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Cost of Goods Manufactured and Optimization of Tapioca Production at PT XYZ in Central Lampung Regency: A Case Study at PT XYZ, Central Lampung Regency

Amanda Putra Seta**[a], Wan Abbas Zakaria[a], Wuryaningsih Dwi Sayekti[a]

[a] *Departement of Agribusiness, Faculty of Agriculture, Lampung University, Bandar Lampung, 35145, Indonesia*

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Correspondence:
amanda.seta@yahoo.com

ABSTRACT

The issue of tapioca imports in 2017 threatened the sustainability of the tapioca agro-industry in Lampung because the local tapioca agro-industry business cannot compete with similar companies abroad, so the production process and profits are not optimal. This study aims to determine the cost of goods manufactured and the optimal level of tapioca production. The study used a case study method at PT XYZ in Central Lampung Regency. Data is collected from February-March 2019. The cost of goods manufactured uses variable costing and full costing methods, and the optimization analysis uses linear programming planning models. The results showed that the cost of goods manufactured for variable costing was 7.482 IDR per kg and for full costing was 8.697 IDR per kg. In the actual condition, the tapioca production per month amounted to 715.761 kg. In contrast, in the optimal condition, tapioca production amounted to 885.501 kg with a profit of 3.305.969.264 every year or an increase of 31% from the actual condition.

INTRODUCTION

The issue of tapioca imports in 2017 threatened the sustainability of the tapioca agro-industry business in Lampung Province. Lampung Province is the largest cassava and tapioca production center in Indonesia, with 80 tapioca factories in 2016 and a milling capacity of 536.449 tons per month or 6.437.388 tons of cassava per year (Department of Industry, Lampung Province, 2016).

According to the research by CDMI (2017), Indonesia's tapioca flour demand in 2016 reached 3.09 million tons, while the domestic production was only 2.15 million tons of tapioca, so it needed as many as 939.58 thousand tons. Tapioca demand excess will continue to increase along with the rapid growth of the domestic food and beverage industry, especially those that use tapioca as the raw material. The high level of imports certainly impacts the domestic tapioca agro-industry due to the low competitiveness of domestic tapioca.

Another problem that threatens sustainability in the tapioca agro-industry in Lampung Province is the lack of raw material supply. Figure 1 shows that during 2017, cassava production declined sharply to below 2.000.000 tons per sub-round, and the trend even declined. In the last sub-round in 2017, cassava production was only around 1.600.000 tons of cassava, and the trend was repeated in 2018. On the other hand, the total factory capacity in Lampung Province reached 2.146.000 tons per sub-round. The lack of supply of raw materials began to affect several factories in 2018. Most factories decided to keep operating even though they

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were below the milling standard (30-50% of factory capacity). In contrast, other factories were off-milling because they could not cover the operational costs.

Limited raw material supply impacts factory productivity because the factory does not operate optimally. Optimal planning at the factory level must be carried out to ensure the sustainability of tapioca agro-industry businesses and provide guarantees for national tapioca supplies.

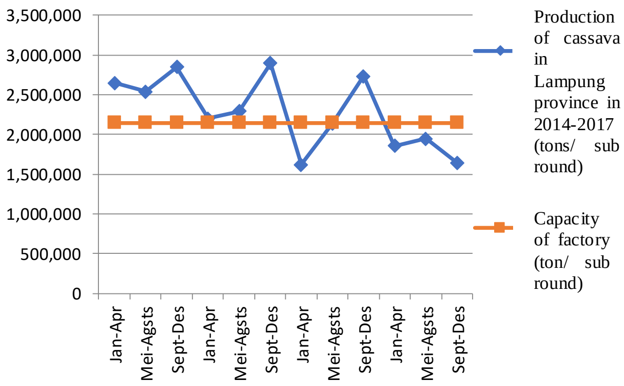

Figure 1. Cassava supply and demand for the tapioca industry in 2014-2017 of Lampung Province

Source: Department of Agriculture Lampung Province, 2017

Mathematically, optimization is a way to get a function's maximum benefit or minimum cost by paying attention to the constraints (Supranto, 1983). Optimization will provide an alternative optimal level of production and optimal use of resources so that production management can improve.

PT XYZ is one of the medium-scale tapioca agro-industries in Lampung Province, precisely in Central Lampung Regency. PT XYZ is one of the agro-industries which is also affected by the scarcity of cassava. PT XYZ, in 2017 and 2018, often operated below the standard. To reach the minimum amount of milled 100 tons of cassava, PT XYZ must wait 2-3 days to meet the raw material.

This study examines: (1) the cost of goods manufactured at PT XYZ and (2) the optimal level of tapioca production at PT. XYZ.

METHODS

This study uses a case study method at PT XYZ, Rumbia District, Central Lampung Regency. The location of the study was determined intentionally (purposive) because PT XYZ is one of the tapioca factories in Lampung Province affected due to the suboptimal production process. PT XYZ is a tapioca factory with a capacity of 250 tons of cassava per day. The study was conducted in February-March 2019.

The type of data collected is secondary data and primary data. Secondary data in this study include tapioca production data, cassava raw material uptake, and other data supporting the tapioca production of PT XYZ. At the same time, the primary data is descriptive information about the tapioca production process of PT XYZ from the Head of PT XYZ Factory.

The quantitative analysis method is carried out to answer the first goal: the analysis of PT XYZ's production cost. This study uses the optimal planning model to answer the second goal.

Cost of goods manufactured (HPP) Analysis

According to Mulyadi (1986), the cost of goods manufactured (HPP) is all cost elements consisting of raw material costs, direct labor costs, and factory overhead costs or other costs directly related to the production process at the factory. The purpose of a company calculating the cost of production is to re-evaluate the specified selling price. HPP can be calculated as follows:

HPP = BBBU + BTKL + BOP

Where: HPP = Cost of Goods Manufactured (HPP)

BBBU = Cost of Main Raw Materials

BTKL = Direct Labor Costs

BOP = Factory Overhead Costs

Analysis of the Optimal Planning Model (Optimization)

Optimization analysis is done because there are limited resources. Optimal planning will show a business's optimal production level and maximum profit. The three elements of optimization problems must be identified: goals, alternative decisions, and resource constraints (Siringoringo, 2005). This research uses optimal planning with a linear programming model.

Linear Programming

The first stage in determining the linear programming model is the determination of decision variables. The decision variables in this study were Y1, Y2, Y3, Y4, Y5, Y6, Y7, Y8, Y9, Y10, Y11, and Y12. Y means tapioca production, whereas 1-12 signifies the January-December production month). Tapioca factory function purpose of PT XYZ:

Max Z = b1Y1 + b2Y2 + b3Y3 + b4Y4 + b5Y5 + b6Y6 + b7Y7 + b8Y8 + b9Y9 + b10Y10 + b1Y11 + b12Y12

Where:

Z = Value of PT XYZ's PuIDRose Function (IDR)

$B_{1\text{-}12}$ = Tapioca profits per month 1-12 (IDR/ kg)

$Y_{1\text{-}12}$ = Number of Tapioca production per month to 1-12 (kg)

According to Putri et al. (2019), variables that influence the rice milling business includes the formal education of entrepreneurs, the age of the machine, and the level of rice yield. These three variables broadly reflect the quality of the workforce's human resources and the quality of production machinery. Another study by Asnawi (2003) concluded that tapioca production in ITTARA was influenced by the number of raw materials and the amount of diesel oil (fuel) used. This study uses the constraint function, including the availability of raw materials, fuel constraints, constraints of factory machinery working hours, and production capacity, where these variables are variables that affect production. The constraint function of the availability of raw materials is as follows:

$$giYi \geq Gi$$

Where:

$g_{1\text{-}12}$ = Use of raw materials for the production of one tapioca (kg)

Gi = Availability of Raw Materials in one year (kg) month i

The constraint function of the constraints of the palm shell fuel:

$$h1Y2 + \ldots + hnYn \leq H$$

Where:

$h_{1\text{-}12}$ = Use of CS fuel for the production of one tapioca (Kg)

H = fuel availability (kg)

Solar fuel constraint function:

$$InYn \leq Ii$$

Where:

$I_{1\text{-}12}$ = Use of diesel fuel for the production of one tapioca (l / kg)

Ii = availability of diesel fuel (l)

The function of factory machinery working hours constraints:

$$j1Y1 \leq Ji$$

Where:

Ji = seconds the factory machine works

j(1-12) = Use of machine working hours for the production of one tapioca unit (sec/kg)

Factory capacity constraint function:

$$Yi \leq Ki$$

Where:

Ki = i's month factory capacity (kg)

Primal, Dual, and Post-Optimal Analysis

The primal analysis is done to find out the best combination of products that can produce maximum profits while considering the limitations of available resources. The dual analysis is done by knowing the value of resources by looking at the value of the slack or surplus from the dual value it generates. A dual value (dual price or shadow price) indicates the change that will occur in the objective function if the resource changes by one unit. The post-optimal analysis is performed to find out how the optimal solution is obtained if there are changes to the parameters that make up the model. (Nasendi and Anwar, 1995).

RESULTS AND DISCUSSION

Tapioca Processing Process at PT XYZ

There are several stages of tapioca processing in PT XYZ, such as Weighing and starch yield testing, washing, cutting (root chipping), extracting, settling, drying, and packing. Based on production experience, the largest production that the factory can do is only 75% of the factory's capacity per month.

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Cost of Goods Manufactured Analysis (HPP)

Components of fixed costs incurred by PT XYZ include depreciation of equipment and buildings, land rent, and taxes. Variable costs incurred by PT XYZ include purchasing cassava's main raw materials, labor costs, operational costs such as fuel, supporting raw materials (sacks, screen printing, oil, etc.), expedition costs, and maintenance costs. Costs calculated for the depreciation of equipment and materials by PT XYZ every month amounted to 128.633.333 IDR. The cost of leasing land with an area of 27 ha is 27.000.000 IDR per month. Then the tax paid by the factory in a year is 8.553.614.846 IDR or around 450.000.000 – 900.000.000 IDR per month.

The main component of variable costs is the cost of raw materials. At PT XYZ, raw material costs have the largest percentage of tapioca production cost variables. The cost of raw materials has the largest percentage (77-85%) in variable costs, which amount to 3.600.000.000-6.700.000.000 IDR.

In addition, fuel has a fairly large share of 6-12% of total variable costs. While for raw materials, the share of less than one percent of the total variable costs. The cost of treatment in a year in 2018 amounted to 229.552.000 IDR. Another variable cost component that is quite large is the cost of expedition or marketing. PT XYZ's products are mainly marketed to Java Island with an expedition fee of 200.000.000-327.000.000 IDR (4.5-5.5%) of the total variable costs.

Tables 1 and 2 show the development of the cost of goods manufactured and the selling price of tapioca. The data shows HPP is always below the tapioca sale price. Tapioca selling price trends are in line with the trend of HPP and cassava buying prices, which means that the price of cassava affects HPP. Differ slightly in the month 8-12 HPP trend declined, but the tapioca price trend actually rose. The average tapioca HPP for the variable and total monthly costs is 7.482 IDR per kg and 8.697 IDR per kg. The average tapioca price in 2018 was 9.933 IDR per kg. Therefore, income from tapioca production is 2.436 IDR per kg for COGS over variable costs and 1.222 IDR per kg for HPP for the full cost.

Table 1. PT XYZ Tapioca's HPP in 2018

Produc-tion Month	Constant Cost (IDR)	Total Cost (IDR)	HPP for Variabel Costing (IDR/Kg)	HPP for full Costing (IDR/Kg)
1	658.252.333	4.702.688.573	6.574	7.648
2	631.992.249	4.281.021.300	6.596	7.737
3	825.951.196	6.110.242.782	7.373	8.525
4	836.220.925	6.394.061.372	7.786	8.954
5	847.849.841	6.403.265.059	7.852	9.050
6	744.342.462	5.415.680.490	7.957	9.228
7	959.244.729	6.792.852.922	7.310	8.515
8	1.100.675.183	7.880.056.766	7.259	8.435
9	997.794.653	7.545.567.059	7.998	9.213
10	1.028.017.573	7.428.771.528	7.776	9.025
11	976.453.333	6.776.464.282	7.742	9.051
12	814.420.033	5.154.170.556	7.564	8.986
Avera ge	868.434.543	6.240.403.557	7.482	8.697

Based on the revenue from HPP, it shows that the tapioca agro-industry at PT XYZ is profitable. It is emphasized by the research of Zairina et al. (2015) that the tapioca flour business by PT BBH is financially feasible to run with NPV 1.511.548.767 IDR, IRR 26.1%, and PP 3.25. In addition, according to Rochaeni et al. (2007), the added value of tapioca product processing in small tapioca agro-industries is 26.5% - 30.3%. Therefore, it can be concluded that the tapioca agro-industry is financially feasible and profitable.

Optimization of Tapioca Production at PT XYZ

The first step in the optimization analysis is determining the objective function's coefficient. Based on Table 2, PT XYZ tapioca production function.

Table 2. Selling prices, average costs, and average income from PT. XYZ in 2018

Production Month	Selling Prices of Tapioca/ kg (IDR)	Average Costs (IDR/kg)	Average Income (IDR/Kg)
1	8.200	7.648	552
2	8.600	7.737	863
3	9.350	8.525	835
4	9.500	8.954	546
5	9.775	9.050	725
6	10.050	9.228	822
7	10.100	8.515	1.585
8	10.100	8.435	1.665
9	10.250	9.213	1.037
10	10.600	9.025	1.575
11	11.000	9.051	1.949
12	11.500	8.986	2.514

Max Z2= 552Y1+ 863Y2+ 835Y3+ 546Y4+ 725Y5+ 822Y6+ 1585Y7+ 1665Y8+ 1037Y9+ 1575Y10+ 1949Y11+ 2514Y12

The second step is the formulation of the constraint function. The first obstacle is cassava raw materials which are limited by the minimum use of raw materials for production in a month. The following functions constrain the use of raw materials:

4,88Y1=>2700000 4,24Y7=>2700000

4,23Y2=>2500000 4,18Y8=>2600000

4,65Y3=>2700000 4,21Y9=>2700000

4,21Y4=>2600000 4,42Y10=>2600000

4,48Y5=>2700000 5,00Y11=>2700000

4,31Y6=>2600000 4,99Y12=>2600000

The second obstacle is machine working time which reflects tapioca processing technology at PT XYZ. The right limit of this constraint function is factory working time in a month. The following functions work time constraints:

1,0537Y1<=1166400 0,9164Y7<=1166400

0,9141Y2<=1080000 0,9038Y8<=1166400

1,0047Y3<=1166400 0,9091Y9<=1123200

0,9087Y4<=1123200 0,9553Y10<=1166400

0,9686Y5<=1166400 1,0800Y11<=1123200

0,9302Y6<=1123200 1,0784Y12<=1166400

The third and fourth constraints which become the limitation are palm shell and diesel fuel. These fuels are the primary fuels in tapioca production at PT XYZ. The following functions are the constraints of the palm shell fuel:

0,1210Y1+0,1245Y2+0,1144Y3+0,1117Y4+0,1101Y5 +0,1280Y6+0,1056Y7+0,0983Y8+0,1071Y9+0,1085Y 10+0,1212Y11+0,1274Y12<=1200000

For the diesel fuel constraint function, namely:

0.055Y1<=60000 0.052Y7<=60000

0.065Y2<=60000 0.045Y8<=60000

0.051Y3<=60000 0.051Y9<=60000

0.053Y4<=60000 0.052Y10<=60000

0.054Y5<=60000 0.058Y11<=60000

0.067Y6<=60000 0.077Y12<=60000

The final obstacle in the tapioca production optimization model is factory capacity. The plant's capacity is limited by the basic capacity of the factory (recorded in the factory's administration). The capacity of mill rollers recorded in the administration of the plant establishment is 200.000 kg of cassava, equivalent to 50.000 kg of tapioca per day.

Y1<=1350000 Y7<=1350000

Y2<=1250000 Y8<=1350000

Y3<=1350000 Y9<=1300000

Y4<=1300000 Y10<=1350000

Y5<=1350000 Y11<=1300000

Y6<=1300000 Y12<=1350000

Primal and Dual Analysis

Primal analysis was carried out to determine the optimal production level at PT XYZ. Table 3 shows that most of the optimal tapioca production is above the actual production. The percentage change in January, April, and May shows a negative value due to the optimal condition of the factory being only recommended to absorb cassava that is not too high because there are not many available raw materials. However, the reality in the factory field can absorb higher than the optimal planning. This result is identified in Table 4, which

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shows that raw material constraints are active constraints in the three months.

Table 3. The comparison between the actual and optimal amount of tapioca production at PT XYZ in 2018

Production Month	Actual Production (Kg)	Optimal Production (Kg)	Change (%)
Y1	612.950	553.279	-10%
Y2	553.906	591.177	7%
Y3	716.918	1.069.632	49%
Y4	716.408	617.577	-14%
Y5	708.150	602.678	-15%
Y6	585.780	603.248	3%
Y7	795.655	1.153.846	45%
Y8	935.685	1.290.551	38%
Y9	821.621	1.176.470	43%
Y10	823.004	1.153.846	40%
Y11	746.200	1.034.483	39%
Y12	572.858	779.220	36%

Table 3 also shows that tapioca production per month is 715.761 kg in actual conditions, while it is 885.501 kg in optimal conditions. Optimization of production causes an increase in production up to 169.739 kg per month or 2.036.872 kg per year. In addition, the optimization of tapioca production caused a rise in income from 10.662.864.275 IDR per year to 13.968.833.539 IDR per year. The optimal and actual income difference is 3.305.969.264 IDR, up 31% from the original income.

According to Rofatin et al. (2016), the optimization of the strawberry-based agro-industry can increase the income from 2.505.000 IDR to 2.552.716 IDR. In addition, Fibrian et al. (2010) research using the goal programming model concluded that optimizing the utilization of waste in oil palm causes financial affordability, minimizes environmental pollution, and provides maximum benefits. Likewise, with Octaviani (2012), the optimization process causes an increase in profit of 31,800 IDR daily in producing Marbella Bakery bread. In line with previous research, optimization of production at PT XYZ is expected to provide optimal production results causing maximum profits.

Table 4. Dual price value, actual and optimal use of resources for the use of cassava raw materials at PT XYZ.

Raw Materials Month	*Dual Price*	Use of Materials		Change (%)
		Actual (kg)	Optimal (kg)	
Y1	67	2.990.000	2.700.000	-10%
Y2	10	2.344.080	2.500.000	7%
Y3	0	3.334.500	5.608.292	68%
Y4	63	3.013.917	2.600.000	-14%
Y5	18	3.175.560	2.700.000	15%
Y6	26	2.522.740	2.600.000	3%
Y7	0	3.375.710	4.892.308	45%
Y8	0	3.915.000	5.294.503	35%
Y9	0	3.458.000	5.052.941	46%
Y10	0	3.640.000	5.000.000	37%
Y11	0	3.731.000	5.272.414	41%
Y12	0	2.860.000	3.788.311	32%

The dual analysis shows the optimal use of resources to achieve optimal production levels. The use of cassava raw materials is closely related to quality and quantity. Table 4 shows the value of dual price and the optimal use of cassava raw materials at PT XYZ. Based on the dual analysis, January, February, April, and May have a positive value of dual price. This finding indicates that every time an additional unit is added to the availability of raw materials, the benefits gained increase by the value of its dual price. It also indicates that the constraints on using raw materials are active.

In addition, Table 4 shows the use of raw materials by the factory in several months is not optimal. This fact means that in these months, the factory has not been able to meet the optimal absorption of raw materials. In July-December, raw materials are abundant; thus, the optimal absorption rate of raw materials is also high. This finding emphasizes the need to improve the plant's performance in the absorption of raw materials. The optimal use of raw materials increases cassava absorption by up to 25% from actual conditions or 4.000.731 kg per month.

Table 5. Dual price values and actual and optimal use for working time resources of cassava machines at PT XYZ.

Production Month	*Dual Price*	Machine Working Time Uses		Change (%)
		Actual (second)	Optimal (second)	
Y1	0	645.840	582.990	-10%
Y2	0	506.321	540.249	7%
Y3	0	720.252	1.074.661	49%
Y4	0	651.006	561.193	-14%
Y5	0	685.921	583.755	-15%
Y6	0	544.912	561.142	3%
Y7	0	729.153	1.057.385	45%
Y8	1048	845.640	1.166.400	38%
Y9	0	746.928	1.069.530	43%
Y10	0	786.240	1.102.269	40%
Y11	0	805.896	1.117.242	39%
Y12	0	617.760	840.312	36%

The optimal absorption and use of raw materials are certainly one of the goals of agro-industry so that business efficiency can be achieved. The raw material variable has a positive and significant influence on the output of the manufacturing industry. Increased use of raw materials will directly cause an increase in production in the processing industry (Wibowo and SBM Nugroho, 2018). In particular, when the business scale is in the area of increasing return to scale (IRTS), the proportion of the addition of inputs will result in the addition of output with a greater proportion (Savitri and Widyastutik, 2013).

The optimal use of the machine's working time shows that most of the machine's working time is not optimal. The actual use of engine working time is 690,489 seconds per month on average, while the optimal use of the machine's working time is 854,761 seconds per month. In August, the dual price was worth 1,048 IDR, so every time there was an increase in one unit of work time, the profit gained increased by the value of the dual price. Adding the work time in question means adding overtime hours in the month.

Table 6. Actual and optimal uses for palm shell and diesel fuel resources at PT XYZ.

Production Month	Uses for Palm Shell Resources			Uses for Diesel Fuel Resources		
	Actual (kg)	Optimal (kg)	(%)	Actual (liter)	Opti-mal (liter)	(%)
Y1	74.200	100.000	35%	34.000	30.431	-10%
Y2	69.000	100.000	45%	35.800	38.417	7%
Y3	82.000	100.000	22%	36.600	54.552	49%
Y4	80.000	100.000	25%	37.400	32.732	-12%
Y5	78.000	100.000	28%	38.200	32.545	-15%
Y6	75.000	100.000	33%	39.000	40.418	4%
Y7	84.000	100.000	19%	41.700	60.000	44%
Y8	92.000	100.000	9%	41.600	58.075	40%
Y9	88.000	100.000	14%	41.500	60.000	45%
Y10	89.300	100.000	12%	42.750	60.000	40%
Y11	90.500	100.000	10%	43.375	60.000	38%
Y12	73.000	100.000	37%	44.000	60.000	36%

Optimal working time is closely related to technology and production management, that is, to optimize some things that can be done, including intensive care and maintenance of the condition of the production machine and the addition of overtime in August. Maintenance of the oven and grinding machine must be routine and follow the standards. It is because the key to tapioca production's success lies in the two machines' effectiveness and efficiency. In addition to settling and packing, the workforce on duty must be trained and experienced.

According to Amalia and Choiron (2017), the important things that agro-industries must consider are technology adoption, fulfillment of quality specifications expected by consumers, and workforce development. The quality specifications expected by consumers are usually different, so the existing technology must be able to adjust to the quality expected by consumers.

Based on the results of the dual analysis, shell fuel is an active obstacle. This conclusion can be seen in the dual price of 7.298 IDR means that the addition of the availability of one palm shell unit increases profits by the value of its dual price. Palm shell fuel is a fuel that is used in the processing process, so indirect availability is very influential on profits. In diesel fuel in July, September to December, the value of its dual price is more than zero, which means that in those months, the addition of one diesel procurement unit impacts optimal profits. According to Asnawi (2003), diesel fuel has an

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effect on increasing Ittara production. The higher use of diesel oil will increase Ittara's production. In detail, Table 6 presents the actual and optimal use of palm shell and diesel fuels at PT XYZ.

Based on Table 6, the optimal increase in the use of palm shell fuel is 24% of the actual use, while the increase in the use of diesel is 22% of the actual use. Changes in fuel use can be used as a consideration for managing resources. Optimal use recommends that the use is not excessive and not less. In particular, oil palm shells are an active constraint factor, so every available regulation influences the factory profits.

A dual analysis of plant capacity shows that this resource is not an active resource. In addition, Table 7 shows that the use of factory capacity is not optimal. Table 7 presents the dual price values and the optimal use of PT XYZ's factory capacity. Increasing the use of factory capacity can be done through an optimal production process. In the long run, if the factory capacity has been reached optimally, PT XYZ can invest in the addition of production machinery to increase profits.

Table 7. Dual price values and the optimal capacity of PT XYZ's factory.

Production Month	*Dual Price*	Product Capacity		Change (%)
		Actual (kg)	Optimal (kg)	
Y1	0	612.950	553.279	-10%
Y2	0	553.906	591.017	7%
Y3	0	716.918	1.069.633	49%
Y4	0	716.408	617.578	-14%
Y5	0	708.150	602.679	-15%
Y6	0	585.780	603.249	3%
Y7	0	795.655	1.153.847	45%
Y8	0	935.685	1.290.551	38%
Y9	0	821.621	1.176.471	43%
Y10	0	823.004	1.153.847	40%
Y11	0	746.200	1.034.483	39%
Y12	0	572.858	779.221	36%

The primal and dual analysis results at PT XYZ showed that PT XYZ tapioca production was not optimal. In reaching the optimal point, PT XYZ is recommended to use the available resources optimally based on the results of the dual analysis. The post-optimal scenario will provide alternative choices in managerial implications so that the use of resources and production processes can run optimally.

Post Optimal Scenario

A post-optimal scenario is carried out to overcome the problem of the raw material deficit. That is because the raw material is an active obstacle that most influences tapioca production. In selling cassava, farmers usually consider the selling price and the rafaction. Increasing the selling price of cassava is expected to attract farmers to sell cassava to PT XYZ. On the other hand, increasing the selling price of cassava must also consider tapioca HPP and cassava quality. Therefore, an optimal post scenario was created with an increase in the price of 2.5%, 5%, and a fixed selling price of 1.200 IDR for a year, assuming a maximum of 16% rafaction (after nine months of harvest, the highest *acid* content).

The increase in the cassava selling price of 2.5%, 5%, and a fixed price of 1,200 IDR per kg caused a profit of 12.373.721.871 IDR, 1.714.890.602 IDR, and 23.401.336.437 IDR, respectively. Based on this, the most profitable scenario is the scenario with a fixed price of cassava at 1,200 IDR per kg. In addition, price certainty can encourage farmers to sell their cassava at PT. XYZ. However, this scenario has the disadvantage that if the price of cassava on the market increases by more than 1,200 IDR per kg, the factory can lose raw materials. Likewise, in scenarios 1 and 2, the profit gained is that the farmer will sell his raw materials to PT XYZ because the price is higher, but an increase in cassava prices decreases the factory's profits.

Managerial Implications

Managerial implications on optimizing tapioca production at PT XYZ aims to provide managerial recommendations to achieve maximum profits. Based on the optimal and post-optimal analysis, managerial improvements that must be done include:

Increasing the quality and absorption of raw materials by 25% in a year.

At the beginning of the year, the factory faced difficulties finding raw materials due to a small supply. At the end of the year, despite the abundance of raw materials, the factory faced problems in price and rafaction competition with other factories. Therefore, to optimize absorption until an increase of 25% from the actual condition, the managerial implications that the factory can carry out are:

a. Rise cassava prices of 2.5% -5%, assuming prices in the market range between 1.000-1.600 IDR per kg.
b. Build partnerships with farmers with a contract farming system to assure price and rafaction for farmers and guarantee the quantity and quality of raw materials for factories.

Based on previous research by Zakaria et al. (2018), the agency collaboration pattern could not provide an optimal impact on the factory. Based on production experience, the agency pattern can only meet around 30-50% of production capacity. Therefore, we need a pattern that is structured/organized, has representative rules and jurisdictional boundaries and regulates the boundaries of the work areas of each stakeholder. These characteristics and conditions can only be realized in partnership contract farming.

A pattern that is structured/organized has jurisdictional boundaries and representative rules and regulates the boundaries of each stakeholder's work area and the ability to carry out the enforcement. In this regard, according to Williamson (1986), several transaction dimensions must be considered:

1. Tapioca factories and cassava have high asset specificity. Industrial types of cassava cannot be consumed directly, so it must be processed at the factory. On the other side, the presence of *lapak* makes the specific nature of the factory decline because farmers have many choices for selling their cassava. Thus, it creates the need for contract security and government support in the form of rules relating to determining the selling price of cassava.
2. High transaction frequency and routine duration are not supported by a certainty of raw material absorption. Then, it will make the transactions very ineffective in the free market.
3. The performance of cassava transactions is difficult and expensive to be measured due to uncertainty in prices and rafaction, harvest age of 8-12 months, the non-optimal role of farmer and extension institutions, and the uncertainty of cassava marketing. Those factors make the transaction costs high.
4. The average farmer in the vicinity of the factory only has 1.08 ha of land, so in actual conditions, the factory must coordinate with many people to get raw materials. Then, it increases the transaction costs, so there needs to be a coordinating container where transaction costs can be minimized.

c. Tapioca quality improvement is greatly influenced by the quality of raw materials. Some things that must be considered are the age of cassava (8-12 months or at least> 6 months) (Rahman, 2015), the ACI amendment test according to SOP, and soil content examination.

Increasing the working time of production machines by 22%.

The optimal use of work time can be done with several strategies, i.e.

a. Using professional, skilled, and experienced HR, mainly by conducting transparent and professional recruitment and developing the workforce by conducting training (training) and comparative studies. According to Rohmatulloh (2009), HR is essential in improving factory efficiency indicators. Key performance measures that affect employee performance include achieving tasks and goals, behavior, and good management. Therefore, the development of HR is one of the priorities for the optimization of PT XYZ tapioca agro-industry.
b. Maintain the production machines following standards, mainly by replacing machine components that cannot operate optimally and adding manufacturing technology investment to create optimal production. The technological approach is intended to encourage the tapioca-cassava conversion coefficient is at ≥ 0.25. Muhadi (2017), in his research, explained the strategies that could be developed, one of which was by increasing production technology by grinding twice.
c. Apply overtime hours when raw materials are abundant (at the end of the year).

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Optimizing the use of fuels, both palm and diesel shells.

Optimizing the use of fuel is intended to avoid waste. Increasing fuel use without increasing production may result in higher production costs. Optimal fuel use can be seen in Table 6.

Development of marketing networks.

The consequence of increased production is the development of marketing networks. The improvement of the marketing network can be done by opening new markets, both local and long-distance. Given the growing demand for tapioca, factories must be able to compete to get a wider market. So far, PT XYZ has sold tapioca to Java. In the context of optimization, PT XYZ must be able to expand the market, especially in Lampung, as well as large industrial centers or SMEs. In addition, the need to cooperate with industry or suppliers of byproducts.

CONCLUSIONS

Based on the study results, it can be concluded that the cost of goods manufactured for the variable tapioca costing is an average of 7.482 IDR per kg, and the cost of goods manufactured for a full-costing tapioca an average of 8.697 IDR per kg.

The actual condition of tapioca production per month is 715.761 kg, and the optimal condition of tapioca production amounted to 885.501 kg with a profit of 3.305.969.264 IDR every year or an increase of 31% from the actual condition. Managerial implications at PT XYZ are carried out in various ways, namely increasing the absorption of raw materials, increasing the working time of the engine (technology), optimizing fuel use, and developing a marketing network.

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