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Increasing the Frequency of Predator Sightings Is the Key to Increasing Rice Production in an Environmentally Friendly Manner

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***Abstract*—IncrEasing rice production is essential in Indonesia because most of the population's staple food is rice. However, the chemical efforts made so far are considered not environmentally friendly, so other efforts that are considered more supportive of environmental sustainability, namely biologically by bringing in predators, are needed. This study aims to explore the influence of predators on increasing rice production. The research location is in Maleber Village, Maleber District, Kuningan Regency, West Java Province, Indonesia. The research was conducted during July-December 2024 using a quantitative research design and survey methods. The sample was 120 rice farmers, and the sampling technique was simple random sampling. Data analysis uses the Structural Equation Model (SEM) with the help of the Analysis Model Structural (AMOS) application. The results showed that the presence of predators had a significant effect on increasing rice production (0.96). The most dominant indicator in the variable of predator presence was the frequency of predator sightings (0.87). Therefore, it is recommended that environmentally friendly rice production be increased by increasing the frequency of predator sightings through refugia planting, diversification, and the creation of natural habitats.**

Keywords— ***Environmentally Friendly; Indicators; Predators; Rice Production; Structural Equation Model;***

I. INTRODUCTION

Improvement efforts in paddy production are necessary in Indonesia because rice is a significant food source for its population. However, this effort creates a serious challenge: the existence of attack pests on rice plants. As a result, they have caused a significant loss of around 375.5 billion throughout 2018-2020 in Indonesia [1]. Examples of pests are leafhopper chocolate and borer stem paddy.

Efforts to overcome attack pests have Been made, especially in a chemical way, namely with the use of pesticides. This method is very effective, but it has damage to the environment, such as pollution of land and water damage to biological diversity [2][3][4]. Therefore, other efforts are assessed as adequate. However, a more friendly environment that is, in a way, biological will bring in predators.

According to Johnson & Belk [5], predators are organisms that eat other organisms, especially those that play a role in controlling pests on plants. These predators can cover various types of creatures alive, like insects (for example) spiders, beetle predator pests, or dragonflies), birds that consume insects, or even microorganisms that help reduce population destructive pests plants. [6][5][7]. Total effort biological This has already started. Lots applied in various areas of world agriculture, including in the Village Maleber Subdistrict Maleber Regency Kuningan, Province West Java, Indonesia.

Village Maleber is located on the plains, so it has become more location-specific for plant paddy.

Regarding the use of predators as effort biology, then several have disclosed that bringing predators to land agriculture can control attack pests so that their production increases, such: 1) Hadi et al. [8] explained that predators could increase production plants by providing service ecosystem through consumption pests; 2) O'Bryan et al., [9], predators can increase production plant with control population pests, such as birds ghost can reduce density animal rodents in alfalfa fields ; 3) Pérez-Hedo et al.,[10], predators such as species zoophytophagy can increase production plant tomatoes and peppers; 4) Garcia et al., [11], some species bird can increase production plant with press pest invertebrate plants; and 5) Lemaire et al., [12] predators play a role for increase fertility land and recycling repeat nutrition, which is No direct support productivity plant.

A review of the research results above shows that the method of data analysis commonly used is descriptive and analytical regression, which is still ongoing. There are several weaknesses, such as not explaining the role of indicators correctly. For that, the research uses the Structural Equation Modeling (SEM) analysis method, which can explain the role of variable indicators to make them more effective and specific. To give recommendation techniques to effort biology and the application of predators to increase production plant rice. Therefore, the difference in the study previously lies in the data analysis method, where the research uses the Structural Equation Modeling (SEM) method, so there is a deep research gap. This is in the form of the methodological gap, namely the differences caused by different methods of analysis, where the SEM method is considered more comprehensive [13] than the study's results. It can contribute to developing knowledge about methodology and giving recommendation techniques to the farmers for increased production of plant paddy in a more friendly and sustainable environment. Therefore, the research entitled Increasing the frequency of predator sightings as the key to increasing rice production in an environmentally friendly manner is fundamental to implement.

Study This aims to explore the influence of predators on rice production in the village of Maleber Subdistrict Maleber Regency Kuningan, Province West Java, Indonesia. The proposed research hypothesis is that the presence of predators has real and positive effects on paddy production.

II. METHOD

The research location was determined in a way, namely in the Village Maleber Subdistrict Maleber Regency Brass Province West Java, Indonesia because the village is one of the area centers of rice production. The farmers Already exploit predators to control pests that attack plant rice. Research This was implemented from July until December 2024 and the results of the data study will be processed in 2025. Object his research that is the presence of predators as an exogenous variable (X) and production paddy as an endogenous variable (Y), with definition operational variables, as follows:

1)_ Variable X (Presence of Predators), measured with five indicators, namely :

X1 (Number of predators per square meter) is the density of the predator population on land, according to perception farmers [14][15] according to perception farmers,

According to perception farmers, **X2** (Types of predators present) is a diverse predator species [16].

According to farmers' perceptions, **X3** (Frequency of predator sightings) is the number of Predators often seen in rice field areas [17].

According to perception, farmers **X4** (Predator activity level) is predator activity in prey pest rice [18].

X5 (Amount of pests caught by predators) is the effectiveness of predators in prey pests, according to perception farmers [19][15].

2) Variable Y (Rice Production), measured with five indicators, namely :

According to perception farmers, **Y1** (Amount production per hectare) is the total tonnage of rice produced per unit wide. [20].

According to perception farmers, **Y2** (Quality) grain rice) is a percentage of grain quality rice high [21].

According to perception farmers, **Y3** (Attack level pests) is the level of damage plant consequence pests [22].

According to farmers' perceptions, **Y4** (Percentage of harvested area) is vast, prosperous land harvested without severe damage [23].

Y5 (Efficiency production) compares inputs (fertilizer, water, energy) and results production according to farmers' perceptions [24].

Second, the above variables are latent, so measurement is conducted on each indicator variable [25][26]. Measurement of this indicator variable using the Likert Scale (scale 5,4,3,2,1), with provisions: Scale 5 means " very agree " if the statement is very by fact; Scale 4 means " agree " if the statement by fact; Scale 3 means " sufficient " agree " if statement the Enough by fact; Scale 2 means "no agree" if statement no by fact; and scale one means " very no agree " if statement very no by the point [27][28][29].

Design study This is quantitative and uses a survey method. The population study is of farmers who use predators to control attack pests on plants and rice in the village Maleber Subdistrict Maleber Regency Kuningan, Province West Java. The number of samples set is based on a loading factor value that is still accepted, which is 0.55, so the amount is as significant as 120 respondents [30]. Considering that both variables measured are latent, the method of data processing uses Structural Equation Modeling (SEM) analysis [31][32] with the help of Analysis of Moment Structural (AMOS) software [33].

Remember that the Likert Scale is ordinal, so to fulfill condition analysis, SEM must transform, moreover formerly become an interval scale, including through the application of

the Method of Successive Interval (MSI) [34][35]. The results of the first AMOS SEM analysis in the form of a structural model must goodness of fit test was carried out to obtain a model that fits so that it can become a proposal recommendation more technical trusted[36][37]. Model fit test based on mark standards on the fit model indicators, namely: Chi-Square, Probability, RMSEA, SRMR, GFI, AGFI, TLI, CFI, NFI, PNFI, and [38][39][40]. After obtaining a fit model, hypothesis testing is carried out to strengthen the findings of the statistics so that the recommendation can be obtained using a robust technique[41].

To test the hypothesis that has been proposed, it is carried out based on the hypothesis testing criteria, namely: 1) If the significance value (sig) < 0.05, then Ho is rejected, meaning that the existence of predators (X) has a real and positive effect on rice production (Y); and 2) If the significance value (sig) ⩾ 0.05 then Ho is accepted, meaning that the presence of predators (X) has no real effect on rice production (Y) [42][43][44].

III. RESULTS AND DISCUSSION

Result:

The result can be seen in Figure 1 based on primary data processing using method analysis, Structural Equation Modeling (SEM), and the help of Analysis of Moment Structural (AMOS) software known as SEM-AMOS.

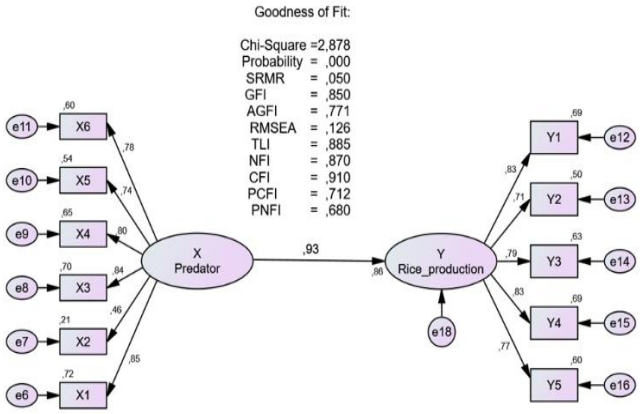

Figure 1. SEM-AMOS analysis output results, 2024

Source: Primary Data Processed, 2024

Figure 1 shows mark indicators in model fit criteria that are summarized and assessed, as seen in Table 1.

TABLE I. GOODNESS-OF-FIT INDICES AND CUT-OFF VALUE

No	Goodness-of-Fit Indices	Cut-off values	Observation value	Interpretation
1.	Chi-Square (CMIN/DF)	< 2.00	2,878	Poor fit
2.	Probability	> 0.05	0,000	Poor fit
3.	RMSEA	< 0.05	0.126	Poor fit
4.	SRMR	< 0.08	0.050	Good fit
5.	GFI	> 0.90	0.850	Poor fit
6.	AGFI	> 0.90	0.771	Poor fit
7.	TLI	> 0.90	0.885	Poor fit
8.	CFI	> 0.90	0.910	Good fit
9.	NFI	> 0.90	0.870	Poor fit
10.	PNFI	> 0.5	0.680	Poor fit
11.	PCFI	> 0 .5	0.712	Good fit

Source: [38][39][40] and primary data was processed in 2025

Table 1 shows that part large (64%) value observation from the SEM-AMOS output does not fulfill the mark standard (cut-off values), so the structural model does not fit or is unreliable. Therefore, model modification must be done, and its results can be seen in Figure 2.

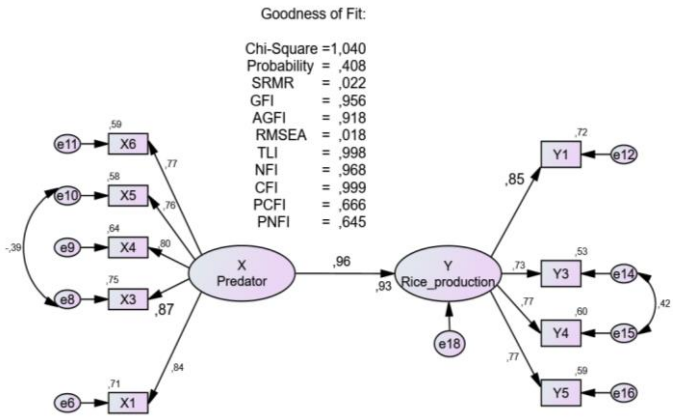

Figure 2. Model fit of influence the presence of predators on rice production

Source: Processed primary data, 2025

Figure 2 shows the resulting structural model. from modifications that can be summarized and assessed, as in Table 2.

TABLE II. GOODNESS-OF-FIT INDICES AND CUT-OFF VALUES AFTER MODIFICATION

No	Goodness-of-Fit Indices	Cut-off values	Observation values	Interpretation
1.	Chi-Square (CMIN/DF)	< 2.00	1,040	Good fit
2.	Probability	> 0.05	0.408	Good fit
3.	RMSEA	< 0.05	0.018	Good fit
4.	SRMR	< 0.08	0.022	Good fit
5.	GFI	> 0.90	0.956	Good fit
6.	AGFI	> 0.90	0.918	Good fit
7.	TAG	> 0.90	0.998	Good fit
8.	CFI	> 0.90	0.999	Good fit
9.	NFI	> 0.90	0.968	Good fit
10.	PNFI	> 0.5	0.645	Good fit

1			0.666	Good fit
1	PCFI	> 0 .5		
.				

Source : [38][39][40], and primary data was processed 2025

Table 2 shows that all mark observations from the SEM-AMOS output have fulfilled the mark standard (100%) to obtain the structural model. This is already fit and reliable (robust). A hypothesis test was carried out to strengthen the fit model, the results of which can be seen in Table 3.

TABLE III. SIGNIFICANCE INFLUENCE THE PRESENCE OF PREDATORS (X) ON RICE PRODUCTION (Y)

The effect of X on Y and the reflective indicator			E.S	P-values*	Interpretation
Y_Rice Production	<	X_Predator	0.962	0.002	Significant
X1	<	X_Predator	0.842	0.003	Significant
X3	**<**	**X Predator**	**0.867**	**0.004**	**Significant**
X4	<	X_Predator	0.798	0.001	Significant
X5	<	X_Predator	0.760	0.003	Significant
X6	<	X_Predator	0.769	0.002	Significant
Y1	<	Y_Rice Production	0.851	0.001	Significant
Y3	<	Y_Rice Production	0.729	0.002	Significant
Y4	<	Y_Rice Production	0.772	0.003	Significant
Y5	<	Y_Rice Production	0.768	0.003	Significant

Source: Processed primary data, 2025

* Probability value using bootstrap standard because the data is not normally distributed.

Table 3 shows that the influence of variable X (predator) on Y (rice production) is significant Because mark the probability is < 0.05. As for the mark coefficient, the standardized regression is 0.962 and positive. Thus, the hypothesis, which states that the presence of predators has a real and positive effect on rice production, can be accepted. Besides that, Table 3 also shows that the most considerable loading factor value on variable X is 0.867 and is significant, located on indicator X3, namely frequency predator sightings.

Discussion:

Influence the presence of predators (X) on rice production (Y)

Based on the results, SEM-AMOS analysis has obtained a model that fits the model and can be reliable in statistics and beneficial for giving recommendations to farmers, namely as an effort to increase the production of paddy in a friendly, environmentally, and sustainable way. The coefficient value regression was standardized to 0.962 and positive. This means that every effort to increase X (predator) by 100% will impact the rice production in the village Maleber Subdistrict Maleber Kuningan Regency by 96.2 %. Such conditions can explain why the presence of predators in field agriculture will prey on pests to plant paddies like brown planthopper, caterpillar gray, and borer stem rice so that the amount is reduced or put under control. Decreasing pests will give more opportunities, which is suitable for the growth and development of plant paddy so that production increases rice previously.

Research results in this is in harmony with several results studies previously, such as 1) Elvina et al. [20] and Iannella et al. [23], who concluded that the application of natural predators is influential actual to the improvement production and area of rice crops; 2) Sakir & Desinta, [45] which shows existence refugia plants can bring in predator as enemy natural and capable increase results production paddy by 15.1%; 3) Lemaire et al., [12] predators play a role for increase fertility land and recycling repeat nutrition, which is No direct support productivity plants; and 4) Ali et al. [46] mention predators, such as parasitoids and spiders, increasing production paddy.

The results of the research above mentioned that the highest loading factor value on variable X is 0.867 or 0.087, which is significant. Located at X3 (frequency predator sightings). Indicators This reflects predator activity in the environment, such as plant rice, so the more often predators are seen in the fields, the taller the chances for prey pest plant rice. Therefore, it can reduce population pests, and plants can grow and develop with more goods than previously. Besides that, it also shows that the most dominant indicator for explaining the condition of variable X is X3 so that it can become a base. For giving recommendations proper to the farmers in the frame to increase production more rice friendly, environmentally and sustainable. As for several efforts nature related to this X3 indicator, among others:

1) Plant refugia plants around ricefield:

Presence This refuge plant can become a home and resource food for the predators that will attack pest plant rice. Therefore, many predators are present and visible on the land of paddy farmers [16][45].

2) Diversifying plants (planting) lots of plants):

Carrying out planting with many plants around land agriculture can create an environment or more atmosphere varies, supporting the creation of diverse life and improving natural predator populations [47].

3) Make habitat experience:

Creating a natural habitat around land agriculture, such as bushes, old trees, trees in large, watery areas, swamp or forested areas, can become a place to take shelter and also be able to become a source of food for predators, such as birds, spiders, dragonflies, insects predators and insects aquatic [48][49].

IV. CONCLUSIONS

The presence of predators has a real and positive impact on rice production in the village Maleber Subdistrict Maleber Regency Kuningan, Province West Java, Indonesia. The indicator variable is the presence of the most dominant predator in increased production paddy, which is the frequency of predator sightings. For that, it is recommended that rice is environmentally friendly and sustainable for increased production, so it can be done with a method to increase the

frequency of predator sightings through planting refugia, diversifying plants, and creating natural habitats.

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