



Economic Viability of Extracting Lemongrass Essential Oil Under Steam Distillation in Pakistan

Rashed Saeed¹, Tahir Saeed ², Arshed Bashir³, Yasir Majeed⁴

¹ Senior Scientific Officer, PARC-Social Sciences Research Institute (SSRI), Faisalabad, Pakistan.

Email: rashedkasuri@gmail.com

² Horticulturist, Horticultural Research Sub-Station for Floriculture and Landscaping, AARI, Faisalabad, Pakistan.

Email: tahird94@gmail.com

³ Principal Scientific Officer, PARC-Social Sciences Research Institute (SSRI), Faisalabad, Pakistan.

Email: arshadparc@gmail.com

⁴ Scientific Officer, (PARC) Mountain Agricultural Research Station, Astore, Gilgit Baltistan, Pakistan.

Email: yasir.majeed@parc.gov.pk

ARTICLE INFO

Article History:

Received: January 04, 2026

Revised: March 26, 2026

Accepted: March 29, 2026

Available Online: March 30, 2026

Keywords:

Aromatic Plants

Benefit-Cost Analysis

Essential Oil

Lemongrass

Steam Distillation

Funding:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

Demand for volatile essential oils is rising in health and wellness sectors of Pakistan but local production is almost negligible due to lack of knowledge about extraction techniques. Present research was aimed at providing practically oriented financial and technical knowledge about essential oil extraction using most common traditional steam distillation technique for lemongrass. A small commercial distillation unit having 500 litre water holding capacity was utilized to estimate the economics of lemongrass essential oil based on prevalent market level input/output prices during year 2025-26. Steam distillation unit was LPG fed and lemongrass fresh leaves were purchased from farmer for Rs.20/Kg. Distillation results on technical side revealed that 231 ml of pure essential oil was extracted out of 100 Kg loaded lemongrass from one round of extraction process, consuming 6 Kg LPG over 4-hours' time span. Monthly cost benefit analysis revealed that processors might earn average gross profit of Rs.82750 with operational expenses of Rs.263750/. Accordingly, processors will have to conduct daily two distillation rounds to produce total 11.5 litre oil to capture wholesale rate of Rs.30000/litre. It was quite obvious from monthly profitability analysis that processing of lemongrass for volatile oil is a highly profitable venture requiring initial small investment up to one million enjoying around 1-year payback period. Therefore, government and private sectors should come forward to promote essential oil industry in the best interests at least of local farmers, entrepreneurs and local consumers including practitioners of alternative/traditional/Unani system of medicine.

© 2026 The Authors, Published by iRASD. This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License

Corresponding Author's Email: rashedkasuri@gmail.com

1. Introduction

World Health Organization termed wild or cultivated plants combating human diseases as medicinal plants. Some of the medicinal plants have fragrance due to their natural volatile compounds present in leaves, flowers, bark, roots of plants. This natural fragrance or volatile essences are usually obtained from plants through different scientific methods such as steam or hydro distillation, solvent extraction and supercritical fluid extraction methods. However, the quality and quantity of the oil yield depend on extraction technique used (Chanthai et al., 2012). Among the different extraction methods, steam distillation is the most common commercial method on account of ease of operation, low cost technology with high quality extracted oils (Machado et al., 2022), accounting for roughly 93% of global production. Literature reports that globally 72000-77000 plants (17-18% of world flora) are currently utilized by more than 220 therapies employed in different cultures (Rao & Rajput, 2010). Utilization also includes forms like essential oils extracted from plants. Global market size-with global essential oil production of more than 300,000 tonne-was valued at USD 23.74 billion in 2023 which is expected to touch \$5trillion by 2050 (Baser & Bonello, 2025). The domestic Pakistani market for essential oils is infinitesimal and represents less than 1% of the world market. Now with the growing population and changing demographics and global demand for natural products, essential oil production has emerged as a promising entrepreneurial venture serving food, agricultural, pharmaceutical/nutraceutical, aromatherapy and wellness industries. There is a huge diversity of medicinal and aromatic plants in Pakistan which has huge potential for essential oils in the global market (Majeed et al., 2024). Among them, lemongrass has higher production due to better adaptability in diverse climatic conditions of Pakistan, from lower altitude (Sindh) to higher altitude in Pakistan (Gilgit Baltistan). This can lead to commercial production of lemongrass oil due to availability of low-cost raw material. Moreover, lemongrass essential oil has great economic value for the perfume, cosmetics and aromatherapy industries (Tohasan et al., 2025).

Globally, a lot of research work is available on lemongrass from using leaves for tea purposes to extraction of essential oil from its leaves for various uses. Sani, Bashir and Muazu (2024) conducted comparative study on steam and hydro distillation to compare the performance of distillation method. The researchers found comparatively higher lemongrass oil yield of 0.76% with steam distillation method against 0.44 % yield with the other method in Nigeria. Safitri and Sinaga (2021) studied the chemical contents of lemongrass oil in Malaysia by reporting citronella amount to 59.28%. oil density as 0.875 and the refractive index value in the range of 1.46735-1.46925. By observing higher demand of lemongrass essential oil, Misli et al. (2025) studied optimization of oil distillation from lemongrass with steam distillation method in order to determine the optimum parameters of steam distillation: extraction time, solvent-solid ratio, and power using Response Surface Methodology. Researchers showed that a solvent solid ratio of 2:1, extraction time of 90 minutes, and a power of 1800 W were the optimal steam distillation conditions for achieving 0.0473% of the lemongrass oil yield. Moreover, steam distillation yielded an average of 0.0458%, which was higher than hydro distillation (0.0358%), suggesting steam distillation a better extraction method for lemongrass oil from its leaves as a means of waste management.

Despite plenty of benefits in essential oil extraction, the adoption of distillation technology for oil extraction is limited in Pakistan. Fortunately, Pakistan is blessed with diverse flora of around 2000 medicinal plants according to definition by World Health Organization. But lack of general awareness of farmers, processors and consumers about essential oils, knowledge on technical skills and economic viability of oils and R&D funding on medicinal plants are among chief barriers to harness potential benefits from medicinal plants in the form of essential oils such as lavender, lemongrass, eucalyptus, mint, rose, rosemary, chamomile, grapefruit, lemon, orange, turmeric, ginger, vetiver, jasmine oil etc. Lemongrass essential oil has wide applications in cosmetics, food, fragrance, as a bio-pesticide in agriculture sector and therapeutic applications in Unani system of medicine including aromatherapy because of its chief volatile compound "citral" preferred in the range of 75-80 percent in oil. However, lemongrass leaves are majorly utilized after drying in herbal tea in Pakistan rather than value added products. Despite the availability of higher quantity and low-cost raw material of lemongrass, there is no commercial unit extracting essential oil from it in Pakistan. Thus, knowledge of production cost of lemongrass essential oil through steam distillation is needed to promote this

sector on commercial scale. Present study was conducted to explore the technical and economic aspects of lemongrass essential oil extracted under widely applied steam distillation method. The objectives included detailed estimation of benefits and costs as well as payback period of investment to guide and attract the potential entrepreneurs in essential oil business.

2. Materials and Methods

This research study mainly focused on determining economic viability of distilling essential oil from lemongrass leaves duly covering possible and easy to understand concepts of cost-benefit analysis particularly Benefit Cost Ratio (BCR) and Pay Back Period based on prevailing market prices of inputs and output of extraction procedure. The study was jointly conducted at (PARC) Social Sciences Research Institute located at Ayub Agricultural Research Institute, Faisalabad in collaboration with Horticulture Department, Government of the Punjab and Mountain Agricultural Research Station, Astore, Gilgit Baltistan during year 2024-25. The research methodology was divided into technical and economic analyses as:

2.1. Technical Analysis

Fresh lemongrass leaves for oil extraction were purchased from farmer and leaves for oil extraction were handed over to a private sector entity "Pak Herbal Dispensary (PHD™)" who has LPG fueled commercial distillation unit with 500 litre water holding capacity designed and manufactured by PAMICO Technologies, Faisalabad.

2.1.1. Steam Distillation Procedure

Steam distillation unit was used in this study, which has mainly three parts namely water and material holding tank; a condenser attached to tank for converting generated steam into liquid via cold water flowing around coil of the condenser, and the third part being oil collecting vessel. The best unit is always made from stainless steel material. Here in the study, around 100 kilograms of fresh lemongrass leaves (to the best filling capacity) were loaded tightly into the tank. The energy source (LPG stove) was placed beneath the distillation tank to make steam having a temperature close to 100 degree centigrade from water filled at the bottom of distillation tank. The oil extraction process finally yielded liquid comprising oil and water in the collecting vessel. Oil being light floated over the water surface in the vessel. The oil was then separated from water with the help of a separating funnel. The collected yield (v/w) of pure lemongrass essential oil was expressed as a percentage of leaves loaded into the distillation tank by following the methodology of Ali, Hassan and Eljimabi (2018) as:

$$\text{Oil Yield} = [\text{Extracted oil (millilitre)} / \text{Weight of loaded leaves (grams)} \times 100]$$

Two batches each using 4 hours were run in a day to have reliable average estimates under steam distillation. The total extraction time of 4 hour consuming 6 Kg LPG in a single round comprised induction time (time from ignition to falling of first drop in vessel), the actual extraction time of oil and unloading of the lemongrass material from tank.

2.2. Economic Analysis

Technical data from first part was used to calculate economic viability of essential oil in local currency. However, the whole economic estimates were based on actual prevailing input/output average market prices and opportunity costs of labor and materials where required during whole process from purchasing leaves to bottling of essential oil. Both the technical and economic analyses were mostly based on mean actual statistics of past distillation experiences as well as current state of the affairs. The benefit cost analyses covering indicators such as benefit cost ratio (BCR), Salvage Value, Depreciation Charges and Pay Back Period were performed as below:

2.2.1. Benefit Cost Ratio

Benefit cost ratio is a metric to determine the value of an investment by dividing the present value of its expected revenue by the present value of its costs as follows:

$$BCR = TR / TC$$

Where TR stands for total revenue and TC stands for total cost.

2.2.2. Salvage Value

The salvage value of a distillation unit is the estimated future monetary value it will have at the end of its useful life, typically calculated as a percentage of its original cost or based on its scrap value. Salvage value is influenced by factors like its original cost, depreciation rate, and useful life, and can also be influenced by its condition, market demand, and resale potential for parts or raw materials. Anyhow, in present study, it was assumed as 10 percent of initial invested amount on purchase of distillation unit (Rs.700000). salvage value was calculated according to the following equation:

$$SV = (0.10 \times \text{Total Investment})$$

2.2.3. Depreciation Charges

The charges made during every batch of extraction in lieu of plant's purchased investment were estimated as follows:

$$D = (TIC - SV) / \text{Economic Life Span of Unit}$$

Where TIC means total investment cost that was equal to plant purchase cost and working capital. In calculating depreciation, the economic life of the unit claimed by the company over 10 years was used. Similarly, "SV" represents salvage value.

2.2.4. Pay Back Period (PBP)

Payback period helps investors to determine how long it will take to recover the initial costs associated with an investment in a business. Shorter this period, more is venture preferred by investors. It was estimated in the study as follows:

$$PBP = TI / AR$$

Where "TI" denotes total investment made and "AR" denotes annual return being sum of income from sale of lemongrass essential oil and cost charged in lieu of depreciation of the distillation unit. Moreover, the extraction procedure was repeated to verify and get reliable average estimates for oil extraction analyses. In the research, 25-days month was taken for generating monthly estimates under economic analysis.

3. Results and Discussion

The results of study were elaborated under two scenarios separately for 4 hour-based first batch and scenario based on monthly estimations for proper understanding of technical distillation and economic analyses of lemongrass essential oil under respective distillation cases as:

3.1. Technical and Economic Analyses of Extracting Lemongrass Oil (Daily Estimates)

The distillation of lemongrass fresh leaves up to 4 hours yielded 231 ml of pure essential oil in one round of distillation procedure using liquefied petroleum gas (LPG) for easy control over heat/energy utilization during extraction. It means, pure lemongrass essential oil yield was 0.231 percent from 100 kg leaves in one round. Kumar et al. (2023) reported 0.3% to 0.4% oil yield of Sugandhi variety in India, whereas Majewska et al. (2019) reported around 1 to 2% of essential oil in a dry matter of lemongrass in Poland by quoting study of Skaria et al. (2012). Almost 6 kg of LPG purchased at average market price of Rs.280 per kg was consumed in distillation. Pure lemongrass oil was a thin liquid having pale to orange yellow color with mind blowing lemony aroma. The oil was filled in dark colored bottle arranged domestically but bottle cost of Rs.10 was included in the analysis based on the principle of opportunity cost of the bottle. The oil was stored at dark place to protect it from environmental degradation and to protect natural healing properties of lemongrass oil. One person was overall enough to carry out distillation on wages of Rs.750 per round. Distillation charges

amounting to Rs.155 per round of extraction were paid as a rental value of distillation unit keeping in view the claimed life span of plant as more than 10 years as depicted in Table 1.

By considering local market prices of inputs and outputs, economic analysis of first batch was performed as shown in Table 1 where total cost of producing 231 ml of lemongrass oil was estimated to Rs.5436. By taking average local wholesale price of Rs.30000 per litre of lemongrass essential oil, the total revenue value turned to Rs.6930 by assuming actual sale of 231 ml oil at this rate. Total profit after extracting total costs from total revenue was Rs.1494 that can be translated as 27 percent of the costs. This was acceptable and reasonable benefit of investment. Benefit cost ratio (BCR) of 1:1.28 implied that investors can earn 28 paise on investing rupee one on extraction of lemongrass essential oil (Table 1).

Table 1: Economic Analysis of Extracting Lemongrass Oil (Daily Estimates)

Items	Unit Price	Total Cost (Rs)
Raw material (100 Kg lemongrass)	20	2000
LPG consumption (6 Kg)	280	1680
Electricity cost (water circulation in distillation)	200	200
Cleanliness	100	100
Labor (distillation round of 4 hours)	1500	750
Bottle (500 ml empty glass container)	10	10
Land rent (@Rs.10000/month)	333	333
Rent/depreciation charges (distillation unit)	155	155
Miscellaneous (@3% of total revenue)		208
Total Cost	-	5436
Yield (ml of essential oil (@ 0.231%) = 231 ml	-	-
Total Revenue	30	6930
@Rs.30000/litre (local market wholesale price)		
Profit (Total Revenue - Total Cost)		1494
Profit % (without any taxes)		27.48
Benefit Cost Ratio (BCR)	-	1:1.27

3.2. Technical and Economic Analyses (Monthly Estimates)

The extraction process of lemongrass essential oil was repeated on the same day to get reliable average estimates in order to work for monthly estimations. The monthly estimations were mostly based on previous rates/wages as expressed in first batch but many of the input prices were relaxed according to the market concessional rates on bulk purchases. For example, LPG was now available for Rs.267 per Kg on using big gas cylinder having 45 Kg gas filling capacity. Electricity commercial rates were charged higher on higher usage of electricity units. Cleanliness charges were higher than single batch because now sweepers was aware of the commercial activity, hence demanding more monthly wages was justified. Similarly, cost of oil filling bottles was higher but still wholesale market offered concession on bulk purchase of good quality glass containers. Cost of raw material (lemongrass leaves) was same (Rs.20 per Kg now inclusive of delivery) instead of concessional rates on bulk purchase from the seller/farmer.

One again, keeping in view the market wholesale prices, economic analysis based on monthly calculations revealed that total cost of producing 11.55 litre oil was estimated as Rs.263750 upon using 5000 Kg leaves, consuming 300 Kg LPG, paying electricity bill amounting to Rs.11250, paying wages to one labor as Rs.37500 upon 8-hours daily working on distillation unit, paying Rs.7750 as plant rental charges and paying Rs.10000 to land owner as a monthly rental amount on using piece of land for business facility (Table 2). At a wholesale rate of Rs.30000 per litre, the sale value of 11.55 litre lemongrass essential oil turned to Rs.346500. Total profit per month was estimated as Rs.82750 which was around 31 percent. It implied that profit margin increased from 27 percent to 31 percent due to economy of scale in essential oil business. Accordingly, BCR was also on higher side. However, BCR was calculated on current market price of lemongrass oil. BCR can increase or decrease with some extent with the fluctuation of market price (Tilaye, Girma, & Philpose, 2018). Table 2 further depicts that shortest payback period of 0.92 years was highly acceptable to the potential investors as the total cost of investment (one million) might be returned to the investor within one year provided no unwanted circumstances hinder the business of essential oil in the

country. In the nutshell, lemongrass essential oil business in the context of Pakistan is highly economical as many inputs are relatively cheaper here than other countries. Only issue is under-serviced local essential oil market, so the entrepreneurs might revert to digital marketing for selling of oils and exporting to other countries is another option. The use of locally made equipment offers a sustainable and economically viable solution for communities in developing regions, promoting the local production of essential oils without the need for expensive imported machinery (Sani, Bashir, & Muazu, 2024).

Table 2: Economic Analysis of Extracting Lemongrass Essential Oil (Monthly Estimates)

Items	Unit Price	Total Cost (Rs)
Raw material (5000 Kg lemongrass)	20	100000
LPG consumption (300 Kg)	267	80100
Electricity cost (water circulation in distillation)	225	11250
Cleanliness	100	6000
Labor (8 hours working)	1500	37500
Bottle (12 empty 1000 ml glass containers)	64	768
Land rent (@Rs.10000/month)	333.33	10000
Rent/depreciation charges (distillation unit)	155	7750
Miscellaneous charges (approximately 3% of total revenue)	-	10382
Total Costs	-	263750
Yield (ml of essential oil (@ 0.231%) = 11550 ml	-	-
Total Revenue	30	346500
@Rs.30000/litre (local market wholesale price)		
Profit (Total Revenue - Total Cost)		82750
Profit % (without any taxes)		31.37
Benefit Cost Ratio (BCR)	-	1:1.31
Estimating Pay Back Period		
Investment on distillation unit (ID)	-	700000
Working capital (WC)	-	300000
Total investment (TI = ID + WC)	-	1000000
Annual total profit (ATP)	-	993000
Annual depreciation charges (ADC)	-	93000
Annual return (AR = ATP + ADC)	-	1086000
Pay Back Period (PBP = TI/AR)	0.92	ears

4. Conclusion and Recommendations

It was quite obvious from the economic performance of steam distillation unit that commercial production of lemongrass essential oil using LPG fuel is highly profitable venture even for whole sale marketing requiring initial small investment up to one million enjoying around 1-year payback period. These promising economic indicators further suggests that jobless youth, if adopt essential oil business, can earn monthly net income of more than 80,000 through wholesale market or even two to three time more benefits upon digital/E-commerce marketing by launching their own brand. Apart from the fact that local market of essential oils is not well developed here, the genuine lemongrass oil has great export potential on account of relatively higher product prices in the international market. It is therefore, strongly recommended that government and private sectors should come forward to promote business of essential oils in the best interests at least of local farmers, entrepreneurs and local consumers including practitioners of alternative/traditional/Unani systems of medicine.

References

- Ali, E., Hassan, F., & Elgimabi, M. (2018). Improving the growth, yield and volatile oil content of *Pelargonium graveolens* L. Herit by foliar application with moringa leaf extract through motivating physiological and biochemical parameters. *South African Journal of Botany*, 119, 383-389. <https://doi.org/https://doi.org/10.1016/j.sajb.2018.10.003>
- Baser, K. H., & Bonello, J. M. (2025). Global trade of essential oils. *Journal of Essential Oil Research*, 37(2), 208-214. <https://doi.org/https://doi.org/10.1080/10412905.2025.2470791>

- Chanthai, S., Prachakoll, S., Ruangviriyachai, C., & Luthria, D. L. (2012). Influence of extraction methodologies on the analysis of five major volatile aromatic compounds of citronella grass (*Cymbopogon nardus*) and lemongrass (*Cymbopogon citratus*) grown in Thailand. *Journal of AOAC International*, 95(3), 763-772. <https://doi.org/https://doi.org/10.5740/jaoacint.11-335>
- Kumar, A., Lal, R., Gupta, A., & Chanotiya, C. (2023). Historical and contemporary development of novel chemotype varieties with high essential oil of lemongrass in India: a review. *Curr Res Med Aromat Plants*, 45(1), 17-27.
- Machado, C. A., Oliveira, F. O., de Andrade, M. A., Hodel, K. V. S., Lepikson, H., & Machado, B. A. S. (2022). Steam distillation for essential oil extraction: An evaluation of technological advances based on an analysis of patent documents. *Sustainability*, 14(12), 7119. <https://doi.org/https://doi.org/10.3390/su14127119>
- Majeed, Y., Khan, H., Akram, A., Ali, I., Din, M., Ayub, M., & Hussain, M. (2024). Gilgit-Baltistan potential: Commercial opportunity for essential oils production in Pakistan to reduce the import bill. Two-day international symposium on medicinal plants and natural products, UAF Community College, PARS, Faisalabad. 7-8 March, p. 49.
- Majewska, E., Kozłowska, M., Gruszczynska-Sekowska, E., Kowalska, D., & Tarnowska, K. (2019). Lemongrass (*Cymbopogon citratus*) essential oil: extraction, composition, bioactivity and uses for food preservation-a review. *Polish Journal of Food and Nutrition Sciences*, 69(4), 327-341. <https://doi.org/https://doi.org/10.31883/pjfn/113152>
- Misli, A. F., Rambli, M. M., Hamzah, M. H., Hamzah, A. F. A., Anoraga, S. B., Julshahril, N. H., & Shamsudin, R. (2025). Optimisation of oil extraction from lemongrass leaves (*Cymbopogon citratus*) with steam distillation using Box-Behnken Design. *Letters in Food Research*, 1(3), e25030. <https://doi.org/http://doi.org/10.26656/lifr.1.e25030>
- Rao, B., & Rajput, D. (2010). Global scenario of medicinal plants. In: Conference: National conference on conservation of medicinal plants - herbal products and their Uses At: Arts and Science College for Women., 10500(I800).
- Safitri, A., & Sinaga, J. (2021). Extracting essential oil from fragrant lemongrass plants by steam-hydro distillation method using microwave as a heater. *J Sains dan Teknol Reaksi*, 19(01), 1-11.
- Sani, I. L., Bashir, A. A., & Muazu, I. (2024). Essential oil extraction from lemongrass using steam and hydro distillation from a locally fabricated extractor. *Global Journal of Engineering and Technology Advances*, 21(1), 190-196. <https://doi.org/http://doi.org/10.30574/gjeta.2024.21.1.0198>
- Skaria, B. P., Joy, P. P., Mathew, G., Mathew, S., & Joseph, A. (2012). Lemongrass. In K. V. Peter (Ed.), *Handbook of Herbs and Spices* (2nd ed., Vol. 228, pp. 348-370). Woodhead Publ. LTD.
- Tilaye, M., Girma, T., & Philpose, M. (2018). Cost benefits analysis of lemongrass (*Cymbopogon citratus*) variety: WG-Lomisar-UA for herbal production Acad. *Agricultural Science Research Journal*, 6, 320-327.
- Tohasan, A., Prihastuty, E., Khilmi, M., & Saleh, A. (2025). Testing of the condenser in the distillation of lemon grass essential oil in Banjarnegara, Central Java. *Mestro: Jurnal Teknik Mesin dan Elektro*, 7(1), 38-48. <https://doi.org/https://doi.org/10.47685/mestro.v7i1.664>