

Optimization Strategy for the Development of Lemongrass Essential Oil in *Science Techno Park*, Trenggalek Regency

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Abstract

This study aims to identify the optimal strategy and evaluate the economic feasibility in the development of citronella essential oil in Science Techno Park (STP) Trenggalek Regency. With a qualitative approach, this study collects data through in-depth interviews, direct observation, and related documentation. The results of the study show that strengthening the supply chain, innovation of derivative products, increasing the technical capacity of farmers, market diversification, and policy and infrastructure support are the key steps needed to develop the citronella essential oil industry in STP Trenggalek Regency in a sustainable and profitable manner. The economic evaluation reveals that this development is economically feasible with a positive rate of return on investment and maintained environmental and social sustainability.

Keywords: *agroindustry, essential oils, industrial development strategies*

Introduction

As an agrarian country, Indonesia makes the agricultural sector the main support in economic development, including through the export of essential oil commodities from the plantation sub-sector. Essential oils, which are oil extracts from aromatic plants, have high economic value and are widely used in the perfume, cosmetic, pharmaceutical, food, and beverage industries (Mustamin, 2015). One of the most promising essential oils is the essential oil of citronella (*Cymbopogon nardus*), which belongs to the family Gramineae (grasses).

Citronella essential oil has great market potential both domestically and abroad. The data shows that the demand for lemongrass essential oil is quite high and continues to increase, while the price remains stable. The growth rate of lemongrass essential oil exports reached 9-10% with a contribution to essential oil export revenue of around 6.89%, making it the third largest export commodity after patchouli oil (60%) and animal oil (12.47%) (Sulaswatty, 2019).

Trenggalek Regency, one of the regions with a strong economic structure in the agricultural sector, has chosen the development of essential products as a strategy to increase local economic value. Lemongrass is the main commodity developed in several sub-districts in mountainous areas such as Watulumo, Munjungan, Panggul, Dongko, Pule, Dam, Suruh, and Kampak. The Science Techno Park (STP) of UPTD Dilem Willis in Trenggalek Regency serves

as a center for the development of innovation in the agricultural sector, including the development of citronella essential oil derivative products. This Science Techno Park integrates the worlds of industry, academia, research centers, and the government to increase the flow of information and technology (BPS, 2021).

Citronella essential oil, known as citronella oil, has various benefits, both for the cosmetics and health industries, as well as as a bioadditive in fuel (Kardinan, 2002). With great local and international market potential, the development of citronella essential oil in Trenggalek is considered strategic. However, there are questions about how optimal the strategy for such development is and whether this venture is economically feasible and sustainable.

Science Techno Park Trenggalek Regency is under the management of the Agricultural Science and Technology Planting UPTD Dilem Wilis Agriculture and Food Office of Trenggalek Regency is located in Dompjong Village, Bendungan District, Trenggalek Regency with an area of 250 Ha. Science Techno Park (STP) has been initiated as one of the centers for the development of citronella plants. Located in the Dilem Wilis Agrotourism Area, Bendungan District, Trenggalek Regency, this area is located in the Wilis mountain ring area. STP or Science and Technology Park is an integrated area that integrates various elements such as industry, universities, research and training centers, entrepreneurship, banking, as well as central and regional governments, in one location, to facilitate the flow of information and technology more effectively and efficiently. STP was built to support the downstream of academic products and innovative research results, as well as become an innovation center for the academic community in various scientific fields.



Figure 1. Citronella field in *Science Techno Park*

The Science and Technology Park (STP) has three main functions in the development of science and technology and innovation: providing the latest technological knowledge, offering unresolved technological solutions, and becoming a center for the development of technology applications for the local economy. Trenggalek Regency established STP in 2018, in collaboration with Brawijaya University through the Essential Institute to develop citronella essential oil. This cooperation includes the construction of distillation equipment, the development of citronella seeds, and technology transfer. STP at UPTD Dilem Wilis, located in Dompjong Village, Bendungan District, Trenggalek Regency, covers an area of about 250 hectares. The Dilem Wilis plantation has many potentials that can be maximized, one of which is the development of citronella plants as a producer of essential oils.

Literature Review

Essential Oils: Definition and Extraction Methods

Essential oils are oils obtained from the extraction of various parts of plants, including leaves, flowers, fruits, seeds, stems, bark, and roots. There are around 150-200 species of essential oil-producing plants, such as citronella, cloves, vetiver, patchouli, and nutmeg. This oil is volatile at room temperature and is often used in the perfume, cosmetics, pharmaceuticals, and food and beverage industries because of its properties as a binder, flavoring, and antibacterial agent (Rahmi, 2018).

Essential oils contain compounds such as aldehydes, ketones, alcohols, esters, and turpentine. Because they contain a variety of volatile compounds, essential oils are volatile at different boiling points. The process of extracting essential oils can be carried out through several methods, such as distillation (distillation), pressing, extraction with solvents, and enfleurage. The distillation method is the most commonly used because it involves the separation of components based on their boiling point, with the most commonly used types including water distillation, water-steam distillation, and direct steam distillation (Guenther, 2006; Swasono, 2016).

Various studies have been conducted to understand the strategy for agribusiness development and production of citronella essential oil. The research of Oktavia et al. (2022) used a SWOT analysis to evaluate the development of citronella agribusiness in Pasir Putih Village, West Sulawesi. The results show that internal strengths such as community enthusiasm and land area can support development, while weaknesses such as manual distillation equipment need to be improved. On the external side, market opportunities and government support provide positive hope, but challenges such as price fluctuations and the pandemic must be addressed.

Alfenia (2022) explained that the citronella essential oil agroindustry business in West Sumatra is included in the micro category, with limited personal capital and labor. Significant daily production and good annual net income indicate the economic potential of these ventures, although there is a need for increased efficiency.

Puteri Nadirah et al. (2022) studied the ethnobotany of citronella and found that this plant is easy to grow and adapts well to local conditions, supporting successful cultivation. Erni et al. (2023) assessed the sustainability of citronella farming with good production yields and profitable income, showing that citronella cultivation has high sustainability potential.

Solekha et al. (2023) examined the distillation process and found that the temperature and duration of distillation affect the yield and quality of essential oils. This study provides an important guide to optimize the extraction process.

Research Questions

The study focuses on two main questions:

1. What is the optimal strategy for the development of citronella essential oil in Science Techno Park, Trenggalek Regency?
2. How is the lemongrass development effort in Science Techno Park, Trenggalek Regency if viewed from the economic and sustainability aspects?

Research Methods

This study uses a qualitative approach to examine the optimal strategy and economic feasibility of lemongrass essential oil development in Science Techno Park (STP) Trenggalek Regency. The qualitative approach was chosen because it is appropriate to describe and analyze social phenomena, events, activities, and perceptions of individuals or groups (Sugiyono, 2010). This research is inductive, where data is obtained from in-depth interviews, direct observations, and relevant documentation.

Location and Duration of Research

The research was carried out at the Science Techno Park (STP) of UPTD Dilem Willis, located in Dompjong Village, Bendungan District, Trenggalek Regency, for three months, from December 2023 to February 2024. The location selection was carried out deliberately (purposive), considering the potential of STP UPTD Dilem Willis in the development of citronella plants and processed essential oil products in Trenggalek Regency.

Sampling Techniques

The purposive sampling method is used to determine informants who have knowledge and experience relevant to the research topic (Sugiyono, 2010). The main informants of this research include Acting Head of UPTD Dilem Willis, garden supervisors, garden workers, refinery officers, and marketing staff at STP. The selection of the informants is based on the consideration that they have in-depth and direct information related to the development and production process of citronella essential oil.

Data Collection Techniques

Data collection is carried out using several following methods to ensure a systematic analysis of the issue being studied.

1. **Semi-Structured Interviews:** In-depth interviews are conducted in person or online, depending on the situation and conditions. This technique is used to dig up detailed information from informants about development strategies, production processes, and challenges faced.
2. **Direct Observation:** The researcher conducted a field visit to observe the production, processing, and marketing activities of citronella essential oil.
3. **Documentation:** Secondary data is obtained from annual reports, internal publications, as well as other relevant documents related to STP activities and essential oil development.

Data Analysis Techniques

The data obtained were analyzed using qualitative analysis techniques with a phenomenological approach. This technique focuses on understanding the informants' experiences and views from their own point of view, as well as exploring the meaning of the phenomenon being studied (Creswell & Poth, 2018). Data analysis is carried out through several stages:

1. **Interview Transcription:** Interview data is transcribed verbatim to ensure the accuracy of the information.
2. **Categorization:** The data obtained is grouped into categories according to the theme and sub-themes that emerge.

3. **Thematic Analysis:** The analysis is conducted to identify the main patterns and themes that are relevant to the research question.
4. **Data Validation:** Triangulation techniques are used to validate data by comparing information from different sources.

Research Results

The results of this study identify several optimal strategies in the development of citronella essential oil in Science Techno Park, Trenggalek Regency which are discussed in the following sections.

Optimization Strategy for the Development of Lemongrass Essential Oil

Based on the results of the study, the optimal strategy that can be implemented includes the following key steps:

- **Strengthening Supply Chains:** Partnerships between citronella farmers and local refining industries and buyers of essential oils need to be built to ensure a stable and quality supply of raw materials.
- **Derivative Product Innovation:** The development of derivative products from citronella essential oils such as aromatherapy oils, soaps, and aromatherapy candles can increase the added value and competitiveness of products. Eva et al. (2024) emphasized the importance of applying agricultural technology in the development of citronella cultivation business, which can be a reference for derivative product innovation efforts in Trenggalek.

Respondents to this study also revealed several derivative products as innovations from the development of products produced from essential oils.

According to Maharani (27 years old), a processing and café officer of UPT TSTP.

"The citronella oil produced is marketed through cafes managed by UPT TSTP, online and through regional local product exhibition stands. It is sold in the form of essential oils as aromatherapy oils, and some of them are processed into aromatherapy candles and lemongrass soaps. However, for aromatherapy wax products and lemongrass soap for now, they are only marketed according to orders or through exhibition stands."

As an ingredient in the soap, perfume, cosmetic, antiseptic, insect repellent and aromatherapy industries, citronella contains essential oils that function as aromatherapy and mosquito repellent. Citronella derivative products produced at *Science Techno Park* such as aromatherapy oils, aromatherapy candles, and solid soaps.

- **Increasing Technical Capacity and Farmer Management:** Providing technical training on citronella cultivation and essential oil refining techniques to farmers can increase productivity and quality of the oil produced. As revealed by Yusrizal et al. (2022), mentoring and training to Siti Hajar Pekanbaru SMEs improves farmers' knowledge and skills in utilizing appropriate technology.
- **Market Diversification:** Seizing opportunities in local and international markets through strategic promotion and marketing, as well as exploring cooperation with international companies. Nuryani (2022) shows the importance of an agro-industrial business development strategy that includes market diversification to expand product distribution networks.

- **Policy and Infrastructure Support:** Support from local governments is needed in the form of policies that support investment in the essential oil sector and the provision of supporting infrastructure such as road access and storage facilities.

Economic Feasibility and Business Sustainability

Economic analysis shows that the development of citronella essential oil in STP Trenggalek Regency is economically feasible. It is based on:

- **Cost-Benefit Analysis:** Shows that the profits obtained from the development of this business exceed the cost of production, including the initial investment, operational, and processing costs of derivative products. Sani and Fitria (2019) in their analysis use the QSPM method to assess the optimal business development strategy, relevant in this context to ensure the economic feasibility of the citronella business.
- **Return on Investment (ROI):** ROI calculations show a significant return on investment, especially with the diversification of derivative products that have a higher selling value.
- **Environmental and Social Sustainability:** This development meets sustainability criteria by utilizing local resources, creating jobs for local communities, and minimizing waste through the use of citronella waste for animal feed and carbol (Bursatriannyo, 2013). Land conservation efforts through agricultural cultivation also need to be considered to overcome land degradation due to agricultural land conversion (Muraslin, 2020).

The development of citronella essential oil in *Science Techno Park* (STP) has quite prospective potential. This was revealed by Acting Head of UPT TSTP Puji Setyono (54 years old).

"The development of citronella oil is expected to develop with cooperation with farmers in the Science Techno Park (STP) area. In addition, it is hoped that the Office can collaborate with related parties to participate in promoting citronella essential oil products as the flagship product of Trenggalek Regency"

In terms of economic feasibility, the development of citronella essential oil in Science Techno Park, Trenggalek Regency shows positive results. Cost-benefit analysis shows that investments in technology and infrastructure development result in significant increases in productivity and revenue. With the right strategy and adequate support, this business can have a beneficial economic impact on the region and farmers.

The development of citronella essential oil in Science Techno Park, Trenggalek Regency offers significant potential in improving the local economy and exports. This study shows that by implementing optimal strategies such as production process optimization, infrastructure development, human resource training, and effective marketing, these developments can make a substantial contribution to economic growth and the well-being of local communities.

The results of this study also show that the success of the development of citronella essential oil is highly dependent on the synergy between various parties, including the government, industry, academics, and the community. Solid and collaborative support between these parties is needed to overcome existing challenges and maximize existing potential.

Conclusion and Recommendations

The development of citronella essential oil in Science Techno Park, Trenggalek Regency has great potential to have a positive impact on the local economy and exports. This study concludes that the optimal strategy for the development of citronella essential oil in STP Trenggalek Regency includes strengthening the supply chain, innovation of derivative products, increasing the technical capacity of farmers, market diversification, and policy and infrastructure support. Economic evaluations show that these developments are feasible and have the potential to generate significant returns on investment. Environmental and social sustainability is also maintained through good agricultural practices and the use of local resources. Thus, the development of citronella essential oil in STP Trenggalek Regency has bright prospects to increase local economic value and contribute to regional development. In addition, commitment from various parties is needed to ensure the effective implementation of this strategy.

Recommendations for further research and development include:

1. Conducting follow-up studies on the long-term impact of citronella essential oil development on the local economy.
2. Examine the potential for technological innovation in the refining and processing process to improve product quality.
3. Develop a more integrated marketing strategy to expand market share, including international market exploration.

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