Affecting factors of CPO yield: An identification

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Abstract. The problem faced in the palm oil processing industry now is the instability of the Crude Palm Oil (CPO) yield. Begin from the condition of Fresh Fruit Bunches (FFB) in harvesting is carried out to the factory transportation, then during the production process. Both of these conditions are factors considered to be the cause of the instability of the CPO yield. This study aims to identify the factors cause the instability of CPO yield in the palm oil industry, which is expected to help the palm oil industry to achieve the CPO yield target set in each company. Control Chart and Fishbone Diagram are used to find the factors cause CPO yield does not reach the target (instability). From the data collected for 2 weeks, the results show that CPO is not controlled by statistically. Causative factors include the quality of raw materials, production equipment and machinery, worker behavior, and environmental conditions.

1. Introduction

At this time palm oil is a very popular plantation commodity in agriculture managed or planted, both by the state, plantations managed by the private sector (both domestic and foreign) and also smallholder plantations [1]. Palm oil has become one of the most important crops for food, energy and international trade in Indonesia [2, 3]. Meanwhile, the demand for vegetable oils continue to increase globally [4]. Although this offers great opportunities, there is an expansion need of palm oil products so that it does not give the negative impact [5, 6].

There are two types of oil found in palm oil. The first oil found in palm oil produced by the fruit (mesocarp) which is red in color, or commonly known as crude palm oil (CPO). Meanwhile, the second oil is found in the colorless palm kernel oil, or commonly known as Palm Kernel Oil (PKO). Palm oil production is measured by the total weight of Fresh Fruit Bunches (FFB) in tones/ha are then processed into CPO and PKO with byproducts in the form of shells, empty bunches and liquid waste [13].

Step done in this observation is the CPO yield. The CPO yield are influenced by several factors, namely the condition of FFB during harvesting-postharvest- process in the factory. The composition of the bunch fraction is influenced by the initial treatment at the harvest time [11]. Important factors are greatly affect the CPO yield are the ripeness of the palm oil and the transportation speed the fruit from the plantation to the factory. When fruit transportation is hampered, it cause delays in the factory process which is result in a decrease in the CPO yield and causes an increase in free fatty acids level of the fruit. Another factor plays a role in the CPO yield is the type of plant variety, but this factor does not significantly influence the CPO yield changes.

The palm oil with the Tenera variety developed by the Indonesian Oil Palm Research Institute (IOPRI) is palm oil plant type has a very high oil content, produce 5.5 – 7.5 tons of CPO and 0.5 tons of palm kernel oil/ ha/ year at the level of oil extraction rate (CPO yield) 23 - 26% and kernel extraction rate (yield) of 6.5 - 8%, with a weight produced of 23 - 28 tones of FFB/ha/year. Many factors cause instability than the CPO yield have not carried out comprehensively yet. Therefore, this observation is carried out with a focus only on identifying the factors cause unstable CPO yield
and does not reach the targets set by the company.

This observation is carried out at the Palm Oil Factory which located in Aceh Singkil Regency, Aceh Province. The quality standard for Crude Palm Oil (CPO) in this company has 3 parameters, namely Free Fatty Acid (FFA) maximum 3.0%, maximum Moisture 0.0% and maximum Dirt 0.02%. Meanwhile, the quality standard for Palm Kernel Oil (PKO) in this company has 3 parameters, namely maximum moisture 5.5 – 6.5%, maximum Dirt 6.5% and maximum Broken 15% [10]. The production process of palm oil fruit into Crude Palm Oil (CPO) and Palm Kernel Oil (PKO) is carried out at 9 work stations, starting from weighing stations, sorting stations, loading ramp stations, sterilizer stations, thresher stations, press stations, clarification stations, nut & kernel station, storage station (CPO storage & Kernel storage).

2. Research Methodology

The data used for identification is information data on Crude Palm Oil (CPO) yield per days in two weeks. The data obtained are analyzed using a Control Chart to see whether the data controlled or not [12]. Furthermore, the fishbone diagram is made to analyze the deviation causes result in process conditions are out of control [14].

The Control Chart and Fishbone Diagram in this observation as a tool to identify the factors cause the unstable CPO yields and does not reach the targets set by the company so that these factors notice or evaluation is carried out for immediate improvement so that the target CPO yield from the company is expected to be consistent in future goals.

3. Result and Discussion

Problem background occurred after an observation that cannot set the target yield by the company, which is 20%. During the observation, there are 7 data from 12 sampling data are not in the company's yield standard, means 58.3% of the total sampling does not match the standard. Of course this is a serious concern for the company because it results in does not reach the minimum target yield that the company wants. Therefore, identification will be carried out to determine the factors affect the CPO yield does not reach the predetermined standard or target of 20%.

A good CPO yield is CPO yield which is should be between 20- 23% [7]. The problems faced by management are not only on the FFB quality but also in the overall production process or on machines are not working optimally. The production process, starting from the FFB reception station to the process of CPO storage in the storage tank, also cause oil losses. The greater the oil losses occur, it can be concluded that there is deviation or damage to the CPO processing machine at a certain station. Oil losses are a condition of a process that cannot be avoided during FFB processing but must be made as small as possible so that it does not occur. Oil losses often occur at the following process points, conditions, or locations: sterilizers, empty bunches, unstripped bunches, fiber press, clarification stations, sludge waste.

The following is the data of CPO yield value at PT. Perkebunan Lembah Bhakti occurred during 2 weeks of observation can be seen in the Figure 1.
From Figure 1, there are 7 out of 12 sampling data are still below standard. So it is necessary to identify the factors cause the yield data does not reach the standards set by the factory.

The yield value that does not reach the target obtained during the observation caused by the machine performance is not good, such as a clarifier. We can see that the following data shows that oil losses occurred several times:

![Figure 1. Control Chart of CPO Yield Value](image)

From the table and chart figure of the oil loss value data above, we can see that from the value of the oil wet basis there are 6 out of 12 data are out of control, while none of the oil dry base data exceeds the set standard which means it is still in control. With the low yield value obtained during the production and processing process, the company or factory to increase the CPO yield consistently. Efforts are made to increase understanding of the applicable SOP at each station to get the better results.

The factors that cause the CPO yield fluctuated are not only about production process or production machines are not working properly causing oil losses, but in the other side, it can be caused by production of Fresh Fruit Bunches (FFB) itself. Palm oil consists of several kinds of...
criteria, namely crude palm, ripe palm and rotten palm. The following is data collected during the observation of crude and rotten palm, that can be seen on the table 1.

Table 1. Crude Palm and Rotten Palm Data

| Period | Crude Palm | Rotten Palm |
|--------|------------|-------------|
| 1      | 11.98%     | 0.88%       |
| 2      | 10.45%     | 0.79%       |
| 3      | 13.39%     | 1.60%       |
| 4      | 10.41%     | 0.67%       |
| 5      | 8.72%      | 0.83%       |
| 6      | 11.70%     | 0.58%       |
| 7      | 13.90%     | 1.15%       |
| 8      | 12.59%     | 0.98%       |
| 9      | 13.12%     | 0.94%       |
| 10     | 12.79%     | 1.55%       |
| 11     | 11.76%     | 0.83%       |
| 12     | 13.32%     | 0.53%       |

From the table 1, it can be seen that the percentage of the incoming crude palm is higher than rotten palm. But, both crude and rotten palm is not expected to enter the production process with that percentage. If these happen, it will affect the unstripped bunch that can decrease loose palm to be processed. The following is the unstripped bunch data observed, it can be seen on the table below:

Table 2. Unstripped Bunch (USB) Value Data

| Period | USB Value | Standard |
|--------|-----------|----------|
| 1      | 5.78%     | 1%       |
| 2      | 4.97%     | 1%       |
| 3      | 6.10%     | 1%       |
| 4      | 5.67%     | 1%       |
| 5      | 5.43%     | 1%       |
| 6      | 5.07%     | 1%       |
| 7      | 4.94%     | 1%       |
| 8      | 5.09%     | 1%       |
| 9      | 5.93%     | 1%       |
| 10     | 4.41%     | 1%       |
| 11     | 5.28%     | 1%       |
| 12     | 5.22%     | 1%       |

From the table above, unstripped bunch (USB) value is completely pass the standard. It means the data are out of control and needs more attention. It caused by decreased palm or production process on palm fruit. If the unstripped bunch is too high, it can decerase the CPO yield because the
processed looses still curled up in bunches.

From the data collected, the problem can be identified for the fluctuated CPO yield and it can’t reach the company standard. The main factor which can be used as references are environment, man, method, material, money, machine and equipment [15]. Problem identification is using the Fishbone diagram, a method that aim to identify and organize causes from significant effects and separate the root cause. The following is the result of yield CPO problem identification that can be seen on the figure below.

![CPO Yield Fishbone Diagram](image)

**Figure 3. CPO Yield Fishbone Diagram**

The problem of CPO yield at Palm Oil Mill consist of several factors, man, machine, material and method. From the fishbone diagram above, it explains that the problem faced by the company is it can’t reach the target and appointed standard in production process. Hence, the productivity value and company target is very weak because there are some losses in factory. And this result is in line with several research, that the biggest factor causes oil losses are machine and human error [8,9].

4. **Conclusion**

Based on the cause and effect diagram, there are some factors that cause the company can’t reach the standard of CPO yield, it consists of man, machine, material, dan method. There are solutions given by this problems are:

- **Man**, precision problem in sorting the palm. Improvements that can be given to workers, especially workers in the grading/sorting section is need training on the criteria for palm allowed by the factory.
- **Machine**, clarifier problem that is not working properly. had a problem with the clarifier that wasn't working properly. The suggestion that can be given is to pay more attention to the performance of the clarification machine, both the separation process, the dryer process, and also the purification process. Then for problems with the whole machine, improvement efforts are
checking and maintaining each machine before the production process is carried out.

- **Material**, high percentage of crude and rotten palm. For this reason, it is necessary to improve the harvest rules in the plantation section and also set the schedule for delivering the harvested fruit to the factory so that it is not too long because it will affect the oil content of the fruit.

- **Method**, harvesting process is not consistent with SOP. Based on the company’s Unstriped Bunch (USB) data, there are still many things not accordance to the TBS standard that can cause oil losses. For this reason, education/training is needed for workers and plantation owners so that harvesting is appropriate for processing FFB standards.

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