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

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

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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 grow 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.

| 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).

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, Camanga 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
citronella oil refiners, and citronella oil collectors. The communities of Gununghalu and Rongga sub-districts play raw materials, citronella oil exporters, and retail consumers. fragrant lemongrass crop collectors, citronella oil distillers, 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 leaves 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) |
|------------------------------|----------|---------------------|---------------|---------------|---------------|---------------|
| **Expenditures**             |          |                     |               |               |               |               |
| 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    |
| **Revenue (Benefit) Selling Leaves** | 20,000 | 900                 | 54,000,000    | 72,000,000    | 72,000,000    | 72,000,000    |
| **Net Income**               |          |                     | 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           | 1,000 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 people)  | 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) |
|----------------------|------------------|-------------|-------------------------|
| **Income**           |                  |             |                         |
| Sales                | 250,000/kg       | 200 kg      | 50,000,000              |
| **TOTAL INCOME**     |                  |             | 50,000,000              |
| **Spending**         |                  |             |                         |
| 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:

\[
NPV = \left(50,000,000 + 30,500,000\right) + 50,000,000 \left(P/A;15\%;12\right) + 2,500,000 \left(P/G;15\%;12\right) - 30,500,000 \left(P/F;15\%;3\right) - 30,500,000 \left(P/F;15\%;6\right) - 30,500,000 \left(P/F;15\%;9\right)
\]

\[
= 80,500,000 + 50,000,000 \left(5.421\right) + 2,500,000 \left(21.185\right) - 30,500,000 \left(0.6575\right) - 30,500,000 \left(0.4323\right) - 30,500,000 \left(0.2843\right)
\]

\[
= 169,824,950,- IDR
\]

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.
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.

TABLE V. INTEREST TABLES

| Compound interest Factors | 15% |
|---------------------------|-----|
| Single Payment | Uniform Payment Series | Arithmetic Gradient |
| **Comp. Amount Factor**<br>**Given P** | **Present Worth Factor**<br>**Find P**<br>**Given F** | **Sinking Fund Factor**<br>**Find A**<br>**Given P** | **Capital Recovery Factor**<br>**Find A**<br>**Given F** | **Comp. Amount Factor**<br>**Given A** | **Present Worth Factor**<br>**Find P**<br>**Given A** | **Gradient Uniform Series**<br>**Find A**<br>**Given G** | **Gradient Uniform Series**<br>**Find P**<br>**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 | 3.5250 | 1.7230 | 5.7750 | 5 |
| 6 | 2.3100 | 0.4323 | 0.1142 | 0.2642 | 8.7540 | 3.7840 | 2.0970 | 7.9370 | 6 |
| 7 | 2.6680 | 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 | 13.0000 | 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/seed (IDR) | Total (IDR) | Net profit (IDR) |
|-------------|---------------|-------|-----------------|-------------|-----------------|
| Seedlings   | 1.00          | 20,000 kg/ha | 900 | 18,000.00 | 19,000.00 |
| Machinery, installations, and buildings | 1 unit | 50,000,000 IDR | 50,000,000 IDR | 50,000,000 IDR |

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.

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