REVIEW ARTICLE

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# Essential Oils Extraction: A Promising Enterprise for Rural Areas' Sustainable Development

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## Abstract

Since ancient times, essential oils have been used in cosmetics, perfumes, and medications. The current research examines the chances for rural communities' survival and livelihoods via the use of essential oil extraction operations. According to the report, demand for essential oils is quickly increasing, as many companies generate large amounts of herbal and cosmetic goods using essential oils. As a result, the potential for establishing rural firms in the essential oil industry is enormous. According to the literature, essential oil extraction may be accomplished at any scale required. Economic research shows that the extraction of essential oils benefits rural income production. Nonetheless, a shortage of small-scale technology for the rural population and a lack of information about essential oil companies' social and economic advantages are likely to be critical issues impeding the establishment of the essential oil extraction sector in rural areas.

**Keywords:** Economic analysis; Hydrodistillation, Lemongrass, Rural income generation, Steam distillation.

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## Introduction

As per the report published by India Population 2020, 65% of India's people live in rural areas.[1] They depend heavily on agriculture for survival; hence, developing and promoting small-scale agro-industries is vital for rural development.[2,3] It has many direct and indirect advantages. Technological problem-solving is the immediate advantage; however, job creation is indirect.[4,5] Small-scale agro-processing industries established on local agricultural resources and the rural labor workforce significantly impact rural development.[6]

Essential oils (EO) are concentrated extracts of plant components containing essences, such as flowers, leaves, stems, bark wood, roots, fruits, rhizomes, and gums. They are widely utilized in the production of food essence, fragrances, and pharmaceuticals all around the globe. The EO business is an agro-based sector that includes farming and distillation. It includes the rural populace by farming raw materials and providing EO processing and marketing jobs. As a result, forming EO firms in rural regions will aid in improving rural residents' livelihoods.

The current research aims to determine the size of EO extraction and evaluate the feasibility of developing small-scale EO extraction firms for rural income production. How are essential oils extracted? What is the size of the essential oil market on a national scale? What are essential oil extraction technologies accessible in rural areas? The current research addresses such concerns. The study aims to understand better the demand for essential oils in the Indian markets. Identify possible raw material availability and familiarize yourself with current technology for essential oil extraction in rural regions. The paper examines EO extraction methods succinctly and displays EO demand in national markets. It also shows the lemongrass essential oil extraction method and economic analysis for rural income generation. Finally, the study concludes with findings, discussion, and recommendations for further work.

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## Essential Oils Extraction Technologies

EO is derived from various medicinal and aromatic plant (MAP) materials, including flowers, leaves, stems, bark wood,

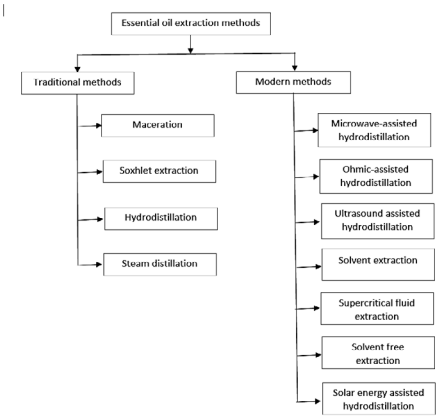


**Figure 1:** Classification of essential oils extraction methods

roots, fruits, rhizomes, and gums. As seen in Figure 1, several methods are used for EO extraction.[4–6]

The maceration procedure entails soaking plant materials in a solvent in a container and leaving it at room temperature for at least three days with continuous agitation; after that, the mixture is pressed, and the EO is extracted. During the Soxhlet extraction process, the plant materials are finely pulverized and put in a porous bag composed of filter paper, which is retained in a thimble chamber of the Soxhlet apparatus. In the bottom flask, the extraction solvent is heated and vaporized. Vapours condense in the condenser, separating the EO. The hydrodistillation (HD) technique uses a spherical container to hold a combination of medicinal plant material and solvent (water). The mixture is heated outside using an electric heating coil, and the resulting vapours are condensed in the condenser, where EO is collected. Steam is created in a separate chamber in the steam distillation process and flows over the plant material for EO extraction.

As a consequence, the oil-containing vapour condenses, and EO is separated. Medicinal plant material and the solvent are used in the oil extraction spherical container during microwave-assisted hydrodistillation (MAHD). This container is then heated in the microwave oven. Vapours generated during the heating process condensate in the condenser, yielding EO. A spherical chamber holding a combination of medicinal plant components and the solvent is externally heated using electrodes in an ohmic-assisted hydrodistillation system (OAHD). The resulting vapours are condensed in the condenser, and the EO is collected. Ultrasound waves ranging from 20 kHz to 2000 kHz are used in an ultrasound-assisted hydrodistillation system or sonication extraction system. Ultrasound waves disrupt materials' physical and chemical characteristics, causing them to liberate their constituents. Solvent extraction is the process of diffusing a solvent into the oil-bearing cells of raw material, culminating in separating the oil from the solvent. Supercritical fluid extraction uses supercritical fluids as the extracting solvent to isolate one component. The solvent-free extraction process is similar to hydrodistillation except that no solvent is introduced into the distillation container[7–9] fever and other medicinal claims are now supported with sound scientific evidences. The study on medicinal plants started with extraction procedures that play a critical role to the extraction outcomes (e.g. yield and phytochemicals content.

## The Demand for Essential Oils in India

India has vast medicinal and aromatic plant potential. Ayurveda mentions around 1200 medicinal plants, Unani mentions 400, Siddha mentions 500, and Tibetan medicine mentions 300. Furthermore, around 7500 plants are employed in India's informal treatment.[10] The Hon'ble Minister of AYUSH Department, Government of India, said in Loksabha on 18 November 2016 that, according to the Botanical Survey of India (BSI) report, the nation has over 8,000 kinds of medicinal fragrant, aromatic plants and herbs .[11]

Almost every state and union territory in the nation contributes to MAP production and EO extraction. Rajasthan (47.78%), Madhya Pradesh (24.57%), Uttar Pradesh (11.28%), Tamil Nadu (9.07%), and Chhattisgarh (3.16%) are the top five states in terms of MAP cultivation area. Similarly, the top five states in terms of percentage contribution to MAP production are Madhya Pradesh (28.33%), Rajasthan (26.40%), Tamil Nadu (20.52%), Chhattisgarh (6.36%), and Andhra Pradesh (3.77%), in that order. This data shows that, whereas Rajasthan has a more significant MAP cultivation acreage, Madhya Pradesh has a higher MAP production rate. The average land area under MAP cultivation and production in the nation was 8,38,460 hectares. It accounts for 0.59% of India's total cultivable land (As per the agricultural statistics-2017, the total cultivable land area is 140 million ha). And the total MAP output was 7,34,340 tonnes.[12,13]

According to the Ministry of Commerce and Industry of the Government of India, MAP generated in the nation is used in a range of sectors. The total revenue of India's EO industries in 2015 was Rs. 1950 crores.[14] The global fragrance & flavour industry is worth USD 24.10 Billion, and India contributes

**Table 1:** Export of EO from the country (Million USD)

| Year | West Asia and North Africa countries (WANA) | Asian countries | Latin America and the Caribbean countries (LAC) | European Union countries | North American countries |
|---|---|---|---|---|---|
| 2017-18 | 13 | 22 | 3 | 33 | 35 |
| 2018-19 | 25 | 27 | 2 | 36 | 37 |
| 2019-20 | 46 | 28 | 2 | 37 | 33 |
| Average | 28.00 | 25.67 | 2.33 | 35.33 | 35.00 |

approximately USD 500 million, which is 2.07% of the international. However, the growth rate in India has been about 11% in the last few years. Still, it is projected to grow exponentially in the upcoming years due to rising personal care, brand awareness, increasing demand in middle-class people, and affordable fragrance price in mass perfumes and deodorants.

From 1996 to 2020, imports of essential oils in India averaged 289.66 USD million, with a peak of 969.98 USD million in 2019 and a low of 26.58 USD million in 1996. In 2020, EO export was 146 USD million. It indicates that India is a net importer of EO. Table 1 shows EO exports from the country in Million USD. It tells that the EO export has increased over the past three years. Table 1 indicates that India's highest EO export is to the European Union and North American countries, with average export of 35 Million USD.[14]

## Essential Oils Enterprises in India

Essential oils cure various ailments, including infectious disorders, depression, and anxiety. They are also employed in the cosmetics and perfume industries as antifungal, antibacterial, anticancer, and wound healing agents.[15] The EO market is populated by many small and medium-sized local manufacturers and suppliers. Table 2 lists the key industries participating in the Indian essential oils industry.

EO extraction takes place in various capacities; for large-scale manufacturing, the extraction plant's capacity ranges from 100 L/day to several liters per day. Concurrently, the cost of EO extraction equipment ranges from Rs. 80,000/- to Rs. 10,50,000/-, depending on its capacity. Table 3 depicts some of the country's EO extraction equipment manufacturers and their product costs and ratings.

The next section of the paper illustrates government schemes and policies to promote MAP and EO use in the country.

## Organizations Promoting MAP Cultivation and EO Enterprises

The government of India is promoting the use of Ayurveda for the healthy well-being of people. It is also essential to attain the United Nations Sustainable Development Goal 3 (SDG 3) to ensure healthy lives and promote well-being for all ages[16] GPW13 sets an overarching goal of reaching 3 billion more people, to move towards Sustainable Development Goal 3 (SDG 3. Indian national and state government reports demonstrate that increasing MAP cultivation grows in small and marginal farmers.[17] Following are some government organizations working in the MAP and EO sectors:

- The essential oil association of India (EOAI) was founded in 1956 to promote advancement in the knowledge of science and technology of EO and help in the production and marketing of EO-based products.[18]
- Fragrance & Flavour Development Centre, Kannauj (FFDC) was set up in 1991 by Govt. of India in collaboration with the United Nations Development Programme (UNDP) and the United Nations Industrial Development Organization (UNIDO). UNDP/UNIDO has provided technologies; Govt. of U.P. has provided land, building and infrastructure, while Govt. of India contributes to the recurring, non-recurring and indigenous apparatus and equipment. This centre is a bridge between research and industries of essential oils, fragrances and flavors.
- On 9th November 2014, the Department of AYUSH was formed as a separate Ministry known as the Ministry of AYUSH. It promotes and strengthens awareness and interest about AYUSH systems of medicine and facilitates the national and international promotion of Ayurveda, Yoga, Naturopathy, Unani, Siddha, Sowa-Rigpa, and Homoeopathy.
- The National Medicinal Plants Board (NMPB) (established on 24$^{th}$ November 2000) has been implementing conservation, development and sustainable management of medicinal plants throughout the country. It supports setting various kinds of herbal gardens at regional, institutional, college, school and homes throughout the country.[19]
- NMPB had launched a 365 days campaign on medicinal plants at Jaipur on 20$^{th}$ and 21$^{st}$ August 2016 to generate awareness about the importance of medicinal plants in societies.

**Table 2:** Top industries in the Indian essential oils market

| *S.No.* | *Industry* | *Address* | *Annual turnover (Crore)* |
|---|---|---|---|
| 1 | AG Industries | Sector 83, Noida, Gautam Budh Nagar, Uttar Pradesh | 100–500 |
| 2 | BMV Fragrances Pvt. Ltd | J-44, 45, 46 and (K-55, Godown) Kasna Industrial Area, Site V, Greater Noida - 201308 U. P., India. | 100–500 |
| 3 | Bo International | A 91, Wazirpur Industrial Area, Delhi - 110052, India | 25–50 |
| 4 | Veda Oils | A-91, Block A, Wazirpur Industrial Area, Wazirpur, Delhi-110052, India. | 25–50 |
| 5 | Kanta Enterprises Private Limited | A-38, Sector-80, Phase 2nd Noida - 201305, Gautam Budh Nagar, Uttar Pradesh, India | 10–25 |

**Table 3:** Price and capacity of some commercially available EO extraction equipment

| *Name of equipment* | *Make and address* | *Price per unit (Rs.)* | *Capacity* |
|---|---|---|---|
| Herbal Extraction Plant | PR Engineering Company Suraram, Hyderabad. | 80,000 | 100 Lit/day |
| Herbs Extractor Plant | Harrisons Pharma Machinery Private Limited, Dariya Ganj, Delhi. | 1,29,000 | 500 Lit/day |
| Microtech Engineering Semi-Automatic Herbal Extraction | Micro-Tech Engineering Krishan Vihar, New Delhi. | 10,50,000 | 5000 Lit/day |

- National AYUSH Mission (NAM) (established on 29th September 2014) supports the cultivation of medicinal plants on farmer's land from the establishment of nurseries to post-harvest management. The cultivation of medicinal plants is supported by providing financial assistance to farmers through the concerned state's identified implementing agency.[20]
- Farmers throughout the country are getting financial assistance from the AYUSH Ministry to encourage herbs and other medicinal plants (Subsidy, as high as 75%).
- NMPB has launched an online virtual platform, 'www.e-charak.in' and a mobile application 'e-charak' to provide an online venue to sellers like farmers, collectors and buyers like traders, manufacturers, and exporters.
- The Central Council for Research in Indian Medicine and Homoeopathy (CCRIMH) was established in 1969 to research Ayurveda, Siddha, Unani, Yoga and Homoeopathy under the Ministry of Health and Family Welfare. Later, in 1978, this composite Council was dissolved to provide the pathway for the formation of four independent research councils, one each for Ayurveda and Siddha, Unani, Homoeopathy and Yoga and Naturopathy to initiate, guide, develop and coordinate scientific research, both fundamental and applied, in different aspects of their respective systems.

## Lemongrass essential Oil Extraction Technology

Lemongrass, also known as Cymbopogon, is a grass-like plant native to tropical islands. Because of their lemon-like fragrance, these are used as medicinal herbs or for cooking purposes. Although this grass is native to Sri Lanka, it is commonly cultivated in Kerala, Karnataka, Tamil Nadu, Uttar Pradesh, Maharashtra, and Assam. Lemongrass is used in cosmetics, pharmaceuticals, medicinal therapies, and the nutritional and scent industries.

Lemongrass essential oil extraction is widely done using steam distillation. The system consists of a stainless-steel cylindrical vessel with a processing capacity of 500 kg, integrated with a shell and tube type condenser, mild steel chimney, as shown in Figure 2.[21]

A 500 kg lemongrass is mixed with 200 kg water. The mixture is kept in a cylindrical vessel. The operating temperature is 200–250$^0$C. When the mixture temperature reaches 100$^0$C, vaporization begins. Steam extracts EO from the lemongrass and condenses in the condenser. An oil separator separates oil

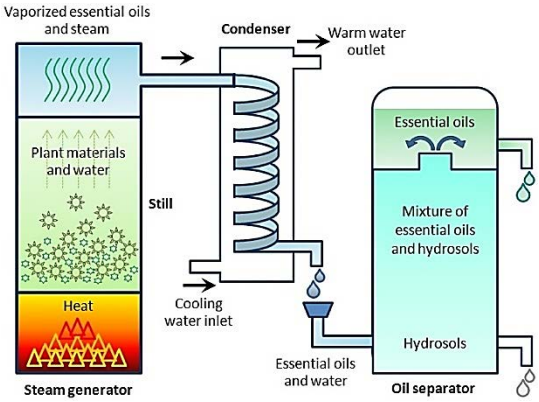


**Figure 2:** Lemongrass essential oil extraction plant[21]

from hydrosols. Wood, coal, biomass and spent lemongrass can be used as fuel. Total 4-5 hours are required to completely extract lemongrass EO.

## The Lemongrass Essential Oil Extraction Enterprise Model for Rural Income Generation

The lemongrass essential oil extraction enterprise model for rural income generation has been described in Table 4. It is based on Net Present Value (NPV) and sensitivity analysis.

The economic study of the lemongrass EO extraction business shows a net positive value that is more than zero. It demonstrates that this business strategy successfully benefits farmers' revenue-generating.

## Summary, Conclusions and Future Scope of Work

The current research looks at essential oil extraction firms for rural income development. This research depicts the national markets for essential oils, the size at which essential oils are extracted, and the possibilities of creating a small-scale essential oil extraction firm for rural income production. The following conclusions are drawn from this study:

- Small-scale agro-processing enterprises that rely on local agricultural supplies and rural labor substantially impact rural lives.
- Global EO production was estimated to reach above 150,000 tonnes in 2017, almost doubling since 1990. The worldwide essential oil market will reach USD 11,188 million by 2022, with a compound annual growth rate (CAGR) of 8.7% from 2016 to 2022.

**Table 4:** Lemongrass essential oil extraction enterprise model for rural income generation

| *Area of land under cultivation* | *1 ha* | | | | | |
|---|---|---|---|---|---|---|
| Cycle of farming | 5 years | | | | | |
| Commodity | Lemongrass | | | | | |
| Cost of farming | Rs. (1st year) | Rs. (2nd year) | Rs. (3rd year) | Rs. (4th year) | Rs. (5th year) | Total (Rs.) |
| Cost of labour for land preparation (Rs.) (Rs. 3,500/ ha) | 3,500 | - | - | - | - | 3,500 |
| Cost of labour for planting (Rs.) (7 days, 10 labours per day, @ Rs. 200/ day) | 14,000 | - | - | - | - | 14,000 |
| Cost of raw material (planting) material (Rs.). For 1 ha of lemongrass plantation, 50000 nos. of slips would be required at a spacing of 45 cm x 45 cm. (Rs. 1 per slip) | 50,000 | - | - | - | - | 50,000 |
| Cost of manure (Rs./ha per year) | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 25,000 |
| Cost of plant protection chemicals (Rs./ha) | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 25,000 |
| Irrigation charges (Rs./ha) | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 50,000 |
| Labour charges for harvesting, distillation, marketing and distribution work @ Rs. 200/day (Rs./year) | 73,000 | 73,000 | 73,000 | 73,000 | 73,000 | 3,65,000 |
| Miscellaneous (Rs./year) | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 25,000 |
| Total expenditure (A) | 1,65,500 | 98,000 | 98,000 | 98,000 | 98,000 | 5,57,500 |
| Cost of distillation, bottling and packing | | | | | | |
| Construction of a distillation MS shed with dimensions 25 x 16 x 15 ft @ Rs. 150 per square feet | 60,000 | - | - | - | - | 60,000 |
| Water tank of 14 ft high with a capacity of 2000 litres and pump set | 30,000 | - | - | - | - | 30,000 |
| Distillation unit (hydro-steam of capacity 500 kg) | 1,20,000 | - | - | - | - | 1,20,000 |
| Installation charges | 10,000 | - | - | - | - | 10,000 |
| Distillation unit running cost (Bio-mass/coal) @ Rs. 120/ kg oil extracted (only required in first period) | 8,640 | - | - | - | - | 8,640 |
| Bottling and packing @ Rs. 2/- per bottle (15 ml) | 33,027 | 33,027 | 33,028 | 33,028 | 33,028 | 1,65,138 |
| Total expenditure (B) (Rs./ha) | 2,61,667 | 33,027 | 33,028 | 33,028 | 33,028 | 3,93,778 |
| Total expenditure (Rs. per ha) (A+B) | 4,27,167 | 1,31,027 | 1,31,028 | 1,31,028 | 1,31,028 | 9,51,278 |
| Yields per ha is 12,000 kg of grass per period. Therefore, for 3 periods i.e. in one year (kg) | 36,000 | 36,000 | 36,000 | 36,000 | 36,000 | 1,80,000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Total oil produced from 1 hectare of Lemongrass farming in one year (kg) (0.6% of total mass) (C) (kg) | 216 | 216 | 216 | 216 | 216 | 1,080 |
| Total volume of oil produced from 1 hectare of Lemongrass farming in one year (kg) (r=0.872 g/ml) (ml) (D) | 2,47,706 | 2,47,706 | 2,47,706 | 2,47,706 | 2,47,706 | 12,38,530 |
| Number of bottles required (15 ml) | 16,514 | 16,514 | 16,514 | 16,514 | 16,514 | 82,569 |
| Production cost of oil ((A+B)/D) (Rs./ml of oil) | 1.72 | 0.53 | 0.53 | 0.53 | 0.53 | 4 |
| Production cost of oil ((A+B)/C) (Rs./kg of oil) | 1,977.63 | 606.61 | 606.61 | 606.61 | 606.61 | 4,404 |
| Income from the farm (At sale price in 15ml bottle @ Rs. 100) | 16,51,373 | 16,51,373 | 16,51,373 | 16,51,373 | 16,51,373 | 82,56,867 |
| Income from the farm (Rs./ha) (E) | 16,51,373 | 16,51,373 | 16,51,373 | 16,51,373 | 16,51,373 | 82,56,867 |
| Profit (Rs./ha) [D-(A+B)] | 12,24,206 | 15,20,346 | 15,20,346 | 15,20,346 | 15,20,346 | 73,05,589 |
| FCF/(1+IR)^n @ interest rate of 15% | 12,24,206 | 13,22,040 | 11,49,600 | 9,99,652 | 8,69,263 | 55,64,760 |
| Net present value (NPV) | 55,64,760 | | | | | |
| Number of days the distillation plant is in operation @ 7hr/day (4 hrs of operation and 1.5 hr for initial start-up time and 1 hr for shutdown time) (Per ha) | 72 | | | | | |

- India has about 8,000 medicinal and aromatic plant species. The average quantity of MAP-cultivated and developed land was 8,38,460 hectares. It represents 0.59% of total cultivable land in India. And the total MAP output was 7,34,340 tonnes. Rajasthan has the greatest MAP-cultivated area, whereas Madhya Pradesh has the highest rate of MAP production.
- From 1996 to 2020, India's essential oil imports averaged 289.66 USD million, with a peak of 969.98 USD million in 2019 and a low of 26.58 USD million in 1996. India's EO exports were valued at 146 million USD in 2020.
- EO extraction may be done in various quantities; the extraction plant's capacity can range from 100 to several litres per day for large-scale processing.
- Economic analysis of lemongrass essential oil enterprise illustrates that the average production cost of lemongrass oil is Rs. 857.66 per kg of oil and Rs. 0.75 per ml of oil. Lemongrass essential oil enterprise profits Rs. 14,66,118 per ha annually. A net positive value for five years of the production cycle is calculated as Rs. 55,89,760.
- The net positive value of the economic study of the lemongrass EO extraction business is more than zero. It demonstrates that this business model is efficient and beneficial to farmers' income generation.

## Future Scope of Work

From this study, it has been found that EOs extraction equipment is voluminous and expensive for rural people. It needs fossil fuel for its operation and has a visible carbon footprint. Consequently, it is required to design and develop portable, cost-effective, energy-efficient and environmentally friendly EOs extraction systems, perhaps running on renewable energy sources for rural people. Subsequently, marginal farmers can use their farmland to cultivate medicinal and aromatic plants and set portable essential oil extraction plants for their income generation.

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