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Farmers' Knowledge and Readiness in Implementing Biological Resource-Based Technology for Seedling Practices of Long Pepper (*Piper retrofractum* Vahl)

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Abstract

Long pepper (*Piper retrofractum* Vahl), known locally as cabe jamu, is one of Indonesia's important medicinal and spice plants. However, farmers' knowledge and readiness to implement biological resource-based technology in seedling practices remain limited. This study aims to analyze farmers' knowledge levels and readiness in implementing biological resource-based technology in Javanese long pepper seedling practices in Bluto Subdistrict, Sumenep Regency. The research employed a descriptive quantitative approach, using primary data obtained through field observations, Focus Group Discussions (FGDs), and questionnaires distributed to 30 selected farmers using purposive sampling. The Wilcoxon Signed-Rank Test was applied to measure differences in knowledge before and after the dissemination of information on biological resource-based technology. The results showed a significant increase in farmers' knowledge after the dissemination of information, with an average pretest score of 49.0 and a posttest score of 78.4. The Wilcoxon test results confirmed a significant difference at the 0.05 level. Farmers' readiness in terms of knowledge, skills, facilities, and support was categorized as medium, while their attitudes were categorized as high, indicating a strong willingness to adopt environmentally friendly innovations, although further guidance and training are still needed. The findings highlight the need for continuous dissemination, training, and mentoring programs to improve farmers' knowledge and readiness in implementing biological resource-based technology, which can support sustainable agricultural practices and enhance the productivity of Javanese long pepper in the region.

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Introduction

Long Pepper or *Piper retrofractum* Vahl is one of the medicinal and spice crops cultivated in Indonesia. The main production areas for long pepper are East Java Province and Lampung. In 2010, the cultivation area for long pepper was recorded at 4,211 hectares, distributed across several regions: on Madura Island, Sumenep Regency had 1,709 ha, Sampang Regency 1,017 ha, Pamekasan Regency 715 ha, and Bangkalan Regency 356 ha. Additionally, Lamongan Regency had 276 ha, and Lampung Province had 630 ha (Evizal, 2013) [9].

The largest cultivation area in Sumenep Regency is located in Bluto District, with 687.83 ha or around 26.48% of the total cultivation area of 2,617.95 ha in Sumenep Regency (Badan Pusat Statistik, 2023) [5]. long pepper is generally cultivated as an intercrop in community forests with various climbing trees such as coconut, fruit trees, coffee, sengon, and others. It is also cultivated intensively in monoculture systems on open land using gliricidia stakes or dadap trees, which function as climbing supports and provide shade for the long pepper plants (Djauhariya & Rosman, 2009) [8].

In Bluto District, long pepper climbing supports use moringa trees propagated vegetatively through stem cuttings (Hasanah & Setiawan, 2016) [11]. Long pepper can be propagated through seeds, climbing branch cuttings, ground branch cuttings, and fruit branch cuttings (Evizal, 2013) [9].

To achieve high production yields, planting materials are selected from superior, healthy, and highly productive mother plants. The success rate of long pepper cuttings needs to be supported by factors essential for plant growth and development, such as water and sunlight (Nurkhasanah *et al.*, 2013) [14].

The success rates of long pepper propagation are around 75% for climbing branch cuttings, 66% for ground branch cuttings, and 38% for fruit branch cuttings (Djauhariya *et al.*, 1992) [7]. The use of growth regulators and fertilizers also plays a significant role in the seedling process. According to Febriyani (2012) in (Rahmawati *et al.*, 2023) [16], one way to increase crop production is by improving soil fertility through fertilization, which aims to maintain, improve, and sustain soil fertility by providing nutrients to the soil to supply adequate plant nutrients

One of the nutrient sources that can be utilized is rice washing water, which is often considered waste (Azhari *et al.*, 2021) [3]. Rice washing water contains Nitrogen 0.015%, Phosphorus 16.306%, Potassium 0.02%, Calcium 2.944%, Magnesium 14.252%, Sulfur 0.027%, Iron 0.0427%, and Vitamin B1 0.043% (Wulandari *et al.*, 2012). According to Risman (2022) in (Apriyanto *et al.*, 2023) [2], rice washing water contains Pseudomonas fluorescens, pectolytic pectin, and *Xanthomonas* maitophilia, some of which play roles in synthesizing carbohydrates and amino acids to produce growth hormones and synthesize metabolites that inhibit pathogen development.

Fermenting rice washing water for a certain period can produce a fungus that appears like coral reefs, brown and chewy in texture, known as Jakaba (an acronym for "Jamur Keberuntungan Abadi" or Eternal Luck Fungus). The nutrients present in rice washing water are also found in Jakaba soaking water (Ani *et al.*, 2023) [1].

Agricultural activities cannot be separated from the role of farmers as the primary actors in performing all agricultural practices. One important aspect for farmers in carrying out their agricultural activities is enhancing their knowledge in absorbing agricultural information and innovations. Farmers' knowledge can be influenced by education level, age, farming experience, environment, information sources, as well as social, cultural, and economic factors (Prastisi *et al.*, 2023) [15]. Furthermore, farmers' willingness to adopt an innovation is closely related to their level of knowledge (Azizah & Sugiarti, 2020) [4].

The implementation of biological resource management technology innovations in long pepper seedling practices by farmers in Bluto District, based on field conditions, is still relatively unknown to many farmers. Therefore, it is essential to conduct information transfer activities to increase the knowledge and willingness of long pepper farmers to apply biological resources as supporting factors for successful seedling practices.

Considering the content and benefits of rice washing water, Jakaba, and other biological resources while reviewing the potential of long pepper in Sumenep Regency, research needs to be conducted to determine the knowledge and readiness levels of farmers in implementing biological resource technology in long pepper seedling practices.

2. Methods

Type and Resource of Data

The type of data used in this research to analyze farmers' knowledge and attitudes toward long pepper (Cabe Jamu) seedling practices using biological resource technology is quantitative (descriptive) data. Data sources are utilized to obtain information related to the research focus. The data sources used are primary and secondary data. Primary data were obtained from field observations and interviews with respondents using research instruments in the form of questionnaires. Meanwhile, secondary data were collected from literature studies and supporting statistical documents to strengthen the research analysis.

Research Instruments

Primary data were obtained through direct discussions in Focus Group Discussions (FGD) and pre-prepared questionnaires, as well as recording devices such as cameras and field notes. The questionnaires for farmer respondents consisted of questions regarding respondent identities and the measurement of farmers' readiness levels in utilizing biological resource technology in long pepper seedling practices.

Determination of Respondents

The respondents in this study were the main actors (farmers) cultivating long pepper in Bluto District. Respondents were selected using purposive sampling. Purposive sampling is a respondent selection technique based on specific considerations (Sugiyono, 2013) [20]. The sampling criteria used in this research included active farmers who have conducted long pepper seedling practices and have cultivated long pepper intensively for at least two years.

The number of farmers serving as respondents was determined using the Lemeshow formula, which is applied when the population size is unknown (Caniago & Rustanto, 2022) [6]. The Lemeshow formula is as follows:

$$n = \frac{Z^2 . p . q}{d^2}$$

Where:

n= minimum required sample size

Z= standard value for a 5% significance level (1,96)

p= estimated prevalence (used as 50% due to unknown data)

q= 1-p

d = percision level (18%)

$$n = \frac{1{,}96^{\,2} . 0{,}5 . (1 - 0{,}5)}{0{,}18^2}$$

$$n = \frac{3{,}8416 . 0{,}25}{0{,}0324}$$

$$n = \frac{0{,}9604}{0{,}0324}$$

$$n = 29{,}64$$

Based on the calculation using the Lemeshow formula, the obtained n value was 29.64, which was then rounded up to 30. Therefore, the total number of respondents used in this study was 30 farmers.

Data Analysis Techniques

The data analysis technique used to analyze the farmers' knowledge and attitudes regarding long pepper seedling practices using biological resource technology was descriptive quantitative analysis. Descriptive quantitative analysis involves collecting data from the sample population, analyzing it using statistical methods, and interpreting the findings (Latif *et al*., 2023) [13].

Farmers' knowledge levels were assessed using pre-tests and post-tests. A pre-test was conducted by providing farmers with a questionnaire before introducing the biological resource technology for long pepper seedlings. After delivering information through extension activities on the application of biological resources in seedling practices, a post-test was conducted. To measure the effectiveness of pre-test and post-test scores, the Wilcoxon Sign-Rank Test was applied, as the small sample size did not meet the assumptions of normal distribution, and the paired data required non-parametric analysis (Zulkipli *et al*., 2024) [23].

Farmers' attitudes toward readiness to implement biological resource technology in long pepper seedling practices were measured using a Likert scale. The Likert scale, according to Sugiyono (2016) [20] in (Windani *et al*., 2022) [22], is a method used to measure individuals' or groups' attitudes, opinions, and perceptions toward specifically defined social phenomena. This study employed a Likert scale with five scoring levels, 5 for Strongly Agree (SA), 4 for Agree (A), 3 for Neutral (N), 2 for Disagree (D), and 1 for Strongly Disagree (SD).

Each statement in the instrument regarding farmers' readiness to implement biological resource technology in long pepper seedling practices was scored based on respondents' answers. The average score was then calculated to represent the overall readiness level. The readiness categories were determined using the following formula:

$$Interval = \frac{Maximum\ Score - Minimum\ Score}{Number\ of\ Categories}$$

$$Interval = \frac{5-1}{3}$$

$$Interval = 1{,}33$$

Based on this calculation, the readiness categories were defined as:

1. Low Category = 1.00 – 2.33
2. Medium Category = 2.34 – 3.66
3. High Category = 3.67 – 5.00

Subsequently, the data were analyzed using descriptive quantitative methods, presenting the mean scores of respondents' answers in table form to facilitate the interpretation of the calculation results.

3. Results and Discussion

Farmer's Knowledge

The results of the study indicate that the majority of farmers have understood the basic stages of long pepper (Cabe Jamu) seedling practices, such as selecting healthy cuttings (vines), using appropriate planting media, and conducting regular watering. However, there are still limitations in their understanding regarding the use of biological materials as supporting technologies, including biofertilizers, natural growth hormones (such as Jakaba water and fermented cow urine), and the application of auxin hormones as root growth stimulants for the plants.

The measurement of farmers' knowledge levels regarding long pepper seedling practices using the biological resource technology package was conducted through pre-test and post-test activities. The pre-test was administered before introducing the technology package to assess the farmers' initial knowledge regarding the use of biological resource technology. The post-test was conducted after the farmers had received information about the technology package. The comparison results between the pre-test and post-test scores can be seen in Figure 1 below

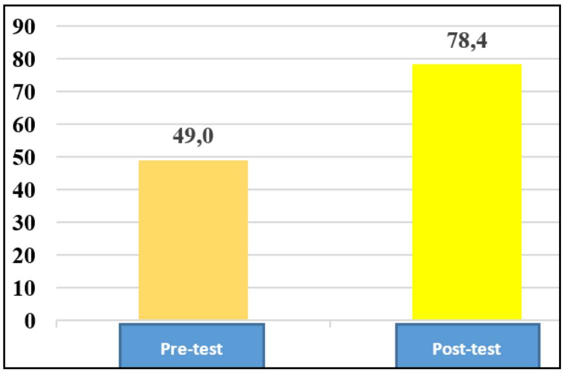

Fig 1: Comparison of Pre-test and Post-test Scores.

Based on Figure 1, the average pre-test and post-test scores obtained from 30 farmer respondents are presented. An increase in the difference between the post-test and pre-test scores was observed. Before the dissemination of information regarding the use of the biological resource technology package in long pepper seedling practices, the farmers' average pre-test score was 49.0. After the dissemination of information, the average post-test score increased to 78.4, indicating an improvement of 28.6 points. This increase occurred because farmers who previously had limited knowledge about the use of biological resource technology in long pepper seedling practices gained understanding after the dissemination activities on the technology package.

The effectiveness of implementing the biological resource technology package in long pepper seedling practices was measured using the Wilcoxon Signed-Rank Test on the pre-test and post-test results. The results of the Wilcoxon Signed-Rank Test are presented in Table 1 below.

Table 1: Wilcoxon Signed-Rank Test Results

Kategori	N	Mean Rank	Sum of Ranks
Negative Ranks	0[a]	0,0	0,0
Positive Ranks	30[b]	15,5	465,0
Ties	0[c]	0	0
Nilai Sig	0,000		

Based on Table 1, it can be seen that the category of Negative Ranks has a value of 0, indicating that no farmers experienced a decrease in readiness after the training or information transfer activities. Meanwhile, the Positive Ranks category shows a value of 30, meaning that all 30 respondents demonstrated an increase in their readiness to implement biological resource technology in long pepper seedling practices. The Ties category also has a value of 0, indicating that there was a change or difference between the pre-test and post-test scores.

The significance value obtained from the Wilcoxon Signed-Rank Test was 0.000, which is smaller than the alpha value of 0.05. Statistically, this indicates a significant difference between the farmers' readiness levels before and after the dissemination of information regarding the use of biological resource technology in long pepper seedling practices. Therefore, the training or extension activities on the use of biological resource technology can be considered to have a positive and significant influence on improving farmers' readiness in long pepper seedling practices.

Information obtained from farmers regarding long pepper seedling practices using biological resource technology, based on the results of the Focus Group Discussion (FGD), revealed that farmers had previously heard or were aware that rice washing water has high benefits for plants. Additionally, farmers stated that cow urine also contains beneficial nutrients for soil and plants. However, in terms of understanding the processing of rice washing water into Jakaba and its benefits for root development and resilience during the seedling stage of long pepper, farmers reported that they had never practiced this. Similarly, the use of biofertilizers derived from fermented cow urine has been introduced to farmers through various trainings and extension activities, including information on dosage, application methods, and timing, but it has not yet been widely adopted by the farmers.

This situation aligns with a study conducted by (Sukmasari *et al*., 2022) [21], which reported that farmers in the Bantarjaya farmer group, Sanca Village, Indramayu District, had a moderate level of knowledge regarding biofertilizers. This indicates the need to enhance farmers' knowledge to adopt biofertilizer technology in soybean cultivation. It also emphasizes that increasing farmers' knowledge and interest can be achieved through continuous programs such as socialization or extension activities regarding the benefits of biofertilizers, accompanied by demonstration plots.

The identification of factors influencing farmers' knowledge levels in the use of biological resource technology, based on discussions during the FGD with long pepper farmers, includes the following:

Access to information and extension services, where farmers who frequently participate in farmer group activities and extension sessions tend to have a better understanding of the benefits and applications of biological resource technology.

Perceived tangible benefits, where farmers are often reluctant to try or adopt a new innovation due to the absence of visible benefits, highlighting the need for specific demonstrations to showcase comparative results of innovation implementation.

Low adoption rates of biological technology, which are also caused by the limited availability of field demonstrations and a lack of supporting materials or tools.

Therefore, the findings of this study indicate the necessity of increasing continuous dissemination and training activities on biological resource-based technologies, enabling farmers not only to understand but also to consistently apply these practices in long pepper seedling cultivation. This is in line with (Heryanto & Nugraha, 2023) [12], who found in their study on behavioral changes among rice farmers in Mekarjaya Village, Purwakarta Regency, that the implementation of environmentally friendly farming practices needs to be re-encouraged, particularly in the use of production inputs utilizing local resources.

Farmer's Readiness

The farmers' readiness level in this study aims to measure the extent to which farmers are prepared to implement biological resource management technology in long pepper seedling practices. Several aspects served as indicators of farmers' readiness, including the cognitive aspect (knowledge), affective aspect (skills), supporting facilities, and attitude aspect. These aspects were measured and classified into three categories: low, medium, and high readiness levels. The determination of categories and score ranges can be seen in Table 2 below.

Table 2: Criteria for Farmers' Readiness in Implementing Biological Resource Technology in Long Pepper Seedling Practices

Category	Score Interval	Interpretation
Low	1,00 – 2,33	Farmers are not ready to implement the biological resource technology package in long pepper seedling practices
Medium	2,34 – 3,66	Farmers are moderately ready to implement the biological resource technology package in long pepper seedling practices
High	3,66 – 5,00	Farmers are ready to implement the biological resource technology package in long pepper seedling practices

Table 3: Farmers' Readiness in Implementing Biological Resource Technology in Long Pepper Seedling Practices

Aspect	Score	Category
Knowledge		
1. I know about the benefits of biological resource technology (Jakaba/Ferinsa) i long pepper seedling practices.	3,4	Medium
2. I know how to manage biological resources (Jakaba/Ferinsa)	3	Medium
3. I know the proper stages of long pepper seedling practices.	3	Medium
4. I know the dosage for applying Jakaba/Ferinsa on plants.	2,7	Medium
Average	3,03	Medium
Skill		
1. I can manage biological resources (Jakaba/Ferinsa) for long pepper seedling practices.	3,6	Medium
2. I can properly mix and apply Jakaba/Ferinsa	2,4	Medium
3. I can properly prepare polybag planting media.	2,9	Medium
4. I can measure and observe the growth of long pepper seedlings.	2,7	Medium
Average	2,89	Medium
Attitude		
1. I am interested in trying biological resource technology.	3,7	High
2. I believe that this technology improves crop yields.	3,8	High
3. I am willing to participate in training or trials of the technology.	3,8	High
4. I am confident that I can carry out seedling practices using this technology.	3,3	High
Average	3,67	High
Supporting Facilities		
1. I have the materials and tools to manage biological resources *(Jakaba/Ferinsa)*	2,8	Medium
2. I have sufficient time to produce and care for long pepper seedlings.	3,1	Medium
3. I can easily obtain local organic materials.	2,7	Medium
4. I receive support from extension agents or farmer groups.	2,9	Medium
Average	2,88	Medium

Table 3 above explains that, in terms of farmers' knowledge regarding the existence and perceived benefits of biological resource technology applied in long pepper seedling practices, the average score was 3.03, which falls into the medium category. Based on interviews conducted during the FGD, the farmers explained that they are aware of the potential benefits of rice washing water and cow urine when applied to plants. However, they have not yet understood in detail the derivative products that can be produced from the fermentation of rice washing water and cow urine. This condition may be influenced by the limited information accessible to farmers and the lack of optimal assistance in managing biological resources such as rice washing water and cow urine.

Farmers' readiness in terms of skills showed an average score of 2.89, which falls into the medium category. Farmers tend not to be accustomed to conducting seedling practices using organic techniques or additional treatments to support the seedling process in long pepper cultivation. They still generally perform seedling activities using conventional methods without the application of supplementary materials that could help accelerate seedling growth. Farmers perceive that they do not have sufficient time to carry out additional treatments during the seedling stage of long pepper.

The farmers' attitude aspect in implementing biological resource technology in long pepper seedling practices obtained the highest average score among all aspects, at 3.67, which falls into the high category. Most farmers expressed a strong interest in trying environmentally friendly new technologies and demonstrated openness toward innovations in long pepper seedling practices. One of the factors driving farmers' interest was that they had been shown the results of using biological-based seedling techniques for long pepper. Additionally, farmers perceived this technological innovation as relatively affordable and easily accessible. However, on the other hand, they still require guidance and technical training to enhance their capacity in managing biological resources effectively.

Farmers' readiness in terms of supporting facilities and resources for managing biological resources, such as Jakaba and Ferinsa, showed an average score of 2.88, which falls into the medium category. The farmers explained that they are aware of the availability of supporting resources for developing the management of biological resources such as Jakaba and Ferinsa. In addition to their farming activities, many farmers are also involved in livestock activities, particularly cattle farming. They recognize that the organic waste produced from cattle manure has beneficial effects on plants. Farmers also realize that household waste, such as rice washing water, holds potential benefits that can positively impact plant growth. In terms of the availability of supporting materials for managing biological resources, these materials are generally accessible. However, farmers still face limitations regarding other supporting facilities necessary for the effective management of biological resources and for long pepper seedling practices.

In general, across all aspects that served as indicators of farmers' readiness, it can be concluded that farmers are willing to try implementing biological resource technology in long pepper seedling practices. Additionally, farmers expressed the need for further guidance regarding the management of biological resources to maximize their benefits. Such assistance and guidance can be provided by relevant parties, such as field agricultural extension workers, who can act as facilitators for farmers. Assistance and guidance activities for farmers will foster renewed motivation among farmers to adopt innovations aimed at increasing their agricultural production. This aligns with a study conducted by (Setiawan *et al.*, 2024) [18] on farmers' readiness to perform oil palm transplanting, where the farmers' readiness in facing plantation rejuvenation was considered sufficient due to government support, having savings, alternative employment, and ownership of plantations, enabling them to continue meeting their daily needs.

Farmers' readiness to implement long pepper seedling practices based on the utilization of biological resources is driven by the perceived benefits generated from such practices. Agricultural and livestock waste, household waste, and other local resources, if managed properly, can provide substantial and sustainable benefits. Additionally, the cost of using biological resources is relatively low and easily accessible, which can help reduce production costs for farmers. These positive impacts on both farmers and the environment serve as reasons for farmers' readiness to adopt biological resource-based seedling practices for long pepper. In general, challenges and threats in agricultural activities need to be considered and addressed to ensure the sustainability of biological resource management. Based on the analysis of farmers' statements collected through FGDs with long pepper farmers and agricultural extension officers in Bluto Subdistrict, several challenges and threats that may hinder the management of biological resources include:

a. Dependency on Inorganic Fertilizers and Pesticides

It is undeniable that the presence of inorganic fertilizers and pesticides has provided significant benefits to farmers, particularly in terms of production scale and productivity. However, the continuous use of inorganic fertilizers can lead to negative effects, such as a decrease in soil organic matter content, increased susceptibility to erosion, reduced soil permeability, and a decline in soil microbial populations Miftahul, 2013 in (Rosalina *et al*., 2021) [17]. Although some farmers recognize the adverse impacts of excessive and continuous use of inorganic fertilizers and pesticides, many continue to use them without considering environmental conditions. Therefore, special attention is needed to mitigate the risks and impacts of inappropriate fertilizer and pesticide use, particularly through providing knowledge and education to farmers, who are the primary actors in agricultural activities.

b. Decline in Soil Fertility

The decline in soil fertility within an area poses a significant challenge to the availability of biological resources in the soil. Improper and environmentally unfriendly management practices can disrupt the balance of soil nutrients. A clear example is the excessive use of fertilizers, which leaves residues that can damage the soil ecosystem. (Soekamto & Fahrizal, 2019) [19] state that plants generally cannot fully absorb 100% of inorganic chemical fertilizers, leaving residues in the soil. Many farmers believe that applying more fertilizers will increase their crop yields, whereas in reality, the residues left in the soil can bind with water over time, creating cement-like layers that damage the soil ecosystem and reduce the availability of nutrients. This condition can lead to nutrient-poor soils if not managed properly through appropriate soil ecosystem maintenance.

c. Low Awareness and Participation Among Farmers

The low awareness and participation of farmers in maintaining environmental sustainability, particularly soil health, contribute to the degradation of soil nutrient quality and the limited availability of local biological resources. This condition also leads to a decline in agricultural productivity in the long term due to reduced soil nutrient content. Thus, participatory education and extension activities are necessary, along with the strengthening of farmer groups and agricultural institutions. Farmers should be involved in the planning and implementation of agricultural environmental maintenance by combining local wisdom with current technological advancements. According to (Fadhli *et al*., 2021) [10], providing farmers with knowledge and skills to produce organic fertilizers can facilitate the implementation of these practices in the field, thereby assisting farmer groups in addressing challenges in the agricultural sector.

4. Conclusion

Based on the results of previous research, it can be concluded that, there was a significant difference in farmers' knowledge regarding long pepper seedling practices using biological resource technology, as indicated by the Wilcoxon Signed-Rank Test analysis, between before and after the dissemination of information on the use of biological resource technology in long pepper seedling practices Farmers' readiness to implement biological resource-based technology in long pepper seedling practices, in terms of knowledge, skills, facilities, and support, was found to be in the medium category. Meanwhile, in terms of attitude, it was in the high category, indicating that farmers are willing to try biological-based technological innovations but still require additional guidance

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