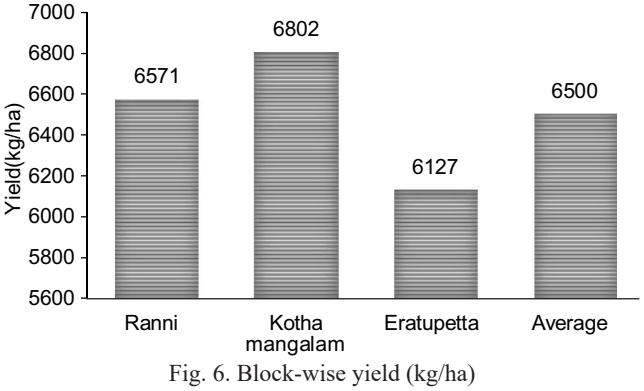

Fig. 6. Block-wise yield (kg/ha)

the regions, highlighting potential for farmer adoption under Kerala's humid tropical conditions.

Table 7. Yield (kg/ha/yr) and returns (Rs/ha/yr)

Particulars	Total
Yield (kg/ha/yr)	6500
Gross returns (Rs/ha/yr)	8,45,000
Total cost of cultivation (Rs/ha/yr)	2,39,993
Net returns (Rs/ha/yr)	6,05,007
BC ratio	3.52

Constraints in production of rambutan: Unfavourable weather conditions (Garrett score = 75.76) emerged as the most severe constraint faced by the respondents due to climatic uncertainties such as irregular rainfall and temperature fluctuations (Table 8). Rambutan starts flowering just before the onset of monsoon, and it is ready for harvest in July-August. This period coincides with the heavy monsoon season in Kerala. Heavy rains are affecting fruit setting as well as shelf life of the harvested crop. High initial cost (60.27) and wild animal attack (56.03) were other major constraints. Other constraints like bird attack (42.94), pest and diseases were other constraints ranked by the respondents. The crop canopy was covered with polythene nets to avoid bird attack during fruit maturity. Similar constraints were faced by growers in Zanzibar, about 26 % reported climate change as a major constraint showing vulnerability of rambutan cultivation to changing climate), wild animal attack was reported as third major constraint by farmers in Zansibar (Kalumanga and Asanjeni, 2023). The result shows that natural and economic factors were the major challenges highlighting the need for climate resilient and cost-effective measures to improve sustainability.

Table 8. Constraints in rambutan production

Constraints	Garrett score	Rank
Unfavourable weather	75.76	1
High initial cost	60.27	2
Wild animal attack	56.07	3
Bird attack	42.94	4
Occurrence of pest and diseases	41.57	5

In summary, rambutan is suitable to midland agroclimatic regions of Kerala and its area under cultivation is found to be increasing. The initial establishment cost of rambutan is relatively high but at the same time, once established, the crop is recognised to provide substantial and stable returns over the yeaRs. Economic analysis showed that crop is promising with respect to profitability and BCR. Thus, it is found to be a viable substitute for the existing crops in the region. However, changing rainfall pattern due to climate change (heavy showers during monsoon season which coincide with the dry season) is found to be a major constraint in the crop enterprise. Strengthening mechanisation along with institutional and market support, can enhance its profitability and promote rambutan as a high-value crop for farm diversification and rural income growth in Kerala.

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