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Extension of *Beauveria bassiana* the Effectiveness As a Coffee Fruit Borer Pest Control in Ngrayudan Village, Ngawi Regency

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Abstract. *The development of coffee cultivation in Ngrayudan Village, Ngawi Regency has experienced a decline in quality due to the attack of the Coffee Fruit Borer pest. The pest causes damage to the coffee fruit. Based on the results of the identification of the area potential, there is a problem regarding the handling of Coffee Fruit Borer pests that had not been maximized by farmers in Ngrayudan Village. Farmers do not have the knowledge and skills to use biological agents as solutions. This study aims to design extension and behavior changes related to farmers' knowledge, attitudes, and skills. This research was conducted in February - March 2024 using a qualitative approach by using the level III action research method which has four stages in extension activities including planning, action, observation, and reflection. Based on observations and interviews with respondents after counseling showed significant changes in behavior. Supported by quantitative data from the extension evaluation results which showed an increase in knowledge of 34%, while the attitude level showed results of 89% including in the category of responsibility in deciding a matter, and a skill level of 80% including in the level of problem-solving farmers can describe problems to find the best solution. The conclusion of this study shows the existence of effective extension in improving behavior change in Farmer Groups in making biological agents such as Coffee Fruit Borer pest control.*

Keywords*: Beauveria bassiana, Behavior change, Extension*

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INTRODUCTION

Coffee producers come from the island of Java with the highest coffee production being in Ngawi Regency with a production of 689 kg per ha (Directorate General of Plantations, 2022). This is a potential for developing coffee plants to increase the productivity of yields in Ngawi Regency. One of the coffee-producing centers in Ngawi Regency is Jogorogo District which has the largest coffee-producing village, Ngrayudan Village with an area of 51.04 ha and the number of planters is 110 households. From the development of coffee plant cultivation in Ngrayudan Village, in August 2023 there were coffee yields of 54.91 kg with a total production of 1.80 ha (BPS Ngawi Regency, 2023). This productivity result can decrease due to various factors that become problems in the cultivation of coffee plants. Meeting the lack of standards, low production, and low yield quality are the main problems for coffee plantations (Siregar *et al*., 2019).

Low yield quality can result from the development of pests on the plant. A pest that is known to be important and causes damage to fruit is the Coffee Fruit Borer. According to Wiryadiputra et al., (2014), coffee fruit borer is the main pest of coffee plants that causes a significant reduction in yield. The occurrence of a decrease in yield due to attacks requires environmentally friendly innovations, especially for farmers, and sustainable agriculture is needed. The Ministry of Agriculture has produced various innovations, one of which is biological agent empowerment technology (Friska *et al*., 2022).

The use of the biological agent *Beauveria bassiana* is an alternative biological control to avoid the use of the negative effect of chemical pesticides used by farmers to overcome pest problems. This fungus has a high reproductive capacity, is easy to produce, its life cycle is short, is easy to produce, and can produce spores that are durable under unfavorable conditions (Friska *et al*., 2022). B. bassiana will release a toxin called Beauvericin. *Beauveria bassiana* can also infect insects through direct contact or feed contamination, disrupting the function of the insect nucleus, and causing swelling and hardening in infected pests so that pests will experience death.

Based on the description of the potential and problems in Ngrayudan Village, Ngawi Regency, research is needed to determine the increase in knowledge aspects, the level of attitude aspects, and skill aspects of Sri Mulyo Farmer Group members in the Utilization of *Beauveria bassiana* as Coffee Fruit Borer Pest Control. Extension is carried out to achieve this goal by providing innovation and learning processes for farmers.

THEORETICAL STUDY

The black-colored coffee berry borer has complete wings and can fly a limited distance. According to Fintasari et al., (2018), ripe coffee fruits with hardened endosperm become larval development sites and habitats for male beetles. According to Fintasari et al., (2018), female insects lay eggs on coffee fruit when the beans are hard. Symptoms of Coffee Fruit Borer pest attack can be recognized from the form of attack by the way the pest gnaws on young to ripe coffee fruit (Hayata, 2016).

The biological control carried out is by utilizing the pathogenic fungus *Beauveria bassiana* which is relatively easy and effective in controlling Coffee Fruit Borer (Muliasari et al., 2018). When utilizing this pathogen is done by multiplying, formulating, and applying. Fungal hyphae can enter the cells of the insect's body and absorb its body fluids, causing the insect to die in a hardened condition similar to a mummy (Ilmi et al., 2018). The duration of insect infection after spraying in direct contact with *Beauveria bassiana*, in the next few days it will be seen that pests lose coordination of the movement system.

RESEARCH METHODS

This research was conducted in Ngrayudan Village, Ngawi Regency from March to May 2024. This research was conducted using the level III action research method. This research is used to find problems, potential, and initial conditions and then researchers develop existing actions to solve problems or improve work improvements. The research population was determined using a purposive sampling technique, namely members of the Sri Mulyo Farmer Group, Ngrayudan Village, which has the characteristics of coffee farmers who are active in farmer groups. The population used in counseling was 23 people.

Data collection instruments used were questionnaires, interviews, observation, and documentation. Data analysis used quantitatively using scoring to determine the success of counseling in aspects of knowledge, attitudes, and skills. Data analysis of counseling evaluation was conducted quantitatively using scoring analysis to determine the effectiveness of counseling conducted.

RESULTS AND DISCUSSION

Description of Location and Target Extension

Ngrayudan Village has an area of 609,730 ha with a dry and rainy climate, it has a direct influence on cropping patterns in Ngrayudan Village, Jogorogo sub-district. From the development of coffee plant cultivation in Ngrayudan Village, in August 2023 there were coffee provided results of 54.91 kg per ha with a total production of 1.80 ha (BPS Ngawi Regency, 2023).

The target implementation of the final project involves the target of counseling, namely members of the Farmers Group "Sri Mulyo" Ngrayudan Village Jogorogo District as many as 23 people. The target is set based on the results of the Identification of Regional Potential (IPW). The target is a coffee farmer who is in the village of Ngrayudan. The target is a coffee farmer who is in Ngrayudan Village.

Implementation of Extension Design

1. Goal Setting

The target in extension activities are members of the farmer group Sri Mulyo Ngrayudan Village Jogorogo District. With a total of 51 members with a sample of 23 people with the characteristics of the respondents used are coffee farmers who are active in farmer groups. Based on the results of the data tabulation that has been done, the data obtained based on the respondents of counseling is as follows:

Table 1. Characteristics Based on Education Level

No	Category	Number (people)	Percentage
1	Elementary School	13	54%
2	Junior High School	5	21%
3	Senior High School	6	25%
	Sum	24	100%

Source: Primary Data (2024)

Based on the table above, it can be seen that counseling respondents have the last education which is dominant is the elementary level with a percentage of 54%. Education will influence a person's mindset. A high educational background will influence more advanced thinking compared to extension respondents who have a low educational background. (Gusti et al., 2022).. Based on the data on the characteristics of the educational background of the dominant counseling respondents is elementary school, it shows that the education of respondents is low

Table 2. Characteristics of Goals by Age

No	Age (years)	Number (of people)	Percentage (%)
1	20 – 30	5	21
2	31 – 40	5	21
3	41 – 50	7	29
4	51 – 60	5	21
5	>60	2	8
	Sum	24	100

Source: Primary Data (2024)

Based on the table above, it can be seen that extension respondents have an age range between 20-60. Farmers who have an age range of 40-60 years are productive but lack experience and skills. Relatively young farmers will be more progressive and dare to take risks. Meanwhile, farmers aged >60 have more tired energy capabilities (Burano & Siska, 2011). (Burano & Siska, 2019). Farmers who are elderly will have longer experience and are selective in accepting innovations so that they have success in farming. According to Setiyowati et al., (2022)According to Setiyowati et al. (2022), differences in farmer age do not show any influence on innovation knowledge because innovations are delivered together to all farmers of various ages.

Based on the results of the interview above, farmers are active in farmer group activities. This farmer group activity can be influenced by the age level of a person's ability to carry out activities and the concept of thinking. The productive age in developing countries according to Firmansyah (2015) is 15 - 54 years. During this productive age, farmers can absorb information well and quickly. As well as having a strong finish in farming and carrying out functions as a farmer group appropriately and quickly. The older the farmer, the better the ability of farmers to carry out the functions of the group. This agrees with Poluan et al., (2017) a person who has a younger age certainly has a stronger physical condition, a desire to try new things, and creative thinking power. Thus, age has an important role in influencing farmers' participation in farmer group activities, where younger farmers show greater potential in innovation and organizational activeness.

Table 3. Target Characteristics Based on the Length of Farm Business

No	Length of Farming Business (years)	Number (people)	Percentage (%)
1	1 – 5	8	33
2	6 – 10	11	46
3	11 – 20	5	21
	Sum	24	100

Source: Primary Data (2024)

Based on the table above, it can be seen that the majority of extension respondents are trying to farm for 1 - 5 years, totaling 6 people with a percentage of 33%, for 6 - 10 years totaling 11 people with a percentage of 46%, while farmers trying to farm 11 - 20 years totaling 7 people with a percentage of 21%. The difference in the length of this farming business in coffee plants is influenced by the cultivation carried out by farmers. Coffee farmers still do not focus on coffee cultivation. Coffee cultivation is carried out from generation to generation from previous heritage. But also many farmers are slowly doing coffee cultivation seeing the potential of Ngrayudan Village, one of which is coffee. This coffee cultivation is not the main livelihood

In coffee cultivation, farmers experience obstacles in planting production to pest control, according to the results of observations and interviews as follows:

a. Planted Production

Based on observations and interviews with farmers, it is found that the coffee yield experienced by farmers is uncertain. The resulting harvest can decrease due to weather, pests, and other factors. This yield can be influenced by the length of time the farmer has been in business. The longer the farmer is in the business, the farmer has more knowledge and experience about the farming that is done (Rohma et al., 20). (Rohma et al., 2023).. So in overcoming the problem farmers do not know how to handle the right way and result in non-optimal results.

The results of interviews related to the constraints experienced by farmers are pests that result in not maximizing crop yields. Handling by farmers related to the constraints they experience with the use of insecticides and without treatment by the experience of farmers. So that the behavior is carried out based on experience. This is by research Effendy et al., (2020), that farming experience can influence farmer behavior. In line with the research conducted Yosep et al., (2017), a farming experience that is classified as long enough will affect the skills of farmers.

Farmers' experience in farming can occur due to the influence of time experienced so that farmers are experienced in overcoming the obstacles faced. (Ayun et al., 2019). However, this is not an absolute thing that farmers with longer farming experience will be better. Farmers who tend to have longer experience are less likely to adopt the innovations provided. This can be caused by farmers who have longer experience using habits and conventional methods without paying attention to the use of appropriate materials and optimal results (Nambela and Sinaga, 2019). (Nambela and Sinaga, 2019).

b. Pest Control

The interview results show that the use of chemical pesticides has become a habit practiced by farmers. This habit is one of the solutions to deal with the problems experienced. The continuous use of chemical pesticides can cause the surrounding ecosystem to be damaged (Situmorang et al., 2021). Farmers will consider the risk of failure rather than the impact of using chemical pesticides (Suharyanto et al., 2015).

Based on the farming experience of farmers in Ngrayudan Village which is classified as long enough for 10 - 21 years with control using chemicals continuously according to the habits carried out. In line with the opinion of Nambela and Sinaga (2019), farmers who have longer experience will use the habits.

c. Utilization of Biological Agents

Based on the results of the interview, shows that farmers do not recognize and know about biological agents as a substitute for chemical pesticides. The control used by farmers only relies on chemical pesticides which are effective according to farmers. Improper application of pesticides can be influenced by farming experience, education level, and the suitability of using pesticides as recommended (Situmorang et al., 2021).

d. Farmer Expectations

Based on the results of interviews with respondents, it shows that farmers expect an increase in coffee quality and productivity. With the hope that the high-selling value of coffee can help farmers be more prosperous.

2. Extension Materials

The counseling material was delivered based on the results of the Identification of Regional Potential. Based on the results of the identification of the potential of the region, the potential and problems are obtained accordingly and continuously. This can provide solutions to farmers' problems by the potential. Then identify the extension objectives,

namely increasing farmers' knowledge, attitude level, and skill level regarding the use of biological agent *Beauveria bassiana* as a Coffe Fruit Borer controller. This objective is by the potential of Ngrayudan Village, namely coffee plants. Next, determine the extension material, namely the utilization of the biological agent *Beauveria bassiana* as a Coffee Fruit Borer pest controller.

3. Extension Methods

Extension methods are used to assist the extension process to be carried out. By considering the material, target characteristics, and field conditions. In this extension, the methods used at each stage are different. The demonstration plot method was used in the early to late stages by applying and observing two farmers as farmer group administrators. In the first extension, the method used was a personal visit and discussion. In the second extension, the methods used were lectures and discussions. In the third extension, the methods used were demonstration of methods, discussion, and lecture. In the fourth extension program, the methods used were practice and discussion

4. Extension Media

Extension media is an extension tool in carrying out counseling that can stimulate extension targets and can receive messages conveyed, this media is a support for the successful delivery of material to the target. The existence of extension media is important for extension workers to gain effectiveness supported by the times. The extension media used are folders, leaflets, power points, video tutorials, and real objects. This media is used as a tool in the implementation of counseling to facilitate the delivery of information.

5. Implementation of Extension

In extension, it is necessary to prepare for counseling to facilitate the process of counseling activities. Before the counseling is carried out, there needs to be coordination between field agricultural extension workers and farmer group leaders. Followed by the Validity Test and Reliability Test of questionnaires that will be given to farmers to measure the evaluation of extension that has been done. Extension preparation is done by preparing a synopsis, extension preparation sheet, minutes, attendance list, and extension evaluation instruments. Extension was conducted with 4 stages with methods, media, and materials that have been determined by the results of the Identification of Regional Potential (IPW). The following is documentation of the implementation of counseling with farmers:

Description: Implementation of Extension
Source: Primary Data (2023)

Figure 1. Implementation of Extension

6. Extension Evaluation

Evaluation of counseling was carried out 3 times to know the increase in knowledge, attitudes, and skills of farmers in the Sri Mulyo Farmers Group, Ngrayudan Village, Jogorogo District, Ngawi Regency. Evaluation is done with 2 stages, namely Pre-test and post-test for knowledge evaluation.

Evaluation of Knowledge Aspects

Evaluation of counseling on knowledge aspects was carried out using a Guttman scale in the form of a questionnaire with a choice of answer options. Assessment of the questionnaire is by scoring if the correct answer is given a score of 1 and if the wrong answer is given a score of 0. Analysis of extension evaluation data was analyzed using the paired T-test. The results of the data analysis of the evaluation of the increase in knowledge aspects of counseling based on the results of the Pre-test and post-test questionnaires are as follows:

Table 4. Results of Knowledge Improvement Evaluation

Paired Samples Test

		Paired Differences					t	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PRE TEST - POST TEST	-5,62500	1,52693	,31168	-6,26977	-4,98023	-18,04	23	,000

Source: Primary data (2024)

Based on the paired t-test table, the results of the knowledge aspect counseling evaluation show that the average Pre-test knowledge score is 6.12 and the average Post-test knowledge score is 11,75. With this comparison, it can be seen that the increase in knowledge aspects of the Pre-test and Post-test. This is by the results of the paired t-test conducted, that the sig value obtained is 0.000 which is smaller than the alpha value of 0.05. By decision making if the sig value <0,05, it can be concluded that there is a significant difference between the results of the *Pre-test* and Post Test knowledge aspect questionnaires.

Increased farmer knowledge is one indication that the delivery of extension materials provided can be well received. Increased farmer knowledge is also able to increase their ability to accept innovations and adopt technology.

Evaluation of Attitude Aspects

Evaluation of the attitude aspect of counseling was carried out using a Likert scale in the form of a questionnaire with a choice of 5 answers. Measurement of attitudinal aspects with scoring analysis summarizes the answer score of the extension target with a total of 15 items. Based on the target answers, the calculation of the results can be seen on the continuum line as follows:

Maximum Score = 5 x 15 (questions) x 24 (goals)
= 1800

Minimum Score = 1 x 15 (questions) x 24 (goals)
= 360

Scores obtained = 1618

Median $= \frac{\text{Skor Maks} - \text{Skor Min}}{2} + \text{Min Score}$

$= \frac{1800 - 360}{2} + 0$

$= 720$

Quadrant I $= \frac{Skor\ MIn + Median}{2}$

$= \frac{360 + 720}{2}$

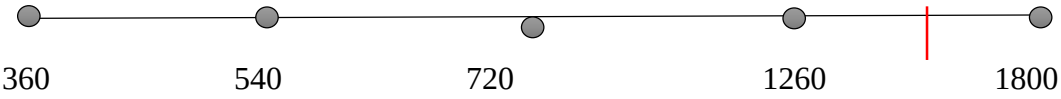
$= 540$

Quadrant II $= \frac{Skor\ Maks + Median}{2}$

$= \frac{1800 + 720}{2}$

$= 1260$

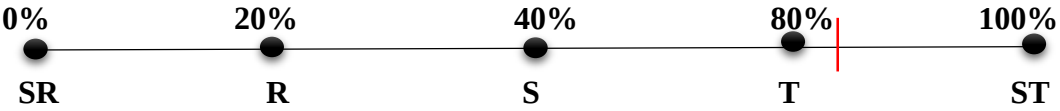
Based on the tabulation of extension evaluation data using the Likert scale, the continuum of attitude aspects after counseling is carried out as follows:



From the results of the score calculation of 1618, the results of the attitude level presentation can be presented as follows:

Percentage $= \frac{\text{Total Skor}}{\text{Skor Maks}}$ x 100%

$= \frac{1618}{1800}$ x 100 % = 89%



Description :

SR	: Very Low	= 0-20%
R	: Low	= 21-40%
S	: Medium	= 41-60%
T	: High	= 61-80%
ST	: Very High	= 81-100%

Based on the data above about the level of attitude of the target, it can be seen that the target has a percentage of 89% with a very high category. When viewed in the aspects of attitude levels according to Notoatodjo (2014) as follows:

Description :

Receive	= 0 – 25%
Respond	= 26 – 50%
Appreciate	= 51 – 75%

Responsibility = 76 – 100%

Based on the attitude level category according to Notoatmodjo (2014), the percentage score of the attitude aspect is 89% which is included in the responsibility category. It can be interpreted that farmers are responsible for everything that has been chosen with all the risks that will be borne. With the responsibility category, farmers make themselves responsible for the organization that is followed and the choices that have been made in deciding something.

Skill Aspects Evaluation

Evaluation of the skills aspect is used to measure the level of farmer skills by evaluating farmers after counseling. Evaluation of skills is done using a Guttman scale with 2 answer options. To determine the level of skills of farmers by giving a score skilled get a score of 1 and not yet skilled get a score of 0. The calculation of the results can be seen on the continuum line as follows:

Maximum Score = 1 x 8 (question) x 24 (goal)
= 192

Minimum Score = 0 x 8 (questions) x 24 (goals)
= 0

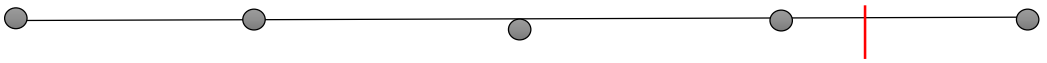
Scores obtained = 155

Median = $\frac{\text{Skor Maks} - \text{Skor Min}}{2}$ + Min Score
= $\frac{192 - 0}{2} + 0$
= 96

Quadrant I = $\frac{Skor\ MIn + Median}{2}$
= $\frac{0 + 96}{2}$
= 48

Quadrant II = $\frac{Skor\ Maks + Median}{2}$
= $\frac{192 + 96}{2}$
= 144

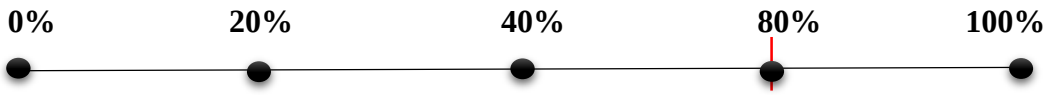
Based on the tabulation of extension evaluation data, the continuum line of skill aspects can be seen as follows:



From the results of the calculation of 155 scores, the results of the skill level presentation can be presented as follows:

Percentage $= \frac{\text{Total Skor}}{\text{Skor Maks}}$ x 100 %

$= \frac{155}{192}$ x 100 % = 80%



Unskilled **Skilled**

Description :

SR	: Very Low	= 0-20%
R	: Low	= 21-40%
S	: Medium	= 41-60%
T	: High	= 61-80%
ST	: Very High	= 81-100%

Based on the data above about the level of attitude of the target, it can be seen that the target has a percentage of 80% included in the skilled category, which means that farmers are skilled in multiplying biological agents to applying biological agents. When viewed the aspects of skill according to Robbins are as follows:

Description

Basic literally skill	= 0% - 25%
Technical skill	= 26% - 50%
Interpersonal Skills	= 51% - 75%
Problem solving	= 76% - 100%

Based on the data analysis that has been done with the results of 80% percentage included in the problem-solving skill level. At the problem-solving level, it can be said that farmers can solve problems regarding how to propagate to apply pests and can describe these problems to find the best solution.

CONCLUSION AND SUGGESTIONS

Conclusion

Extension of the utilization of biological agents *Beauveria bassiana* as a control of coffee fruit borer pests in Ngrayudan Village, Jogorogo District, Ngawi Regency was arranged with 4 stages of extension. The methods used were demonstration plots, lectures, discussions, demonstration methods, and personal visits. The media used are leaflets, folders, PowerPoint, video tutorials, and real objects. The results of the evaluation of the extension of the utilization of biological agents such as Coffee Fruit Borer pest control showed an increase in the extension of the knowledge aspect of the average Pre-test score of 8.17 and the average Post-test score of 11.46. This is to the data analysis conducted there is a significant difference between the results of the questionnaire aspects of the knowledge Pre-test and Post-test. The results of the evaluation of the attitude aspect of 89% are included in the responsibility category. Measurement of the skill level of 80% including the level of problem solving.

Suggestion

It is expected to be able to improve the ability and add information related to the knowledge obtained from the research carried out and be able to innovate, especially in agriculture. For farmers is expected to be able to implement integrated pest control, one of which is the utilization of the biological agent *Beauveria bassiana.*

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