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Optimization of corn production using the simplex method in Sumbawa Regency

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Abstract. The utilization of land in Sumbawa District to produce corn will effect cutting trees new land fields it's not paddy field. It has effect on environment. Those such as lack of water in ground, flood, and soon. Henceforth this research aim at making optimisation model cutting tree for new land could enhance the productivity of corn and making appropriate model to optimize of farmers benefit by using simplex method. Therefore, this study aims to create an optimization model for new land clearing to improve corn productivity and make the right model to optimize the benefits of corn farmers with the simplex method. This research is a literature study with the main subject of the simplex method. Based on the results of the data analysis using the simplex method, the maximum production of corn in 2019 was 701984 tons of corn with a paddy field area of 44198.5 hectares and 55292.5 hectares of land not paddy fields.

1. Introduction

Sumbawa Regency is one of the districts in West Nusa Tenggara Province that makes corn as a source of export value commodities. Production and government targets for corn production which increase annually indirectly have an impact on clearing new land as corn planting land. The new land which is used as a corn planting media is of course not a rice field, which is often used as land which is a source of water absorption. Non-paddy fields that will be used if opened without good planning will certainly have a negative impact such as flooding, lack of springs and other problems.

Corn as one of the superior products of Sumbawa Regency along with cattle and seaweed is expected to contribute positively to the improvement and improvement of the community economy in the future. Efforts to increase added value must be in line with efforts to maintain the consistency of raw material production so that it can be available continuously

Problem solving related to minimizing the costs of production or land clearing and maximizing productivity is called the optimization process. There are various types of optimization problem solving methods including non-linear programming, linear programming, destination programs and others. In the case of corn productivity, land productivity and supporting factors of productivity have linear losses, so the method used is a linear programming method.

Optimization problems in real life often involve more than two variables resulting in less effective completion of the graph method [1]. One method that can be used in this case is optimization using the simplex method.

Simplex method is a method that systematically starts from a sound basic solution to other feasible solutions, done repeatedly so that finally an optimum basic solution is achieved and at each step produces



a value of the objective function which is always greater or equal from the previous step [2]. Of the various types of cases that are resolved in both maximization and minimization cases, the simplex method shows consistency in determining solutions with the cessation of iterations if a certain point is obtained [3].

Some of the previous studies on optimization of production with the simplex method were carried out by Firmansyah et al. [4] which concluded that the simplex method could be used as a solution in solving production system problems to get the best value in maximizing profits. Based on the brief description above, this study aims to maximize the productivity of corn with limited resources. As well as minimizing land clearing instead of rice fields for the environmental rehabilitation process.

2. Experimental Method

This type of research is a library research. With the main subject is the simplex method. This research was conducted in Sumbawa Regency. The data used are secondary data sourced from the Sumbawa District Agriculture Office, which includes data on maize planting area in 2018, planned planting area in 2019, as well as data on the amount of fertilizer stock in 2019. Other data obtained from the Agency for Implementing Agricultural Extension, Fisheries and Sumbawa Regency Forestry, namely in the form of data analysis of hybrid corn farming.

The steps in this study include: 1) literature study, 2) data collection, 3) Creating an optimization model, and 4) solving the optimization model with the simplex method. The steps of solving a linear program with the simplex method [5] are:

1. Formulate and form a standard model of a linear program problem
2. Forms the initial simplex table as shown in Table 1

Table 1. Example of a simplex table

Basic Variable	Z	X ₁	X ₂	...	X _n	S ₁	S ₂	...	S _n	NK
Z	1	-C ₁	-C ₂	...	-C _n	0	0	0	0	0
S ₁	0	a ₁₁	a ₁₂	...	a _{1n}	1	0	0	0	b ₁
S ₂	0	a ₂₁	a ₂₂	...	a _{2n}	0	1	0	0	b ₂
...	...	...	...	...	...	...	...	...	...	...
S _n	0	a _{m1}	a _{m2}	...	a _{mn}	0	0	0	1	b _n

3. Determine the key column between the existing variable columns, namely the column containing the value $(c_j - z_j) \geq 0$ the biggest for cases is maximization and / or contains value $(c_j - z_j) \leq 0$ smallest for minimization cases.
4. Determine the key rows between the rows of variables that exist, i.e. lines that have the ratio of the quantity with the smallest positive value.
Quantity to - $i = \frac{b_i}{\text{positive column element}}$
5. Form the next table, which is replacing the base variable with entering variables and issuing non-variable variables (leaving variables) from the column, and transforming variable rows using the transformation formula:
 - a) New row exclude key row = previous row - (key ratio $\times$ previous key row), with the key ratio = $\frac{\text{key column data}}{\text{key row}}$
 - b) New key row = $\frac{\text{all data in previous key row}}{\text{key number}}$
 The key number is the intersection between the key row and the key column.
6. Perform an optimality test. If all coefficients are on the line $(c_j - z_j)$ there is no more positive value (for maximized cases) or there is no more negative value (for minimization cases), meaning that the table is optimal. However, if this criterion has not been fulfilled, then the process is repeated

back to step 3 until the value of all coefficients on the line $(c_j - z_j)$ negative for maximized or positive cases for minimization cases.

3. Result and Discussion

Data from various sources that have been obtained are processed and grouped into several stages of completion, namely:

3.1. Decision Variables

The decision variables in this study relate to land area that must be used to optimize corn production, namely:

X_1 = Paddy Field

X_2 = Non paddy field

3.2. Constraint Function

Some of the things that are the function of limitation of optimization of corn production in Sumbawa Regency are the plan of the Sumbawa Regency Government for the land area to be used for planting corn, the area of rice fields used in 2018, non-paddy land area used in 2018, and stock of Urea and NPK fertilizer subsidized in 2019.

1. Constraint land

The Sumbawa regency government plans to use land for planting corn in 2019 with an area of 99491 hectares, with the hope that more land will be cleared than non-rice fields. Rice fields and non-rice fields used in 2018 are 3093 hectares and 77873 hectares. Based on the planned land area, the limitation function can be written as:

$$X_1 + X_2 \leq 99491 \quad (1)$$

$$X_1 - X_2 \geq 80966 \quad (2)$$

$$X_1, X_2 \geq 0$$

2. Constraints the stock of subsidized fertilizer

Every year the Sumbawa Regency government gets subsidized fertilizer allotments. The type of fertilizer used for corn is Urea and NPK. The amount of fertilizer used can be seen in Table 2.

Table 2. Amount of use And fertilizer supply

Land Type	Amount of Fertilizer Use (Ton/Ha)	
	Urea	NPK
Paddy field (X_1)	0,25	0,1
Non paddy field (X_2)	0,35	0,15
Total inventory	30402 Ton	14774 Ton

Based on the amount of subsidized fertilizer stock in 2019, the limit function can be written as:

$$0,25X_1 + 0,35X_2 \leq 30402 \quad (3)$$

$$0,1X_1 + 0,15X_2 \leq 14774 \quad (4)$$

3.3. Objective Function

The aim to be achieved is to maximize corn productivity from each type of land. The productivity of corn in each field is shown in Table 3.

Table 3. Corn Productivity

Land Type	Productivity (Ton/Ha)
Paddy Field	6,5
Non Paddy Field	7,5

The objective function model that can be formed based on table 3 is maximizing

$$Z = 6,5 X_1 + 7,5 X_2 \quad (5)$$

3.4. Settlement with the simplex method

Before compiling a simplex table, the objective function and constraint function are changed first in the standard form (canonical form), namely:

Maximum :

$$Z - 6,5 X_1 - 7,5 X_2 + 0S_1 - 0S_2 - 0S_3 + 0S_4 + 0S_5 + 0S_6 = 0$$

With constraints:

$$X_1 + X_2 + S_1 = 99491$$

$$X_1 + X_2 - S_2 = 80966$$

$$0,25X_1 + 0,35X_2 + S_3 = 30402$$

$$0,1X_1 + 0,15X_2 + S_4 = 14774$$

After the objective function and constraint function are changed in the standard form, the form is stated in the initial simplex table form as shown in Table 4.

Table 4. The Initial Simplex Table

Basic Variable	Z	X ₁	X ₂	S ₁	S ₂	S ₃	S ₄	Ratio
Z	1	-6,5	-7,5	0	0	0	0	0
S ₁	0	1	1	1	0	0	0	99491
S ₂	0	1	1	0	-1	0	0	80966
S ₃	0	0,25	0,35	0	0	1	0	30402
S ₄	0	0,1	0,15	0	0	0	1	14774

Repeated iteration process (iteration 4) produces a maximum value of $X_1 = 44198.5$ Ha and $X_2 = 55292.5$ Ha with a value of $Z = 701984$ tons.

4. Conclusion

After applying the simplex method to optimize maize production in Sumbawa Regency, the maximum productivity obtained was 701984 tons with cultivated paddy fields of 44198.5 hectares and 55292.5 hectares for non-paddy fields.

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