

Economics Feasibility Analysis of Fragrant Lemongrass (*Andropogon nardus*) Cultivation and Distillation System

(Case study in Ganunghalu and Rongga sub-district, Bandung Barat Regency)

Nugraha Nugraha*, Aviasti Aviasti, Dewi Shofi
Mulyati, Reni Amaranti, Chicha Nursagita
Department of Industrial Engineering, Faculty of
Engineering
Universitas Islam Bandung
Bandung, Indonesia
*nugraha69@unisba.ac.id

Indra Topik Maulana
Department of Pharmacy, Faculty of Mathematics and
Science
Universitas Islam Bandung
Bandung, Indonesia

Abstract—One of the regions that produce lemongrass oil in West Java is Gununghalu and Rongga sub-district, Bandung Barat Regency. The problem faced in citronella cultivation is uncertainty on the quality of lemongrass and simple refining technology. This research was conducted to determine lemongrass cultivation (including procurement of raw materials, post-harvest handling) and refining technology used (in the refining process) that was economically feasible. In this study, the economic feasibility of citronella cultivation and refining was measured by considering the availability of raw materials; refining facility capacity, and operational costs incurred. This paper will describe the analysis of the Net Present Value of the cultivation and refining of citronella oil. The results showed that to maximize the distillation of citronella oil, raw materials needed as much as 1800 kg for each refining process. The raw material is needed for distillation in a refinery with a capacity of 600 kg and three times a day distillation. Based on Net Present Value analysis, it can also be seen that the business of refined fragrant lemongrass oil is considered economically feasible and can provide benefits if managed properly.

Keywords: *fragrant lemongrass, economic feasibility, net present value, citronella oil*

I. INTRODUCTION

The use of superior seeds is one of the factors that influence the production of fragrant lemongrass. Changes in the amount of fragrant lemongrass production will increase farmers' incomes. Research conducted by Sabarman explained that the income of lemongrass farmers using superior varieties was higher than those using local seeds [1]. In addition to the use of superior seeds, the maximum benefit can be obtained through optimal and effective labor. Development of the use of superior seeds needs to be socialized through farmer groups or community leaders by providing seed sources through community participation and related technical services.

Fragrant lemongrass cultivation and citronella oil refining are the livelihoods of most people in Gununghalu and Rongga

sub-districts, Bandung Barat Regency. The community utilizes agricultural land planted with fragrant lemongrass plants and conduct distillation using simple distillation methods to produce citronella oil. Fragrant lemongrass can growth either at irrigated and nonirrigated conditions [2]. Fragrant lemongrass is a source of important essential oils that has several benefits. It had activity as antibacterial to *Salmonella choleraesuis*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* [3], and *Acinetobacter baumannii* [4]. It also gave activity as antidiabetic [5], atherosclerosis [6], anticancer agents [7]. It's leaves also widely used as tea herbal [8]. So that, fragrant lemongrass essential oil is often used traditionally as medicines and food seasoning and it also used as raw materials for the chemical industry. The essential oils produced by distillation from every part of the plant, from leaves, flowers, tree bark to roots [9]. Especially in lemongrass cultivation, the yield of essential oil from the source was influenced by several factors that are the cultivation [2], the moisture content [8], drying condition [10,11], storage time [8] and extraction method [11].

Based on preliminary observations of the cultivation and refining of citronella made by the community, several problems were found. These problems include uncertainties in the quality of lemongrass plants, unsustainable raw material supply, poor management and production processes, marketing of lemongrass oil which depends on collectors, the uncertainty of the price of lemongrass oil, and simple refining technology. These problems cause the efforts of farmers to not have a significant impact on improving their welfare. There was a high gap between farmers who planted fragrant lemongrass, citronella distillers, and citronella oil collectors. Therefore, it is necessary to provide guidance to farmers and citronella refiners in managing the businesses they run.

The increase in yields obtained from the citronella oil refining industry is highly dependent on the ability of farmers to cultivate citronella, especially post-harvest handling, manage refined citronella oil, and sell the citronella oil they produce. These capabilities can be provided through training programs

and mentoring to the community which is carried out jointly by the village government, non-governmental organizations, educational institutions, or related institutions in West Bandung Regency. Therefore, training and assistance to the people of Gununghalu and Rongga sub-districts are needed in developing the Sereh Wangi oil refining industry according to their capacity. This effort aims to optimize the effort of refining lemongrass that has been the livelihood of the community so that it can improve the economy and welfare of the local community. This paper describes the feasibility test of the lemongrass distillation business economically so that it can be a benchmark for citronella farmers and refiners to develop their business.

II. LITERATURE REVIEW

A. Essentials Oils

Essential oil is a type of oil produced from plants. Essential oils and oleoresins include a wide variety of products that are used as scents and fragrances. Many essential oils are used traditionally as medicines and food additives to maintain health and are also used as raw materials for the chemical industry. Essential oils are distilled from every part of the plant, from leaves, flowers, tree bark to roots [9]. Essential oil is a type of oil produced from plants, has a liquid form and easy to vapor at room temperature [12].

B. Fragrant Lemongrass

Fragrant Lemongrass belongs to a group of grasses called *Andropogon nardus* or *Cymbopogon nardus*. This genus includes almost 80 species, but only a few species produce essential oils that have economic significance in the world of commerce [13]. Fragrant Lemongrass is a perennial aromatic plant of the Poaceae grass family, which comes from tropical Asia. This is a source of an essential oil known as "Fragrant Lemongrass oil". Fragrant Lemongrass plants can grow up to 1-1.5 m. The length of the leaves reaches 70-80cm and the width is 2-5 cm, light green, rough and has a strong aroma [14].

C. Net Present Value (NPV)

NPV is calculated based on the difference between benefit and cost-plus investment [15]. NPV is useful to measure the ability and opportunity of a company to carry out its investment for several years to come when the value of the currency changes and the impact on the company's cash flow. Feasible or not an investment is run can be seen from the NPV calculation results.

TABLE I. NPV VALUES

IF	Mean	Then
NPV Value > 0	Then the investment to be carried out is projected to bring profits to the company.	Projects are recommended to run
NPV Value = 0	Then the investment that will be run, is projected not to bring profits or losses for the company.	It needs to be discussed further about other benefits that will be obtained if the investment continues to run.
NPV Value < 0	Then the investment to be carried out is projected to bring a loss for the investment company is definitely profitable.	If it is detrimental, it is not an investment. So the Project is recommended to be canceled.

III. METHOD

This research was conducted in Gununghalu and Rongga sub-districts, Bandung Barat Regency. Both are in high altitude areas suitable for agricultural land. The majority of the population works as farmers and most of them are fragrant lemongrass farmers. In this study, data collection was done through interviews with farmers and citronella distillers at Gununghalu and Rongga sub-district. Based on the data obtained, an analysis of the management of citronella has been carried out so far by calculating the Net Present Value (NPV). Then the possibility of development in the citronella-based agroforestry-based agroforestry pattern in community activities is examined. Figure 1 describes the stages of research that have been conducted.

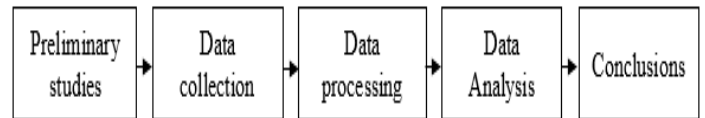


Fig. 1. The research stages.

IV. RESULTS AND DISCUSSION

A. Development of Fragrant Lemongrass Oil Production

Indonesia is the third-largest producer of essential oils in the world after China and Vietnam [16]. The types of essential oils exported include citronella oil, patchouli oil, clove oil, fragrant root oil, nutmeg oil, Cananga oil, ginger oil, and others. In general, essential oils are used in food flavoring, perfume, cosmetics, aromatherapy, and medicine [17]. World export-import statistics show that consumption of citronella oil and its derivatives has increased by around 1% per year in line with the industry's growth for these products. Essential oils in Indonesia are still largely cultivated by the community traditionally so that sometimes the oil produced does not meet the specified quality requirements. If it does not meet the quality requirements, then the selling price of oil will be much cheaper [18].

The demand for citronella oil is quite high and the price is stable. The data also shows that the market demand for citronella oil always increases by approximately 3-5% per year. Countries that imported citronella oil from Indonesia were

Singapore, Japan, Australia, Mexico, India, Taiwan, the United States, France, United Kingdom, Germany, and Spain [19].

B. Business Profile of Citronella Oil Refining in Gununghalu and Rongga Sub-District

Citronella oil refining activities currently carried out by the community involve several actors in the citronella oil supply chain. These actors include fragrant lemongrass farmers, fragrant lemongrass crop collectors, citronella oil distillers, citronella oil collectors, industrial products with citronella oil raw materials, citronella oil exporters, and retail consumers. The communities of Gununghalu and Rongga sub-districts play a role as farmers, collectors of fragrant lemongrass crops, citronella oil refiners, and citronella oil collectors.

1) Farmer groups and partnership patterns: Refined lemongrass oil in Gununghalu and Rongga sub-districts is still managed traditionally. Although the activities of citronella cultivation and distillation have been carried out for a long time by most people in Gununghalu and Rongga, their management still faces many problems. This causes the lemongrass refining business has not had a significant impact on the welfare of citronella farmers and citronella oil refiners. Currently, farmers and fragrant lemongrass refiners still do their business individually.

There is no organization that becomes a place for them to manage all the activities that they do. As a result, these citronella refining activities are only able to be a source of community income for their daily needs. Another problem faced is the extremely high dependence of fragrant lemongrass refiners on fragrant lemongrass oil collectors to sell the oil they produce. This causes the price of fragrant lemongrass oil to be determined entirely by the collectors. Uncertain oil quality also determines the price of oil that cannot be controlled by refiners. Therefore, a container for citronella farmers is needed to form a farmer group so that the farmers can work together to improve the quality and amount of citronella produced so that they can meet the raw material requirements for refining.

2) The refining process: The distillation process carried out by most refiners in Gununghalu and Rongga uses the water distillation method. The water distillation method is the easiest method compared to other methods. This method is relatively simple and uses a kettle with raw materials that are easily obtained. Some refiners even use used oil drums or used asphalt drums as a kettle. In this way, fragrant lemongrass leaves are placed in a kettle that has been filled with water so that the fragrant lemongrass is mixed with water. The ratio of water to leaves must be balanced. Lemongrass leaves are loaded and compacted, then the kettle is tightly closed so that

there is no vapor gap. Steam from boiling water and the material has then flowed through a pipe from the boiler to the condenser which contains cold water so that the condensation process occurs. In most refineries in Gununghalu and Rongga, boiling water vapor is channeled through pipes through the water in ponds that are made as coolers. Next, water and oil are collected in a separation tank.

C. Financial Analysis of Lemongrass Fragrant Business

The data used in the financial analysis of citronella cultivation and refining are as follows:

- Fragrant lemongrass leaf production is 20.000 kg/period.
- Distillation capacity of 200 kg/period.
- The need for raw materials (citronella leaves) per period (3 months) is 20.000 kg/period.
- The price of fragrant lemongrass leaves from farmers is IDR 900/kg
- Selling prices of lemongrass oil Rp. 250.000/kg
- Distillers provide distillation facilities, production facilities and wages for planting, caring for plants, and buying fragrant lemongrass from farmers.

This paper describes the financial analysis conducted in this study, including the calculation and financial analysis of citronella farmers (Table 2), financial calculations and analysis on citronella oil refiners (Table 3 and Table 4), calculation of the net present value of oil refining citronella (Table 5), and the calculation of the estimated profit (Table 6).

1) Financial analysis at the farmer level: Costs incurred by fragrant lemongrass farmers are the cost of renting land to grow citronella, the cost of caring for lemongrass plants, as well as the costs for harvesting and transporting fragrant lemongrass to the distillery. Financial calculations at the farmer level are shown in Table 2.

Table 2 shows the number of costs incurred by farmers for each cost element. The annual rental fee per hectare of land is 875.000 IDR. This rental fee does not increase for four years of calculation. For fertilizer, farmers use manure at a cost of 4.500.000 IDR in the first year and 6.000.000 IDR in the second to the fourth year. The cost of harvesting and transportation in the first year reached Rp 30.000.000 IDR, while in the second to fourth years it was 40.000.000 IDR. Income obtained from the sale of lemongrass leaves amounted to 50.000.000 IDR so the net profit earned in the first year amounted to 18.625.000 IDR and in years 2 to 4 amounted to 25.125.000 IDR.

TABLE II. SPENDING AND INCOME OF FRAGRANT LEMONGRASS BUSINESS FOR FARMERS

	Description	Amount	Unit Price (Rp)	1st Year (Rp)	2nd Year (Rp)	3rd Year (Rp)	4th Year (Rp)
<i>Expenditures</i>							
1	Land Lease	1 ha	35.000 / 400 m	875.000	875.000	875.000	875.000
	Manure	100 karung	15.000	4.500.000	6.000.000	6.000.000	6.000.000
	Harvesting and transportation	20.000 kg	50.000 / 100 kg	30.000.000	40.000.000	40.000.000	40.000.000
	Total Expenditures			35.375.000	46.875.000	46.875.000	46.875.000
2	Revenue (Benefit) Selling Leaves	20.000	900	54.000.000	72.000.000	72.000.000	72.000.000
<i>Net Income</i>				18.625.000	25.125.000	25.125.000	25.125.000

2) *Financial analysis at the level refiners*: Costs incurred by refiners include the purchase of raw materials (fragrant lemongrass leaves), costs of leaf depreciation, labor costs, maintenance costs for refining machines, fuel costs, and

transportation costs. Details of costs incurred by refiners are explained in Table 3 and the income statement is shown in Table 4.

TABLE III. REQUIRED COST

No	Cost Type	Price/unit (IDR)	Amount	Total (IDR)
1	Shrinkage of leaf	900/kg	1000 kg	900.000
2	Engine maintenance	600.000/period	1 period	600.000
3	Raw materials	900/kg	20.000 kg	18.000.000
4	Workers (2 person)	50.000/person/day	1 period	6.000.000
5	Transportation	10.000/100kg	20.000 kg	2.000.000
6	Fuel	50.000/day	1 period	3.000.000
TOTAL COST				30.500.000

Note: Calculation of 1 distillation (1 period = 3 months), 1 month = 20 working days

TABLE IV. INCOME STATEMENT

Category	Price/unit (IDR)	Total needs	Total cost/period (IDR)
<i>Income</i>			
Sales	250.000/kg	200 kg	50.000.000
TOTAL INCOME			50.000.000
<i>Spending</i>			
Production cost			
Cost of raw materials	900/kg	20.000 kg	18.000.000
Worker cost (2 people)	50.000/person/day	1 period	6.000.000
Transportation cost	10.000/100kg	20.000 kg	2.000.000
Fuel cost	50.000/day	1 period	3.000.000
Leaf depreciation	900/kg	1000 kg	900.000
Maintenance	600.000/period	1 period	600.000
TOTAL COST			30.500.000
BENEFIT			19.500.000
TAX (10%)			500.000
NET BENEFIT			19.000.000

3) *Calculation of Net Present Value (NPV)*: The calculation of NPV values requires an interest in Table 5. NPV calculations are explained as follows:

$$NPV = (50.000.000 + 30.500.000) + 50.000.000 (P/A;15\%;12) + 2.500.000 (P/G;15\%;12) - 30.500.000 (P/F;15\%;3) - 30.500.000 (P/F;15\%;6) - 30.500.000 (P/F;15\%;9)$$

$$= 80.500.000 + 50.000.000 (5,421) + 2.500.000 (21,185) - 30.500.000 (0,6575) - 30.500.000 (0,4323) - 30.500.000 (0,2843) = 169.824.950,- IDR$$

Based on the calculations that have been made, it can be seen that the Net Present Value (NPV) is greater than 0 (zero). This shows that investment in refined citronella oil refineries is projected to be profitable and feasible.

TABLE V. INTEREST TABLES

15%		Compound interest Factors							15%
n	Single Payment		Uniform Payment Series				Arithmetic Gradient		n
	Comp. Amount Factor Find F Given P	Present Worth Factor Find P Given F	Sinking Fund Factor Find A Given F	Capital Recovery Factor Find A Given P	Comp. Amount Factor Find F Given A	Present Worth Factor Find P Given A	Gradient Uniform Series Find A Given G	Gradient Present Worth Find P Given G	
n	F/P	P/F	A/F	A/P	F/A	P/A	A/G	P/G	n
1	1.1500	0.8696	1.0000	1.1500	1.0000	0.8700	0.0000	1.0000	1
2	1.3220	0.7561	0.4651	0.6151	2.1500	1.6260	0.4650	0.7560	2
3	1.5210	0.6575	0.2880	0.4380	3.4720	2.2830	0.9070	2.0710	3
4	1.7490	0.5718	0.2003	0.3503	4.9930	2.8550	1.3260	3.7860	4
5	2.0110	0.4972	0.1483	0.2983	6.7420	3.3520	1.7230	5.7750	5
6	2.3130	0.4323	0.1142	0.2642	8.7540	3.7840	2.0970	7.9370	6
7	2.6600	0.3759	0.0904	0.2404	11.0670	4.1600	2.4500	10.1920	7
8	3.0590	0.3269	0.0729	0.2229	13.7270	4.4870	2.7810	12.4810	8
9	3.5180	0.2843	0.0596	0.2096	16.7860	4.7720	3.0920	14.7550	9
10	4.0460	0.2472	0.0493	0.1993	20.3040	5.0190	3.3830	16.9790	10
11	4.6520	0.2149	0.0411	0.1911	24.3490	5.2340	3.6550	19.1290	11
12	5.3500	0.1869	0.0345	0.1845	29.0020	5.4210	3.9080	21.1850	12
13	6.1530	0.1625	0.0291	0.1791	34.3520	5.5830	4.1440	23.0000	13
14	7.0760	0.1413	0.0247	0.1747	40.5050	5.7240	4.3620	24.9720	14
15	8.1370	0.1229	0.0210	0.1710	47.5800	5.8470	4.5650	26.6930	15

TABLE VI. ESTIMATED PROFIT

Description	Land area (Ha)	Needs	Price/s eed (IDR)	Total (IDR)	Net profit (IDR)
Seedlings	1ha	20.000k g/ha	900	18.000.000	19.000.000
Machinery, installations, and buildings		1 unit	50.000.000	50.000.000	

V. CONCLUSION

Based on result research that has been done, it can be concluded several things as follows:

- Fragrant lemongrass businesses show very favorable prospects for farmers if managed properly,
- Calculation of Net Present Value (NPV) shows that the investment to be carried out is projected to bring profit to the company, so it is recommended to run.
- Currently, the market opportunity for fragrant lemongrass oil is wide open. This opportunity needs to be utilized as well as possible to develop citronella-based agroforestry models to significantly increase community income and welfare.
- Suggestions that further research is needed in the form of developing appropriate technology in order to optimize growth and the results obtained in this pattern and minimize the negative impacts that may occur.

ACKNOWLEDGMENT

Thank you to the research institute and community service of the Universitas Islam Bandung for funding the research and all parties who have helped in this research.

REFERENCES

- [1] D. Sabarman, "Analisis Ekonomi Sistem Pertanian Sereh (Studi Kasus di Gunung Halu, Kabupaten Bandung Selatan)" Balitro, Vol. XVIII No. 2, 203 – 221, 2007
- [2] V.D. Zheljzkov, C.L. Cantrell, T. Astatkie and J.B. Cannon, "Lemongrass Productivity, Oil Content, and Composition as a Function of Nitrogen, Sulfur, and Harvest Time," Agronomy Journal, vol. 103, no. 3, pp. 805-812, 2011.
- [3] M.A. Falcão, A.L.B. Fianco, A.M. Lucas, M.A.A Pereira, F.C. Torres, R.M.F. Vargas and E. Cassel, "Determination of antibacterial activity of vacuum distillation fractions of lemongrass essential oil" Phytochem Rev, vol. 11, pp. 405-412, 2012.
- [4] E.C. Adukwu, M. Bowles, V. Edwards-Jones and H. Bone, "Antimicrobial activity, cytotoxicity and chemical analysis of lemongrass essential oil (Cymbopogon flexuosus) and pure citral", Appl Microbiol Biotechnol, 100, pp. 9619–9627, 2016.
- [5] H. Agarwal, S.V. Kumar, and S. Rajeshkumar, "Antidiabetic Effect Of Silver Nanoparticles Synthesized Using Lemongrass (Cymbopogon Citratus) Through Conventional Heating And Microwave Irradiation", Approach, J Microbiol Biotech Food Sci, vol. 7, no. 4, pp. 371-376, 2018.
- [6] R. Orrego, E. Leiva and J. Cheel, "Inhibitory Effect of Three C-glycosylflavonoids from Cymbopogon citratus (Lemongrass) on Human Low-Density Lipoprotein Oxidation", Molecules, no. 14, pp. 3906-3913, 2009.
- [7] K. Ghosh, "Anticancer effect of lemongrass oil and citral on cervical cancer cell lines" Pharmacognosy Communications, vol. 3, no. 4, pp. 41-48, 2013.
- [8] L.C.A. Barbosa, U.A. Pereira, A.P. Martinazzo, C.R.A. Maltha, R.R Teixeira, and E.D.C. Melo, "Evaluation of the Chemical Composition of

- Brazilian Commercial *Cymbopogon citratus* (D.C.) Stapf Samples”, *Molecules*, no. 13, pp. 1864-1874, 2008.
- [9] Ministry of Trade, 2017.
- [10] S. Mujaffar and S. John, “Thin layer drying behavior of West Indian lemongrass (*Cymbopogon citratus*) leaves”, *Food Sci Nutr*, no. 6, 1085–1099, 2018.
- [11] D. Dutta, P. Kumar, A. Nath, N. Verma and B. Gangwar, “Qualities of lemongrass (*Cymbopogon citratus*) essential oil at different drying conditions”, *IJAEB*, vol. 7, no. 4, pp. 903-909, 2014.
- [12] R.J. Fassenden and J.S. Fassenden. *Dasar-dasar Kimia Organik*. Translated by Maun, S., Anas, A & Sally, S. Jakarta: Binarupa Aksara. 1997.
- [13] I.H.B. Santoso, *Sereh Wangi, Bertanam dan Penyulingan*. Kanisius, 1992.
- [14] W. Wijayakusuma, *Ramuan Herbal Penurun Kolesterol*. Pustaka Bunda, Jakarta. 2005.
- [15] M.S. Anwar, A.I. Hasyim and M.I. Affandi, “ANALISIS KELAYAKAN FINANSIAL USAHA PEMBIBITAN LADA DI DESA SUKADANA BARU KECAMATAN MARGA TIGA KABUPATEN LAMPUNG TIMUR,” *Jurnal Ilmu-Ilmu Agribisnis*, vol. 6, no. 2, 2018.
- [16] M.S. Rusli, *Sukses Memproduksi Minyak Atsiri*. Jakarta: PT. Agromedia Reader, 2010.
- [17] E. Guenther, *Minyak Atsiri Jilid IIIA*, translated by Ketaren, 408. Universitas Indonesia Press. Jakarta.1991.
- [18] S. Esti, *Tanaman Kelapa*. Accessed February 14, 2019. www.ristek.go.id, 2001.
- [19] Ministry of Industry and Trade. *IKM Buku I Kebijakan dan Strategi Umum Pengembangan Industri Kecil dan Menengah*. Jakarta: Ministry of Industry and Trade. 2002.