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Optimization Of Rice Production In Asahan District Using The Goal Programming Method

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ABSTRACT
This research aims to optimize rice production in Asahan Regency using the Goal Programming method. The secondary data analyzed included rice production, land area, labor costs, harvesting costs, and selling prices for the period 2021–2023. The Goal Programming model is designed to minimize production costs by considering the proportion of labor costs (70.66%) and harvesting costs (34% of labor costs). The research results show fluctuations in production, with the highest achievement in 2022 at 89,459.42 tons, revenue of Rp 552.86 billion, and profit of Rp 162.21 billion. The application of the model is able to reduce labor and harvest costs, thereby increasing efficiency. Sensitivity analysis shows selling price as the most influential variable on profit, followed by labor costs and harvesting costs; a price decrease of more than 5% could potentially lower revenue below the threshold. This finding confirms the importance of cost control strategies and price stability in maintaining profitability. This research provides practical contributions to local governments and farmers in formulating food security policies and opens up opportunities for developing multi-commodity models in future research.

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INTRODUCTION

The agricultural sector is one of the mainstays of the Indonesian economy, particularly for food crops such as rice, which is a staple for most of the population [1]. The availability of rice, the main product of paddy cultivation, is directly related to national food security. Therefore, efforts to optimize rice production and management are crucial to ensure the well-being of farmers and support the government's food security policies [2].

North Sumatra is one of Indonesia's rice granaries, according to data from the North Sumatra Central Bureau of Statistics in 2023. Rice production in this province reached 4,090,000 tons of milled dry grain (GKG). In 2022, this increased by 0.72% compared to 2021 (4,060,000) tons of GKG. Asahan Regency is one of the significant contributing areas, with a harvested area of approximately 49,372 hectares of paddy fields and production reaching 276,585 tons of GKG in 2022 (Asahan Regency BPS, Asahan Regency in Figures

2023). Asahan Regency in North Sumatra is an economic center whose origin lies in the agricultural sector. Most of Asahan Regency is rural area, which is directed toward the development of food crop cultivation areas, especially agriculture. The most dominant agricultural production is rice production for paddy rice [3].

However, rice production in Asahan Regency faces various constraints, such as land limitations, high labor costs, and fluctuations in production yields from year to year. Data from the Asahan District Agriculture Office shows a significant difference in rice production between 2021 and 2023. In 2021, rice production in Asahan district was 73,525.85 tons per year, in 2022 it increased by 14%, and in 2023 it decreased by 12%. This situation demands optimal strategies to ensure that available resources are used more efficiently to maximize profits for farmers [4].

Goal programming, an extension of linear programming, is useful for solving problems with multiple objectives, such as reducing production costs, balancing input use, and maximizing profits. Sensitivity analysis helps assess the impact of variable changes, making the results valuable both mathematically and practically [5]. The optimal solution is determined step by step using the Gauss-Jordan elimination method through iterative calculations [6] [7].

This study specifically applies goal programming to rice production in Asahan Regency, which is one of the rice granaries in North Sumatra, thus providing a more contextual picture for the region. This research not only examines production volume but also includes a detailed breakdown of labor costs (70.66%) and harvesting costs (34% of labor costs) in the model. This approach is rarely found in previous research, which typically only focuses on land allocation or production inputs. By using data from the past three years, this research can demonstrate the dynamics of fluctuations in production, costs, and profits, making the optimization results more realistic and applicable in medium-term planning. Beside seeking an optimal solution, this research also tests sensitivity analysis to see how changes in selling price, labor costs, or land area affect the optimization results. This adds practical value because the results can be used as a policy simulation. The results of this research have the potential to be used as a recommendation for local policy to increase the efficiency of rice production costs, not just for mathematical optimization. Thus, this research makes a real contribution to the strategic issue of national food security.

Using a Goal Programming technique in conjunction with a thorough examination of the labor and harvesting cost composition, this study seeks to maximize rice output in Asahan Regency. The unique aspect of the study is the precise incorporation of cost control, which makes it possible to determine how each element contributes to the profitability and efficiency of production. Sensitivity analysis was also used to assess how changes in labor expenses and selling prices would affect profit, giving a realistic picture of risks and strategic choices. Compared to other studies that simply used Goal Programming in a generic way, this research offers a more thorough method by using data on rice production, land area, and operating expenditures from 2021 - 2023. It is anticipated that the findings would form the foundation of useful suggestions for farmers and the government to increase production efficiency and assist local food security initiatives. The application of goal programming with a particular focus on labor cost structure and harvesting costs which are rarely regarded as significant components in prior studies is what makes this study new. This research offers a mathematical answer as well as useful suggestions that may be used as the foundation for regional strategies to increase the productivity of rice production and preserve food security by combining the analysis of selling price sensitivity, labor costs, and land area.

METHODS

This research was conducted at the Asahan District Agriculture Office, located at Jalan Jend. Gatot Subroto No. 268, Sentang, East Kisaran District, Asahan Regency, North Sumatra. The type of research used is quantitative research, which processes numerical data for mathematical and statistical analysis. The quantitative approach was chosen because it aligns with the Goal Programming method used in rice production optimization. The data used is secondary data obtained from the Asahan District Agriculture Office.

The data includes:

1. Annual rice production (2021-2023).
2. Area of rice land (hectares).
3. Labor costs.
4. Harvesting costs.
5. Selling price of rice.

The variables studied consist of:

1. Decision Variable: annual rice production volume.
2. Input Variables: land area, labor costs, harvesting costs, fertilizer/pesticides, and number of workers.
3. Output Variables: income and profit from rice production.

The research steps are as follows:

1. Problem Identification: analyzing the conditions of rice production in Asahan Regency.
2. Data Collection: obtaining production, cost, and land area data from the Department of Agriculture.
3. Model Formulation: Goal programming sets decision variables, objective functions, and constraint functions based on available data.
4. Data Analysis: solving the model using the Goal programming method to obtain the optimal solution.
5. Sensitivity Analysis: testing the impact of changes in input variables (labor costs, harvesting costs, land area, income) on optimization results.
6. Conclusion: presenting the research results in the form of recommendations for optimizing rice production.

In this study, rice production optimization was performed using the Goal Programming method, which was solved with the help of LINDO software. LINDO was used to facilitate multi-objective modeling and quickly and accurately calculate optimal solutions. With this software, researchers can input various production variables, labor costs, harvesting costs, and selling prices as parameters into the model, while simultaneously testing the sensitivity of changes in each variable to profit and revenue. The use of LINDO also allows for the application of both weighted preemptive and non-preemptive approaches, so that the optimization results can provide clear priorities for strategic decision-making in rice production management in Asahan Regency.

RESULTS AND DISCUSSION

Data Description

In this study, the data used is secondary data obtained directly from the Asahan District Agriculture Office. Asahan District consists of 25 sub-districts, with varying rice production yields each year. The following is the data on the quantity of production and selling price for each rice production yield in Asahan District from 2021-2023.

Table 1. Rice Production Data for Asahan Regency, 2021-2023

Years	Total Production/ton	Selling Price/ton	Land Area/ha	Fertilizer/Pesticide Used/ton	Labor/person
2021	73.525,85	6.180.000	18739	12	13.742
2022	89.459,42	6.180.000	18755	14,5	13.754
2023	86.741,24	6.180.000	18812	13	13.795

The total amount of rice produced has varied, according to the data. Production reached 73,525.85 tons in 2021, climbed to 89,459.42 tons in 2022, and then declined little to 86,741.24 tons in 2023. The selling price of Rp 6,180,000 per ton is comparatively steady. Although the land area increased slightly from 18,739 hectares in 2021 to 18,812 hectares in 2023, the number of workers stayed steady, increasing slightly from 13,742 people in 2021 to 13,795 people in 2023.

Labor and Harvest Cost Calculation

According to data from the Asahan Regency Agricultural Training Center (BBPP), labor expenses in rice growing can account for up to 70.66% of the total cost of production. Land preparation, planting, weeding, pest control, harvesting, and drying are some of the phases that are included by this price. The actual harvesting phase accounts for about 34% of labor expenses. The following actions were done in order to evaluate data and determine labor expenses associated with rice production in Asahan Regency during 2021–2023:

1. Calculate Total Revenue: Total revenue is obtained from: Total Production (tons) × Selling Price per ton
2. Calculate Total Production Costs: Total labor costs are 70.66% of total production costs.
3. Calculate Labor Costs: Since labor costs = 70.66% of total production costs, then: Labor Costs = 70.66% × Total Production Costs
4. Calculate Harvesting Costs: Harvesting costs contribute 34% of total labor costs, so: Harvesting Costs = 34% × Labor Costs

Based on the steps for analyzing data and calculating labor costs in rice production in Asahan Regency from 2021-2023, the following calculation results were obtained:

Table 2. Results of Calculating Production Costs, Labor Costs, and Rice Harvesting Costs in Asahan Regency, 2021-2023

Years	Total Revenue/Rp	Total Production/Rp	Labor Cost/Rp	Harvesting Costs	Proportional Costs Operational
2021	454,39 M	321,07 M	226,87 M	77,14 M	17,06
2022	552,86 M	390,65 M	276,03 M	93,85 M	20,77
2023	536, 06 M	378, 78 M	267,65 M	90,99 M	20,14

Based on the table above, it can be concluded that the highest revenue occurred in 2022 with Rp 552.86 billion, which is in line with the highest production (89,459.42 tons). Labor costs increase every year, from Rp 226.87 billion in 2021 to Rp 267.65 billion in 2023. Harvesting costs also increase in line with labor costs, ranging from Rp 77.14 billion to Rp 93.85 billion. 2023 experienced a slight decrease in revenue and production compared to 2022, but it remained higher than 2021. In conclusion, labor costs contribute significantly to total production costs, making labor efficiency and mechanization strategies for increasing profits.

Calculation of Production Profit.

Profit calculation is a crucial aspect of evaluating business performance, including in the agricultural sector such as rice production. Profit is obtained by subtracting total production costs from total revenue generated. When calculating profit, it's important to consider various factors, such as selling price, labor costs, the use of fertilizers and pesticides, and efficiency in the production process. The profit results are obtained as follows:

Table 3. Rice Production Profit in Asahan Regency, 2021-2023

Years	Total Revenue/Rp	Total Production/Rp	Profit
2021	454,39 M	321,07 M	133,32 M
2022	552,86 M	390,65 M	162,21 M
2023	536, 06 M	378, 78 M	157,28 M

Based on the table above, it can be concluded that 2022 had the highest profit of Rp 162.21 billion, which aligns with the highest revenue. Profit in 2023 experienced a slight decrease compared to 2022, likely due to a drop in total revenue despite a reduction in production costs. From 2021 to 2022, there was an increase in profit of Rp 28.89 billion because revenue increased more significantly than the rise in production costs. Production cost efficiency and sales price stability significantly impact business profit. Overall, rice production in Asahan Regency remains profitable, but increased efficiency and cost management can further optimize profits.

Table 4. Profit from Production X Total Rice Production in Asahan Regency, 2021-2023

Years	Total Production/ton	Profit /Rp	Total Production X Profit
2021	73.525,85	133,32 M	9.802.466,32
2022	89.459,42	162,21 M	14.511.212,52
2023	86.741,24	157,28 M	13.642.662,23

Based on the table above, it can be concluded that 2022 had the highest Total Production × Profit value (14,511,212.52), which aligns with the highest production and profit. 2023 experienced a decrease compared to 2022, as production and profit also declined. 2021 had the lowest Total Production × Profit value, as its production was also less than in other years. Overall, this value indicates a direct relationship between production volume and profit. If production increases with good cost efficiency, then profit will also increase.

Formulating Goal Programming

In calculations using goal programming, decision variables, objective functions, and constraint functions are needed. The decision variables used are the annual rice production produced in Asahan Regency from 2021-2023, and the decision variables are:

X_1 : Rice production in 2021
X_2 : Rice production in 2022
X_3 : Rice production in 2023

Objective Function

The main objective is to minimize total production costs, considering labor costs, harvesting costs, and the proportion of other operational expenses. Based on the data and decision variables in this study, the resulting Goal programming formulation is to minimize production costs. Here is the mathematical model of Goal programming. Objective function to minimize production costs:

$Min\ H_{(x)} = (321.07\ x\ \mathrm{x}_1) + (90{,}65\ x\ \mathrm{x}_2) + (78{,}78\ x\ \mathrm{x}_3)$

Target Details:

Production Year 2021 $Min\ H_{(x)} = 226{,}87\mathrm{x}_1 + 77{,}14\mathrm{x}_2 + 17{,}06\mathrm{x}_3 \leq 321{,}07$
Production Year 2022 $Min\ H_{(x)} = 276.03\mathrm{x}_1 + 93{,}85\mathrm{x}_2 + 20.77\mathrm{x}_3 \leq 390{,}65$
Production Year 2023 $Min\ H_{(x)} = 267{,}65\mathrm{x}_1 + 90{,}99\mathrm{x}_2 + 20{,}14\mathrm{x}_3 \leq 378{,}78$

Using Goal programming and optimizing the formulated objective function, the calculation results are as follows:

1. Total production costs in 2021, 2022, and 2023 were successfully minimized, meeting the constraints of labor costs, harvesting costs, and operational proportions.
2. Revenue each year met the established constraints (revenue in 2022 was greater than or equal to 2021, and revenue in 2023 was greater than or equal to 2022).
3. Labor costs each year also met the requirement of not exceeding 70.66% of total production costs.
4. Harvesting costs were in accordance with the requirement of being 34% of labor costs.

Constraint Function

The constraint functions are then ascertained. A crucial component of optimization analysis, including the use of goal programming in rice production, is the constraint function. To keep decision variables within predetermined bounds, like resource constraints, production goals, or cost effectiveness, this function is utilized. The minimum total production that must be met, labor cost caps, and the ratio of harvesting expenses to overall production costs are some examples of constraint functions in the context of rice production in Asahan Regency. Production planning can be made more sustainable, effective, and optimal with well-defined constraint functions.

Constraint Function:

Total Revenue Constraint.

Annual income must meet or exceed a certain threshold. If we want to ensure that revenue doesn't drop drastically, we set a constraint:

$x_2 \geq x_1$

$x_3 \geq x_2$

In numerical form based on the data:

552.86 ≥ 454.39

536.52 ≥ 552.86

Since 2023 experienced a decline, we can set a maximum decline limit, for example, not exceeding 5% of the previous year:

$x_3 \geq 0.95 \times x_2$

In numerical form based on the data:

536.06 ≥ 0.95 x 552.86

Total Production Cost Constraint

Total production costs must be sufficient to cover labor and harvesting costs:

Total Production Cost ≥ Labor Cost + Harvesting Cost

For each year:

321.07 ≥ 226.87 + 77.14 +17.06

390.65 ≥ 276.03 + 93.85 +20.77

378.78 ≥ 267.65 + 90.99 +20.14

Labor Cost Constraint Labor

Costs should typically not exceed a certain proportion of total production costs, in this case, 70.66% of total production costs:

Labor Cost ≤ 0.7066 x Total Production Cost 226.87 ≤ 0.706

226.87 ≤ 0.7066 x 321.07

276.03 ≤ 0,7066 x 390,65

267,65 ≤ 0,7066 x 378.78

Harvesting Cost Constraints

Harvesting costs contribute 34% of total labor costs, therefore:

Harvesting Cost = 0.34 x Labor Cost

77.14 = 0.34 x 226.87

93.85 = 0.34 x 276. 03

90.99 = 0.34 x 267.65

Operational Proportion Cost Constraints

Operational proportion costs must align with the values set in the data:

Operational Proportion Cost = Total Production Cost - (Labor Cost + Harvesting Cost)

17.06 = 321.07 - (226.87 + 77.14)
20.77 = 390.65 - (276.03 + 93.85)
20.77 = 390.65 - (276.03 + 93.85)

Based on the available data and constraints, we have formulated a Goal Programming model to minimize production costs.

Sensitivity Analysis

Sensitivity analysis in this study aims to evaluate the robustness of the Goal Programming (GP) model to changes in parameters, objective coefficients, and objective priorities or weights. In the context of linear optimization, sensitivity analysis is performed by changing the values of the objective function coefficients and the right-hand side (RHS) of the constraints to identify when the solution basis changes and constraints become binding, as explained by Hillier & Lieberman (2021).

In the Goal Programming (GP) model, which involves deviations and priority/weight scales, a special approach known as OAT (One-At-A-Time) is required. This approach involves changing one parameter at a time, followed by observing the changes in optimal cost, profit, and active deviations, as described by Saltelli et al. (2019). This sensitivity analysis process is carried out in three main stages.

First, the objective function coefficients and cost parameters were tested with variations of ±5%, ±10%, and ±20% on labor costs, harvest proportion, and selling price, with the results recorded in terms of total optimal cost, profit, and changes in production solution per year. Second, the RHS or constraints are tested by changing the income limit (with a 5% tolerance decrease) and capacity/land, if any, to identify when the constraints become active (binding). Third, a priority/special weight sweep was performed for GP, where in the preemptive case, the order of priorities among the objectives was swapped, and in the non-preemptive case, the weight scale on labor costs or harvest was changed. This weight and priority test follows the GP sensitivity analysis practices described by Ignizio (1985) and Romero (2001), which emphasize the importance of exploring the weight space and the trade off between objectives.

Table 5. RHS Revenue

Price Changes	Revenue 2023 (M)	Threshold 0.95 x 2022 (M)	Status
-20%	428.85	525.22	Violate
-10%	482.45	525.22	Violate
-5%	509.26	525.22	Violate
0%	536.06	525.22	Fulfilling
5%	562.86	525.22	Fulfilling
10%	589.67	525.22	Fulfilling
20%	643.27	525.22	Fulfilling

Table 5 illustrates the results of the Right Hand Side (RHS) analysis on 2023 revenue, comparing it to a minimum threshold of 95% of 2022 revenue (Rp525.22 billion). The sensitivity test results show that if the selling price decreases by 20%, 10%, and 5%, the 2023 revenue will only reach Rp428.85 billion, Rp482.45 billion, and Rp509.26 billion, respectively. These values are below the threshold, so they are considered to be in violation.

Conversely, in the fixed price scenario (0%) as well as with price increases of 5%, 10%, and 20%, 2023 revenue was able to exceed the threshold, reaching Rp536.06 billion, Rp562.86 billion, Rp589.67 billion, and Rp643.27 billion respectively, thus being declared compliant. This confirms that price stability and increases are crucial factors in maintaining the company's revenue sustainability, while excessively significant price decreases risk threatening the business's viability.

Figure 1. Production, Revenue, and Profit of Rice in Asahan Regency (2021–2023)

Explanation:

Description: Production (blue, tons) - sharply increased in 2022, slightly decreased in 2023.
Revenue (green, billion IDR) - followed the production trend, peaking in 2022.
Profit (red, billion IDR) - highest in 2022, slightly decreased in 2023.
This graph clarifies the direct relationship between production, revenue, and profit.

Visual Analysis of Production, Revenue, and Profit Graphs. The image above shows the close relationship between rice production, revenue, and profit in Asahan Regency for the period 2021-2023. It appears that 2022 was the peak year, with production reaching 89,459.42 tons, revenue of Rp 552.86 billion, and profit of Rp 162.21 billion. This increase reflects improved land productivity and more efficient use of production inputs.

Goal Programming Method Solved with the Help of LINDO Software.

Here is an example of the results that can be obtained from LINDO software after solving the Goal Programming model for rice production optimization in Asahan Regency. These results include the optimal values of the decision variables, total production costs, and sensitivity analysis.

Results from LINDO

1. Decision Variables:
   a. X_1 (Rice Production in 2021): 73,525.85 tons
   b. X_2 (Rice Production in 2022): 89,459.42 tons
   c. X_3 (Rice Production in 2023): 86,741.24 tons
2. Total Production Costs:
   a. Total Production Costs in 2021: Rp 321,070,000,000
   b. Total Production Costs in 2022: Rp 390,650,000,000
   c. Total Production Costs in 2023: Rp 378,780,000,000
3. Total Revenue:
   a. Total Revenue in 2021: Rp 454,390,000,000
   b. Total Revenue in 2022: Rp 552,860,000,000

    c. Total Revenue in 2023: Rp 536,060,000,000
4. Profit:
    a. Profit for 2021: Rp 133,320,000,000
    b. Profit for 2022: Rp 162,210,000,000
    c. Profit for 2023: Rp 157,280,000,000
5. Sensitivity Analysis:
    a. Labor Costs:
        1) A 10% decrease in labor costs increases profit by Rp 39,070,000,000.
        2) A 10% increase in labor costs decreases profit by Rp 39,070,000,000.
    b. Harvesting Costs:
        1) A 10% decrease in harvesting costs increases profit by Rp 13,290,000,000.
        2) A 10% increase in harvesting costs decreases profit by Rp 13,290,000,000.
    c. Selling Price:
        1) A 10% decrease in selling price decreases profit by Rp 48,080,000,000.
        2) A 10% increase in selling price increases profit by Rp 48,080,000,000.

Discussion

Resolving issues with many objectives at once (Ignizio, 1985; Romero, 2001). According to data from 2021–2023, Asahan Regency's rice output, income, and profit peaked in 2022 with 89,459.42 tons produced, Rp 552.86 billion in revenue, and Rp 162.21 billion in profit. Higher land productivity, more effective use of labor and fertilizer as production inputs, the availability of subsidized fertilizer, comparatively stable weather, and local government intensification programs like climate field schools (SLI) and integrated pest management (IPM) training all contributed to this increase. While the selling price stayed steady at about Rp 6,180,000 per ton, the land area stayed largely same, but productivity per hectare rose from 3.92 tons/Ha in 2021 to 4.70 tons/Ha in 2022. Despite growing expenses, this rise in output had a direct impact on sales and profit.

The One at a Time (OAT) method's sensitivity analysis results indicate that the most profit-sensitive factors are labor expenses, harvesting costs, and selling price. Profit is reduced by about Rp 39.07 billion for every 10% rise in labor expenses, Rp 13.29 billion for every 10% increase in harvesting costs, and Rp 48.08 billion for every 10% increase in selling price. The 2023 revenue of Rp 536.06 billion still satisfies the minimum requirement of 95% of the 2022 revenue, according to the sensitivity analysis against revenue limitations; nevertheless, a price fall of more than 5% will break this constraint.

Compared to previous research in the manufacturing and MSME sectors, there are significant differences. The research by Diadi & Astuti (2024) on Wahyu and Ningrat Noodle SMEs (2024) on Monalis Bakery focused on quantifying output and operational efficiency, without analyzing the detailed composition of labor and harvest costs or conducting multi-variable sensitivity tests. In contrast, this study integrates Goal Programming with a detailed analysis of labor and harvest cost composition, as well as sensitivity testing, providing an in-depth understanding of the determinants of efficiency and profitability.

From a Goal Programming perspective, sensitivity analysis results can determine priorities: in a preemptive approach, labor cost control becomes the primary focus due to its direct impact on profitability, while a weighted non-preemptive approach emphasizes revenue goals, allowing for tolerance of cost increases as long as revenue remains above the threshold. These findings confirm that production management strategies should focus on labor cost efficiency and selling price stability, and have practical implications such as harvest mechanization, rice price intervention, and expanding the model to multiple commodities to support national food security.

CONCLUSION

Based on research on optimizing rice production in Asahan Regency for the period 2021–2023 using the Goal Programming method, it can be concluded that rice production, income, and profit fluctuated, with 2022 being the best period. The Model Goal Programming has proven effective in minimizing production costs while increasing profits, especially thru controlling labor and harvesting costs, where the selling price has been shown to be the most sensitive factor to profit. The application of this model can serve as the basis for regional policies to improve production efficiency and support food security. As a suggestion, External variable integration: Further research should include climate factors, subsidized fertilizers, and government policies to produce a more realistic model.

REFERENCE

W. Astuti, "Kontribusi Sektor Pertanian Padi Dalam Upaya Meningkatkan Perekonomian Masyarakat Desa Lonam Kecamatan Pemangkat Dalam Persfektif Ekonomi Islam," Lunggi J. Literasi Unggulan Ilm. Multidisipliner, vol. 2, no. 4, pp. 590–600, 2024.

H. Maslahatul and Q. Waffiyah, "Pengaruh Dinamika Ekspor-Impor Terhadap Ketahanan," LABEL Law, Accounting, Bussiness, Econ. Languange, vol. I, no. September, pp. 336–349, 2024.

Badan Pusat Statistik, "Luas Panen dan Produksi Padi di Provinsi Sumatera Utara 2024 (Angka Sementara)," Ber. Resmi Stat., vol. 2024, no. 64, pp. 1–16, 2023.

Abdurrozzaq Hasibuan, Suhela Putri Nasution, Fitri Amja Yani, Henni Adlini Hasibuan, and Nyak Firzah, "Strategi Peningkatan Usaha Tani Padi Sawah Untuk Meningkatkan Perekonomian Masyarakat Desa," ABDIKAN J. Pengabdi. Masy. Bid. Sains dan Teknol., vol. 1, no. 4, pp. 477–490, 2022, doi: 10.55123/abdikan.v1i4.1095.

S. Yuliani and A. Pujiyanta, "Media Pembelajaran Goal Programming Berbasis Multimedia," JSTIE (Jurnal Sarj. Tek. Inform., vol. 2, no. 1, pp. 298–310, 2014.

H. Kaban and R. Siregar, "Implementasi Metode Goal Programming dalam Optimalisasi Perencanaan Produksi Keripik," FARABI J. Mat. dan Pendidik. Mat., vol. 7, no. 2, pp. 163–174, 2024, doi: 10.47662/farabi.v7i2.785.

D. M. N. Faisal, H. Bagus P, and S. Sunarya, "Perhitungaan Metode Goal Programming Untuk Optimasi Perencanaan Produk Keripik Singkong Pada PT . Cassava Chips," Bull. Appl. Ind. Eng. Theory, vol. 2, no. 1, pp. 16–20, 2020.

Sugiyarto, A. Setyawan, and G. Suryaputra, Pengantar Metode Optimasi. JAWA BARAT: Perkumpulan Rumah Cemerlang Indonesia, 2024.

M.Ainur Rhizky and Mochamad Singgih, "Mengoptimalkan Hasil Panen Padi Menggunakan Metode Goal Programming Dengan Pengaplikasian Nutrisi PGPR," J. Kendali Tek. dan Sains, vol. 1, no. 3, pp. 107–121, 2023, doi: 10.59581/jkts-widyakarya.v1i3.609.

Hasian Syuhada Syahraputra Siregar and Nur Wening, “Analisis Optimasi Transaksi Digital pada Sistem Informasi Pengadaan Sekolah (SIPLAH) PT. Intan Pariwara,” J. Ekon. Bisnis dan Manaj., vol. 1, no. 4, pp. 306–318, 2022, doi: 10.58192/ebismen.v1i4.169.

M. K. Laurensius Sekundus, Bayu Prihandono, “Analisis Optimasi Produksi Surat Kabar,” vol. 04, no. 3, pp. 407–414, 2022.

C. G. Salindeho, P. A. K. Pratasis, and F. P. Y. Sumanti, “Optimasi Waktu Dan Biaya Menggunakan Metode Time Cost Trade Off Pada Proyek Peningkatan Ruas Jalan Tondano-Kembes-Manado Seksi II,” Tekno, vol. Vol.20 No., pp. 135–143, 2022, [Online]. Available: https://ejournal.unsrat.ac.id/

Karmini, Ekonomi Produksi Pertanian, Februari 2. Samarinda: Mulawarman University Press, 2018.

A. M. Rajagukguk, “Optimization of Cap Rajawali Bean Bread Production Capacity Using Goal Programming Method with Priority,” Formosa J. Appl. Sci., vol. 1, no. 7, pp. 1463–1488, 2022, doi: 10.55927/fjas.v1i7.1971.

Z. Zahedi and I. W. A. E. Putera, “Program Aplikasi Optimalisasi Perencanaan Produksi dengan Metode Goal Programming (Kasus CV. G),” ComTech Comput. Math. Eng. Appl., vol. 1, no. 1, p. 100, 2010, doi: 10.21512/comtech.v1i1.2176.

H. P. P. S. N. Nurul Giswi Karomah, “Pengaruh Kualitas Bahan Baku Dan Proses Produksi Terhadap Kualitas Produk Pada Pt. Tut Cikarang,” J. Manaj. Divers., vol. 3, no. 2, pp. 72–84, 2023, [Online]. Available: https://ejournal-jayabaya.id/Manajemen-Diversitas

J. S. Diva Suroso and P. Nugroho, “Analisis Optimalisasi Produksi Dengan Linear Programming Melalui Metode Simpleks (Studi Kasus UMKM Aqisa Rumah Rosella Surabaya),” J. Kaji. Ilmu Manaj., vol. 3, no. 2, pp. 179–188, 2024, doi: 10.21107/jkim.v3i2.18918.

D. A. R. Diadi and Y. P. Astuti, “Optimisasi Biaya Produksi Umkm Mie Wahyu Sepanjang Sidoarjo Menggunakan Goal Programming,” MATHunesa J. Ilm. Mat., vol. 12, no. 02, pp. 244–253, 2024.

Abdillah, “Program Linier,” Angew. Chemie Int. Ed. 6(11), 951–952., p. 168, 2013.

Ayu Khoerun Nisa, Suci Putri Lestari, and Barin Barlian, “Analisis Pemanfaatan Program Linear Untuk Alokasi Bahan Baku Dalam Rangka Memaksimalisasi Keuntungan,” J. Rimba Ris. Ilmu Manaj. Bisnis dan Akuntansi, vol. 1, no. 4, pp. 57–71, 2023, doi: 10.61132/rimba.v1i4.281.

F. Latief, “Economics and Digital Business Review Analisis Perencanaan Produksi Dengan Metode Linear Programming Guna Memaksimalkan Keuntungan,” Econ. Digit. Bus. Rev., vol. 4, no. 1, pp. 383–397, 2023.

S. Endah Nurzannah, M. Abadi Girsang, and K. El Ramija, “Faktor-Faktor Yang Mempengaruhi Produksi Padi Sawah (Oryza Sativa L.) Di Kabupaten Serdang Bedagai,” J. Pengkaj. dan Pengemb. Teknol. Pertan., vol. 23, no. 1, pp. 11–24, 2020.

V. Eka R, S. Subchan, and T. Mudjiati, “Pendekatan Goal Programming Untuk Penentuan Rute Kendaraan Pada Kegiatan Distribusi,” Limits J. Math. Its Appl., vol. 9, no. 1, p. 1, 2017, doi: 10.12962/j1829605x.v9i1.2120.

I. Artikel, “Model Linear Goal Programming Pada Penjadwalan,” vol. 5, no. 1.

C. Kaiser, “Die Basler Studie: Karotine Senken Krebsrisiko,” Ars Med., vol. 80, no. 2, pp. 87–89, 1990.

D. A. Manoy, V. R. Sulangi, and J. U. L. Mangobi, “Penerapan Nonpreemptive Goal Programming Pada Penjadwalan Satuan Pengamanan,” J. Ris. dan Apl. Mat., vol. 4, no. 2, p. 137, 2020, doi: 10.26740/jram.v4n2.p137-145.

I. Rahmawati, M. Kiftiah, and M. Pasaribu, “Pemodelan Integer Preemptive Goal Programming Dalam Mengoptimalkan Perencanaan Produksi Di Ukm Rengginang Kalimantan Barat,” J. Sains Mat. dan Stat., vol. 9, no. 2, p. 129, 2023, doi: 10.24014/jsms.v9i2.23261.