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Goat Livestock Production Planning Using The Goal Programming Method (Case Study: Living Lab Glugur Rimbun, Sampecita Village, Kutalimbaru District)

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ABSTRACT

This study was conducted to predict the planning of PE goat livestock production in the Al Amin Science and Industrial Park (Living Lab) Area, Glugur Rimbun, Sampecita Village, Kutalimbaru District, Deli Serdang Regency. The method used to predict livestock production planning using Sensitivity Analysis with the Goal Programming Method. The data used is data from Tharaya Farm which has the same management concept as PE goat livestock in the Al Amin Science and Industrial Park (Living Lab) Area, Glugur Rimbun, Sampecita Village, Kutalimbaru District, Deli Serdang Regency later. In this study, the research variables are processed products from goat livestock in the form of goat milk and goat meat. Product A (Goat Milk) requires 30 hours of processing time and product B (Goat Meat) for 20 hours with profits of Rp 400,000 and Rp 800,000, respectively. The results of the study indicate that the profit target can be increased by goat farmers by Rp 1,400,000, - by maximizing the production of at least 2 products for each variable.

Keyword : Production Planning; Sensitivity Analysis; Goal Programming

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INTRODUCTION

In a goat breeder, especially an industrial goat breeder, sometimes several problems are difficult to solve simply, but every goat breeder has the desire to achieve the goal of getting optimal results with limitations in the form of raw materials, equipment, machines, time, costs, and labor. To meet the desired goals of goat breeders, production planning is needed. Production planning is a function of the management system, where in the planning the efforts and actions that need to be taken by goat breeders to achieve their goals are determined. The advantages of the management system that has been applied to several industrial goat breeders have made these goat breeders grow rapidly along with consumer needs and demands. According to Chowdary and J. Slomp (2002), in making a production plan three elements need to be considered, namely consumers, products, and manufacturing processes, these three problems are very complex and must be faced by every industrial goat breeder.

Goal Programming is an extension of linear programming and is a tool in operations research that is considered effective for solving problems in decision-making. According to (Rangkuti. A, 2013) Goal Programming is a technique for analyzing and creating solutions to problems that involve many goals. This technique provides an opportunity for decision-makers to involve various goals that are always in conflict with the formulation process and goal priorities. As one of the tools in operations research that plays an important role in decision making, Goal Programming is considered appropriate for solving problems in a goat farmer, because it contains problem-solving techniques that are based on the uniqueness of the solution discovery process so that it can not only solve problems correctly but also produce optimal solutions.

In addition, sensitivity analysis certainly plays an important role in achieving production planning for a goat farmer, where the aim is to see changes in parameters to the optimal solution that has been obtained using Goal Programming in the sense that sensitivity analysis in goat farmers is generally used to determine how much

influence changes in the price of products produced without reducing or increasing the production of these products have on the income obtained through analysis of changes in the coefficient of the objective function. The analysis of changes in the right-hand value constant in the constraint function aims to determine how much influence changes in the resources owned and indirectly affect the change in the number of products produced on income.

Forecasting Production planning in this study is a forecast of PE goat livestock product planning. This forecast aims to simulate the description of PE goat livestock production planning that will be built in the Al Amin Science and Industrial Park (Living Lab) Area, Glugur Rimbun, Sampecita Village, Kutalimbaru District, Deli Serdang Regency. This forecast is an initial step in analyzing a business that will be run by taking into account the actual production planning data from PE goat livestock businesses that have been producing and have similarities in certain conditions.

THEORETICAL BASIS

Linear programming is a method for making decisions between various alternative activities when the activities are limited by certain activities. The decision to be taken is stated as an objective function, while the constraints faced in making the decision are stated in the form of constraint functions (Rangkuti. A., 2013). Goal programming is an extension of linear programming that can solve problems with multiple objectives through deviation variables. Deviation variables are deviations that occur above or below the target. The deviation variable is used to assess the optimality of a goal (Putri E. Yunitasari et al., 2017).

According to (Putri E. Yunitasari et al., 2017) sensitivity analysis is an analysis tool used to determine changes in parameters so that the solution remains optimal. In sensitivity analysis, parameter changes can be made to:

1. Objective function coefficient
2. Right-hand side constant of the constraint function
3. Constraint function

Sensitivity analysis is designed to determine the effect of changes in linear programming problem parameters on optimal solutions. The ultimate goal of this analysis is to obtain information about the new optimal solution (Rangkuti. A., 2013).

RESEARCH METHOD

The type of research used in this study is descriptive quantitative research. Descriptive quantitative research is a study aimed at describing existing phenomena, which are taking place at present or in the past. This study uses real data sourced from the Tharaya Farm livestock business. The Tharaya Farm Goat Livestock Business has certain conditions in common such as the same type of goat. In addition, the goat products (processed) produced from the Tahraya Farm livestock business are also diverse such as Goat Milk, Goat Yogurt, Aqiqah Meat, and processed dishes made from goat meat from the livestock business. So that Tharaya Farm can describe the conditions of the Al Amin Science and Industrial Park (Living Lab) Glugur Rimbun Area, Sampecita Village, Kutalimbaru District, Deli Serdang Regency in the future.

This research was conducted in the Al Amin Science and Industrial Park (Living Lab) Glugur Rimbun Area, Sampecita Village, Kutalimbaru District, Deli Serdang Regency. Deli Serdang from November 2023 to April 2023. The data collection methods used in this study are as follows:

1. Observation, namely by visiting the research location in the Al Amin Science and Industrial Park (Living Lab) Area, Glugur Rimbun, Sampecita Village, Kutalimbaru District, Deli Serdang Regency.
2. Conducting an excursion study to the Tharaya Farm goat farming business to then collect the data needed to obtain production planning that will be implemented in the Al Amin Science and Industrial Park (Living Lab) Area, Glugur Rimbun, Sampecita Village, Kutalimbaru District, Deli Serdang Regency.
3. Taking literature study data as consideration and reference in analyzing PE goat farming production planning.

Interviews, namely by conducting direct interviews with experts (professionals) in the field of PE goat farming. The data to be collected are:

1. Primary data, namely data sourced from direct interviews with experts (professionals) in the field of PE goat farming related to this research.
2. Secondary data, namely data sourced from literature studies related to this research.
   The secondary data to be collected are:
   a. The amount of main ingredients needed
   b. Working hours per day
   c. Goat Business Capital
   d. Production Time for each Dependent Variable
   e. Selling Price for each Dependent Variable
   f. Employee Wages

a) Goal Programming Method
The steps for solving goal programming problems using the simplex method are as follows:

1. Create an initial simplex table.
2. Determine the pivot column by selecting the maximum value or the largest positive value in the $cj - Zj$ row. If $cj - Zj > 0$, continue to the next iteration, but if $cj - Zj \leq 0$ then the iteration is stopped.
3. Determine the ratio or θi by dividing the elements in the bi column by the elements in the pivot column.
4. Select the smallest positive value in the θi column to determine the pivot row. The row that shows the smallest positive value in the θi column is the pivot row.
5. Determine the pivot element, which is the intersection between the pivot column and the pivot row.
6. Change the decision variables in the pivot row with the decision variables in the pivot column, and change all elements in the pivot row by dividing them by the pivot element.
7. Change the values in other rows (outside the pivot row) using the OBE approach (elementary row operations) where the new row values are the same as the old row values minus the values in the new key row that have been multiplied by the key column coefficient in the initial row.

RESULTS AND DISCUSSION

According to (Putri E. Yunitasari et al., 2017) the elements used in goal programming are as follows:

1. Decision variables are variables that completely describe the decisions to be made and are usually symbolized by xj (j = 1,2, ..., n).
2. Right-hand side values are values that indicate the availability of resources that will be determined as lacking or over-utilized, usually symbolized by bi.
3. Deviation variables are variables that indicate the possibility of deviations from a right-hand side value of the goal constraint (right-hand side values).

According to Siswanto (2007), the general form of the goal programming model is as follows:

Minimize :

$$Z = \sum_{i=1}^{m} (\eta_i + \rho_i)$$

With Constraints :

$$\sum_{j=1}^{n} (a_{ij} x_j) + \eta_i - \rho_i = b_i \quad \text{untuk } i = 1,2,3,\dots,m$$

$$x_j, \eta_i, \rho_i \geq 0 \quad \text{untuk } j = 1,2,3,\dots,n$$

Description:
Z : objective function for which the magnitude of the deviation value is sought (minimum)
xj : level of activity nth (decision variable)
aij : parameter of constraint function to-i required for decision variable to-j
bi : capacity of resource or nth target
ηi : magnitude of negative deviation value towards target achievement
ρi : magnitude of positive deviation value towards target achievement.

Case Study:

Goat Farm which has processed products from goat farming, produces 2 types of products, namely Goat Milk symbolized as product A, and Goat Meat symbolized as product B. Each product requires time to be handled in 2 processes, namely process I and process II. Product A requires 20 hours in process I and 10 hours in process II. Product B requires 10 hours in process I and 10 hours in process II. Each process has a limited time capacity, process I has a time limitation of up to 60 hours, and Process 2 has a time limitation of up to 40 hours. If the goat farmer gets a profit from each type of product respectively Rp. 400,000 and Rp. 800,000, then what is the maximum profit obtained when the goat farmer targets Rp. 1,000,000 with a minimum production of 2 units for each type of product.

Solution:

Decision variables: $x1$ = product A, $x2$ = product B,

The form of the linear programming model for the problem above is as follows:

Maximize:

$$Z = 400.000x_1 + 800.000x_2$$

Constraint :

$$20x_1 + 10x_2 \leq 60$$
$$10x_1 + 10x_2 \leq 40$$
$$x_1, x_2 \geq 0$$

Because the constraint function is in the form of an inequality (≤), the constraint function is changed into an equation (=) by adding a slack variable, so that we obtain:

Maximize:

$$Z = 400.000x_1 + 800.000x_2 + 0x_3 + 0x_4$$

Constraint :

$$20x_1 + 10x_2 + x_3 = 60$$
$$10x_1 + 10x_2 + x_4 = 40$$
$$x_1, x_2, x_3, x_4 \geq 0$$

Based on these objectives and constraints, the initial simplex table form is obtained as follows:

Initial Simplex Table

V_B	c_i	Z_j	400.000	800.000	0	0	θ_i
		b_i	x_1	x_2	x_3	x_4	
x_3	0	60	20	10	1	0	6
x_4	0	40	10	10	0	1	4
c_j		0	0	0	0	0	
$c_j - Z_j \geq 0$		0	-400.000	-800.000	0	0	

Based on Table 4.2, there is a value of $cj - Zj < 0$, to determine the pivot column, the minimum value of $cj - Zj$ is chosen (-800,000) so that column $x2$ is the pivot column and will then replace the position of the pivot row ($x4$) which has the smallest positive θi value. So that the first iteration table is obtained as follows:

First Iteration Simplex Table

V_B	c_i	Z_j	400.000	800.000	0	0
		b_i	x_1	x_2	x_3	x_4
x_3	0	20	10	0	1	-1

x_2	800.000	4	1	1	0	0,1
c_j		3.200.000	800.000	800.000	0	80.000
$c_j - Z_j \geq 0$		3.200.000	400.000	0	0	80.000

Based on Table First Iteration Simplex Table, it can be seen that the values in the row $cj - Zj$ have shown ≥ 0, so the solution has been achieved.

$$\{x_1, x_2, x_3, x_4\} = \{0,4,20,0\}$$

The maximum benefits are as follows:

$$\begin{aligned} Z &= 400.000x_1 + 800.000x_2 + 0x_3 + 0x_4 \\ &= 400.000(0) + 800.000(4) + 0(20) + 0(0) \\ &= \text{Rp. } 3.200.000 \end{aligned}$$

So it can be seen that the amount of profit obtained by the goat farmer in Example 2.1 is Rp. 3,200,000 by producing 0 units of product A and 4 units of product B.

Solution :

Decision variables: $x1$ = product A, $x2$ = product B

Formulation of constraint functions and objective functions

Goals:

- Goal 1: Maximize profit (≥ Rp. 1,000,000)
- Goal 2: Maximize production of product A (≥ 2 units)
- Goal 3: Maximize production of product B (≥ 2 units)

Goal Achievement Table

No	Constraint	Goal	Result	Information
1	Maximizing Profit	≥ Rp. 1.000.000	Rp. 2.400.000	Achieved
2	Maximizing Production of Product A	≥ 2 unit	2	Achieved
3	Maximizing Production of Product B	≥ 2 unit	2	Achieved

Based on the Achievement Table, it can be seen that ;

1. Goal 1 is achieved, meaning that the goat farmer's target to maximize profits is met, this is because there is no negative deviation value, namely $\eta 1 = 0$.
2. Goal 2 is achieved, meaning that the goat farmer's target to maximize production of product A is met, this is because there is no negative deviation value, namely $\eta 2 = 0$.
3. Goal 3 is achieved, meaning that the goat farmer's target to maximize production of product B is met, this is because there is no negative deviation value, namely $\eta 3 = 0$.

CONCLUSION

From the results of the research that has been conducted If the goat farmer provides capital of Rp 1,000,000, - with a minimum production of 2 units for each type of product, then the conclusion is as follows:

1. The profit obtained by the goat farmer by producing each product of 2 (two) units is Rp 2,400,000, -
2. If the goat farmer produces less than 2 units of each product, the goat farmer will not make a profit.

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