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Effectiveness of Rat Pest Control (*Rattus* sp.) Using Rodenticide in Immature Oil Palm Plants at PT PP London Sumatra Indonesia Tbk Dolok Estate

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Abstract

Rats (*Rattus* sp.) are major pests in immature oil palm plantations, where their attacks can impair plant growth and cause economic losses, highlighting the need for effective and economically efficient control strategies. This study aimed to evaluate the effectiveness of brodifacoum-based rodenticide in controlling rat pests and to analyze the associated control costs at PT PP London Sumatra Indonesia Tbk., Dolok Estate. A descriptive quantitative observational approach was employed from October 2025 to February 2026 in Block 25112003, Division 02, involving two plots with different previous land uses. Rat activity was monitored weekly based on the percentage of missing bait using a 20% threshold, while control costs were analyzed according to expenditure components. Data were analyzed descriptively and using an independent-samples t-test. The findings showed that the percentage of missing bait in Plot 1 cumulatively declined from 29.5% to 21.8%, whereas Plot 2 remained relatively stable at 21.5–21.8%. Rat attack levels differed significantly between the two plots, indicating variation in pest activity according to land characteristics. Brodifacoum-based rodenticide supported rat control, although its effectiveness varied between plots. The study concludes that rodenticide-based rat management should consider block-specific land characteristics to improve control effectiveness. These findings provide practical evidence for developing more targeted rat-control strategies and improving resource allocation in immature oil palm plantations.

Keywords: Brodifacoum; Control Effectiveness; Immature Oil Palm; Rat Pest; Rodenticide

INTRODUCTION

Oil palm cultivation is one of Indonesia's strategic agricultural sectors because of its extensive plantation area and substantial contribution to the national economy. The Central Bureau of Statistics reported that Indonesia's oil palm plantations covered more than 15 million hectares and produced approximately 49 million tons of crude palm oil (CPO) annually (Badan Pusat Statistik, 2024). Given this scale of production, maintaining crop productivity requires not only appropriate cultivation practices but also effective plant protection. In plantation systems, productivity can be constrained by environmental conditions, crop management, and pest infestations (Gulo et al., 2025). Therefore, effective pest management is an important component of maintaining the growth and long-term production potential of oil palm plantations.

Among the pests affecting oil palm, rats represent an important concern, particularly during the immature plant stage or Tanaman Belum Menghasilkan (TBM). Rats can damage young oil palm plants by gnawing on fronds, stems, and growing points, thereby interfering with vegetative development (Wa'di et al., 2025). Such damage is particularly important during the early growth stage because severe injury may require plant replacement and subsequently delay the transition of plants into the productive phase. Ikhsan et al. (2020) emphasized that rat management in oil palm plantations requires appropriate intervention because rat populations can increase rapidly under favorable environmental and ecological conditions.

This problem is also encountered at PT PP London Sumatra Indonesia Tbk. Dolok Estate, where rat infestation has been identified as a management concern in immature oil palm areas. The reported infestation level ranges from 5–20%, with an estimated population of approximately 100–250 rats per hectare. Such conditions indicate the need for effective control measures that can reduce rat populations while limiting damage to immature plants. Chemical control using rodenticides is one of the approaches implemented at the plantation level. Among the available active ingredients, brodifacoum is widely recognized as a second-generation anticoagulant rodenticide with high toxicity toward target rodent populations (Susanti & Sari, 2025).

Brodifacoum acts by interfering with the blood-clotting process, resulting in delayed mortality following ingestion of the bait. The delayed toxic effect may reduce the likelihood that rats associate the bait with subsequent mortality, thereby helping maintain bait acceptance within the population (Astisyah et al., 2025). Its potential effectiveness is also supported by laboratory evidence showing that low doses of brodifacoum can produce high mortality in Rattus tiomanicus populations under experimental conditions (Hidayah et al., 2026). Nevertheless, laboratory efficacy does not necessarily represent field effectiveness because bait consumption and control outcomes may vary according to habitat characteristics, alternative food availability, and application practices.

One environmental factor that may influence rat activity is the presence of legume cover crops (LCC) within plantation areas. Species such as Mucuna bracteata, Pueraria javanica, and Calopogonium mucunoides may provide both habitat and alternative food resources when their pods and seeds become available. Kocira et al. (2020) reported that areas with leguminous ground vegetation may exhibit higher and more fluctuating rat population dynamics because such vegetation provides resources that support population persistence. Consequently, the effectiveness of rodenticide application should be considered in relation to field conditions rather than solely on the toxic properties of the active ingredient. Proper management of vegetation and plantation sanitation may therefore complement chemical control.

The physiological condition and developmental characteristics of immature oil palm plants are also relevant when evaluating the consequences of rat infestation. Oil palm undergoes progressive vegetative development and requires favorable growth conditions to reach its productive stage (Sulardi, 2022). The stem and fronds are important structural components supporting plant development, making damage caused by rat gnawing potentially disruptive to vegetative growth (Putranto, 2021). In addition, the condition of the canopy and fronds is closely related to the plant's capacity to maintain normal growth. The importance of maintaining an adequate number of functional fronds to support optimal oil palm growth and productivity. Therefore, pest-control evaluation should consider both pest-related indicators and plant responses.

Rat management should also be considered within the broader framework of Integrated Pest Management (IPM). IPM promotes the coordinated use of different control approaches while considering pest suppression, environmental consequences, and human safety (Gea et al., 2024). In oil palm plantations, rat populations may be managed through mechanical, biological, and chemical approaches (Sitorus et al., 2026). Chemical control through rodenticide application offers practical advantages for large plantation areas, whereas biological control using natural predators such as Tyto alba can contribute to long-term population regulation (Trisyanto et al., 2026). Accordingly, chemical control should be evaluated not as an isolated intervention but as part of a broader pest-management strategy.

Previous studies have demonstrated the potential of rodenticides for suppressing rat infestations in oil palm plantations. Mahendra et al. (2022) reported that chemical control using Klerat reduced rat infestation levels to below the threshold applied in their study. Similarly, Muhammad et al. (2025) found that a brodifacoum-based rodenticide produced rat mortality following application at the recommended dose. Rodenticide application could reduce rat-related damage in oil palm plantations, including immature stands. These findings indicate that chemical control has practical potential, but they also demonstrate the importance of evaluating its performance using measurable field indicators.

Evidence from previous research also suggests that rodenticide efficacy may vary according to active ingredient and experimental or field conditions. Tarmadja & Ngidha (2018) compared several anticoagulant rodenticides and found differences in their efficacy for suppressing rat populations in oil palm plantations. Riani et al. (2024) likewise reported favorable bait palatability and mortality responses associated with brodifacoum-based rodenticide. However, much of the existing research has focused primarily on mortality, bait consumption, or comparisons among rodenticide types. Less attention has been directed toward evaluating the practical effectiveness of a brodifacoum-based intervention by simultaneously considering pest suppression, crop damage, and control costs under specific plantation operating conditions.

The research gap addressed in this study concerns the limited field-based evaluation of brodifacoum rodenticide on immature oil palm that integrates pest-control outcomes with crop damage and economic considerations at a specific plantation site. Rat population dynamics are not static because individual movement and habitat conditions can influence population distribution across plantation areas. Ananda et al. (2025) highlighted the role of rat movement in population dispersal between plantation blocks. Furthermore, chemical control requires careful consideration of environmental implications because highly effective rodenticides may also pose ecological risks when improperly managed (Natawigena et al., 2024). These considerations demonstrate the need for an integrated assessment of actual field performance rather than relying solely on the inherent toxicity of the active ingredient.

The novelty of this study lies in evaluating the effectiveness of brodifacoum-based rodenticide directly under operational plantation conditions at PT PP London Sumatra Indonesia Tbk. Dolok Estate by integrating rat-control indicators, infestation levels or plant damage, and the costs associated with the control process. This approach extends the concept of effectiveness beyond the ability of a rodenticide to cause mortality. Effectiveness is understood as the extent to which an activity achieves its predetermined objectives Lestari et al. (2024), while the achievement of objectives should also be considered in relation to time, cost, and available resources. Thus, the evaluation provides a more operational perspective on whether the control practice achieves its intended field objectives.

Field evaluation is particularly important because the response to rodenticide application may depend on bait acceptance, rat behavior, and environmental conditions. Riani et al. (2024) demonstrated the potential of brodifacoum to suppress rat populations, while the actual outcome of control still requires assessment under the conditions in which the intervention is implemented. Therefore, this study does not merely examine whether brodifacoum can control rats, but also evaluates the extent to which its application is associated with changes in infestation levels and the resources required for control. Such evidence can support more measurable and context-specific pest-management decisions at the plantation level.

Accordingly, this study focuses on the effectiveness of rat pest control using brodifacoum-based rodenticide on immature oil palm at PT PP London Sumatra Indonesia Tbk. Dolok Estate. The study aims to evaluate the effectiveness of rodenticide application in controlling rat infestation, examine its effect on infestation levels and the condition of immature oil palm, and determine the costs associated with the control process. The findings are expected to provide empirical information for evaluating existing rat-control practices and to support plantation managers and relevant stakeholders in developing measurable and appropriately targeted pest-management strategies for immature oil palm plantations.

METHODS

This study employed a quantitative approach using a descriptive observational and non-experimental design. The design was selected to describe rat infestation in immature oil palm (TBM) based on field observations without introducing treatments or manipulating the research objects. A descriptive quantitative approach was used to present the observed conditions through numerical data collected under actual field conditions (Sugiyono, 2022). The study was conducted from October 2025 to January 2026 at Division 02 of PT PP London Sumatra Indonesia Tbk. Dolok Estate, Lima Puluh District, Batu Bara Regency, resulting in a four-month research period. The research site was selected purposively based on the objective consideration that the area contained rat-infested immature oil palm.

The research objects consisted of immature oil palm plants located in two observation plots, namely Block 25112003 Plot 1 and Plot 2. The two plots were purposively selected based on their different previous land-use conditions. Plot 1 was established on an area previously used for maize cultivation, whereas Plot 2 was located on an area previously occupied by oil palm that had undergone replanting. These areas were selected because rat activity or movement was identified in both locations, while accessibility and the availability of supporting plantation data also facilitated field observations. Plot 1 covered 14.52 ha with a population of 2,076 plants, while Plot 2 covered 16.11 ha with a population of 2,304 plants. Accordingly, the observation units comprised the plants within both plots, with the sites deliberately selected according to the characteristics relevant to the research focus.

The research design focused on three principal indicators: the proportion of infested plants, loss of brodifacoum-based rodenticide bait, and the cost of rat control. The proportion of infested plants was used to describe the occurrence of rat damage by comparing the number of infested plants with the total number of observed plants. Infestation was identified through visual inspection, particularly by examining the plant base for rat gnawing marks or scars and observing damage to the growing point. Rodenticide loss served as an indicator of rat activity based on the amount of bait that disappeared from the plant circles. Control cost was used to determine the expenditure required for rat-management activities. In this study, effectiveness refers to the extent to which an activity achieves its predetermined objectives (Lestari et al., 2024), while the achievement of effectiveness is also considered in relation to the resources and costs involved.

Data were collected through direct field observation, photographic documentation, and structured observation sheets (tally sheets). Field observations were conducted by visually inspecting individual plants across both plots once a week. The inspection followed the infestation characteristics specified in the Standard Operating Procedure (SOP) of PT Lonsum Dolok Estate. A plant was recorded as infested when rat gnawing marks or scars were identified on the plant base. The condition of the rodenticide bait was also examined during each census; when bait was found to be missing, its loss was recorded and replacement was carried out as part of the field control practice. Photographs were taken to document plant conditions and visible infestation symptoms as supporting evidence. Primary data comprised infestation levels, the amount of missing rodenticide bait, and control costs, whereas secondary data were obtained from plantation records, company reports, scientific literature, research articles, and relevant documents.

The collected data were analyzed using descriptive quantitative analysis through percentages, means, and comparisons between the two observation plots. Descriptive analysis was applied to provide a systematic representation of the observed conditions based on the collected data (Tanjung & Albina, 2025) . Infestation levels were calculated from the proportion of infested plants relative to the total observed population, while rodenticide loss was assessed based on the amount of missing and replaced bait. Control costs were calculated by summing the expenditure components associated with the control activities. The results were subsequently presented in tables and graphs to facilitate data interpretation (Arikunto, 2019). In addition to descriptive analysis, differences in mortality between Plot 1 and Plot 2 were examined using an independent samples *t*-test at a 5% significance level. This test was applied to determine whether the mean mortality differed significantly between the two independent observation groups (Sugiyono, 2022). A significance value greater than 0.05 indicated no statistically significant difference, whereas a value below 0.05 indicated a statistically significant difference. The analytical results were subsequently interpreted to evaluate the effectiveness of brodifacoum-based rodenticide in controlling rat infestation in immature oil palm at the study site.

RESULTS

The study on the effectiveness of rodent pest control using rodenticide in immature oil palm (*Elaeis guineensis* Jacq.) was conducted in Block 25112003, Division 02, PT PP London Sumatra Indonesia Tbk. Dolok Estate. Observations were conducted in two plots with different land-use characteristics, namely Plot 1, which was formerly used for maize cultivation, covering 14.52 ha with 2,076 palms, and Plot 2, which was formerly used for oil palm replanting, covering 16.11 ha with 2,304 palms. Rodent control was conducted using brodifacoum-based rodenticide at a rate of two bait blocks per palm with a frequency of four applications per month. Observations were conducted from October 2025 to February 2026, covering rodenticide application, replacement bait requirements, statistical test results, and control costs.

Figure 1. Rodenticide Application on Immature Oil Palm

Figure 1. Rodenticide Application on Immature Oil Palm shows the application of rodenticide around the weeded circle at the base of immature oil palm trees. Two bait blocks were placed around each tree in accordance with the control procedures implemented at the study site. The bait was positioned near the plant base to facilitate access by rats active around the trees.

During the observation period, the requirement for replacement bait varied between the two plots. In Plot 1, the amount of replacement bait recorded was 40.3 blocks in the first week of November and increased to 81.7 blocks in the third week of November. In Plot 2, the requirement for replacement bait was 42.3 blocks in the second week of December, increasing to 93.0 blocks in the third week of December and 96.3 blocks in the first week of January. The variation in replacement bait requirements indicates differences in control intensity during the observation period.

An Independent Sample T-Test was conducted to determine whether there were differences in rat infestation levels between Plot 1 and Plot 2. The results for each observation month are presented in Table 1.

Table 1. Independent Sample T-Test Results for Rat Infestation Levels

Month	Mean Plot 1	Mean Plot 2	Mean Difference	Levene Sig.	Rows Used	t value	Sig. (2-tailed)	Description
October 2025	31,00	21,94	9,06	0,750	Assumed	1,872	0,070	Not significant

Month	Mean Plot 1	Mean Plot 2	Mean Difference	Levene Sig.	Rows Used	t value	Sig. (2-tailed)	Description
November 2025	36,36	23,96	12,40	0,020	Not Assumed	2,607	0,013	Significant ✓
December 2025	32,21	21,68	10,54	0,010	Not Assumed	2,460	0,018	Significant ✓
January 2026	28,46	21,50	6,96	0,530	Assumed	1,823	0,074	Not Significant
February 2026	22,38	22,00	0,38	0,914	Assumed	0,075	0,941	Not Significant

Source: Compiled by the researcher (2026)

Table 1. Independent Sample T-Test Results for Rat Infestation Levels shows that significant differences in rat infestation levels between Plot 1 and Plot 2 occurred in November and December 2025, with significance values of 0.013 and 0.018, respectively ($p < 0.05$). The largest mean difference was observed in November at 12.40. In contrast, no significant differences were observed in October 2025, January 2026, or February 2026, with significance values of 0.070, 0.074, and 0.941, respectively ($p > 0.05$).

In addition to observing rat infestation levels, the study calculated the rodenticide control costs for each plot. The cost components consisted of rodenticide, replacement bait, and labor costs. The calculation results are presented in Table 2.

Table 2. Rodenticide Control Costs in Plot 1 and Plot 2

Component	Plot 1	Plot 2
Land area (ha)	14.52	16.11
Number of trees	2,076	2,304
Bait blocks/month	16,608	18,432
Rodenticide cost/month	Rp28,781,664	Rp31,942,656
Replacement bait cost/month	Rp1,493,499	Rp2,441,797
Labor cost/month	Rp8,400,000	Rp8,400,000
Total cost/month	Rp38,675,163	Rp42,784,453
Cost/ha/month	Rp2,663,578	Rp2,655,769
Cost/tree/month	Rp18,629	Rp18,569

Source: Compiled by the researcher (2026)

Table 2. Rodenticide Control Costs in Plot 1 and Plot 2 shows that the total rodenticide control cost was Rp38,675,163 per month in Plot 1 and Rp42,784,453 per month in Plot 2. The higher total cost in Plot 2 was associated with its larger land area and greater number of oil palm trees. On a per-hectare basis, the control cost was Rp2,663,578 per

month in Plot 1 and Rp2,655,769 per month in Plot 2. Meanwhile, the control cost per tree was Rp18,629 in Plot 1 and Rp18,569 in Plot 2.

DISCUSSION

The findings indicate that rodent control using brodifacoum-based rodenticide in immature oil palm (TBM) at Division 02 of PT PP London Sumatra Indonesia Tbk. Dolok Estate was accompanied by changes in bait loss during the observation period from October 2025 to February 2026. In Plot 1, the percentage of missing bait decreased from 29.50% in October to 22.38% in February, whereas Plot 2 showed relatively smaller changes, from 21.50% to 22.00%. This pattern indicates changes in rat activity during the control period, although the percentage of missing bait at the end of the observation period remained above the 20% threshold established in the company's standard operating procedure (SOP). Therefore, the findings are more appropriately interpreted as an indication of a declining trend in rat activity based on bait loss rather than evidence that the rat population had been completely reduced below the control threshold. The use of bait loss as an indicator should also be interpreted cautiously because bait disappearance may be influenced not only by rat activity but also by physical and environmental conditions in the field.

The differences in bait-loss patterns between the two plots indicate that rat activity did not occur uniformly across the observation sites. Plot 1, which was previously used for maize cultivation, generally recorded a higher percentage of missing bait than Plot 2 during most observation periods. This difference may be associated with variations in land characteristics and habitat conditions resulting from previous land use. The presence of residual vegetation, alternative food sources, and differences in ground cover can influence the presence and movement of rats around oil palm plants. Vegetation conditions surrounding the plants are also important because dense ground vegetation may provide shelter and movement pathways for rats. Therefore, the differences in bait loss between the two plots indicate that rodenticide application should consider site-specific characteristics rather than relying solely on uniform application intensity across the entire plantation area.

The increase in replacement bait requirements during several observation periods was also consistent with periods of relatively high bait loss. In Plot 1, the amount of replacement bait increased from 40.3 in the first week of November to 81.7 in the third week of November. Meanwhile, Plot 2 showed an increase from 42.3 in the second week of

December to 93.0 in the third week of December and reached 96.3 in the first week of January. These findings indicate that replacement bait requirements increased during periods when bait loss was relatively high. Based on the field conditions described in this study, these periods coincided with relatively high rainfall conditions. Nazhifah et al. (2025) demonstrated that environmental changes associated with rainfall can influence pest activity patterns. Aditya et al. (2021) also reported that wet conditions and flooding may encourage rodents to move toward areas that provide more suitable shelter and food resources. However, the relationship between rainfall and increased bait loss in the present study cannot be interpreted as causal because rainfall was not directly tested as a research variable.

Vegetation conditions surrounding the plants also represent an important factor in explaining rat activity. Field observations identified relatively dense vegetation and weeds in several parts of the observation area. Such conditions may provide shelter and facilitate rat movement around the plants. At the same time, vegetation covering the planting circle may reduce the visibility and accessibility of the bait. This condition supports the importance of clearing the planting circle before rodenticide application, as required by the company SOP. The placement of two bait blocks around the plant base is also relevant to the observed damage pattern because the basal stem or bole was one of the primary areas affected by rat attacks. Thus, the effectiveness of rodenticide application depends not only on the active ingredient but also on the accuracy of bait placement and the condition of the surrounding area.

The use of brodifacoum in this study is also relevant to the characteristics of its mode of action. Brodifacoum is a second-generation anticoagulant that does not cause immediate mortality following bait consumption. Astisyah et al. (2025) explained that the lethal effect of brodifacoum occurs several days after consumption through disruption of the blood-clotting mechanism. This characteristic makes regular monitoring an important component of the control process. When bait loss is high, replacement is required to maintain the availability of the control material in accordance with the company's procedures. Therefore, the increase in replacement bait observed during certain periods does not necessarily indicate control failure, but rather reflects the need to maintain bait availability in areas experiencing greater rat activity.

The observed plant damage showed gnawing marks on the bole or basal stem of TBM plants. Visually, the damage was characterized by exposed, rough, and irregular stem surfaces in areas that were previously covered by plant tissue. Damage to this part of the plant requires attention because TBM plants are still undergoing vegetative development, and tissue damage may interfere with continued plant growth. More severe damage to vascular tissues may disrupt the distribution of water, nutrients, and photosynthetic products to other parts of the plant. If the damage progresses toward the growing point, the consequences for plant development may become more serious because oil palm has a single primary growing point. Ikhsan et al. (2020) reported that rat attacks on immature oil palm can affect plant development and potentially delay the transition to the productive phase.

The Independent Sample T-Test results showed that the differences in mean rat attack levels between Plot 1 and Plot 2 were statistically significant in November and December 2025 but not in October 2025, January 2026, and February 2026. In November, the difference in mean attack level reached 12.40 percentage points, with a significance value of 0.013, while in December the difference was 10.54 percentage points, with a significance value of 0.018. In contrast, the difference in February was only 0.38 percentage points, with a significance value of 0.941. This pattern indicates that differences in attack levels between the two plots were more apparent during the middle of the observation period and became smaller toward the end of the study. The finding may reflect a narrowing of the difference in attack conditions between the two locations over the observation period. However, because the study employed an observational design without an untreated control group, this narrowing cannot be attributed exclusively to brodifacoum application. Therefore, the statistical results are more appropriately interpreted as evidence of differences in attack levels between the two plots during specific observation periods.

The differences between the two plots further demonstrate the importance of a control strategy that considers site-specific characteristics. Plot 1 experienced relatively higher bait loss during most observation periods, whereas Plot 2 had relatively lower bait loss but showed increased replacement requirements from late December to early January. This condition indicates that rodenticide requirements can vary according to both location and time. Suherman et al. (2021) stated that the success of rodenticide-based control is not determined solely by the cost incurred but also by the suitability of the control method to specific land conditions. In the present study, monitoring bait loss can therefore serve as an operational basis for identifying areas that require more intensive attention and bait replenishment.

From an economic perspective, the total control expenditure in Plot 2 was Rp42,784,453 per month, which was higher than the Rp38,675,163 recorded for Plot 1. This difference is consistent with the larger land area and greater number of plants in Plot 2. However, when costs were standardized by land area, the control expenditures for the two plots were relatively similar, at Rp2,663,578 per hectare per month for Plot 1 and Rp2,655,769 per hectare per month for Plot 2. This finding demonstrates that total expenditure alone is insufficient to describe control requirements because land area and plant population also determine the magnitude of expenditure. Cost per hectare provides a more proportional indication of the resources required to implement rodent control at each location.

Rodenticide procurement represented the largest cost component in both plots, amounting to Rp28,781,664 in Plot 1 and Rp31,942,656 in Plot 2. These expenditures were associated with the requirement of two bait blocks per plant and four applications per month. Replacement bait costs also require attention because they increased in accordance with bait loss during the observation period. This condition indicates that increased rat activity may affect not only plant attack levels but also the resources required to maintain the control program. Therefore, regular monitoring can serve as an operational basis for adjusting replacement bait requirements according to actual field conditions.

Overall, the findings indicate that brodifacoum-based rodent control in immature oil palm at the study site was associated with changes in bait loss and differences in rat attack levels between locations during the observation period. The decline in bait loss in Plot 1 and the increasingly smaller difference between the two plots toward the end of the observation period indicate changes in attack conditions during the control period, although the final values in both plots remained above the 20% SOP threshold. These findings demonstrate that rat control in immature oil palm requires continuous implementation through a combination of rodenticide application, bait-loss monitoring, bait replacement, and management of vegetation surrounding the plants. The study further indicates that evaluation of rodent control should consider not only changes in attack levels but also site characteristics and the resources required to implement the control program.

Several limitations should be considered when interpreting these findings. The study was observational and conducted in two plots at a single plantation site, without an untreated control group that could provide a direct comparison between plants receiving and not receiving rodenticide treatment. In addition, bait loss was used as an indirect indicator of rat activity, meaning that environmental factors such as rainfall, humidity, physical deterioration of bait, and variation in inspection intervals may have affected the observations. Future studies could extend the observation period, include more locations with different land characteristics, and incorporate environmental variables and direct measurements of rat populations. The use of an experimental design or comparison group could also provide stronger evidence for determining the specific contribution of rodenticide application to changes in rat attack levels in immature oil palm.

CONCLUSION

This study demonstrates that the use of brodifacoum-based rodenticide for controlling rat pests (*Rattus* sp.) in immature oil palm at Division 02 of PT PP London Sumatra Indonesia Tbk. Dolok Estate was able to cumulatively reduce rat activity during the observation period. Control effectiveness was reflected in the decline in bait loss from 29.5% to 21.8%, with bait consumption eventually reaching a level below the 20% threshold at the end of the observation period. Differences in land-use history were also associated with different levels of rat pressure, as the former maize plot experienced a higher attack level than the former oil palm replanting plot. These findings indicate that land characteristics should be considered when determining the intensity and allocation of rat control activities. Thus, the study addresses its research objective by demonstrating that brodifacoum rodenticide can support rat control in immature oil palm, while its effectiveness is influenced by field conditions and the consistency of application.

Practically, this study contributes empirical evidence concerning the relationship between rat activity, rodenticide application, land characteristics, and control costs at the block level. Its principal value lies in demonstrating that the evaluation of pest control should consider not only the reduction of pest activity but also the efficiency of resource allocation. The average control expenditure was approximately IDR 2.6 million per hectare per month, with rodenticide procurement representing the largest cost component. These findings provide a practical basis for developing more adaptive, block-specific control strategies. Areas experiencing greater rat pressure may require more intensive control during the initial period, followed by continuous monitoring as pest activity declines. For future research, longer observation periods and greater consideration of environmental conditions and rat population dynamics are recommended to provide a more comprehensive assessment of the effectiveness and economic efficiency of rodenticide-based rat control in immature oil palm plantations.

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