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The Influence Of Socioeconomic Factors On Sustainable Pepper Agroforestry Systems

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ABSTRACT

BACKGROUND AND OBJECTIVES:
Pepper production in Central Bangka Regency declined from 2019 to 2023 because pepper cultivation practices have not yet been implemented according to GAP (Good Agricultural Practices). The agroforestry system is one approach to addressing this issue. However, many pepper farmers have not widely applied this system, so it is necessary to understand farmers' attitudes toward the successful implementation of a sustainable pepper agroforestry system. This study aims to describe pepper farmers' attitudes toward the agroforestry system as a solution for sustainable agriculture and analyze the socioeconomic factors influencing their adoption of a sustainable pepper agroforestry system in Central Bangka Regency.
METHODS:
The research method used is quantitative with a descriptive approach and multiple linear regression analysis. Primary data were collected through questionnaires from 105 pepper farmers selected by purposive sampling.
FINDINGS:
The results show that the attitude of pepper farmers towards the agroforestry system falls into the 'agree' category, with an average variable achievement rate of 80.27%. The cognitive and conative attitude components fall into the strongly agree category, while the affective component falls into the agree category. Socioeconomic factors have a significant simultaneous effect on the attitude of pepper farmers in implementing a sustainable pepper agroforestry system, contributing 64.2%. Partially, the variables of age, formal education, income, and culture have a significant effect on the attitude of pepper farmers in implementing a sustainable pepper agroforestry system, while the variables of non-formal education and farming experience do not have a significant effect.
CONCLUSION:
The attitude of pepper farmers towards the agroforestry system is in the strongly agree category, consisting of cognitive, affective, and conative components. Socioeconomic factors simultaneously have a significant effect on the attitude of pepper farmers in implementing a sustainable pepper agroforestry system. Meanwhile, partially, the socioeconomic factor variables that influence the attitude of pepper farmers include age, formal education, income, and culture.

Keywords: Agroforestry; Pepper; Attitude; Farmers; Socioeconomic

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INTRODUCTION

Global agricultural development today increasingly emphasizes the importance of implementing sustainable agricultural systems that can address the challenges of climate change, natural resource degradation, and food security (1). In this context, agroforestry systems are recognized as an adaptive approach because they integrate forestry and agricultural crops within one land system to improve land efficiency, enhance ecosystem conditions, and increase farmers' incomes (2). An international study shows that agroforestry significantly contributes to land conversion, increased land productivity, and carbon sequestration (3).

One commodity that can be integrated into this system is pepper (*Piper nigrum* L.), which holds a strategic global position as a major spice in international trade (4). Research in India reveals that pepper-based agroforestry systems planted with shade trees can increase pepper yields while maintaining soil fertility and micro-moisture levels (5). These findings strengthen the argument that developing pepper agroforestry systems is not only ecologically relevant but also provides sustainable economic benefits in various geographic contexts.

One of the largest pepper production centers in Indonesia is Bangka Belitung Islands Province, which contributed 37.48% of the national total pepper production during the 2018-2022 period (6). However, Central Bangka Regency, as one of the producing areas, has experienced a decline in pepper production over the past five years. Data from the Agriculture Office shows pepper production decreased from 3,471 tons in 2019 to 2,373.96 tons in 2023, with productivity falling from 1.48 tons/ha to 1.22 tons/ha (7).

This decline is influenced by farmers shifting to more profitable commodities, as well as minimal adoption of cultivation technologies that meet Good Agricultural Practices (GAP) standards. Farmers tend to plant crops with higher market prices, so many have switched from pepper to other, more profitable crops. Furthermore, pepper farmers in Central Bangka Regency still rely on traditional cultivation methods that have been passed down culturally for generations. However, along with advancements in time and agricultural technology, more modern and sustainable pepper cultivation standards are now available. One standard that can be implemented is Good Agricultural Practice (GAP), established by the International Pepper Community (IPC) in 2011, aiming to improve the quality and productivity of pepper crops through the application of good agricultural practices (8). One GAP recommendation is the use of living stakes such as *Gliricidia maculata* (4). However, field facts show that pepper farmers still use dead stakes. In 2015, there was a shortage of quality dead stakes that impacted pepper cultivation practices. Therefore, the local government recommends using living stakes in accordance with GAP pepper cultivation as the best solution (9).

The decline in pepper plant production can also be caused by pest and disease attacks, resulting in decreased farmers' income. Consequently, many farmers consider that pepper cultivation is no longer profitable (8). The local government has recommended the implementation of agroforestry systems as a solution for more sustainable and adaptive pepper farming in response to climate and economic changes (2). This system aligns with GAP principles and offers additional benefits such as income diversification and pest attack risk mitigation (10).

Although it has been socialized, the adoption rate of agroforestry systems by pepper farmers in Central Bangka Regency remains low. This indicates the importance of examining farmers' attitudes as a key factor in innovation adoption. Attitude is an individual's predisposition influenced by internal and external factors, and it can affect intentions and actions ((11); (12); (13)). Based on this, this study is important to review farmers' attitudes toward the pepper

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agroforestry system and the factors that influence them. This understanding is expected to provide a foundation for developing strategies to strengthen farmers' capacity in supporting the sustainability of pepper cultivation in Central Bangka Regency.

The novelty of this research lies in the study of the pepper agroforestry system with an emphasis on farmers' attitudes as the main determinant in implementing sustainable agroforestry systems, as well as identifying the influence of socioeconomic factors on these attitudes. The objectives of this study are 1) to describe farmers' attitudes toward the pepper agroforestry system in supporting sustainable agriculture and 2) to analyze the socioeconomic factors influencing pepper farmers' attitudes in applying a sustainable pepper agroforestry system in Central Bangka Regency.

RESEARCH METHOD

The research was conducted in Namang and Simpang Katis Subdistricts, Central Bangka Regency, Bangka Belitung Islands Province. These two subdistricts were chosen because they are pepper production centers and have been targeted areas for extension programs regarding the agroforestry system. The research was carried out from March to April 2025. This study used a survey method. The survey method is used to obtain data from specific natural locations through treatments such as distributing questionnaires, structured interviews, or observations (14). This method is suitable for illustrating the actual conditions in the field related to farmers' attitudes toward the pepper agroforestry system.

The sampling technique was determined using a non-probability sampling method with purposive sampling. The criteria for respondents to be sampled were farmers who cultivate pepper and have received extension on the agroforestry system. Based on these criteria, the sample size was set at 105 pepper farmers spread across Namang and Simpang Katis Subdistricts, Central Bangka Regency.

Data collection techniques involved both primary and secondary data. Primary data were obtained through questionnaires and interviews with respondents, covering respondent identity, farmers' attitudes, subjective norms, behavioral control perceptions, and socioeconomic factors (age, education, income, farming experience, culture). Secondary data were obtained from relevant agencies such as the Agricultural and Food Security Service of Bangka Belitung Islands Province. Data collection techniques included non-participant observation to observe field conditions, structured interviews to explore in-depth information, and open and closed questionnaires with a 5-point Likert scale.

Data analysis in this study was conducted using two approaches. Prior to this, validity and reliability tests were performed on all questionnaire items to determine whether the research data were valid and reliable. The validity test result is assessed by comparing the calculated r value to the table r value (r calculated > r table), while the reliability test result is assessed by Cronbach's Alpha > 0.60.

The first objective of this study was analyzed using quantitative descriptive analysis with the variable achievement level method using the following formula (15).

$$\text{Variable Achievement Level (\%)} = \frac{\text{Average answer score}}{\text{Maximum score}} \times 100\%$$

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After calculating using the formula, the next step was to categorize the assessment. This analysis aimed to describe the characteristics of each research variable by looking at the percentage results and the achievement category of the research variables (15). These categories are as listed in Table 1 below.

Table 1. Category Level of Achievement of Pepper Farmers' Attitude Variables 2024

No.	Category Achievement Level Variable (%)	Description
1.	0-20	Strongly disagree
2.	>20-40	Disagree
3.	>40-60	Neutral
4.	>60-80	Agree
5.	>80-100	Strongly agree

Source: Pranoto (2024)

The second objective of this study was analyzed using multiple linear regression analysis with the following equation.

$$Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + bdD + e$$

Explanation:
Y = Pepper farmers' attitude (Likert scale score that has been transformed)
X1 = Age (years)
X2 = Formal education (years)
X3 = Non-formal education (times per year)
X4 = Farming experience (years)
X5 = Income (rupiah)
D = Cultural dummy variable (modern = 1, traditional = 0)
a = Constant
b1 = Regression coefficient of age on pepper farmers' attitude
b2 = Regression coefficient of formal education on pepper farmers' attitude
b3 = Regression coefficient of non-formal education on pepper farmers' attitude
b4 = Regression coefficient of income on pepper farmers' attitude
b5 = Regression coefficient of farming experience on pepper farmers' attitude
bd = Regression coefficient of cultural dummy variable on pepper farmers' attitude
e = Error term

Instrument testing and classical assumption tests are conducted first (validity, reliability, normality, multicollinearity, and heteroscedasticity) before model interpretation. Parameter significance testing is performed at a 5% significance level to test the research hypotheses. After conducting multiple linear regression analysis to determine the relationships between variables, F-test and T-test need to be performed. From these tests, the influence of socioeconomic factors and pepper farmers' attitudes in implementing a sustainable pepper agroforestry system can be identified.

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RESULTS AND DISCUSSION

Farmers' Attitudes Towards Sustainable Pepper Agroforestry Systems

The attitude of pepper farmers towards the implementation of an agroforestry system on sustainable pepper plants reflects behavioral tendencies that represent the farmers' views, understanding, and feelings towards the system. In this study, farmers' attitudes were analyzed using a Likert scale, which was then processed by the variable achievement level. The attitude consists of three components: cognitive, affective, and conative. The results of the analysis regarding the attitude of pepper farmers towards the implementation of an agroforestry system on sustainable pepper plants can be seen in Table 2.

Table 2. Variable Achievement Levels of Pepper Farmers' Attitudes 2025

No	Component	Number (People)	Percentage (%)	Category
1	Cognitive	105	81.28	Strongly agree
2	Affective	105	77.19	Agree
3	Conative	105	82.35	Strongly agree
	Average		80.27	Agree

Source: Primary data processing 2025

Based on the analysis results of the achievement level of variables presented in Table 2, it was found that farmers' attitudes towards the implementation of the agroforestry system show a tendency to agree. This is based on the fact that these farmers have a good understanding of the benefits of the pepper agroforestry system, emotionally support the presence of the pepper agroforestry system, and have a strong desire to implement the system in their pepper cultivation practices. These results also align with study (17), which states that village youths show an agreeable attitude towards organic salak farming. Study (18) also states that rice farmers have a positive attitude towards the utilization of organic farming. Study (5) further shows that pepper farmers in India who apply agroforestry systems have a positive understanding of ecological and economic benefits. Study (3) also states that farmers tend to agree with agroforestry because it helps maintain biodiversity and improves family welfare. This condition shows a strategic opportunity to expand the implementation of agroforestry systems more structurally and sustainably, certainly with consistent support from the government, related institutions, and the private sector through extension programs, practical training, and continuous incentives.

The Influence of Socioeconomic Factors on Pepper Farmers' Attitudes in Implementing Pepper Agroforestry Systems

This study aims to examine the influence of socioeconomic factors, namely age (X1), formal education (X2), non-formal education (X3), farming experience (X4), income (X5), and culture (D), on the variable of pepper farmers' attitudes towards implementing the pepper agroforestry system (Y). The Model Summary test results show a coefficient of determination (R^2) value of 64.2%, indicating that the variable of pepper farmers' attitudes towards implementing the pepper agroforestry system (Y) can be explained by the socioeconomic factor variables, namely

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age (X1), formal education (X2), non-formal education (X3), farming experience (X4), income (X5), and culture (D) by 64.2%. The regression ANOVA results show that the regression model is statistically significant with an F value of 32.044 and a significance (p-value) <0.001. This means that simultaneously, the six independent variables have an influence on the attitudes of pepper farmers in implementing the agroforestry system. The partial regression test results can be seen in Table 3.

Table 3. Regression Test Results 2025

No	Variable	Calculated T	Sig	Description
1	Age	2.377	0.019	Significantly Influential
2	Formal Education	4.206	<0.001	Significantly Influential
3	Non-Formal Education	0.271	0.787	Not Significantly Influential
4	Farming Experience	-1.777	0.079	Not Significantly Influential
5	Income	2.172	0.032	Significantly Influential
6	Culture	-7.485	<0.001	Significantly Influential

Source: Primary data processing 2025

Table 3 shows that age, formal education, income, and culture have a significant influence on pepper farmers' attitudes toward implementing agroforestry systems, while non-formal education and farming experience do not have an effect. Older age is generally correlated with experience and understanding of the risks and challenges of long-term farming systems, encouraging farmers to have a more positive attitude toward agroforestry systems. This is supported by research (19), which states that the age range of older farmers is still within the productive age that can support farmers' performance in carrying out their farming activities. Formal education enhances the cognitive abilities of pepper farmers in accepting innovations and understanding the benefits of agroforestry systems, thereby encouraging the formation of a more positive attitude. This is supported by studies (18) and (20), which state that the higher the level of formal education a farmer has, the better their attitude toward a behavior or action will be. Higher income enables access to agricultural information and technology, thereby strengthening farmers' readiness to adopt the pepper agroforestry system. This aligns with the view of (21), which states that income level plays an important role in economic decision-making. Values, norms, and habits developed within the farming community shape farmers' perceptions and views toward the agroforestry system. Local culture, which has been formed from traditional pepper cultivation practices passed down through generations, reflects a deeply rooted traditional cultivation pattern and serves as a determining factor in the successful implementation of sustainable farming systems (22). This is in line with research (16), which states that one of the problems in pepper development in the Bangka Belitung Province is that farmers' use of cultivation technology is still based on traditional cultural patterns that have become a longstanding tradition or culture.

Non-formal education followed by pepper farmers, including training, extension services, or farmer group activities, has not been optimally carried out, thus affecting farmers' perspectives and readiness to accept and implement the agroforestry system. This can be caused by the low participation intensity of pepper farmers in non-formal education activities, limited materials, and limited methods of information delivery. The findings are reinforced by studies (18), (19), and (20), which state that the lower the frequency of farmers participating in non-formal education activities,

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the worse the farmers' attitudes will be toward a behavior or action. Meanwhile, the length of time farmers spend in pepper cultivation activities does not necessarily correspond with their readiness or openness to the pepper agroforestry system. One reason is that farmers tend to follow conventional farming patterns and lack motivation or facilities that encourage them to shift from the long-established pepper cultivation practices to a more sustainable farming system. This is supported by research (18) which states that farming experience does not always guarantee the formation of a positive attitude toward agricultural innovation, as experience generally increases over time and can lead to more mature decision-making by farmers.

CONCLUSION

The conclusion obtained from this study is that pepper farmers have a favorable attitude towards the agroforestry system. The cognitive and conative attitude components fall into the category of strongly agree, while the affective component is in the agree category. This indicates that pepper farmers generally have a positive understanding, feelings, and desire regarding the implementation of a sustainable pepper agroforestry system. Socioeconomic factors simultaneously have a significant effect on the attitude of pepper farmers in applying the sustainable pepper agroforestry system. Partially, the variables of age, formal education, income, and culture have a significant effect on the attitude of pepper farmers in applying the sustainable pepper agroforestry system, while the variables of non-formal education and farming experience do not have a significant effect.

RECOMMENDATIONS

Recommendations based on the research results include that pepper farmers are expected to improve their understanding and knowledge of the benefits of implementing a sustainable pepper agroforestry system through active participation in extension activities, field-based practical training, and farmer group discussions. These activities need to be facilitated by agricultural extension officers, local governments, or related institutions using an approach that not only focuses on delivering technical information but also strengthens the emotional aspects and motivation of farmers to build collective awareness of the importance of agroforestry systems for environmental and agricultural economic sustainability. The agroforestry system needs to be framed as an adaptive innovation aligned with local traditions to enhance farmer acceptance sustainably, so agricultural extension officers, local governments, or related institutions are expected to design conceptual extension approaches that consider local cultural values and social norms prevailing in farming communities. Future researchers are expected to expand the scope of research by exploring other variables beyond socioeconomic factors that may also influence the successful implementation of agroforestry systems.

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GRAPHICAL ABSTRACT