



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(8): 708-713
Received: 14-06-2026
Accepted: 18-07-2026

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Investment pattern and establishment cost of pomegranate (*Punica granatum* L.) orchards in Chitradurga district of Karnataka: An economic analysis

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i8i.6320>

Abstract

Pomegranate (*Punica granatum* L.) has emerged as an economically viable fruit crop in the semi-arid regions of Karnataka owing to its drought tolerance, high market demand, and export potential. However, establishment of a pomegranate orchard requires substantial initial investment, and empirical information on investment patterns and establishment costs remains limited. The present study analysed the investment pattern and establishment cost of pomegranate orchards in Chitradurga district of Karnataka. Primary data were collected from 90 randomly selected pomegranate growers across three major pomegranate-growing taluks, namely Hiriyur, Hosadurga, and Challakere, using a pre-tested structured interview schedule. Descriptive statistics and tabular analysis were employed to estimate the investment pattern, establishment cost, and annual maintenance costs during the gestation and bearing periods. The results revealed that the average establishment cost of a pomegranate orchard was ₹188,577.43 per acre. Investment costs accounted for 66.06 per cent of the total establishment cost, while maintenance expenditure during the gestation period constituted 33.94 per cent. Among the investment components, borewell installation represented the largest share (22.51%), followed by drip irrigation (11.68%) and fencing (10.87%), indicating the capital-intensive nature of orchard establishment. The average annual maintenance cost during the gestation period was ₹64,008.72 per acre, with variable costs contributing 76.33 per cent of the total expenditure. During the bearing period, the average annual maintenance cost increased to ₹110,678.98 per acre, of which marketing expenses alone accounted for 25.43 per cent. Plant protection chemicals, fertilizers, and labour for orchard management constituted the major recurring production expenses. The study concludes that pomegranate cultivation is a highly capital-intensive enterprise during its establishment phase, requiring considerable investment in irrigation infrastructure and orchard management. Improving access to affordable institutional credit, promoting micro-irrigation support, and strengthening extension services for efficient input use could substantially reduce establishment costs and enhance the long-term profitability and sustainability of pomegranate cultivation in semi-arid regions.

Keywords: Pomegranate, establishment cost, investment pattern, orchard economics, annual maintenance cost, Chitradurga, Karnataka

Introduction

Pomegranate (*Punica granatum* L.) is one of the oldest cultivated fruit crops, valued for its nutritional, medicinal, and commercial significance. Native to the region extending from Iran to the Himalayas, the crop is now widely cultivated in tropical and subtropical regions across the world owing to its adaptability to diverse agro-climatic conditions. The fruit is highly appreciated for its attractive appearance, pleasant flavour, and rich content of antioxidants, vitamins, minerals, and bioactive compounds, making it an important component of healthy diets. Besides fresh consumption, pomegranate is processed into juice, syrup, concentrates, wine, jelly, and nutraceutical products, thereby creating substantial opportunities for value addition and export. India is the world's leading producer of pomegranate and contributes a major share of the global production. The crop has gained considerable economic importance because of its high productivity, favourable market prices, increasing domestic consumption, and expanding export demand. Among the major pomegranate-producing states, Maharashtra occupies the leading

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position, followed by Karnataka, Gujarat, Andhra Pradesh, Rajasthan, and Tamil Nadu. In Karnataka, pomegranate cultivation has expanded rapidly over the past two decades, particularly in the semi-arid districts, owing to the crop's drought tolerance, relatively lower water requirement under drip irrigation, and higher profitability compared with traditional field crops. The state has emerged as one of the major contributors to India's pomegranate production, with Chitradurga being one of the most important production clusters.

The semi-arid agro-climatic conditions prevailing in Chitradurga district, characterised by low and erratic rainfall, recurrent droughts, and limited irrigation resources, have encouraged farmers to diversify from conventional cereal and pulse-based cropping systems to perennial horticultural crops such as pomegranate. The adoption of micro-irrigation technologies, improved cultivars, and scientific orchard management practices has further accelerated the expansion of pomegranate cultivation in the district. In addition, the superior fruit quality, attractive skin colour, and export potential of cultivars such as Bhagwa, Ganesh, Arakta, and Dholka have strengthened farmers' confidence in investing in orchard development.

Despite its attractive economic prospects, pomegranate cultivation is highly capital intensive during the establishment phase. Considerable investment is required for land development, borewell construction, drip irrigation systems, fencing, planting material, and orchard management before the crop reaches commercial bearing. Since pomegranate begins yielding economically only after approximately 18 months, farmers incur substantial establishment and maintenance costs during the gestation period without generating immediate returns. Moreover, recurring expenditure on plant protection, nutrient management, irrigation, labour, and marketing significantly influences the profitability and long-term sustainability of orchard enterprises.

Understanding the investment structure and cost composition of pomegranate orchards is therefore essential for assessing the economic viability of orchard establishment and identifying opportunities to improve resource-use efficiency. Reliable estimates of establishment and maintenance costs also provide valuable information for farmers, financial institutions, extension agencies, and policymakers involved in horticultural development. Such information is particularly useful for designing institutional credit programmes, subsidy schemes for micro-irrigation, and interventions aimed at reducing production costs and improving farm profitability. Although several studies have examined the economics of pomegranate cultivation in different regions of India, empirical evidence on the investment pattern and establishment cost of orchards under the semi-arid conditions of Karnataka remains limited. Furthermore, changing production technologies, increasing input prices, and the growing adoption of precision irrigation necessitate location-specific economic assessments. Against this backdrop, the present study analyses the investment pattern and establishment cost of pomegranate orchards in Chitradurga district of Karnataka. Specifically, the study estimates the establishment cost of orchard development, examines the annual maintenance costs during gestation and bearing periods, and identifies the major investment components influencing the overall economics of pomegranate cultivation. The findings are expected to provide useful insights for improving investment planning, enhancing resource allocation, and formulating policies to promote sustainable and profitable pomegranate production in the semi-arid regions of Karnataka.

Materials and Methods

Study Area

The study was conducted in Chitradurga district of Karnataka, one of the major pomegranate-producing districts in the state. Located in the Central Dry Zone of Karnataka, the district lies between 13°34' and 15°02' N latitude and 75°37' and 77°01' E longitude, at an average elevation of 524 m above mean sea level. The region is characterized by a semi-arid climate, low and erratic rainfall, and frequent droughts, making it suitable for drought-tolerant horticultural crops such as pomegranate. The district has a geographical area of 770,702 ha and comprises six administrative taluks: Chitradurga, Challakere, Hiriya, Hosadurga, Holalkere, and Molakalmuru. The expansion of pomegranate cultivation in the district has been driven by recurring crop failures under rainfed agriculture, increasing water scarcity, and the higher profitability of perennial fruit crops compared with traditional field crops.

Sampling Design

A multistage sampling technique was employed for selecting the sample respondents. In the first stage, Chitradurga district was purposively selected because of its significant area under pomegranate cultivation in Karnataka. In the second stage, three taluks—Hiriya, Hosadurga, and Challakere—were purposively selected based on the highest acreage under pomegranate cultivation. In the third stage, three villages were randomly selected from each taluk. Finally, ten pomegranate growers were randomly selected from each village, resulting in a total sample of 90 respondents (3 taluks × 3 villages × 10 farmers). The selected farmers represented commercial pomegranate orchards established under the prevailing production systems of the district.

Sources of Data

The study was based on both primary and secondary data. Primary data were collected from the selected pomegranate growers through personal interviews using a well-structured and pre-tested interview schedule. Information collected included socio-economic characteristics of farm households, landholding pattern, orchard characteristics, investment in orchard establishment, annual maintenance costs, input use, labour utilization, production practices, marketing expenses, yields, returns, and constraints associated with pomegranate cultivation.

Secondary data relating to the study area, land use, irrigation, and district-wise area, production, and productivity of pomegranate were collected from the District Statistical Office, Department of Horticulture, Government of Karnataka, and other published reports relevant to the study.

Analytical Framework

The collected data were compiled, classified, and analysed using descriptive statistical techniques. Tabular analysis, including averages and percentages, was employed to describe the investment pattern, cost structure, and maintenance expenditure of pomegranate orchards. The cost estimates were classified into variable and fixed cost components to facilitate a detailed assessment of orchard establishment and maintenance economics.

Estimation of Establishment Cost

The establishment cost represented the total expenditure incurred from orchard establishment until the commencement of commercial bearing (approximately 18 months). The establishment cost was grouped into variable and fixed costs.

Variable Cost

Variable cost comprised expenditure incurred on labour and material inputs.

Labour cost

Included expenses on land preparation, pit digging, pit filling, planting, application of farmyard manure and tank silt, fertilizer application, pruning, staking, weeding, irrigation, and plant protection operations. Human labour employed in different field operations was converted into man-days for estimating labour costs.

Material cost

Included expenditure on borewell construction, drip irrigation installation, fencing, planting material, tank silt, farmyard manure, fertilizers, plant protection chemicals, staking materials, irrigation accessories, and miscellaneous expenses. Interest on working capital was computed at the prevailing rate on the total variable cost incurred during the establishment period.

Fixed Cost

Fixed cost included land revenue, depreciation on farm machinery and implements, rental value of land, and interest on fixed capital. Depreciation was estimated using the straight-line method, while rental value was imputed based on the prevailing lease value of irrigated land in the study area. Interest on fixed capital was calculated on the value of fixed assets employed in orchard establishment.

Estimation of Annual Maintenance Cost

Annual maintenance cost referred to the recurring expenditure incurred for managing the orchard after establishment. Separate estimates were prepared for the gestation period and the bearing

period. During the gestation period, maintenance cost comprised labour employed for basin formation, weeding, pruning, application of manures, fertilizers and plant protection chemicals, together with expenditure on tank silt, fertilizers, manures, plant protection chemicals, and other material inputs. Fixed costs included land revenue, depreciation, rental value of land, and interest on fixed capital. During the bearing period, maintenance cost additionally included harvesting and marketing expenses such as grading, packaging, transportation, and commission charges incurred in marketing the produce. Interest on working capital was also included while estimating total maintenance cost.

Estimation of Returns

Gross returns were estimated by multiplying the quantity of marketable produce by the average sale price received by farmers. Net returns were obtained by deducting total cultivation cost from gross returns. Returns over variable cost were calculated by subtracting total variable cost from gross returns, while returns per rupee of investment were estimated as the ratio of gross returns to total cost of cultivation. These indicators were used to evaluate the economic performance of pomegranate orchards under the prevailing production conditions.

Results and Discussion**Investment Pattern and Establishment Cost of Pomegranate Orchards**

Pomegranate cultivation requires substantial initial investment before the orchard reaches commercial bearing. The establishment cost includes expenditure incurred on the creation of fixed assets such as borewell, drip irrigation system, fencing, and planting infrastructure, in addition to maintenance costs incurred during the gestation period. The investment pattern of pomegranate orchards in the study area is presented in Table 1.

Table 1: Establishment cost of pomegranate orchard (₹/ac.)

Sl. No.	Particulars	Cost	
		Value (₹.)	% to total
A.	Investment costs		
1	Bore well	42455.66	22.51
2	Drip irrigation	22022.86	11.68
3	Sprayer	13500.25	7.16
4	Fencing	20493.69	10.87
7	Plating material and planting	8785.17	4.66
5	Investment in land leveling and digging of pits	4256.11	2.26
6	Staking material and staking charges	13054.97	6.92
	Sub total	124568.71	66.06
B.	Maintenance cost up to bearing period		
	I Year	64008.72	33.94
	Total	188577.43	100.00

The average establishment cost of a pomegranate orchard was estimated at ₹188,577.43 per acre. Of the total establishment cost, investment expenditure accounted for 66.06 per cent (₹124,568.71 per acre), while maintenance expenditure during the gestation period constituted 33.94 per cent (₹64,008.72 per acre). These findings indicate that orchard establishment is highly capital intensive and requires substantial financial investment before generating economic returns.

Among the investment components, borewell construction represented the largest share (22.51%) of the total establishment cost, reflecting farmers' dependence on assured irrigation under the semi-arid conditions of Chitradurga district. The investment in drip irrigation accounted for 11.68 per cent, highlighting the

widespread adoption of micro-irrigation systems for efficient water management. Expenditure on fencing (10.87%) was another major investment, undertaken primarily to protect orchards from stray animals and livestock. Other important investment components included staking materials (6.92%), sprayers (7.16%), planting material and planting operations (4.66%), and land levelling and pit preparation (2.26%). The predominance of irrigation-related investments underscores the importance of water infrastructure in ensuring successful orchard establishment under water-scarce environments. Similar observations have been reported in earlier studies on pomegranate cultivation in Karnataka (Koujalgi and Kunnal, 1992; Ravikumar, 2009; Sahana, 2017) ^[7, 16, 17].

Annual maintenance cost of pomegranate orchards during gestation period

The annual maintenance cost incurred during the gestation period represents the expenditure required to sustain orchard growth until the commencement of commercial bearing. The average annual maintenance cost was estimated at ₹64,008.72 per acre, of which variable costs constituted 76.33 per cent, while fixed costs accounted for 23.67 per cent. The higher proportion of variable costs reflects the intensive management practices required during the early growth stages of pomegranate orchards.

Within the variable cost component, material costs formed the largest share (55.71%) of the total maintenance cost. Expenditure on plant protection chemicals was the single largest item (15.15%), followed by fertilizers (14.87%), farmyard manure (12.28%), and tank silt application (10.67%). The relatively higher expenditure on plant protection chemicals indicates the susceptibility of pomegranate orchards to insect pests and diseases, necessitating frequent plant protection measures for

maintaining orchard health and productivity.

Labour expenditure accounted for 14.32 per cent of the total maintenance cost. Among various operations, labour employed for plant protection chemical application (3.46%), pruning (2.83%), and weeding (2.81%) constituted the major components, reflecting the labour-intensive nature of orchard management during the establishment phase. Interest on working capital accounted for 6.30 per cent, indicating the importance of short-term financial resources in sustaining orchard operations during the non-bearing period.

The fixed cost amounted to ₹15,149.24 per acre, with the rental value of land contributing the largest share (18.80% of the total maintenance cost), followed by interest on fixed capital (2.54%), depreciation (2.27%), and land revenue (0.06%). These findings suggest that land ownership and capital investment substantially influence the economics of orchard establishment, Table 2.

Table 2: Annual maintenance cost of pomegranate orchards during gestation period ₹/ac.

Sl. No.	Particulars	Unit	Quantity	Cost	Per cent
A.	Labour cost				
1	Loosening of soil around trunk and formation of basin	Man days	5.68	1031.24	1.61
2	Manure and tank silt application	Man days	9.28	1601.80	2.50
3	Fertilizer application	Man days	7.32	708.10	1.11
4	Pruning	Man days	8.15	1812.40	2.83
5	Plant protection chemical application	Man days	14.09	2213.13	3.46
6	Weeding	Man days	12.7	1800.35	2.81
	Total labour cost			9167.02	14.32
B.	Material cost				
1	Tank silt	Mt.	24.15	6828.37	10.67
2	Manures	Mt	3.24	7859.33	12.28
3	Fertilizer	Kg	241.23	9515.14	14.87
4	Plant protection chemical application	Lit + Kg	9.23+0.65	9694.84	15.15
5	Miscellaneous	Rs.		1760.51	2.75
	Total material cost			35658.19	55.71
	Interest on working capital @ 9%			4034.27	6.30
	Sub total			48859.48	76.33
C	Fixed cost				
1	Land revenue	Rs.		35.36	0.06
2	Depreciation	Rs.		1456.18	2.27
3	Rental value of land	Rs.		12034.57	18.80
4	Interest on fixed capital @ 12%			1623.13	2.54
	Total fixed cost			15149.24	23.67
	Total cost (A+B+C)			64008.72	100.00

Annual maintenance cost of pomegranate orchards during bearing period

Once the orchard attained commercial bearing, the annual maintenance cost increased substantially because of additional production and marketing activities. The average annual maintenance cost during the bearing period was estimated at ₹110,678.98 per acre. Variable costs, marketing expenses, and fixed costs accounted for 38.17 per cent, 25.43 per cent, and 19.91 per cent, respectively, of the total maintenance cost.

Among labour operations, Watch and ward (4.12%), plant protection chemical application (4.05%), Pruning (2.35%), and weeding (2.21%) were the major contributors to labour expenditure. These activities are essential for maintaining canopy architecture, reducing pest incidence, and improving fruit quality, thereby enhancing marketable yield.

Material costs continued to constitute a substantial proportion of production expenses. Expenditure on plant protection chemicals remained the largest cost component (15.90%) followed by fertilizers (8.86%), manures (6.08%), and miscellaneous expenses (2.47%). The consistently high expenditure on plant protection chemicals during both gestation and bearing periods

indicates the critical importance of integrated pest and disease management in commercial pomegranate cultivation.

Marketing emerged as a major cost component during the bearing period, accounting for 25.43 per cent of the total maintenance cost. Within marketing expenses, commission charges constituted the largest share (14.88%), followed by packing materials (5.26%), transportation (3.83%), and grading and packing labour (1.46%). These findings demonstrate that post-harvest handling and market intermediation significantly influence the overall cost of pomegranate production and reduce producers' net returns. Efficient marketing systems, producer collectives, and direct marketing initiatives could therefore improve farm profitability by reducing transaction costs.

The total fixed cost during the bearing period was ₹22,037.66 per acre, with the rental value of land accounting for the largest share (10.87%), followed by interest on fixed capital (7.58%), depreciation (1.42%), and land revenue (0.03%) Table 3. The predominance of rental value and capital costs indicates that long-term investment remains an important determinant of orchard profitability even after commercial bearing begins.

Table 3: Annual maintenance cost of pomegranate orchards during bearing period

Sl. No.	Particulars	Unit	Quantity	Cost	Per cent
A.	Labour cost				
1	Weeding	Man days	14.57	2447.52	2.21
2	Manure and fertilizer application	Man days	14.19	2305.33	2.08
3	Plant protection chemical application	Man days	23.50	4484.24	4.05
4	Pruning	Man days	10.31	2600.21	2.35
5	Gap filling	Man days	0.41	109.58	0.10
6	Watch and ward	Rs.	0.41	4557.32	4.12
7	Harvesting	Man days	9.91	1751.75	1.58
	Total labour cost		73.30	18255.95	16.49
B.	Material cost				
1	Manures	mt.	2.08	6733.63	6.08
2	Fertilizer	Kg	299.04	9811.39	8.86
3	Plant protection chemicals	Lit+Kg	18.86+1.30	17595.01	15.90
4	Planting material for gap filling	Rs.	12.75	378.09	0.34
5	Miscellaneous	Rs.	-	2728.61	2.47
	Total material cost		-	37246.73	33.65
	Interest on working capital @ 9%		-	4995.24	4.51
	Sub total		-	42241.97	38.17
C.	Marketing cost				
1	Packing material	No.	371.25	5822.65	5.26
2	Grading, packing and loading	Rs.	5.73	1615.69	1.46
3	Transportation	Rs.	-	4238.83	3.83
3	Commission @ 9%	Rs.	-	16466.23	14.88
	Sub total		-	28143.40	25.43
D	Fixed cost				
1	Land revenue	Rs.	-	35.00	0.03
2	Depreciation	Rs.	-	1576.18	1.42
3	Rental value of land	Rs.	-	12034.57	10.87
4	Interest on fixed capital @ 12%		-	8391.91	7.58
	Total fixed cost		-	22037.66	19.91
	Total cost (A+B+C+D)			110678.98	100.00

The findings clearly demonstrate that pomegranate cultivation is a capital-intensive horticultural enterprise requiring substantial investment in irrigation infrastructure, orchard establishment, and crop management before economic returns are realized. Borewell construction and drip irrigation together constituted more than one-third of the establishment cost, highlighting the dependence of commercial pomegranate cultivation on assured irrigation under semi-arid conditions. Likewise, the high share of expenditure on plant protection chemicals and fertilizers during both gestation and bearing periods emphasizes the importance of scientific nutrient and pest management for sustaining productivity and fruit quality.

The increasing share of marketing costs during the bearing period further indicates that improvements in market infrastructure, collective marketing through Farmer Producer Organizations (FPOs), and reduction in intermediary commissions could substantially enhance producers' profitability. Overall, the results underline the need for timely institutional credit, continued support for micro-irrigation, strengthened extension services, and improved market linkages to promote sustainable and economically viable pomegranate cultivation in Karnataka.

Conclusion

The study examined the investment pattern and establishment cost of pomegranate (*Punica granatum* L.) orchards in Chitradurga district of Karnataka. The findings revealed that pomegranate cultivation is a highly capital-intensive enterprise, requiring substantial investment during the establishment phase before commercial production begins. The average establishment cost of an orchard was estimated at ₹188,577.43 per acre, with investment expenditure accounting for nearly two-thirds of the

total cost. Borewell construction, drip irrigation, and fencing emerged as the major investment components, highlighting the critical role of irrigation infrastructure and orchard protection in ensuring successful orchard establishment under the semi-arid conditions of the study area.

The annual maintenance cost during the gestation period averaged ₹64,008.72 per acre, with variable costs constituting the largest share of total expenditure. Plant protection chemicals, fertilizers, and labour for orchard management were the major recurring cost components. During the bearing period, the annual maintenance cost increased to ₹110,678.98 per acre owing to additional harvesting and marketing expenses. Marketing costs, particularly commission charges, packaging, and transportation, accounted for a significant proportion of total production costs, indicating the need for more efficient post-harvest and marketing systems.

The study highlights that the economic viability of pomegranate cultivation depends not only on efficient orchard management but also on timely investment in irrigation infrastructure, scientific crop management, and effective marketing practices. Facilitating access to affordable institutional credit, expanding support for micro-irrigation, strengthening extension services on integrated nutrient and pest management, and improving market linkages through Farmer Producer Organizations (FPOs) and direct marketing channels could substantially reduce production costs and enhance farm profitability. Such interventions would encourage sustainable expansion of pomegranate cultivation in the semi-arid regions of Karnataka and contribute to higher farm income and long-term horticultural development.

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