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Identification of Risk Factors for Sugarcane Cultivation to Minimize the Impact of Crop Failure

Inggit Marodiyah[1)], Atikha Sidhi Cahyana[2)], Intan Rohma Nurmalasari[3)]
[1,2)]Dept. of Industrial Engineering, Universitas Muhammadiyah Sidoarjo
[3)]Dept. of Agrotechnology, Universitas Muhammadiyah Sidoarjo
e-mail : inggit@umsida.ac.id, atikhasidhi@umsida.ac.id, intan.rohma@umsida.ac.id

Abstract

The sugarcane cultivation process has diverse and uncertain risks. Many risk trigger factors arise in sugarcane planting activities, such as land conditions, land area, seeds, fertilizers and fertilization processes, and labor. These factors resulted in disrupted sugarcane yields and decreased quality and quantity. This study aims to identify and determine the highest risks in the sugarcane planting process so that mitigation can be implemented.

The method applied in this study is Failure Mode Effect Analysis (FMEA) based on ex-ante, interactive, and ex-post strategies. This method is used because FMEA can find potential failures in sugarcane planting and identify risks that occur to reduce possible risks or prevent failures.

The study's results found the highest risk was irrigation factors, pest control factors, and dry leaf exfoliation time factors.

Keywords: Risk mitigation, Quality Risk Management, Failure Mode Effect Analysis

Introduction

A risk is an event that may occur when carrying out a process or activity. Because it has properties that can be detrimental when it occurs, the risk requires control measures (Asrol et al., 2021). According to Suryaningrat et al. (2019), risk control can minimize losses caused by events. All activities have risks that can never be separated from uncertainty so they must be known from the beginning. The risks and impacts can be known if the phenomena are understood. Measurement of the extent of information they have and experience that has been gained. Identification of solutions should also be done to reduce the impact of risk. If risk impacts are not immediately known and handled properly, achieve the target within a certain period. Each risk must also be identified by monitoring its development so that anticipation can occur in case the target is not achieved .

The method that discusses the whole thing about risk is quality risk management (QRM). According to Reddy et al. (2014), QRM minimizes risk to optimize its usefulness. QRM assesses, controls, and assesses the risks of a product as a basis for effective and consistent decision-making based on risk assessment. An effective QRM approach can assure quality by identifying and controlling problems. Evaluating risks to quality is carried out based on scientific knowledge and is associated with the ultimate goal of carrying out its activities. The effort and assessment of the level of risk should be equivalent to the quality to be produced. QRM starts from identifying risks,

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analyzing risks, and evaluating risks. After that, risk control is carried out by reducing risk and accepting risk. This decision-maker must have adequate and adequate resources to be responsible for the decision-making.

Indonesia is an agricultural country, where one of the agricultural products that is the main food for people besides rice is sugar. Sugar is a basic need of the Indonesian people. According to a report by the Central Statistics Agency (BPS), sugar consumption increased from 2.35 million tons in 2021 to 6.48 million tons in 2022. The sugar production process that uses sugarcane requires farmers to produce sugarcane with good quality and high yields. The quality of sugarcane is characterized by a high degree of sugarcane yield. The higher the sugarcane yield, the better the quality of sugar produced (kominfo.jatimprov.go.id).

Several incidents of sugarcane crop failure have occurred in several places in Indonesia. In 2014, climate differences resulted in sugarcane crop failure in Pekalongan (jateng.antaranews.com). In 2021, hundreds of hectares of sugarcane failed to harvest because the land was damaged by flooding (kompas.com). Crop failure must be minimized; to minimize failure, risk mitigation is necessary. FMEA(Failure Mode Effect Analysis) is a suitable risk mitigation method.

According to Xiao et al. (2011), FMEA is a very effective analytical tool in assessing probability and failure modes and eliminating potential failures so that the focus can be directed to act on the impact that occurs. FMEA can be used to reduce risk, especially in the highest risk priority, by prioritizing corrective actions, providing documents for continuous improvement, improving quality, and minimizing risk. Risk assessment is carried out using the Risk Priority Number (RPN) with three determining factors, including:

a) Failure rate (severity)

b) The frequency of failures (*occurrence*)

c) Rate of the probability of failure before an event (*detection*)

Risk estimation is done using the RPN formula. RPN calculation is obtained from RPN = severity X occurrence X detection.

To date, many risk mitigation studies have used FMEA. Risk mitigation aims to reduce the magnitude/level of the main risk. By taking mitigation actions, risks and impacts can be either avoided or accepted.

Methodology

The initial stage carried out in this study is (a) identifying risks, the identification process is carried out during the sugarcane planting process, (b) analyzing the risks that occur, (c) evaluating risks, (d) following up on risks, namely by prevention to minimize the occurrence of risks and their impacts. This must be addressed immediately so as not to further harm sugarcane farmers. Thus, optimization requires monitoring and control (Darnhofer, 2014).

The second stage is data collection with (a) Focus Group Discussion (FGD) involving farmers and agricultural experts to determine risk points during the sugarcane planting period. (b) List failure models and effects/impacts of failure modes occurring (FMEA), a powerful and effective analysis widely used in engineering projects to examine possible failure modes and eliminate potential failures during the cropping process. (c) Determine the severity rating and event rating. (d) Calculating the Risk Priority Number (RPN) value, RPN is obtained from severity x occurrence x

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detection. (e) Prioritizing failure modes to provide corrective actions, and (f) Risk mitigation (lowering risk levels)

Results and Discussion

Data processing

Stage 1, FGD results show the factors that cause sugarcane crop failure as risks that may arise in the planting process. These factors include: the land selection process, maintenance process (seed selection, fertilization, pest control, klentek, water supply, and land fires)

Stage 2, list of failure models and the effects of failure modes that occur (FMEA): sugarcane does not grow well (small/dry / dead) to reduce the quality of sugarcane, which means it can reduce the yield value.

Stage 3, Determine the severity rating, event rating and probability of failure occurring: an assessment using the Likert scale based on the level of failure (severity), the level of frequency of failure (occurrence), and the level of probability of failure before the event (detection)

Stage 4, Calculating the value of Risk Priority Number: calculation by multiplying risk based on severity, occurrence, and detection levels.

Stage 5, Prioritizing failure modes to provide corrective actions: from the results of the recapitulation of the risk analysis obtained the highest risk value first in the water supply process, second in pest control, and third in the *klentek* process.

Discussion

The sugarcane planting process and its risks are as follows:

Ex Ante Strategy

a. **Soil Structure**

The phase before the planting process is:

First, the selected soil must be fertile, and spark channels and water intake must be present. A spark channel is the creation of a channel for water. Second, garden roads or roads for sugarcane transportation must be ensured to exist or be available and feasible to expedite the fertilization/treatment/logging process. Third, historical plantations where the land is often attacked by diseases/rats, former rice fields or not, and an increased land rental system will make prices higher

b. Seed

Sugarcane is classified as a type of grass, so it is suitable for planting in the lowlands. As a result, three different planting methods resulted in three different types of sugarcane seedlings. How to plant sugarcane seedlings as follows:

– Cuttings of cane shoots

Sugarcane seeds are harvested from shoots about 3 to 4 internodes long. Remove sprouted leaves. First, prepare the planting hole, place the shoots in the ground, and plant.

- Rayungan

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This type of sugarcane seed is obtained from young sugarcane that has become buds. Each sprout stem must have an eye to be called a seed because all eyes become buds. These seeds are then planted as needed. These seeds are also commonly used for embroidery. Sewing requires grafting or re-embroidery if there are dead seedlings or damaged plants so that they can be harvested together later. I also need a planting hole for embroidery.

- Hump

  This type of weevil is a seed obtained from the remaining sugarcane that has been cut down. The remaining weevils embedded in the ground will grow and sprout new. To collect and plant these seeds, seed selection is also necessary. Therefore, these weevil seedlings are obtained from good-quality sugarcane.

Interactive Strategy

c. Fertilizer

In the process of planting sugarcane, there are several types of fertilizers used, such as ZA which is a mandatory fertilizer because it does not have the effect of reducing sugar content (yield). ZA fertilizer can increase sugarcane yield production and yield and make sugarcane fresher. Then Phonska, which is a fertilizer enriched with sulfur and zinc, contains 15% N, 15% P2O5, 15% K2O, and 10% S. The use of biocompost accompanied by Phonska fertilizer in sugarcane plants is expected to be able to meet the needs of nutrients and water in plants, especially in the vegetative period and be able to improve land quality.

d. Pests

Rats are pests that are often found in the process of growing sugarcane. Symptoms of rat wounds based on the stage of growth of sugarcane plants are a). Rats gnaw through the segments of mule saplings, but when irradiated, damage to the stems just above the ground causes the upper leaves to wither, dry, and die. b) Young plants, age 2-3 months. Damage to young plants is similar to damage to Layungan seedlings. Damage to young plants is visible from leaves that appear to have been pruned with a blunt knife. Damage to the stems and aboveground shoots. This damage is usually accompanied by damage to the roots, causing the leaves to wither, turn yellow, dry out, and cause the plant to be easily pulled out.

Rats' damage to sugarcane plantations is often severe, but they cannot survive and reproduce simply by eating sugarcane plants. Especially in Java, rats attack sugarcane plantations because they do not have access to other foods that rats like in the area. Unlike the damage caused to sugarcane plantations that are far from other crops, such as rice and other crops, the presence of rats in this area shows that they prey on sugarcane plants and other foods around existing sugarcane plantations.

e. Klentek

Klentek is an activity of stripping, cleaning, and removing sugarcane leaves still attached to sugarcane stalks. Klentek is made with a sickle or just by hand. This activity was carried out three times. First, run *klentek* when the sugarcane already has 3-5 internodes.

Klentek is an activity to remove old leaves on sugarcane stalks, reduce the spread of pests and diseases, reduce plant stress so that sugarcane plants do not fall easily, reduce the risk of fire, improve good air circulation, and reduce simple sugars. They were intended to form sucrose

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from to speed up and facilitate logging activities. *Klentek* runs twice during the growing season. That is when sugarcane is ±5 months old and ±8 months to increase sugarcane yield.

f. Water Supply

Sugarcane plants must get enough water to remain productive at every growth stage. However, in practice, due to limited water sources, it is not easy to achieve maximum conditions at any stage of growth. The reason is that the number and weight of stems greatly influence the amount of sugarcane produced. Water security is needed by using an irrigation system when the water supply is cut off.

g. Land Fire

Most of the fires are caused by people throwing cigarette butts carelessly. Therefore, fire becomes a very difficult risk to predict. The charred sugarcane must be immediately cut down and transported to the sugar factory in a fire. Because if the trees are not cut down immediately, the sugarcane will wither and cannot be accepted by the sugar factory.

Ex-Post Strategy

h. Capital

Capital used for sugarcane plantations usually uses KUR loan funds. KUR funds are submitted at the beginning of the planting process and paid after the milling process.

Risk Mitigation

Action to follow up the risks that occur is by mitigating risks.

Table 1. Risk Mitigation

No	Process	Risk	Risk Mitigation
1	Water Supply	Poor drainage system	Creating a good irrigation system
2	Pest	Pest attack	Administration of pest control drugs according to levels
3	Klentek	Leaves not exfoliated/*klentek*	Pay attention to the time of *kletek* and carry out *klentek* well
4	Land fires	Burning sugarcane	Always supervise the situation around the land
5	Fertilization	Improper dosing of fertilizer	Following the direction of the fertilizer team for sugarcane
6	Nursery	Failed embroidery process, resulting dead plants	Always check the land and re-embroidery
7	Fertilization	Sugarcane does not get the appropriate nutrients	Ensure a good and smooth irrigation system

8	Soil structure	Incompatibility of soil structure with sugarcane	Adjusting seedlings to the land to be used
9	Fertilization	Sugarcane does not grow accordingly	Conduct intensive treatment
10	Pest	No hoarding	Landfilling and weeding are carried out
11	Nursery	Seedlings are laid not according to their type	Adapting seedlings to the field

Conclusion

Based on the results of the study, it was found that the highest risk based on the RPN value on irrigation factors was at a value of 32.30, pest control factors with a value of 32.37, and exfoliation time factors / klentek with a value of 20.39. Risk mitigation by making/ensuring the irrigation system runs well, giving pest control drugs so they are not easily attacked by disease, and paying attention to the exfoliation time of leaves / *klentek* according to schedule.

Suggestion

The weakness of this study is that it does not discuss the costs spent during the sugarcane planting process. So that for the sustainability of research, risk analysis based on cost can be carried out.

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