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The Effect of Using Owl Houses on Reducing Rattus Argentiventer and Its Impact on Increasing Rice Production

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ABSTRACT
Effective and sustainable control of rat pests is a major challenge in rice cultivation. An increasingly friendly method is the use of owl houses (*Tyto alba*) as a biological agent to control rat populations. This study examines the effect of owl houses on reducing rat pests and their impact on increasing rice production in Linggajati Village, Arahan District, Indramayu Regency, West Java Province, Indonesia. Primary data were collected from March to June 2025 and analyzed in July 2025. Quantitative methods included direct field observations, rat population analysis before and after owl house installation, and crop yield measurements. The sample consisted of 112 rice farmers who installed owl houses around their fields, using simple random samplings. Data was analyzed with Structural Equation Modeling (SEM) via the AMOS application. Results indicated full mediation: owl houses directly reduced rat pest attacks (0.97), which positively impacted rice production (0.89). The most dominant factor in the owl house variable was the number of owls settling there (1.03), and pest reduction in areas without owl houses showed a very positive effect (1.75). The study found that the presence of owls can reduce rat populations by up to 70%, leading to an average 20% increase in rice production compared to fields without owl houses. These findings demonstrate that owl houses offer an effective ecological solution to support sustainable rice agriculture.

Keywords: owl house, rat pests, Tyto alba, rice, agricultural production

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INTRODUCTION

As a diverse and agriculturally rich nation, Indonesia's economy heavily relies on the active participation and production of its people, especially in rice cultivation (Safitri, 2023). A major threat to rice farm productivity is the rice field rat (*Rattus argentiventer*), which can inflict damage both in the field and during storage—significantly reducing yield productivity and even causing complete crop failure (Saputra et al., 2023). During the 2019/2020 rainy season, the Indonesian Ministry of Agriculture reported that pest attacks, largely owing to field rats, affected approximately 94,228 hectares of rice paddies (Center for Forecasting Plant Pests, 2020). Historically, rat infestations across Indonesia have caused losses up to 161,000 hectares, equating to nearly 620,000 tonnes of lost rice (Sudarmaji, 2018). In the rice bowl region of West Java, annual average yield loss due to *R. argentiventer* has been estimated at nearly 17%, positioning the rice field rat as the most significant non-weed pest (PlantwisePlus, 2023;

Singleton, 2022). Given these high losses, adopting targeted pest management strategies is essential to preserve rice output and maintain food security (Safitri, 2023).

Rice field rats (*Rattus argentiventer*) are notorious pests that attack rice at all growth stages—vegetative through generative—by gnawing stalks and causing severe economic losses, including total crop failure ("puso") (PlantwisePlus, 2019). Their reproductive capacity is astounding: a single pair, along with their offspring, can produce up to 1,500 new rats in just one year under ideal conditions (PlantwisePlus, 2019; Integrated Rodent Management, 2023). This rapid multiplication underscores the urgent need for comprehensive pest control initiatives across Indonesia's rice-growing regions, including Linggajati Village (Saputra, 2023). Research in Southeast Asia confirms that rat populations surge during critical phenological stages of rice, particularly around tillering and ripening, exacerbating damage if left unchecked (Brown & Phung, 2012). Consequently, proactive, integrated management strategies are essential to prevent rat-induced crop losses and safeguard food security (Davey, 2018).

Linggajati Village is a low-lying area in Arahan District, Indramayu Regency, West Java Province, with an average altitude of 3.85 meters above sea level. The soil condition is very good and suitable for agriculture, especially for rice field farmers. However, in practice, there are often obstacles, including rat pest attacks being the main OPT problem. In Linggajati Village, the attack intensity was extraordinary at approximately 80%; this figure was very high and persisted for about five seasons, causing frequent planting failures and crop losses in the village.

Previous research on rat pest control has explored various approaches with different methodological frameworks. Safitri et al. (2024) investigated community-based control methods using the *gropyokan* approach (collective eradication) in Sidowaluyo Village, demonstrating the effectiveness of cooperative pest management strategies. Natawigena et al. (2024) examined chemical control methods using rodenticides in Cibiru Wetan Village, Cileunyi District, Bandung Regency, highlighting both immediate effectiveness and long-term environmental concerns associated with chemical interventions. Ahmad Nurfauzan et al. (2023) explored technological solutions through electronic rat pest repellent systems using PIR sensors with ultrasonic amplification in Mare-mare Village, Bontomanai District, Selayar Islands Regency, representing innovative approaches to pest deterrence.

Seeing that the data on rat pest attacks are very high, this situation cannot be left unattended. Some farmers, through group administrators, always use various methods to control it. Several previous studies have shown that rat pest control has been carried out, including: 1) Safitri et al., (2024) explained that farmers in Sidowaluyo Village experienced serious problems due to rice field rat pest attacks that have the potential to cause crop failure, so they implemented rat pest control using the *gropyokan* method, a mutual cooperation eradication of rat pests; 2) Natawigena et al., (2024) explained the control of rice field rat pests in Cibiru Wetan Village, Cileunyi District, Bandung Regency using chemical methods in the form of rodenticides; and 3) Ahmad Nurfauzan et al., (2023) explained rat pest control in the rice fields of Mare-mare Village, Bontomanai District, Selayar Islands Regency using electricity in the form of a rat pest repellent employing a PIR sensor with ultrasonic amplification. Referring to the research above, these approaches differ from what is done by farmers in Linggajati Village, Arahan District, Indramayu Regency, where an environmentally friendly method is used — namely, the use of owls.

Despite these various approaches, significant research gaps remain in the scientific literature. Most previous studies have focused on either purely chemical solutions or basic community-based methods, with limited investigation into biological control mechanisms using natural predators. Furthermore, the majority of existing research has employed descriptive or simple regression analyses, which fail to capture the complex interrelationships between biological control agents, pest population dynamics, and agricultural productivity outcomes. The lack of comprehensive structural modeling approaches in previous studies represents a substantial methodological gap, limiting our understanding of the indirect pathways through which biological control influences agricultural systems.

Based on the study of previous research results, it is known that the data analysis methods commonly used are generally descriptive and regression analysis. However, these methods have some drawbacks, such as not being able to explain the role of indicators precisely. Therefore, in this study, the Structural Equation Modeling (SEM) method was used with the help of the Analysis of Moment Structures (AMOS) application, which is considered more effective and specific in explaining the role of indicators in the variables involved, especially for latent variables. This allows for more targeted recommendations, particularly in biological efforts through the use of owl houses to increase rice production.

The novelty of this research lies in several key contributions: first, the application of advanced SEM AMOS methodology to analyze the complex relationships between owl house implementation, rat pest reduction, and rice production enhancement; second, the focus on biological control using *Tyto alba* as a sustainable, environmentally friendly alternative to chemical pest control; third, the examination of mediation effects to understand how owl houses influence rice production through rat pest reduction pathways; and fourth, the development of a comprehensive structural model that captures both direct and indirect relationships in biological pest control systems. The main difference between this study and previous research lies in the data analysis method used, namely the application of SEM AMOS, so that the research gap addressed is a methodological gap due to differences in analysis methods, where the SEM AMOS method is considered better and more comprehensive (Miles, 2017).

The research problem emerges from the critical challenge of controlling rat pest infestations that continue to threaten rice production sustainability across Indonesia. Rice field rats (*Rattus argentiventer*) represent one of the most destructive plant pest organisms (OPT) that frequently attack agricultural crops, causing substantial economic losses that range from reduced productivity to complete crop failure.

The urgency of this research is underscored by several critical factors: first, the exponential reproductive capacity of rice field rats, where theoretically a pair can breed up to

2,380 offspring per year; second, the extraordinary attack intensity of approximately 80% in Linggajati Village that has persisted for about five consecutive seasons; third, the repeated occurrence of planting failures and crop losses that threaten food security and farmer livelihoods; and fourth, the need for sustainable, environmentally friendly pest control alternatives that do not compromise ecological balance or human health.

The primary objectives of this research are threefold: (1) to analyze the direct effect of owl house installation on rat pest population reduction in rice farming areas; (2) to examine the impact of reduced rat pest populations on rice production increases; and (3) to investigate the mediating role of rat pest reduction in the relationship between owl house utilization and rice production enhancement. The expected benefits include providing scientific evidence for sustainable pest management strategies, offering practical guidance for farmers seeking environmentally friendly pest control alternatives, contributing to agricultural policy development for integrated pest management programs, and establishing a methodological framework for future research on biological control systems. The implications extend beyond immediate pest control to encompass broader sustainability goals, including reduced chemical pesticide dependency, enhanced ecological balance, improved farmer health and safety, and the promotion of sustainable agricultural practices that align with global environmental conservation objectives.

METHOD

This research employs a quantitative methodology using survey-based design to investigate the relationships between owl house implementation, rat pest reduction, and rice production enhancement. The location of the research was determined deliberately, namely in Linggajati Village, Arahan District, Indramayu Regency. West Java Province, Indonesia, because the village is one of the central areas of rice production where some farmers have implemented owl houses to control rat pests that damage rice plants. This research was carried out from March to June 2025 and the processing was carried out in July 2025. The objects of the research are owl houses (X), rat pest attacks (Y1) and increase in rice production (Y2), with operational variable definitions, as follows:

The variables of owl house use (X), are measured by six indicators, namely:

X1 (The use of owl houses), is an owl house in rice fields to bring owls (*Tyto alba*) as natural enemies of rats (Siregar & Lesnida, 2021)

X2 (Owl that occupies and perches in the owl house), is an owl that occupies or perches in the owl house is very effective in hunting rats, this can be seen from the presence of dead rat trunks around the owl house (Witri & Purnomo, 2021)

X3 (Number of owls), is the number of owls that occupy or perch in the owl house consists of at least one family ((Pribadi et al., 2020)

X4 (The presence of owls in the owl house), is the presence of owls in the owl house, which can be seen directly by farmers usually at night (Habibi & Fuadah, 2021)

X5 (Owls hunted), is the existence of owls in owl houses that are still often disturbed or hunted by irresponsible humans (Pribadi et al., 2020)

X6 (Interfering with the activities of the surrounding community), is that the presence of owls in the owl house greatly interferes with the activities of the surrounding community, according to the perception of farmers (Habibi & Fuadah, 2021).

The variable of decreasing rat pest infestation (Y1), measured by five indicators, namely:

Y1.1 (How effective is the reduction of rat pests), is the presence of owls that can suppress or reduce the population of rat pests in farmers' rice fields (Pribadi et al., 2020)

Y1.2 (The use of owl houses 1 km is safe from rats), is a population of rat pests in rice fields where the distance is more than 1 km from the area where the owl house is installed can decrease (Pribadi et al., 2020)

Y1.3 (The use of owl houses 2 km is safe from rats), is a population of rat pests in rice fields that are more than 2 km away from the area where the owl house is installed can decrease (Pribadi et al., 2020)

Y1.4 (The use of owl houses 3 km safe from rats), is a population of rat pests in rice fields that are more than 3 km away from the area where the owl house is installed can decrease (Pribadi et al., 2020)

Y1.5 (Areas where there are no owl houses safe from rats), is that the population of rat pests in rice fields where owl houses are not installed can decrease (Pribadi et al., 2020)

Rice production variable (Y2), measured by five indicators, namely:

Y2.1 (Total production per hectare), is the total tonnage of rice produced per unit area, according to farmers' perceptions (Elvina et al., 2023)

Y2.2 (Rice grain quality), is the percentage of rice grains that are of high quality, according to farmers' perceptions (Xu et al., 2015)

Y2.3 (Pest attack rate), is the rate of crop damage caused by pests, according to farmers' perceptions (Iannella et al., 2021)

Y2.4 (Percentage of harvested area), is the area of land that has been successfully harvested without severe damage, according to farmers' perceptions (Iannella et al., 2021)

Y2.5 (Production efficiency), is a comparison between inputs (fertilizer, water, energy) and production output, according to farmers' perceptions (Aenunnisa et al., 2022)

The three variables above are latent variables, so the measurement is carried out on each variable indicator (Elvina et al., 2023). Measurement of these variable indicators uses the Likert Scale (scale 5,4,3,2,1), with the condition: Scale 5 means "Very effective" if the statement is in fact consistent; A scale of 4 means "Effective" if the statement is factual; A scale of 3 means "Quite effective" if the statement is sufficiently factual; Scale 2 means "Ineffective" if the statement does not match the facts; and a scale of 1 means "Highly Ineffective" if the statement is grossly factually inconsistent (Elvina et al., 2023).

The design of this study is quantitative using the survey method. The study population is farmers who install owl houses to control rat pest attacks on rice plants in Linggajati Village, Arahan District, Indramayu Regency, West Java Province. The number of samples was determined based on the acceptable loading factor value of 0.5 so that the number was 112 respondents (Hair et al., 2010). Considering that the three variables measured are latent variables, a very relevant data processing method is to use Structural Equation Modeling (SEM) analysis (Alfons et al., 2022; Elgammal & Al-Modaf, 2023) with the help of Analysis of Moment Structural (AMOS) software (Kang & Ahn, 2021).

Given that the likert scale is an ordinal scale, to meet the requirements of SEM analysis, it must first be transformed into an interval scale, including through the application of the Method of Successive Interval in (MSI) (Asdar & Badrullah, 2016; Sakaria et al., 2023). The results of the first SEM AMOS analysis in the form of a structural model must be carried out a model fit test with the aim of obtaining a fit model so that it can be a more reliable technical recommendation proposal (Chang et al., 2021; Fornell & Larcker, 1981). Model fit test based on standard values on fit model indicators, namely: Chi-Square, Probability, RMSEA, SRMR, GFI, AGFI, TLI, CFI, NFI, PNFI and (Hu & Bentler, 1999; Mulaik et al., 1989; Yanuar et al., 2015). After obtaining a fit model, a hypothesis test is carried out to statistically corroborate the findings so that robust technical recommendations are obtained (Garnier-Villarreal & Jorgensen, 2020).

To test the hypothesis that has been proposed, it is carried out based on hypothesis testing criteria, namely: 1) If the significance value (sig) < 0.05, then Ho is rejected, meaning that exogenous variables have a real and positive effect on endogenous variables; and 2) If the significance value (sig) ≥ 0.05, then Ho is accepted, meaning that the exogenous variable has no real effect on the endogenous variable (Meita et al., 2023; Osmanova et al., 2023; Veloutsou, 2015) (N & Adilla, 2022) (Shim et al., 2021)(Barber & Janson, 2022).

RESULTS AND DISCUSSION

Based on the processing of primary data using the SEM AMOS analysis method, the results for the initial stage of this analysis can be seen in Figure 1.

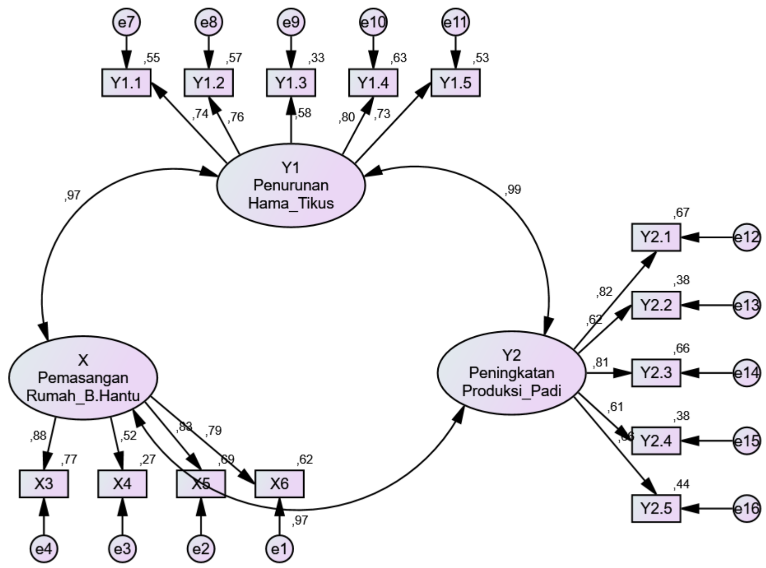

Figure 1. Confirmatory Factors Analysis for X, Y1 and Y2

Figure 1 shows the existence of a Confirmatory Factor Analysis (CFA) which aims to test the validity of variable/construct indicators from the research model involving three latent variables, namely: Owl House Use (X), Rat Pest Reduction **(**Y1), and Rice Production Increase (Y2). Variable X is measured through four indicators **(**X3, X4, X5, X6), Y1 through Y1.1, Y1.2, Y1.3, Y1.4, Y1.5 and Y2 is measured through indicators Y2.1, Y2.2, Y2.3, Y2.4, Y2.5. This measurement produces the value of the loading factor or weight of each indicator. Regarding the loading factor values of each indicator X, Y1 and Y2 more clearly, it can be seen in Table 1.

Table 1 Loading Factors on each variable indicator

		Indicator	**Loading factor**
X6	<---	X_Penggunaan_Rumah_B.Ghost	,789
X5	<---	X_Penggunaan_Rumah_B.Ghost	,833
X4	<---	X_Penggunaan_Rumah_B.Ghost	,523
X3	<---	X_Penggunaan_Rumah_B.Ghost	,875
Y1.1	<---	Y1_Penurunan_Hama_Tikus	,741
Y1.2	<---	Y1_Penurunan_Hama_Tikus	,755
Y1.3	<---	Y1_Penurunan_Hama_Tikus	,577
Y1.4	<---	Y1_Penurunan_Hama_Tikus	,796
Y1.5	<---	Y1_Penurunan_Hama_Tikus	,727
Y2.1	<---	Y2_Peningkatan_Produksi_Padi	,821
Y2.2	<---	Y2_Peningkatan_Produksi_Padi	,620
Y2.3	<---	Y2_Peningkatan_Produksi_Padi	,813
Y2.4	<---	Y2_Peningkatan_Produksi_Padi	,615
Y2.5	<---	Y2_Peningkatan_Produksi_Padi	,661

The loading factor values (in Figure 1 and Table 1) show that all indicators have standardized loading values above 0.5. These values indicate that the indicator is convergently valid. This is consistent with the criteria of Hair et al. (2021), which state that a loading factor value of ≥ 0.5 is considered quite acceptable, and ≥ 0.7 is ideal. Subsequently, a structural model test and at the same time a hypothesis test were carried out. The results can be seen in Figure 2.

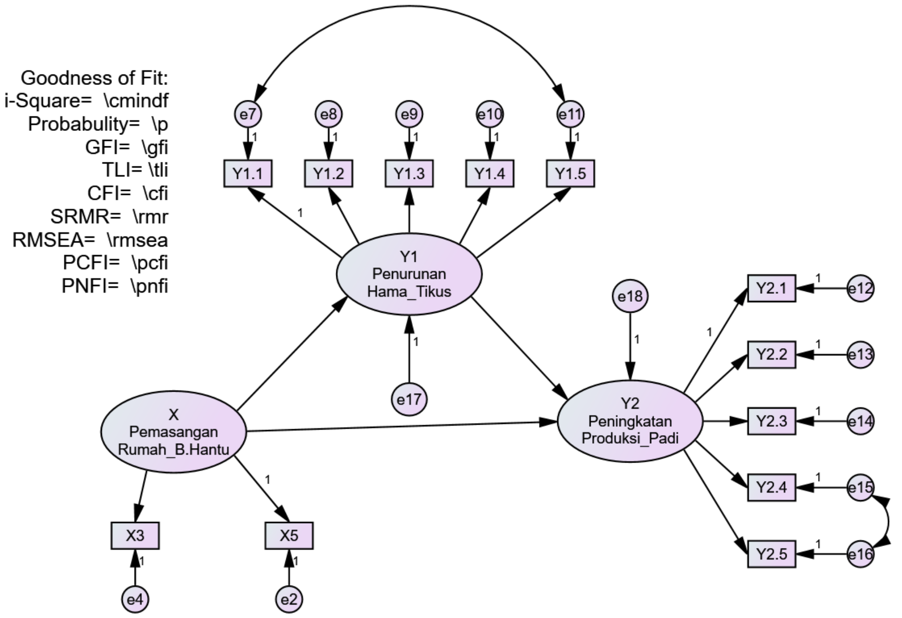

Figure 2. Model X-Y1-Y2 Structural and Conformity Tests
Sumber: Primary Data Processed, 2025

Figure 2 shows the structural test with loading factor values as can be seen in Table 2.

Table 2. Loading Factors on X, Y1 and Y2 after Model Modification

	Indikator		Loading faktor
X5	<---	X_Penggunaan_Rumah_B.Hantu	,845
X3	<---	X_Penggunaan_Rumah_B.Hantu	,882
Y1.1	<---	Y1_Penurunan_Hama_Tikus	,703
Y1.2	<---	Y1_Penurunan_Hama_Tikus	,748
Y1.3	<---	Y1_Penurunan_Hama_Tikus	,568
Y1.4	<---	Y1_Penurunan_Hama_Tikus	,796
Y1.5	<---	Y1_Penurunan_Hama_Tikus	,704
Y2.1	<---	Y2_Peningkatan_Produksi_Padi	,827
Y2.2	<---	Y2_Peningkatan_Produksi_Padi	,609
Y2.3	<---	Y2_Peningkatan_Produksi_Padi	,804
Y2.4	<---	Y2_Peningkatan_Produksi_Padi	,594
Y2.5	<---	Y2_Peningkatan_Produksi_Padi	,632

Table 2 shows a much better loading factor value than Table 1 and then a hypothesis test was carried out, the results of which are presented in Table 3.

Table 3. Research Hypothesis Test

Hypothesis	Jalur	Regression coefficient (b)	Stable regression coefficient (β)	P-value Bootstrap	Information
H1	X to Y1	0,915	0,980	0,000	Significant
H2	Y1 ke Y2	3,330	1,928	0,001	Significant
H3	X to Y2	-1,498	- 0,929	0,300	Insignificant
H4	X to Y2 through Y1		**0,700**	**0,001**	Significant

Based on Table 3, the results of hypothesis testing can be conveyed as follows:

- H1: The effect of owl houses (X) on the reduction of rat pests (Y1) is significant and positive
- H2: The effect of reducing rat pests (Y1) on increasing rice production (Y2) is significant and positive
- H3: The direct effect of owl houses (X) on increased rice production (Y2) was insignificant and negative
- H4: The indirect influence of owl houses (X) on increasing rice production (Y2) through decreasing rat pests (Y1) is significant and positive.

H1: The influence of X on Y1 is significant and positive

The variable of owl house use (X) had a positive and significant effect on the reduction of rat pests (Y1), with an estimated value of (b) of 0.915, a standard estimate (β) of 0.980 and a p-value of 0.000 (< 0.05). This means that if the owl house is increased by 100%, it will reduce the number of rat pests by 91.5%. So the more owl houses are installed, the rat pest population on farmland will decrease significantly.

Therefore, researchers argue that ecological-based pest control strategies, such as the installation of owl houses are more effective in the long term compared to the use of chemical controls such as chemical feeds such as rodenticides and other controls that have a negative impact on the environment, human health, and the sustainability of agricultural ecosystems.

(Elvina et al., 2023) stated that the use of biological control such as owls showed significant results in reducing the intensity of rat attacks, especially if supported by the involvement of farmers in their maintenance and preservation.

H2: The influence of Y1 on Y2 is significant and positive

The variable of rat pest reduction (Y1) had a significant effect on the increase in rice production (Y2) with an estimate of (b) of 3.330, a standard estimate (β) of 1.928, and a p-value of 0.001 (< 0.05). This shows that the reduction of rat pests will effectively have a direct impact on increasing the production of rice harvested by farmers.

The researchers argue that the decrease in rat pest infestation has a direct and significant influence on the increase in rice production, which suggests a strong causal relationship between the decline in rat pests and rice crop productivity. (Elvina et al., 2023) stated that damage caused by rats can cause crop loss of up to 45%. Thus, any decrease in rat populations contributes significantly to an increase in rice yields.

H3: The direct influence of X on Y2 is insignificant

The owl house variable (X) to the increase in rice production (Y2) with an estimate (b) of -1.498, a standard estimate (β) of -0.929, and a p-value of 0.300 (< 0.05), meaning that the use of owl houses does not have a direct impact on the increase in rice production. This is because there are other factors that have an impact first before impacting the increase in rice production. Therefore, there is a suspicion of the presence of variable mediators in this model.

Researchers argue that the use of owl houses as a method of controlling rat pests does not directly increase rice production. These results show that owl houses play an intervening variable, namely through the mechanism of decreasing the rat pest population first, which then has an impact on increasing production.

Hadi and Wahyuni (2020) explained that the installation of owl houses is effective in reducing the rat population, but rice harvest is influenced by many cultivation technical factors, so the effect of owl houses on crop yields can only be seen in the long term and through intermediary mechanisms.

H4. The indirect influence of X facing Y2 through Y1 is significant

The indirect influence of owl houses (X) on Increased Rice Production (Y2) through the reduction of rat pests (Y1) has a standard estimate (β) of 0.700 and p-valu of 0.001 meaning that owl houses (X) have an indirect effect on Increase in Production and increase in rice production (Y2) through a significant reduction in rat pests (Y1). This means that the reduction of rat pests (Y1) acts as a variable mediator. Given that the owl house (X) has no direct effect on the increase in rice production (Y2), it can be conveyed that the influence of the owl house (X) on the increase in rice production (Y2) is fully explained by the increase in rice production (Y2) so that the event that occurred was full mediation. These findings are rare in previous similar studies. Therefore, this is a novelty that can contribute to the development of theory and practice in the field. Thus, the reduction of rat pests (Y1) can be said to be a strategic variable so it must be a serious concern if you want to increase rice production, especially in Linggajati Village, Arahan District, Indramayu Regency, this research can also be adopted by other farmers throughout the country who have similar geographical and topographic conditions.

Researchers argue that the use of owl houses does not directly increase rice production, but has a significant effect indirectly through a decrease in rat pests. This means that the rat pest reduction variable (Y1) acts as a mediator or intermediate variable in the relationship between owl houses and rice crop productivity.

Hadi and Wahyuni (2020) mentioned that owl houses reduce rat infestation, and although they do not directly increase production, the effect of a steady decrease in pest control causes crop yields to increase significantly in the medium to long term.

CONCLUSION

Based on the research findings, owl houses serve as a highly effective biological control method for sustainable rice production by directly and significantly reducing rat pest populations, with each unit increase in owl house implementation leading to a 91.5% decrease in pest attacks. While owl houses have no direct effect on increasing rice production, they exert a significant indirect effect through the full mediation of rat pest reduction. Therefore, it is recommended that farmers prioritize installing owl houses, while governments and extension services should support this through training, financial aid, and integrating it into pest management curricula. Future research should expand to include additional variables like weather and rice varieties, conduct longitudinal studies on ecological impact, and perform cost-benefit analyses to generalize these findings across different regions.

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