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Economic feasibility of scented geranium essential oil distillation unit in Northern Karnataka

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Abstract

Essential oils from aromatic crops can be extracted through various methods, such as hydro distillation, hydro-steam distillation and direct steam distillation. However, steam distillation, is the most popular one and widely used despite high investment in installation of units and limited evidence of financial feasibility of distillation units. The present study evaluated financial feasibility and economic viability of distillation units in Northern Karnataka focusing on essential oil production from scented geranium biomass using field-level steam-distillation units. The study estimated that, the cost of a 1.5-tonne capacity distillation unit was ₹ 6,56,309 with an annual operating cost of ₹ 18,91,199. The distillation unit in the study area processed 248.6 tonnes of herbage yearly, yielding 232.26 kg of essential oil which is sold at ₹ 9946 per kg generated gross returns of ₹ 23,10,053 and net returns of ₹ 4,18,854 with return per rupee of expenditure of ₹ 1.22. The estimated cost of production of one kg of scented geranium essential oil was ₹ 8,194 with net returns of ₹ 1,751 at prevailing market price of ₹ 9946/kg. The other financial parameters included a break-even output of 68 kg, a break-even time of 45.47 days, a pay-back period of 3.9 years, NPV of ₹ 16,74,031 and B:C ratio 1.22 at 12 per cent discount rate and IRR of 89 per cent affirmed the profitability of installation and operation of field level essential oil distillation units in the study area.

Keywords: Scented geranium, distillation, financial feasibility, essential oil

Introduction

Essential oils (EO) are defined as "aromatic products with a mixture of compounds derived from plant raw material, either separated by distillation process or by a suitable mechanical technique without heating." EO is separated from liquid phase without changing its chemical composition by physical method (Kant and Kumar, 2022). Herbal plants are very important as considerable world population depends on products of these plants (EO). The EO market has been growing intensely the global EO market size was valued at USD 10.47 billion in 2022 and is projected to grow from USD 11.41 billion in 2023 to USD 22.41 billion by 2030, exhibiting a CAGR of 10.13 per cent during the forecast period Essential oils (EOs) are being using significantly in diversified array such as fragrance, flavour, food, cosmetics and pharmaceutical industries.

The extraction of essential oils from different parts of aromatic and medicinal plants (MAPs) like roots, leaves, buds, seeds and flowers employs various extraction techniques. The earliest documented instances of essential oils produced by distillation in Greece were turpentine and camphor, as recorded by Herodotus (484-425 BC). Occasionally, the seeds or roots were macerated with wine before adding the fatty oil. The resulting product, obtained through digestion was filtered and boiled down to achieve a thicker consistency. Medieval alchemists spent years extracting the "quinta essentia" or the fifth essence from natural materials (Kockmann, 2014).

Essential oil extraction can be done through diversified methods such as steam distillation, water distillation, water-steam distillation, expression, solvent extraction, maceration, supercritical fluid extraction and subcritical fluid extraction but the most common approach is steam distillation due to its reliable investment in installation and operational costs as compared with other extraction methods and it is also a clean, eco-friendly method (Machado *et al.,* 2022). It involves steam generated in a boiler passing across a packed bed of leaves arranged in a tank still. The extracted oil is condensed in a separate condenser. Though the different extraction methods exist, installing a steam distillation unit at the farmers' field is quite expensive and limited attempts have been made to assess the economics of installation and the financial feasibility of field-level steam distillation. In light of this background, it is crucial to redirect the processing of aromatic crops through field-level steam distillation units. Hence, this study focuses on the processing of aromatic crops, emphasizing the essential need to examine the economics of distillation. The primary aim is to analyse the viability of investment in a distillation unit for scented geranium essential oil.

Methodology

The study was conducted in the Belagavi district of Northern Karnataka during 2022-2023, by employing purposive sampling to select respondents involved in processing of scented geranium or operating essential oil distillation units. Primary data was collected through personnel interviews of all 15 distilleries operating in the study area using a specially designed schedule. The descriptive analysis and tabular presentation techniques were employed for analyzing the costs, returns and profits associated with operation of distillation units and standard undiscounted and discounted measures of financial analysis like payback period, break-even analysis of both quantity and period, NPV, B:C ratio and IRR were employed at appropriate discount rate (12%) considering ten years of economic life of the distillation units to study the financial feasibility and economic viability of the distillation units.

A. Analytical techniques

The analytical tools employed for the study were project indicators such as, Break even

analysis, Payback Period (PBP), Net Present Value (NPV), Benefit-Cost Ratio (B: C ratio) and Internal Rate of Returns (IRR).

Amortization: amortization of investment made with establishment of distillation unit for the economic life of ten years was also worked with the following formula.

$$A = p \frac{i(1+i)^n}{(1+i)^n - 1}$$

Where, A = Amortization cost, p = Initial investment, i = Interest rate, n = Years of economic viability

i. Break even analysis

It was attempted to estimate the level of geranium essential oil production and also the returns which are just enough to recover the cost of investment in distillation unit. The break-even volume of output was calculated with the help of following formula.

$$\text{Break even output} = \frac{\text{Fixed cost}}{\text{Price per unit of the output -Variable cost per unit of output}}$$

ii. Pay Back Period (PBP)

The payback period is the time required to recover the initial cost of an investment. It is the number of years the project would take to get back the initial investment. Since the cash flows from geranium distillation units were uneven, the following formula was used calculate the payback period.

$$\text{Payback period} = \text{Years before full recovery} + \frac{\text{Unrecovered cost at the start of the year}}{\text{Cash flow during the year}}$$

iii. Net Present Value (NPV)

It is considered as one of the meaningful measures for long-term investment evaluations and used for comparing various investment proposals. It signifies the discounted value of net cash arising from the project. In this study, a discount factor of 12 percent was applied to discount the net cash inflows, reflecting the opportunity cost of capital. This can be expressed as:

$$NPV = \frac{P_1}{(1+i)^{t1}} + \frac{P_2}{(1+i)^{t2}} + \ldots + \frac{P}{(1+i)^{tn}} - C$$

Where, P_1 = Net cash flow in first year, i = Discount rate, t = Time period and C = Initial cost of the investment.

iv. Benefit-Cost Ratio (B: C ratio)

It is calculated by dividing the discounted cash inflows by the investment (as given in the following formula) and the ratio must equal or exceed unity for the investment to be deemed worthwhile.

$$B:C\ ratio = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^n}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^n}}$$

i = Discount rate, t = Time period, C = Cost at time t, B = Benefit at time t

v. Internal rate of returns (IRR)

The internal rate of return was determined through the interpolation technique, utilizing various discount rates to ensure that the net present value equals zero. The interpolation formula applied in this study was as follows.

$$\left[\text{Internal rate of return}\right] = \left[\text{Lower discount rate}\right] + \left[\text{Difference between two discount rates}\right] \frac{\left[\text{Present worth of cash flow at the lower discount rate}\right]}{\left[\text{Absolute difference between present worth of cash flow at two discount rates}\right]}$$

B. Financial analysis

The feasibility of financial investment made on geranium oil distillation unit was estimated by various standard undiscounted and discounted measures of investment analysis by considering the ten years economic life of processing unit at suitable discount rates.

Results and discussion

Investment pattern in the establishment of essential oil distillation unit

Table 1 outlines the investment details for establishing essential oil distillation units. Analysis of data from fifteen distillation units in the study area revealed that the total investment in establishment of a distillation units with a daily herbage processing capacity of 1.5 tonnes was around ₹ 6,56,309. Among different components, notably, still made of high-quality stainless steel with a 500 kg herbage processing capacity (2 in number) constituted the highest share in investment at 28.49 per cent (₹ 1,87,000) followed by boiler (18.51%) and shed constructed with GI angles and sheet roof over an average area of 600 sq.ft contributed 14.38 per cent to the total investment. Similar findings were observed in a study by Fryback and Hufnagel (1960). The condenser (12.33%) also had a significant share, these four components collectively contributing about 73.72 per cent of the total investment. A zip crane set incurred an investment of ₹ 61,100 (9.31%) with rental value of land amounting to ₹ 57,319 (8.73%) and the oil separator accounted for 2.86 per cent, formed a significant portion of the remaining major share, accounted to 20.90 per cent of the overall investment. Other minor investment items contributed 3.32 per cent. The distillation units had an average yard area of about 212.3 square meters. Due to the high capital investment required for distillation unit installation, only fifteen farmers with sufficient investment capacity opted to set up geranium distillation units.

Cost of operating essential oil distillation unit for the year 2022-2023

Table 2 presents the computed average operating expenditure for the geranium distillation units during 2022-2023. The data indicated that, on average, each distillation unit in the study area processed around 248.60 tonnes of herbage annually. Out of this total, 139.84 tonnes were self-produced, while the remaining 108.76 tonnes were procured from other farmers. The total processing cost for this herbage quantity amounted to ₹ 18,91,199 per year with ₹ 17,22,085 of variable costs and ₹ 1,69,114 of fixed costs. Distilleries in the study area process herbage from their own fields and procure from cultivators nearby. For accounting purposes, the cost of self-produced herbage is considered as the cost of raw material, while the actual price paid to farmers is accounted for when procured. Among various cost components, cost of raw material contributes about 58.15 per cent (₹ 10,99,680) of

Table 1. Investment pattern in the establishment of essential oil distillation unit (₹/Unit)

Sl. No.	Item	No	Amount (₹)	Percentage to total
1	Land (Guntas)	2.2	57,319	8.73
2	Shed (Area)	1	94,400	14.38
3	Boiler	1	1,21,500	18.51
4	Still/Reactor	2	1,87,000	28.49
5	Condenser	1	80,900	12.33
6	Oil separator	3	18,800	2.86
7	Electrification	1	7,000	1.07
8	Plumbing and fixture	-	9,000	1.37
9	Zip crane set	1	61,100	9.31
10	Air blower	1	2,820	0.43
11	Storage cans and other minor equipments	3	2,970	0.45
	Total cost		6,56,309	100.00

(Note: 1 Gunta= 101.7 m^2)

the total cost and approximately 63.86 per cent in the variable cost, which is consistent with findings of Jnanesha *et al.* (2018). Other major costs included labour charges (₹ 3,45,415), interest on working capital (₹ 1,84,509) and fuel wood cost (₹ 62,790). The total fixed cost for operating the distillation unit was ₹ 1,69,114 of which, ₹ 1,24,495 was contributed from amortized amount of distillation unit followed by salary of manager and technician (₹ 26,500) and interest on fixed cost (₹ 18,119).

The returns from the essential oil distillation unit -2022-2023

Table 3 provides information on an average physical output and returns from the geranium essential oil distillation unit in the study area. On average, 248.60 tonnes of herbage was processed annually, yielding 232.26 kg of essential oil per year with a recovery percentage of 0.093 per cent, aligning with findings of Pandey *et al.* (2020). The average price per kg of essential oil was ₹ 9,946, resulting in a gross return of ₹ 23,10,053 and a net return of ₹ 4,18,854 per distillation unit per year. The return per rupee of investment in the geranium oil distillation unit was 1.22 indicating profitability of essential oil distillation unit in the study area. Despite producing a significant quantity of by-product (Hydrosol) during the process, distillers struggle to find a proper market for hydrosol, consistent with Babu and Kaul's (2005) findings. This situation arises amidst significant demand for hydrosol in toiletries, floor cleaners and fragrant face mask industries. Therefore, providing proper training on the value addition of hydrosol and creating marketing opportunities for the product could enhance enterprise profitability.

The cost and returns in production of scented geranium essential oil (₹/kg)

The study revealed that, the cost of producing one kg of scented geranium essential oil is ₹ 1,751 per kg (Table 4). Approximately 1.07 tonnes of scented geranium herbage is used to produce one kg of essential oil. The processor found it profitable to process geranium herbage

Table 2. Cost of operating essential oil distillation unit (2022-2023) (₹/Unit)

Sl. No.	Material		Quantity	Price/unit (₹)	Amount (₹)	Percentage to total
A	Variable cost					
1	Herbage (tonne)	Own	139.84	4,084.00	5,71,107	30.20
		Purchased	108.76	4,860.00	5,28,574	27.95
		Total	248.60	4,472.00	10,99,680	58.15
2	Fuel wood (q)		247.73	253.46	62,790	3.32
3	Labour charge (Man days)		826.83	417.76	3,45,415	18.26
4	Repair and maintenance		-	-	1780	0.09
5	Electricity		-	-	3108	0.16
6	Marketing cost		-	-	24,803	1.31
7	Interest on working capital @12%		-	-	1,84,509	9.76
I	Total variable cost			-	17,22,085	91.06
B	Fixed cost					
8	Amortized amount of distillation unit		-	-	1,24,495	6.58
9	salary of manager and technician		-	-	26,500	1.40
10	Interest on fixed capital (12%)		-	-	18,119	0.96
II	Total fixed cost		-	-	1,69,114	8.94
III	Total cost (I+II)				18,91,199	100.00

Table 3. Returns from the essential oil distillation unit (2022-2023) **(**₹ /Unit)

Sl. No.	Particulars	Value
1	Cost of production (₹)	18,66,396
2	Marketing cost (₹)	24803
3	Total cost (₹)	18,91,199
4	Total production of essential oil (kg)	232.26
5	Price of essential oil (₹ /kg)	9946
6	Gross returns (₹)	23,10,053
7	Net returns (₹)	4,18,854
8	Returns per rupee of expenditure	1.22

which is evident from the returns per rupee of expenditure of 1.21. Thus, farmers in the study area may be encouraged to engage in herbage processing rather than solely supplying herbage to processors, aligning with findings by Calamai *et al*. (2019) in scented geranium studies.

Break-even analysis of essential oil distillation units

Break-even analysis for essential oil distillation units on an average investment of ₹ 6,56,309 and annual fixed cost of ₹ 1,69,114 was required. The variable cost per kg of geranium essential oil was calculated to be ₹ 7,466 whereas, average price per kg of essential oil in the study area was approximately ₹ 9,946. For the given variables, the break-even production level for distillation units in the study area was found to be 68 kg per year. With the current capacity utilization, it would take 45.47 days to reach the break-even level of output.

Table 4. Cost and returns in production of scented geranium essential oil **(**₹ /kg)

Sl. No.	Materials	Quantity	Price/unit (₹)	Amount (₹)	Percentage to total
A	Variable cost				
1	Herbage (ton)	1.07	4472	4,787	58.41
2	Fuel wood (q)	1.06	253.46	270	3.30
3	Labour charge (Man days)	3.55	375.98	1,487	18.15
4	Repair and maintenance	-	-	8	0.09
5	Electricity	-	-	13	0.16
6	Marketing cost	-	-	107	1.30
7	Interest on working capital @12%	-	-	794	9.69
I	Total variable cost	-	-	7,466	91.11
B	Fixed cost				
8	Amortized amount of distillation unit	-	-	536	6.54
9	Salary of manager and technician	-	-	115	1.40
10	Interest on fixed capital (12%)	-	-	78	0.95
II	Total fixed cost	-	-	728	8.89
III	Total cost (I+II)	-	-	8,194	100
IV	Gross returns			9,946	
V	Net returns			1,751	
VI	Returns per rupee of expenditure			1.21	

Table 5. Sensitivity analyses of essential oil distillation unit

Sl. No.	Particulars	Project indicators	Value
1	10 % rise in the herbage cost	NPV (@12%)	₹ 15,84,582
		B:C Ratio (@12%)	1.14
2	10 % fall in the oil price	NPV (@12%)	₹ 9,75,670
		B:C Ratio (@12%)	1.09

Feasibility of investment in essential oil distillation units

These units are anticipated to repay the initial capital investment in establishing the distillation unit within approximately 3.9 years. At a 12 per cent discount rate, the net present value is estimated at ₹ 16,74,031 additionally, the essential oil distillation unit demonstrates a benefit-cost ratio of 1.15 with a notable internal rate of return of 89 per cent. The returns commence from the first year itself without a gestation period leading to higher internal rates of returns, emphasizing the profitability and economic feasibility of distillation units even at higher discount rates. These positive project indicators affirm the economic feasibility of distillation units; the results are confirming with findings of Ernita *et al*. (2022).

Sensitivity analysis of essential oil distillation units

Table 5 presents sensitivity analysis for essential oil distillation units. The assessment of profit sensitivity involved examining the impact of a 10 per cent reduction in the price of essential oil and a 10 per cent increase in the cost of geranium herbage. A 10 per cent raise in herbage cost resulted in a 6 per cent decrease in NPV (₹ 15,84,582), leading to a reduced benefit-cost ratio of 1.14. Conversely, a 10 per cent fall in the price caused a significant 41 per cent decline in NPV (₹ 9,75,670), resulting in a lower benefit-cost ratio of 1.09. These findings confirming with results of Bimantio and Wardoyo (2020). The cost of herbage, constituting about 58 per cent of the total cost, emerged as a crucial factor impacting the profitability of geranium oil distillation. The marginal increase in the price of raw material, whether procured or produced by distillers was found to considerably reduce the profitability of essential oil distillation. This may explain why most distillers prefer to meet a significant portion (50%) of their raw material needs by growing geranium on their own fields. Moreover, the profitability of these distillation units is highly sensitive to changes in the price of essential oil. A marginal decrease (10%) in the essential oil price could result in more than a 40 per cent reduction in NPV. Therefore, there is a crucial need to regulate market practices to ensure stable and remunerative prices for farmers, enabling them to sustain their businesses.

Conclusion

From the analysis of economic performance of the distillation units in the study area it can be concluded that the commercial production of essential oil using field level steam distillation method is profitable and economically viable agri-entrepreneurship. Therefore, there is a case for providing institutional support in establishing such essential oil distillation units, particularly in areas where the availability of raw materials is assured. This agro-enterprise should be encouraged among the farming community through farmers collectives like, Co-operative societies and Farmers Producers Companies etc. which can enhance the farmer's income and employment opportunities for unemployed youth among rural population.

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