Empowering Communities of Coffee Farmers via Risk Management and Coffee Berry Borer Control

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ABSTRACT

Background: Coffee farmers in Central Aceh face challenges with coffee berry borer pests, reducing yields and market value. Empowering the Musara Miko farmer group aims to address these issues through education and training in risk management and environmentally friendly pest control.

Contribution: The purpose of this community service project is to raise awareness about coffee berry borer pest risk management and control. It is intended that by engaging in this activity, the community will be able to reduce the risk associated with producing coffee while simultaneously increasing output and improving quality.

Method: This activity includes socialization, training, and practice. Risk management socialization activities are carried out to provide an understanding of risk management, training activities to make pest control tools using simple materials, then practice controlling coffee berry borer pests in the field. This activity involved 21 farmers as training participants.

Results: This empowerment program showed an increase in knowledge about risk management and control of coffee berry borer pests by 71%.

Conclusion: The program significantly improved farmers' ability to manage pests, enhancing productivity, quality, and market value, fostering sustainable coffee farming and economic welfare.

1. Introduction

Pegasing Village, located in Central Aceh Regency, Aceh Province, is known as one of the premium Arabica coffee producing regions in Indonesia. Located at an altitude of between 1,200 and 1,400 meters above sea level, Pegasing has climatic conditions that support the optimal growth of coffee plants, especially Arabica coffee, which is valued for its strong aroma and distinctive taste. The favorable geographical potential makes it a strategic region for the sustainable development of the coffee industry [1]. Coffee from Pegasing has been in high demand, both in the domestic and international markets, creating great opportunities for local farmers to improve their welfare through coffee cultivation [2]. However, despite this potential, farmers in the region, including the Musara Miko Farmer Group, are faced with significant challenges, particularly regarding pest risk management.

One of the biggest threats faced by farmers in Pegasing is the attack of the coffee berry borer (Hypothenemus hampei) [3][4]. The coffee berry borer (Hypothenemus hampei) is a major pest of coffee [5] [6]. It can cause substantial damage to coffee fruits, which has a direct impact on reducing the quality and quantity of the crop [7] [8]. Coffee fruit borer infestation is higher on yellow fruits and red fruits at 96%- 99.5% [9]. Research shows that this pest can reduce coffee production by 10-40%, while production costs can increase by 10-15% due to ineffective pest control efforts [10] . In highlands like Pegasing, cooler temperatures may slow down the life cycle of the coffee borer, but without proper risk management, it remains a major threat to the sustainability of coffee production in the region.

The main challenge for the Musara Miko Farmer Group and other farmers in Pegasing lies in the lack of awareness and knowledge in early detection of pest infestations as well as the lack of access to environmentally friendly pest control technologies. Many farmers still rely on chemical control methods that are not only potentially damaging to the environment, but also not always effective in preventing pest infestations. A limited understanding of risk management and the inability to implement preventive measures early on often results in substantial losses, both in terms of quality and quantity of coffee yields. For example, pest infestations are often noticed only after coffee cherries show signs of damage, such as holes or blanks, which reduce their market value, so pest and disease management will be an important part of the better management system that will be required if coffee yields are to be increased [11] [12].

In addition to pest attacks, sub-optimal land maintenance, such as the lack of regular weeding practices and good soil management, also worsens the condition of coffee plants. Weeds growing around the plants compete for nutrients, making the coffee plants less healthy and more susceptible to pest attacks. Poor maintenance also contributes to other problems, such as harvesting immature fruits, which significantly reduces the quality of the final coffee product [13] [14]. Coffee fruits harvested too early produce beans that are smaller, less dense, and have suboptimal flavor, which ultimately affects the selling price and income of farmers

[15].

To deal with these problems, the implementation of comprehensive risk management is an urgent need. Risk management in the agricultural sector, particularly in coffee cultivation, involves identifying, analyzing, evaluating and controlling various risks that may affect production. In the context of coffee berry borer infestation, farmers must be able to identify the risk of infestation early on, analyze its potential impact, and implement effective control strategies, such as the use of natural predators or other biological control methods. In addition, keeping the land clean and conducting regular monitoring of coffee plants can help prevent the spread of pests and strengthen plant resistance to attack.

Although some farmers already have experience in coffee cultivation, their reliance on unsustainable conventional methods is a major obstacle in improving yields and coffee quality. Therefore, capacity building of farmers through training on the importance of proactive risk management should be a priority. A more structured approach based on sustainable practices will enable farmers to be better prepared for challenges that arise, from pest attacks to changing environmental conditions.

With the proper implementation of risk management, farmers in Pegasing are expected to reduce the negative impact of coffee borer infestation and increase the stability of their production. This will not only improve the quality and quantity of coffee produced, but will also improve farmers' welfare and support the sustainability of the coffee industry in Pegasing. Therefore, this community service was conducted to provide an understanding of risk management and control of coffee berry borer pests that can be applied to increase coffee production and sustainability in Pegasing Village.

2. Method

This community service program was implemented in Pegasing Village, Pegasing District, Central Aceh Regency in August 2024, with the participation of 21 members of the Musara Miko farmer group. The implementation of this program was divided into three stages, namely: socialization, training, and practice (Figure 1), with the aim of increasing farmers' knowledge and capacity in sustainable pest management, especially in controlling coffee berry borers. The main outcome of this program is an appropriate technology in the form of a cheap and sustainable pest trap to increase the production and quality of coffee beans.
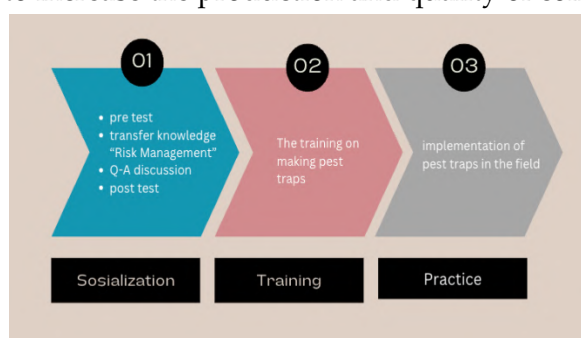

Figure 1. Method of community service

2.1. Socialization

The socialization stage aims to transfer knowledge about risk management and pest control. This activity was held at Musholla Mersa Kul in Pegasing Village, starting with a pre-test in the form of multiple-choice questions to evaluate farmers' initial knowledge of risk management and pest control strategies. After that, the presentation of material on risk management, interactive discussions with participants, and ended with a post-test to measure the increase in knowledge of participants after socialization.

2.2. Training

At the training stage, farmers were introduced to coffee berry borer traps consisting of traps and attractants. These devices are used to effectively control pests. In addition, farmers were also trained to make pest traps independently using simple materials easily found around them, such as used plastic bottles, scissors, rope, and dish soap. The process of making the traps involves making holes in the plastic bottles as entry points for pests, hanging the bottles with ropes, and adding dish soap as a trapping liquid inside the traps.

The training was designed to enable farmers to save costs in pest control by utilizing materials available in the surrounding environment. That way, they will not only get the traps from the service team, but also be able to make the traps independently in the future. The main objective of this training is to increase farmers' independence in managing pests in a cost-effective, sustainable, and environmentally friendly way.

This method was chosen because the combination of traps and attractants has been proven effective in reducing coffee berry borer pests. In addition, the materials used are easy to find, environmentally friendly, and do not require harmful chemicals. The use of simple materials such as used bottles and dish soap also helps in keeping pest control costs down, making it a reliable solution that can be sustainably applied by farmers.

Figure 2. practice of making pest traps

2.3. Practice

After the training on making pest traps was completed, the farmers immediately practiced setting up the traps in their respective coffee fields. Installation is done by hanging the traps at a height of about 1.2 meters from the ground [16] [17], according to the recommended standard to maximize the effectiveness of the traps. The distance between traps is set at about 20 meters to ensure even distribution and optimal control of pest populations across the entire field area.

The traps were filled with a mixture of water and dish soap to a height of 2 cm from the bottom of the trap, which serves to capture incoming pests. In addition, the attractant is pierced on the prepared area to lure the pests into the trap. This process is done carefully by farmers to ensure that the traps function optimally in suppressing the coffee berry borer population.

Figure 3. Installation of pest traps in the field

3. Results and Discussion

3.1 Impact of Training on Risk Management Awareness

Coffee production risk management training in Pegasing, Central Aceh, significantly increased farmers' awareness of managing various production risks, particularly coffee berry borer (PBKo) infestation, which can reduce yields by up to 40%. Farmers were introduced to the concept of risk management and learned how to identify, evaluate, and mitigate various risks affecting their coffee production.

Analysis of the pre-test and post-test showed a 71% increase in risk management knowledge, reflecting the effectiveness of the training program. The average understanding before the training was 54.76, which increased to 93.81 after the training (figure 4). This indicates that there was a positive impact of the intervention on farmers' knowledge.
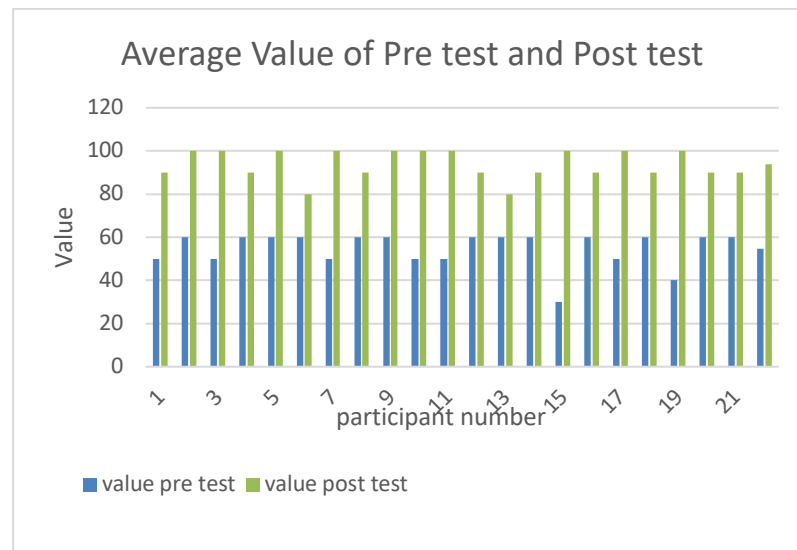
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Figure 4. Average Value of Pre test and post test

Figure 4 shows that the training was very effective in improving farmers' understanding of risk management. This increased knowledge has important implications for coffee production in the region, as better risk management can help reduce losses due to pest attacks and other production challenges.

3.2 Effectiveness of Pest Control Techniques

During the training, farmers were introduced to environmentally friendly pest control methods, particularly the use of simple traps made from used bottles, soap, and pheromone lures. These traps target the PBKo pest that damages coffee fruits. The choice of this method was based on its effectiveness [18] [19] and low cost, allowing farmers to control pests without relying on chemical pesticides.

Field practice shows that these traps significantly reduce the coffee borer population in farmers' coffee plantations. Farmers can see firsthand the efficiency of these traps, which helps them better understand how to implement pest control independently. The eco-friendly nature of this method is also in line with sustainable agricultural practices, which provide long-term benefits to the community [20].

3.3. Future Implications for Coffee Quality

The program's success in improving pest control practices and risk management has important implications for future coffee quality in Pegasing. By preventing coffee borer infestation, farmers can maintain the quality of their coffee beans, which can be sold at a higher price in the market. This improved quality not only increases the economic value of their products, but also contributes to the sustainability of their farming practices.

The field application of this pest control technique is directly correlated with increased crop yields and reduced losses due to pests. Farmers are now better prepared to recognize the early

signs of pest attacks and take appropriate preventive measures, ensuring that their coffee production remains of high quality. These practices have the potential to increase farmers' income and improve their overall livelihoods.

3.4 Qualitative Feedback from Farmers

Farmers provided positive feedback regarding the practicality of pest control techniques. They appreciate the cheap and accessible trap methods and express confidence in continuing these practices on their land. Some farmers also reported a decrease in pest activity after installing the traps, further reinforcing the effectiveness of this program.

Figure 5. The pest trap successfully caught the coffee borer pest

This training model can be applied to other farming communities facing similar pest management challenges. The success of the program in Pegasing shows that environmentally friendly pest control and risk management training can be expanded to benefit more farmers in the region. By integrating these practices into local agricultural policies, communities can promote sustainable coffee production while addressing key issues such as pest control and crop loss.

Although this program was successful, there are several limitations, such as the small sample size involving only 21 farmers, which may not fully represent the broader community. Additionally, the short duration of the study limits the ability to assess the long-term impact on coffee production. Future research could expand the sample size and extend the monitoring period to gain deeper insights into the effectiveness of these interventions.

To ensure the sustainability and expansion of the program, additional funding is needed so that more farmers can participate in this training and to provide resources for sustainable pest control practices. Collaborating with agricultural organizations and integrating more advanced technologies, such as digital pest monitoring systems, can further enhance the effectiveness of these interventions. In addition, expanding the scope of training to include other aspects of sustainable agriculture, such as soil health and water management, will be very beneficial for farmers in the long run.

This community service program has a significant impact on the livelihoods of coffee farmers in Pegasing. The increased awareness of risk management and pest control methods has contributed to the improvement in coffee production quality and the increase in selling prices in the market. As the program progresses, it is expected that more farmers will experience increased income and sustainability in their coffee farming practices. By facilitating a better understanding of risks and pest control, this program has the potential to positively impact economic and environmental sustainability in coffee production in Central Aceh.

4. Conclusion

The empowerment program in Pegasing Village successfully improved risk management techniques and control of coffee fruit borer pests. The knowledge and skills of farmers have significantly increased, evidenced by a 71% increase in understanding, which is expected to contribute to the improvement of productivity, coffee quality, and farmers' income. The economic benefits of this program include increased income stability for farmers as well as strengthening the independence and resilience of farmer groups in facing challenges. Continuous support and training are greatly needed so that the practices taught can continue to be applied. High optimism regarding the potential of farmers to adapt and innovate with these new skills, which are expected to have a long-term impact on the improvement of their welfare and the sustainability of their coffee farming.

Acknowledgement

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