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Profit Optimization of Ngawen Orchid MSME

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Abstract. The Ngawen Orchid MSME (Micro, Small, and Medium Enterprise) in Ngawen Hamlet, Ngawen Village, Muntilan District, Magelang Regency, is a promising business opportunity. Apart from being in great demand, ornamental orchid plants also have a very high selling value. Orchid ornamental plants that are cultivated consist of three types: Dendrobium, Cattleya, and Phalaenopsis. This study aims to optimize profits by considering the number of plants and fertilizers used. This optimal profit can be achieved by applying the science of linear programming, one of which is the simplex method. The data collection techniques used in this study were interviews and direct observation of the Ngawen Orchid MSME. Based on the results of a linear programming analysis of the number of ornamental plants of Ngawen Orchid cultivation, optimal benefits were obtained from planting 40 Cattleya and 40 Phalaenopsis types orchids, and there was no need to plant Dendrobium types to get an optimal profit of IDR 4,600,000.

Keywords: Ngawen Orchid, Profit Optimization, Linear Programming, Simplex Method.

1 Introduction

Business in the agribusiness sector is one type of business that has the potential to be developed in Indonesia, including ornamental plant business floricultural, which has an important position in the economic sector in the 20th century. In [9] ornamental plants are an essential and exciting commodity. The phenomenon of ornamental plant cultivation is becoming a new trend among the public since the pandemic hit a year ago. Limitations on activities outside the home seem to trigger people to divert their activities to cultivating ornamental plants. One of the best ornamental plant businesses is the cultivation of orchids. In [6] Indonesia has at least 25% of the world's flowering plant species. This means that Indonesia is the seventh largest country, with 20,000 species, of which 40% are endemic or native to Indonesia. The plant family with the most species members is the orchids (Orchidaceous).

Magelang Regency is one of the largest producers of orchids. According to [4] the production of ornamental orchid plants in Magelang Regency in 2020 was 42,789, and in 2021 it was 21,483. If seen from these data, the production of orchids in Magelang Regency has decreased quite a lot. Several constraining factors may cause this. Significant factors and an obstacle in the ornamental plant business are business capital, availability of seeds, availability of fertilizers, availability of pesticides, labor, and land area.

Problems related to maximizing profits or minimizing costs are called optimization. In addition to land area, labor, seeds, and fertilizer, business capital size also affects the income earned by ornamental plant businesses.

The existence of sufficient capital allows supplies for the procurement of fertilizers and seeds to be fulfilled. This affects the level of income or profits of ornamental plant business owners [16]. Based on the background, this study aims to optimize the production of orchids using linear programming through the simplex method, which aims to determine the most optimal amount of product so that the Ngawen Orchid MSME (Micro, Small, and Medium Enterprise) gets the maximum profit.

2 Method

This research was conducted by interviewing and directly observing the Ngawen Orchid MSME in Ngawen Hamlet, Ngawen Village, Muntilan District, Magelang Regency, on May 27th, 2023. This research used a quantitative method. The quantitative method is used to examine specific populations and samples. Sampling is done randomly and then analyzed quantitatively or statistically, intending to test hypotheses that have been applied [14]. The quantitative method in this study is used to find out how to solve problems and calculate the problems that exist in the Ngawen Orchid MSME. The data of this study used primary data, including ornamental orchid plants (Dendrobium, Cattleya, Phalaenopsis), the profit of ornamental orchid plants per seed, the dose of fertilizer used, and the amount of available fertilizer stock. The data analysis techniques in this study used linear programming through the simplex method assisted by the Microsoft Excel application.
Linear programming is one of the methods in operational research used to find optimal solutions possible within limited resources [7]. Linear programming has been widely used to solve real-world problems in industry, transportation, trade, agriculture, advertising, engineering, etc. At the same time, the simplex method is an iteration calculation procedure with little repetition starting from a feasible basic solution. Suppose the basic feasible solution is not optimal. In that case, the simplex method will look for other, better, feasible essential solutions to obtain an optimal feasible basic solution, if any [7].

3 Results and Discussion

This research regarding profit optimization in Ngawen Orchid MSME as a case study in Ngawen Hamlet, Ngawen Village, Muntilan District, Magelang Regency gives the following results:

3.1 Data

In cultivating orchids, it is necessary to use the proper type of fertilizer and fertilizer dosage.

Table 1. Availability of Raw Materials

No	Types of Fertilizers/Plants	Orchid Dendrobium	Orchid Cattleya	Orchid Phalaenopsis	Availability	Unit
1	Gardasil	2	1,5	1	100	Gram
2	Gaviota	1	1	1,5	100	Gram
3	VTS	0,5	0,2	0,7	1000	Gram

Based on Table 1, the availability of raw materials can be noted.

3.2 Discussion

Identifying Research Data and Formulating it into a Linear Program Form

The previous survey data used linear programming variables using the simplex method, based on [2] and [7] as follows:

Decision Variables:
X1= Orchid Dendrobium
X2= Orchid Cattleya
X3= Orchid Phalaenopsis
Purpose Function:

The objectives to be achieved in this research can be seen in Table 2.

Table 2. Objective Function

No	Product	Profit Per Product (Rp)
1	Dendrobium Orchid	75.000
2	Cattleya Orchid	65.000
3	Phalaenopsis Orchid	50.000

Based on Table 2, the objective function can be formulated as follows:

$$\text{Maximum: } Z=75.000X1+65.000X2+50.000X3 \quad (1)$$

Constraint Function:
The distribution of factors or constraints that are owned in this research can be described in Tabel 3.

Table 3. Constraint Function

No	Product	Gardasil	Gaviota	VTS
1	Dendrobium Orchid	2	1	0,5
2	Cattleya Orchid	1,5	1	0,2
3	Phalaenopsis Orchid	1	1,5	0,7
Availability		100	100	1000

Thus, the constraint function can be formulated as follows:

$$\text{Gandasil fertilizer} : 2X1+1{,}5X2+1X3\leq 100 \quad (2)$$

$$\text{Gaviota fertilizer} : 1X1+1X2+1{,}5X3\leq 100 \quad (3)$$

$$\text{VTS fertilizer} : 0{,}5X1+0{,}2X2+0{,}7X3\leq 1000 \quad (4)$$

$$X1, X2, X3\geq 0$$

Calculating Linear Programming Problems with the Simplex Method

Based on equations (1), (2), (3), and (4) in the linear programming model, it will be converted into the simplex model, then the steps for solving the simplex method are based on [2] and [7] as follows.

Changing the objective function and constraint function

Changing the objective function and constraint function from inequality to equality by adding variables slack on the objective function and the constraint function.

Objective function:

$$Max: Z = 75.000X1 + 65.000X2 + 50.000X3 + 0S1 + 0S2 + 0S3 \quad (5)$$

Constraint function:

Gandasil fertilizer : 2X1+1,5X2+1X3+S1=100 (6)

Gaviota fertilizer : 1X1+1X2+1,5X3+S2=100 (7)

VTS fertilizer : 0,5X1+0,2X2+0,7X3+S3=1000 (8)

X1, X2, X3, S1, S2, S3≥0

(S1, S2, and S3 is a slack variable)

Arranging equations into tables

Based on the objective and constraint functions in Step 1, we can write them in Table 4. Arranging equations (5), (6), (7), and (8) into the simplex table.

Table 4. Arranging Equations (5), (6), (7), and (8) into a table

			75.000	65.000	50.000	0	0	0	
Cb	Vdb	Q	X1	X2	X3	S1	S2	S3	Assessment
0	S1	100	2	1,5	1	1	0	0	50
0	S2	100	1	1	1,5	0	1	0	100
0	S3	1000	0,5	0,2	0,7	0	0	1	2000
		Zj-Cj	-75.000	-65.000	-50.000	0	0	0	

Choosing a key column

A key column is a column that has a value on the row Zj-Cj, the negative value with the most significant number. In this case, the value on row Zj-Cj is the most significant negative number in column X1, worth -75.000. Then X1 is the key column. Put a mark in X1, and pay attention to Table 5.

Table 5. Selecting Key Column

	75.000	65.000	50.000	0	0	0	

Cb	Vdb	Q	X1	X2	X3	S1	S2	S3	Assessment
0	S1	100	2	1,5	1	1	0	0	50
0	S2	100	1	1	1,5	0	1	0	100
0	S3	1000	0,5	0,2	0,7	0	0	1	2000
		Zj-Cj	-75.000	-65.000	-50.000	0	0	0	

Selecting a key row

The critical row is the row that has the smallest positive value of or more than 0.

Evaluation= $\frac{\text{Column value Q}}{\text{Key column value}}$

With the condition that the divisor must be positive or more than 0. If negative, then the assessment is ignored. In Table 5, row S1 has a value Q = 100 and has a key column value X1 = 2 then, from the formula above, is obtained $\frac{100}{2} = 50$. Row S2 has the value Q = 100 and has a key column value X1 = 1, then from the formula above, is obtained $\frac{100}{1} = 100$. Row S3 has the value Q = 1000 and has a key column value X1 = 0,5 then from the formula above, is obtained $\frac{1000}{0,5} = 2000$. Obtained the smallest assessment, which is 50, so S1 is to be the key row. Put a mark in row S1, and pay attention to Table 6.

Table 6. Selecting Key Row

			75.000	65.000	50.000	0	0	0	
Cb	Vdb	Q	X1	X2	X3	S1	S2	S3	Assessment
0	S1	100	2	1,5	1	1	0	0	50
0	S2	100	1	1	1,5	0	1	0	100
0	S3	1000	0,5	0,2	0,7	0	0	1	2000
		Zj-Cj	-75.000	-65.000	-50.000	0	0	0	

Defining key elements

Determine the critical element by determining the intersection between the vital row and column.

In Table 6, the intersection between the critical row (S1) and the key column (X1) is 2. Then 2 is the crucial element. Put a mark on 2, and pay attention to the Table 7.

Table 7. Defining Key Elements

			75.000	65.000	50.000	0	0	0	
Cb	Vdb	Q	X1	X2	X3	S1	S2	S3	Assessment

0	S1	100	2	1,5	1	1	0	0	50
0	S2	100	1	1	1,5	0	1	0	100
0	S3	1000	0,5	0,2	0,7	0	0	1	2000
		Zj-Cj	-75.000	-65.000	-50.000	0	0	0	

Changing/transforming fundamental row values

Fundamental row transformation by dividing all key rows by critical elements.

Table 8. Changing Key Row Values

			75.000	65.000	50.000	0	0	0	
Cb	Vdb	Q	X1	X2	X3	S1	S2	S3	Assessment
0	S1	$\frac{100}{2}$	$\frac{2}{2}$	$\frac{1,5}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{0}{2}$	$\frac{0}{2}$	50
0	S2	100	1	1	1,5	0	1	0	100
0	S3	1000	0,5	0,2	0,7	0	0	1	2000
		Zj-Cj	-75.000	-65.000	-50.000	0	0	0	

Table 9. New Key Row Values

			75.000	65.000	50.000	0	0	0	
Cb	Vdb	Q	X1	X2	X3	S1	S2	S3	Assessment
75.000	X1	50	1	0,75	0,5	0,5	0	0	50
0	S2	100	1	1	1,5	0	1	0	100
0	S3	1000	0,5	0,2	0,7	0	0	1	2000
		Zj-Cj	-75.000	-65.000	-50.000	0	0	0	

Changing values other than row keys

By the manner, the old row beside the key row– (key column multiplied by new key row).

Table 10. Changing Values Other than Key Rows

			75.000	65.000	50.000	0	0	0	
Cb	Vdb	Q	X1	X2	X3	S1	S2	S3	Assessment

75.000	X1	50	1	0,75	0,5	0,5	0	0	50
0	S2	100-(1×50)	1-(1×1)	1-(1×0,75)	1,5-(1×0,5)	0-(1×0,5)	1-(1×0)	0-(1×0)	100
0	S3	1000-(0,5×50)	0,5-(0,5×1)	0,2-(0,5×0,75)	0,7-(0,5×0,5)	0-(0,5×0)	0-(0,5×0)	1-(0,5×0)	2000
		Zj-Cj	-75.000	-65.000	-50.000	0	0	0	

Based on Table 11, changes in the initial value are obtained by a new key row value (row X1), and there are still negative values on rows Zj-Cj. Therefore, calculating the optimal value has not been completed, and we must find (iteration) the transformation value that will eliminate the negative value. Do the iteration from the beginning of selecting the key column. Iteration stops when the objective function Zj-Cj nothing is harmful.

Table 11. Initial Transformation Value

			75.000	65.000	50.000	0	0	0	
Cb	Vdb	Q	X1	X2	X3	S1	S2	S3	Assessment
75.000	X1	50	1	0,75	0,5	0,5	0	0	50
0	S2	50	0	0,25	1	-0,5	1	0	100
0	S3	975	0	-0,175	0,45	-0,25	0	1	2000
		Zj-Cj	0	-8750	-12500	37500	0	0	

Table 12. First Iteration

			75.000	65.000	50.000	0	0	0	
Cb	Vdb	Q	X1	X2	X3	S1	S2	S3	Assessment
75.000	X1	50	1	0,75	0,5	0,5	0	0	100
0	S2	50	0	0,25	1	-0,5	1	0	50
0	S3	975	0	-0,175	0,45	-0,25	0	1	2166,667
		Zj-Cj	0	-8750	-12500	37500	0	0	

After the iteration and repair program, the optimal table is obtained as follows.

Table 13. Final Result of Simplex Method Iteration

			75.000	65.000	50.000	0	0	0	
Cb	Vdb	Q	X1	X2	X3	S1	S2	S3	Assessment
65.000	X2	40	1,6	1	0	1,2	-0,8	0	

50.000	X3	40	-0,4	0	1	-0,8	1,2	0
0	S3	964	0,46	0	0	0,32	-0,68	1
	Zj-Cj	4600000	9000	0	0	38000	8000	0

Based on Table 13, the program has been optimal due to the objective function Zj-Cj for all non-negative elements. So that the calculation is stopped after the values in the objective function are all positive. The results obtained are X1=0, X2=40, X3=40, with Zmax=IDR 4,600,000.

With the implementation of linear programming through the simplex method, profits will be increased. To get the optimal profit of IDR 4,600,000, the owner of the cultivation of Ngawen Orchid plants must increase the cultivation of this type of Orchid Cattleya, as many as 40 pieces and types Phalaenopsis as many as 40 pieces and no need to plant varieties Dendrobium.

4 Conclusion

Based on the results of the analysis using linear programming through the application-assisted simplex method Microsoft Excel on the number of Ngawen Orchid cultivation in Ngawen Hamlet, Ngawen Village, Muntilan District, Magelang Regency, an optimal profit of IDR 4,600,000. The owner will get an optimal profit if planting orchid species *Cattleya* (X2) as many as 40 pieces and types *Phalaenopsis* (X3) as many as 40 pieces, and no need to plant varieties *Dendrobium* (X1).

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