

# Optimization of fresh fruit bunches as crude palm oil production material

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**Abstract.** The increasing demand for Crude Palm Oil (CPO) makes palm oil production companies continue to improve production planning continuously in order to meet customer demand. Companies that are engaged in CPO production in the Medan city experience problems are not optimal due to companies are often faced with a situation in the form of a production mismatch with the volume of demand due to demand fluctuation. Therefore it is necessary to optimize the procurement of CPO by using linear programming methods. This method is used to maximize or minimize the resources owned by the company with several decision variables, objective functions and constraint functions. The results shows that the decision variables used are CPO cost, the cost of procurement using their own FFB, purchasing FFB cost and processing costs. The objective function is the maximization of company resources and constraint functions consisting of the maximum capacity of the factory, the availability of purchase FFB, the purchase quota of FFB, the availability of direct labor, processing transfers and processing costs.

## 1. Introduction

Current economic growth causes market competition increasingly, related to an active free market system in the next year. Every business person competes to improve the best quality, especially in the industrial sector. Competition in the industrial sector now affect companies to increase productivity in their production activities, such as product quality improvement by obtaining an optimal result. In order to get an optimal result, all production activities are first planned well, effectively, and efficiently [1]. To face active free market competition, carefulness is needed in planning raw material inventories and it can calculate the optimal purchase rate and there is no excess or lack of inventory in order to save costs and not disrupt the smooth production process [2]. In optimizing the production of raw materials, companies do not only pay attention to consumer demand but companies also need to pay attention to three elements, namely consumers, products, and manufacturing processes [3]. One of the control activities especially for the procurement of raw materials. Procurement of raw materials is done in such a way able to serve the needs of raw materials appropriately and at a low cost. So far, companies generally control not based on standard methods, but only based on previous experiences. Raw material inventory control is very important in an industry to develop its business because it will affect the cost efficiency, smooth production and profitability of the business itself. The availability of inventory is expected to facilitate the running of the production process in a company [4]. Optimization of raw material is very important in various aspects. It is one of the most decisive factors for the quality and product cost. Roughly speaking, half of the quality of a product is determined by the characteristics of

raw materials in the current production technology. Use of proper raw material is critical for producing high quality at a minimal cost [5].

The company engaged in the production of Crude Palm Oil is experiencing problems, namely the existence of mismatch between raw material requirements and factory capacity. Constraints faced by companies are the limited number of raw material fulfillments, the inefficient use of company capacity and the use of company labor. The company does not have a plan to procure good raw materials to anticipate factory capacity has not met the fulfillment of raw material needs. For that reason, it is necessary to do optimal raw material planning for the company in order to anticipate this. The procurement of optimal raw materials in meeting factory capacity is carried out by several methods, one of them is the linear programming method. Goal Programming is an extension of linear programming is used to achieve desired objectives or targets [5]. Linear program (LP as known as Linear Programming) is one of the most extensive and well-known techniques of Operation Research. Linear program is a mathematical method in allocating scarce resources to achieve goals [6]. In managerial practice, Linear Programming deals with nonnegative solutions to determinate system of linear equations. Due to this limitation, negative solutions are eliminated from the decision-making process. The other possibility is to incorporate this necessary limitation into the set of conditions [7]. Linear optimization problems are found in the fields of product production and distribution, economics and other fields included in operational research studies. Optimization problems can be solved with linear programs. Linear Program is one problem solving in the optimal solution determination [8].

Research to overcome the problems of raw material procurement has been done before. Renta (2015) conducted an optimization analysis of the procurement of raw materials in palm oil processing companies with the aim of providing input to optimize the procurement of FFB with a linear programming concept (LP). Through the optimal EOQ approach, the purchase of external FFB during 2014 is still below the optimal standard and the company should carry out a policy of procurement combination of FFB raw materials from its own garden and purchasing outside FFB [9]. O.S. Balogun, et al (2012) presented a research using linear programming in Coca-Cola Company. Linear Programming of the operations of the company was formulated and optimum results derived using Software that employed Simplex method. The result shows that two particular items should be produced even when the company should satisfy demands of the other - not - so profitable items in the surrounding of the plants [10].

## **2. Methodology**

The research was conducted in one of the industries in the Medan city produces Crude Palm Oil. The object examined in this study was the procurement of FFB raw materials for the company. Research begins with observations to observe and see the condition of the industry. After observation, the topic and purpose of the study are determined according to the conditions on the production floor. Then data collection is needed to overcome the problems of production planning occur. Data collected in the form of the quantity and availability of raw materials, plant capacity, direct labor availability, transfer of CPO and Palm Kernel, processing costs and other data. The data collected is then processed using the linear programming method. The stages of implementation in overcoming the problem of optimal raw material procurement planning begins with forecasting demand. Forecasting is carried out with the aim of the procurement estimation of CPO raw materials in the following period. Calculation of forecasting is done by the time series method and consider the errors estimation. The next step is to do production volume planning using the goal programming

method. Goal Programming (GP) model where the objective is to minimize the sum of positive and negative deviations from those goals [11]. This method begins by the decision variable determination. Decision variables in question are problem variables that will affect the value of the objectives to be achieved. Decision variables must be determined before formulating the objective function and constraints. After the decision is obtained, then the objective function (target) and the constraints for the value of the objectives to be achieved are determined.

### 3. Result and Discussion

#### 3.1. Forecasting of Product Demand

Forecasting carried out aims to predict raw materials in the next period using the time series method. Forecasting results are selected based on the smallest error estimation.

#### 3.2. Procurement of Optimal Raw Material Using Linear Programming

##### 3.2.1. Decision Variables

Decision variables are factors want to be controlled. Decision variables explain the problem and formulation of decisions made to optimize output and it meets the criteria and constraints. Data grouping and model formulation used as a function in the Linear Programming model compiled 60 decision variables over a period of one year. The decision variables used are CPO cost, PK cost, procurement cost using their own FFB, purchasing cost of FFB and processing costs. The decision variable in production planning in CPO production is  $X_{11} - X_{112}$  CPO procurement of FFB using their own garden every month;  $X_{21} - X_{212}$  FFb purchasing cost every month;  $X_{31} - X_{312}$  CPO cost every month ;  $X_{41} - X_{412}$  PK cost every month;  $X_{51} - X_{512}$  processing cost every month.

##### 3.2.2. Objectives Function

The objective function in this study is profit maximization. In this study, company profits are obtained by calculating the difference between the CPO cost and PK products with the total cost of raw materials procurement and processing. Value of profit calculated is profit before deducting fixed cost, general cost or also called gross profit. This is because the fixed cost does not change according to changes in the production quantity and they are in accordance with the assumptions based on linear program.

Maximization

$$Z = (TR - TC) \quad (1)$$

$$TR = (\sum X_1 * P_1)_{ij} + (\sum X_2 * P_2)_{ij}$$

(2)

$$TC = (\sum X_3)_{ij} + (\sum X_4)_{ij} + (\sum X_5)_{ij}$$

(3)

$$TR - TC = (\sum X_1 * P_1)_{ij} + (\sum X_2 * P_2)_{ij} - (\sum X_3)_{ij} - (\sum X_4)_{ij} - (\sum X_5)_{ij}$$

(4)

Description:

Z = Variable value of profit maximization objective (IDR)

TR = Total revenue (Gross income from sales of CPO and PK)

TC = Total cost (Raw material procurement and processing)

$X_1$  = CPO quantity per month resulted from FFB purchasing (Kg)

$X_2$  = PK quantity per month resulted from FFB purchasing (Kg)

$P_1$  = CPO cost per Kg (Rp/kg)

$P_2$  = PK cost per Kg (Rp/kg)

$X_3$  = Procurement cost of FFB from their own garden (Rp/Kg FFB)

$X_4$  = Procurement cost of FFB from outside garden purchasing (Rp/Kg FFB)

$X_5$  = Processing cost of FFB to be CPO and PK (Rp/Kg FFB)

$I$  = Sources of Raw Material to- $i$  (1, 2, 3...12)

$J$  = Production Month (January to December)

### 3.2.3. Determination of Constraints Function

Constraints are factors limitation for the company management to make production decisions. The constraint function formulated in this study is based on the availability of resources owned by the company. There are a quantity of constraints formulated in this study, namely, constraints to maximum factory production capacity, availability of FFB purchasing, quotas purchasing, labour availability and transfer constraints.

1. Constraint of factory capacity

Constraint function of factory capacity for January is: (5)

$$X_{11} + X_{21} \leq 19.734.000$$

2. Constraint of FFB purchasing availability

The supply of FFB raw materials from plasma plantations is an alternative source of availability in processing CPO and PK, which is continuous. Function constraints on the availability of FFB purchasing for January, namely:

$$0,4X_{21} - 0,6X_{11} \leq 0 \quad (6)$$

3. Constraint of purchasing FFB quota of palm oil

The policy taken by the company by setting a maximum limit for FFB purchasing from plasma plantations. Function of the constraints for purchasing FFB quota for January, namely:

$$0X_{21} \leq 4.485.000$$

4. Constraint of direct labor availability

The labor in each shift has 65 direct labors that operate processing machinery, where each day is divided into 2 shifts. One day is available for a labor of 130 people. Based on the calculation of 26 working days per month. The function of direct availability of labor constraints for January is:

$$0,00037X_{11} + 0,00310X_{21} \leq 3.887$$

(7)

5. Constraint of processing transfer

Transfer constraints are a percentage of the CPO value and PK produced from each kilogram of FFB processing. The processing transfer constraint function for January is:

$$X_{31} - 0,2013X_{11} - 0,19X_{21} \leq 0$$

(8)

6. Constraint of processing cost

Processing costs for companies are the cost of processing CPO and PK. The monthly processing costs for the kilogram are different depending on the price of CPO and PK produced. The function of the processing cost constraint for January is that:

$$X_{51} - 0,0582X_{31} - 0,0582X_{41} \leq 0$$

## 4. Conclusion

Linear programming method is used to maximize or minimize the resources owned by the company with several decision variables, objective functions and constraint functions. The

result shows that the decision variables used were CPO cost, the procurement cost using their own FFB, the cost of purchasing FFB and processing costs. The objective function is the maximization of company resources and constraint functions consisting of the maximum capacity of the factory, the availability of FFB purchasing, the purchasing quota of FFB, and the availability of direct labor, processing transfers and processing costs.

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