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INTRODUCTION

We had the great honor of of 5th International Conference on Engineering, Natural and Social Sciences ICENSOS 2025. It was truly a great pleasure for us to greet a lot of participants from many different countries attending ICENSOS 2025! We firmly believe that the conference will become an important international event in the field of cross-industry discussion about innovations in Academic Studies.

Three cooperating organizations supported the two-day conference. There were 152 papers accepted for presentation at ICENSOS 2025, contributed from different countries. We had plenary speeches and several well-known scientists and experts, to give invited talks at differentsessions.

The purpose of ICENSOS 2025 was to provide a forum for the participants to report and review innovative ideas, with up-to-date progress and developments, and discuss novel approaches to the application in the field of their own research areas and discuss challenges of doing science.

We sincerely hope that the exchange of ideas on doing research, science and improving education will help the participants, and international cooperation sharing the common interest will be enhanced.

On behalf the Organization Committee of ICENSOS 2025, we would like to heartily thank our cooperating organizations for all they have done for the conference. We would also like to thank the authors for theircontribution to the proceedings; the participants and friends of ICENSOS 2025, for their interest and efforts in helping us to make the conference possible; and the Editorial boards for their effective work and valuable advice, especially the ICENSOS 2025 secretariat and the ICENSOS 2025 staff, for their tireless efforts and outstanding services in preparing the conference and publishing the Proceedings.

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Can Lavender (Lavandula angustifolia MILLER.) Production be an Alternative Source of Income for Forest Villagers? Economic Evaluation of Case Study in Safranbolu

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Abstract – Humans have utilized the natural resources in their surroundings to meet their nutritional needs and develop treatments for health issues. Throughout history, plants have served not only as sources of food and medicine but also as cultural, spiritual, and economic assets. Culturing medicinal and aromatic plants offers significant opportunities as an alternative production method, particularly in rural areas. This study examines the economic viability of lavender (Lavandula angustifolia Miller.) cultivation, which has gained popularity among forest villagers in Turkey, who belong to the lowest income group in the country. The research was conducted in the Beştepeler region of Safranbolu district, Karabük province. The study employs the internal rate of return (IRR) as the economic analysis method. The primary data source consists of the revenues and expenditures associated with lavender production in Safranbolu. According to the results of the analysis, the IRR for one hectare of lavender cultivation is 24.12%. This rate corresponds to Turkey's 2019 deposit interest rate, that is, it has a low rate of profitability. These findings suggest that lavender production could serve as an alternative source of income for forest villagers.

Keywords – Forest villagers, Economic analysis, Alternative income, Lavender production, Türkiye

I. INTRODUCTION

Archaeological findings from the early ages demonstrate that humankind's profound relationship with nature, particularly with flora, extends back to antiquity. Utilising the natural resources found in their environment, humans have met their nutritional needs and developed treatment methods for health problems [1]. Furthermore, throughout history, humans have utilised plants for nutritional and therapeutic purposes and employed them as an essential cultural, spiritual and economic resource.

In addition to agricultural production, non-wood forest products obtained from forest resources constitute an essential source of livelihood for people living in these regions. Using medicinal and aromatic plants for culinary purposes, as flavour enhancers in food products, and medicinal and therapeutic applications has a long historical precedent [2].

Producing medicinal and aromatic plants presents significant opportunities as an alternative production method, particularly in rural areas. These plants generate employment in regions characterised by high labour demand and contribute to the augmentation of agricultural earnings. It is important to note that rural areas frequently have livelihoods based on agricultural activities; the production of medicinal and aromatic plants in these areas creates a significant opportunity to support economic growth [3].

The present study poses whether it is economically feasible to cultivate medicinal, aromatic plants, which have the potential to serve as an alternative source of income for forest villagers, who currently occupy the lowest income bracket in Turkey. The economic viability of lavender (Lavandula angustifolia Miller.) cultivation, which is so popular nowadays, was examined in this context.

II. Materials and Method

The study area is in Beştepeler in the Safranbolu district of Karabük province. The elevation of the study area is 1050 meters. The mean temperature of the area ranges from 16 to 20°C from May to July and from 3 to 5°C from November to January. The average rainfall is 50 mm in November-December and 70 mm in May-June [4], [5]. Figure 1 illustrates the geographical location of the study area.

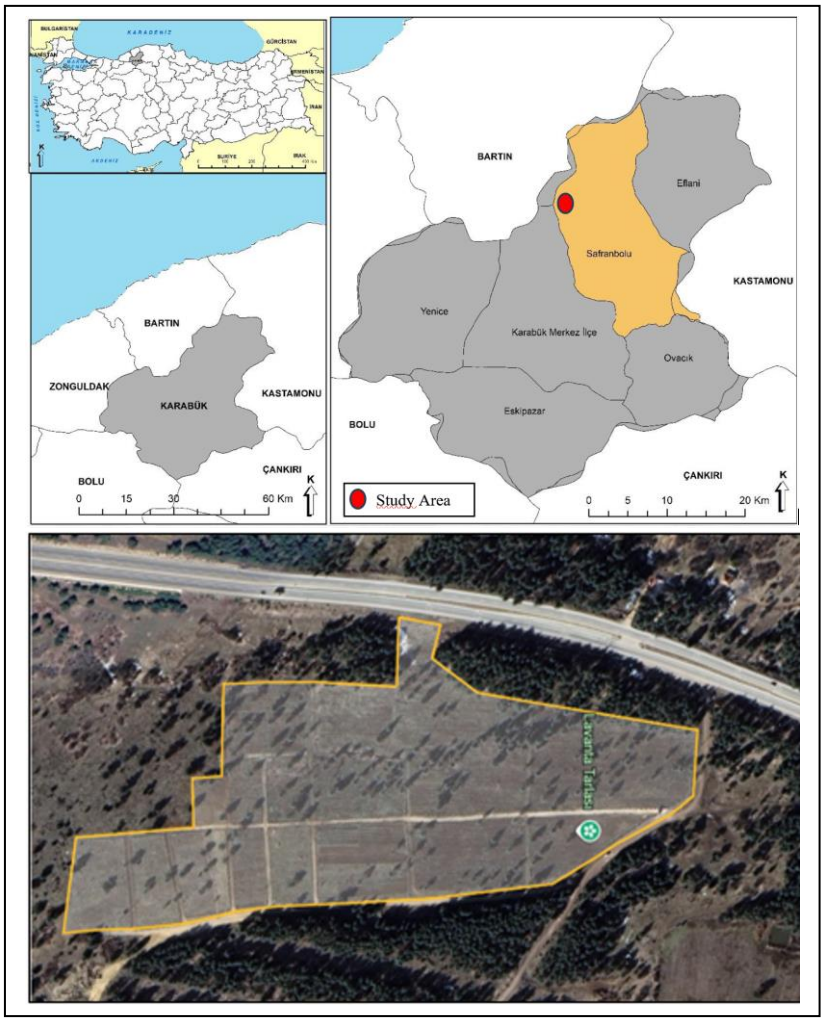

Fig. 1 Geographical location of the study area

The study data comprises the application results of Lavender production in Safranbolu. These data comprise production costs and revenues from product sales between 2019 and 2024.

The present study employed the internal rate of return (IRR) as a methodological framework for economic analysis. This analysis is one of the methods commonly used in the economic evaluation of agricultural investments [6], [7], [8], [9]. The production model under scrutiny involves periodic irrigation, requiring minimal labour, and short-term harvesting activities lasting 10-15 minutes daily during harvest. Consequently, as the activities are undertaken with the existing resources of forest villagers and do not generate additional wages or alternative costs, alternative costs are not calculated in the analyses and are assumed to be zero [10]. Furthermore, given that forest villagers will utilise the

materials in their daily lives and for other works, the costs incurred for agricultural tools were disregarded in the analyses.

IRR is the interest rate that makes the present value of a project's future cash flows equal to the present value of its expenses. It is the rate at which the present value of the revenue generated over the project's life matches the present value of the costs incurred. The IRR is the discount rate that reduces the net present value (NPV) to zero [11], [12]. This interest (or discount) rate is a key factor in calculating this financial criterion.

The method can be formulated as follows (Formula 1):

$$\sum_{t=0}^{n} \frac{G_t}{(1+i_r)^t} = \sum_{t=0}^{n} \frac{M_t}{(1+i_r)^t} \quad (1)$$

G_t = Cash inflows (revenues and benefits) in year t
M_t = Cash outflows (expenses and costs) in year t
$İ_r$= Internal rate of return (IRR).

Analysts typically determine IRR through trial and error. Initially, analysts employ two distinct interest rates to approximate an NPV close to zero, obtaining one positive and one negative value. Thereafter, financial experts utilize two distinct methodologies—arithmetic and analytical—to calculate the IRR [13]. In arithmetic method, the utilized interest rates and the corresponding calculated NPVs are substituted into the interpolation formula described below to determine the IRR (Formula 2).

$$İ_{r=İ_1} + \frac{\mathrm{PNBD}(İ_2 - İ_1)}{\mathrm{PNBD} + |\mathrm{NNBD}|} \quad (2)$$

PNPV : Positive NPV of the project at low discount rate
NNPV : Negative NPV of the project according to high discount rate
$İ_1$: Low discount rate
$İ_2$: High discount rate.

III. RESULTS

The researchers commenced the study in May 2019 and concluded it in June 2024. In this context, they initially cultivated the soil to prepare the area for agricultural production. After completing this preparatory phase, they carried out agronomic operations, including sowing, planting, and protection activities. Following this, they removed the dead cover at specific intervals within the area and harvested the crops at the designated harvest time.

The study area covers an area of 3.5 hectares. After the planting year 2019, workers conducted weeding and hoeing biannually. The area contains 50,000 lavender seedlings planted in 2019. Workers irrigated the area four times per week for three hours. The irrigation period is limited to two months within a season. Analysts calculated the economic analysis for 1 hectare. They based the economic analysis on cost and income data from May and June 2019. The income data reflect the sales prices of essential oils obtained from lavender flowers. Since farmers harvest the same lavender plant for 15 years, analysts determined the project lifetime to be 15. As the harvest amount remains constant after the fifth year, analysts use the same values for harvest and cost amounts from 2024 until the project ends. Depreciation values are absent in the calculations because the accepted value is zero. Because The land value is considered zero, the costs do not include land value. They use the unit price schedule of the General Directorate of Afforestation to determine some costs and use local unit prices for others.

Table 1 presents the income, discounted to April 2019, and the costs, discounted to June 2019, derived from the application results of 1 hectare of lavender production. It also showcases the net cash flow values.

Table 1. Discounted costs, income and net cash flows from lavender production (for 1 hectare)

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Incomes	0,0	0,0	10499,2	16952,9	67422,3	49863,4	49863,4	49863,4	49863,4	49863,4	49863,4	49863,4	49863,4	49863,4	49863,4
Costs	76575,1	8330,6	9451,9	9360,0	12218,9	14039,0	14039,0	14039,0	14039,0	14039,0	14039,0	14039,0	14039,0	14039,0	14039,0
Net cash flow	-76575,1	-8330,6	1047,3	7592,9	55203,4	35824,4	35824,4	35824,4	35824,4	35824,4	35824,4	35824,4	35824,4	35824,4	35824,4

Table 2 shows the results of the economic analysis of the study's IRR calculations.

Table 2. Lavender production NPV and IRR analysis results

i_1 (+)	i_2 (-)	PNPV (TL)	NNPV (TL)	IRR (%)
24	25	410,44	-2943,31	%24,12

IV. DISCUSSION

This study analyzes the economics of lavender cultivation in the Beştepeler area of the Safranbolu district in the Karabük province. The researchers calculated the value of IRR as part of this analysis. They examined the investment values for 1 hectare of lavender production. Their calculation determined that the IRR value for lavender cultivation in 2019 was 24.12%, which matches the deposit interest rate in Türkiye during the same year.

These findings indicate that lavender cultivation has low profitability. Consequently, lavender cultivation emerges as an activity that requires long-term investment commitments. Enhancing the value of essential oil derived from lavender by converting it into high-value-added products such as perfume can increase the profitability of the investment. Furthermore, as the economy stabilizes and deposit interest rates decline, the attractiveness of the investment may improve, making it a more viable option for forest villagers.

Singh & Dhillon (2017) conducted a study in which the internal rate of return for lavender production was 12.72% [14]. This variation of resoults can be attributed to economic differences across countries. In contrast, Güler & Korkmaz (2015) analyzed the economic aspects of lavender species in a study conducted in Isparta, Türkiye, where the internal rate of return was determined to be 22.59% for fresh lavender and 29.24% for dried lavender. Both products yielded returns exceeding the 13.37% prevailing interest rate in 2017. The study concluded that lavender cultivation was economically viable for forest villages in Isparta. Additionally, dried lavender demonstrated a higher price advantage over fresh lavender [15]. These results align with the findings of the present study.

According to the Feasibility Report on Lavender Agriculture and Industry prepared by BAKA (2020), the income, expenses, and investment return period for Lavandin (Lavandula intermedia) cultivation on a 50-decare plot were examined. The report indicated that lavender production offers rapid returns and high income, positioning it as a long-term investment [16]. These findings are consistent, with the results of the present study.

Moreover, areas designated for lavender cultivation contribute to tourism and the service sector due to their aesthetic appeal. Some marrying couples have expressed interest in capturing wedding photographs within the study area, particularly during the flowering season. This phenomenon highlights the economic potential of these areas, not only in medicinal and aromatic plant production but also in rural tourism.

V. CONCLUSION

As a result, this study demonstrates that lavender cultivation yields a low profitability rate, requiring investors to thoroughly assess regional conditions and market potential before making investment decisions.

Producers must prioritize the extraction of aromatic oils to maximize the economic value of harvested products. Packaging these oils in small-scale bottles and selling them directly enhance marketability and secure higher profits. Additionally, they can transform extracted oils and distillation waters into high-

value cosmetic products such as cologne, soap, and perfume, then market these products directly to boost economic returns significantly.

Selecting cultivation areas with easy access, proximity to tourism regions, and closeness to city centres ensures logistical efficiency and leverages agro-tourism opportunities.

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