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Innovative Adoption of The Use of Biosaka Elisator in Rice Cultivation in Aceh

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Abstract

The importance of innovation in the agricultural sector to increase the productivity and welfare of farmers, especially in the use of environmentally friendly technologies such as Biosaka on rice plants. Although Biosaka offers a wide range of benefits, the adoption of this innovation still faces challenges, especially related to the characteristics of farmers, the nature of the innovation, and the effectiveness of extension. The purpose of this study is to analyze the influence of farmer characteristics, innovation nature, and counseling on the adoption of innovation in the use of Biosaka on rice plants. This study uses a quantitative method with a survey approach that involves sampling from one population and using questionnaires as a data collection tool. The research was conducted in three clusters in Pidie, East Aceh and West Aceh with a population of 50 people in each cluster so that a total of 150 respondents. The results showed that the characteristics of farmers and the nature of innovation had a significant effect on the adoption of innovations in the use of Biosaka. Farmers who have experience, education, and a certain age tend to be more receptive to the use of Biosaka because they feel the benefits and usefulness of the innovation. However, counseling on Biosaka did not have a significant effect on the adoption of this innovation, showing that the counseling carried out was still less effective in increasing farmers' understanding and interest. The implication of this study is the need to improve the quality and intensity of extension programs to better target the characteristics of farmers and increase their understanding of the benefits of Biosaka.

Keywords: *Biosaka Elisator, Innovation Adoption, Rice Cultivation*

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1. Introduction

In Indonesia, most of the population, especially in rural areas, choose to become farmers because of the rural conditions that are very supportive of agriculture, also supported by an ideal climate. This is very beneficial for farmers because they can increase their income and meet their living needs, as well as avoid poverty (Ayakeding, 2019). If farmers are able to manage their farmland efficiently, this will automatically increase crop yields and farmers' living standards. In addition, abundant production will have a positive impact on food availability for the country (Pretty, Toulmin and Williams, 2011), so that Indonesia no longer needs to import agricultural products from abroad because domestic needs have been met. (Vintarno, 2019).

As a country dominated by the agricultural sector, development in the agricultural sector is the main focus. This is due to Indonesia's high commitment to food security development as a key element in national development efforts. Agriculture offers great potential to provide livelihoods to communities, so it can serve as an effective source of income (Losch, Freguin-Gresh and White, 2012) and help reduce unemployment rates (Mucharam et al., 2020). Usually, in rural areas, the main source of people's income comes from the agricultural sector (Losch, Freguin-Gresh and White, 2012). Therefore, it is not surprising that the countryside is dominated by agricultural land. Indonesia has a tropical climate that is very supportive of agriculture, as evidenced by the country being one of the leading rice exporters in the world.

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In addition, Indonesia is also ranked at the top as a palm oil producer, with around 40% of the world's palm oil supply coming from Indonesia (Satrio, 2022). Therefore, efforts are needed to develop the economy in rural areas with the aim of providing better income for the population, so that it can improve economic welfare (Nurul Aini Mustika Dewi, 2020). Economic development in rural areas can be realized through counseling, training, and the provision of affordable fertilizers at prices that are in accordance with agricultural costs. This is so that farmers can carry out agricultural activities without experiencing losses (Widodo et. al, 2020).

Fertilizer is an important factor in production that must be provided in running a farming business. Fertilization is given in the context of providing nutrients to the soil with the aim of increasing soil fertility, providing plant nutrients, and improving plant quantity (ALnaass, Agil and Ibrahim, 2021). Increasing agricultural production requires support for the provision of fertilizers for farmers at affordable prices (Jayne and Rashid, 2013; ALnaass, Agil and Ibrahim, 2021), so the government has made regulations regarding the provision of subsidized fertilizers for farmers (Jayne and Rashid, 2013; Gede, 2017). The procurement of subsidized fertilizers by the government aims to enable farmers to obtain fertilizers at affordable prices. This fertilizer subsidy has been stipulated by the government which is regulated in Ministerial Regulation Number 1 of 2020 which states that certain types of fertilizers will get price subsidies that can be accessed only in certain circles. In the distribution of subsidized fertilizers, there are several problems faced, including the scarcity of fertilizers, the time of fertilizer application that is often late (Auliyah and Suryani, 2024), uneven distribution of fertilizers, and a long fertilizer redemption chain. This problem, according to (Darwis, 2013), arises in the irregularities in fertilizer distribution.

The intensity of chemical fertilizer use in Indonesia has increased from time to time (Andriyani and Patricia, 2021). However, without farmers realizing it, the use of inorganic fertilizers in the long term has a bad impact on the soil. According to Ratriyanto et al., (Ratriyanto et al., 2019) in the long term, the impact of the use of inorganic fertilizers is that it can erode important nutrients and minerals in the soil so that it can reduce soil fertility (Sarkar et al., 2020; Dimkpa et al., 2023; Penuelas, Coello and Sardans, 2023). Currently, the use of chemical fertilizers carried out by farmers has exceeded the recommended dosage so that the balance of the ecosystem is disturbed, the soil becomes barren and decomposing organisms such as dead worms, therefore if countermeasures are not carried out, these lands are not optimally productive and sustainable (Septiani et al., 2021). Low soil fertility due to the presence of chemical compounds can cause excessive soil pollution if used continuously and is a major problem in agricultural cultivation (Ratriyanto et al., 2019, Anon., 2021; Ma et al., 2023). So that it can be easier for plants to be attacked by pests and diseases. In addition, another problem experienced by farmers is that fertilizer subsidies from the government have decreased, while the majority of farmers are dependent on chemical fertilizers (Budiartiningsih et al., 2022). To overcome these problems, it is necessary to implement an environmentally friendly sustainable agricultural system by minimizing the use of chemicals both from fertilizers and chemical pesticides. This can be done through increasing the use of organic fertilizers (Sunada and Juwaningsih, 2019, Anon., 2021; Fernández et al., 2022; Ma et al., 2023). Biosaka is one of the renewable technology systems of modern organic agriculture in the form of bio-technology. Biosaka can be made from grass mixed with water and crushed. After that, it can be directly applied in the field for all types of plants.

The development of biosaka innovation in Aceh began with the Technical Guidance of the Local Agriculture Office, as has been carried out on March 14, 2023 at the BPP of Kaway XVI District, West Aceh Regency accompanied by POPT (Sudirman) and followed by farmers and field Agricultural Extension Workers (PPL) of Kaway XVI District, which was followed by other Aceh regions such as Pidie and East Aceh under the guidance of the Food Crop Protection Center and Horticulture of the Agriculture and Aceh Plantations. With this technical guidance, it is hoped that PPL in the sub-district can socialize to farmers about how to make and the benefits of using Biosaka on their planting land. Biosaka manufacturing materials are also very easy to obtain by utilizing several types of healthy plant leaves around farmers' land (BPTPHP Distanbun Aceh, 2023). The implementation of Biosaka is expected to bring

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improvements in crop yields and overall productivity. By increasing the amount of rice produced per unit of land, farmers are likely to obtain greater yields. This, in turn, can have an impact on increasing income and improving people's living standards. However, it is important to recognize that the effectiveness of Biosaka's impact on income is influenced by a variety of factors, including the level of farmers' understanding of its use, the level of technical support provided, and the specific environmental conditions of the area. By examining the real impact of the implementation of Biosaka in Aceh, this research is expected to contribute to knowledge about agricultural innovations that can increase farmers' income. In addition, this research can encourage sustainable agricultural growth and improve the economy in rural areas. This is in line with global efforts to achieve food security and reduce poverty (Rizki et al., 2023).

2. Method

This study is a survey study, which involves sampling from one population and using a questionnaire as a data collection tool. The research was conducted in three clusters in Pidie, East Aceh and West Aceh with a population of 50 people in each cluster so that a total of 150 respondents. The sample placement technique uses cluster random sampling. The determination of the sample was carried out using the Slovin formula. The results of the sample calculation using the Slovin formula show that the number of samples from a population of 150 people is 108 people. This sample was divided into 35 people from Pidie Regency, 35 people from East Aceh Regency, and 38 people from West Aceh Regency. with details as in Table 1.

Table 1. Sampling Framework and Number of Samples for Each District and Regency

No	Regency	District	Population (People)	Sample
1	Pidie	Keumala	14	13
		Tiro/Truseb	16	10
		Padang Tiji	20	12
		Amount	50	35
2	Aceh Timur	Julok	20	10
		Nurussalam	15	10
		Peurelak Timur	15	15
		Amount	50	35
3	Aceh Barat	Johan	15	10
		Pahlawan	20	15
		Meurebo	15	13
		Sama tiga	50	38
		Amount		
		Total	150	108

Source: Data Processing

This study uses the Structural Equation Modeling (SEM). Data processing and analysis in this study used Smart PLS. Smart-PLS software is used to analyze the data using Structural Equation Modelling (SEM) with the Partial Least Square (PLS) approach. The endogenous variable in analyzing this relationship is the Biosaka adoption rate (Y) which has 3 indicators of exogenous variables, including: Farmer Characteristics (X1), innovation traits (X2), Agricultural Extension (X3).

3. Results and Discussion

Biosaka is an innovation in agriculture that utilizes microorganisms to help improve soil fertility and plant health. In Aceh, the use of biosaka has begun to be implemented as part of efforts to support sustainable agriculture and increase agricultural yields. The implementation of biosaka in Aceh began as part of an organic farming project that aims to reduce dependence on chemical fertilizers and improve the quality of agricultural products. The local government

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together with various non-governmental organizations (NGOs) and educational institutions have conducted socialization and training to farmers on the benefits and ways to make biosaka. (Distanbun Aceh 2022).

Characteristics of farmers

1. Age

Lifespan is the length of time a person lives from birth to research. Age is described as something that if it increases will have an impact on declining performance (Robbins 2003). According to BPS, based on the results of the 2023 Agricultural Census (ST) Phase 1, in the last 10 years, the age of farmers in Indonesia has been getting older. The productive age group of farmers (25-44 years) in 2023 will amount to around 32.32% of 29.3 million people. This situation is quite worrying, considering that agriculture is a crucial sector in Indonesia, but there are no human resources to take care of it in the next few years. Age is divided into 3 groups, namely unproductive age (<17 years), productive age (17 – 64 years), and unproductive age (>64 years). Based on the results of the study, the age distribution of farmers can be seen in Table 2.

Table 2. Distribution of Respondents by Farmer Age Group

No	Interval	Population (People)	Percentage (%)
1	< 17 years	18	16%
2	17 to 64 years	80	75%
3	>64 years	10	9%
	Total	108	100%

Source : Primary Data Analysis, 2024

In Table 2, it is known that the age of the respondents is included in the productive group, namely 17 – 64 years old, which is as many as 80 people with a percentage of 75% percent. Farmers in the productive group will affect the activities carried out in running the farming business, where the physical will be stronger. In addition, the productive age also affects farmers in participating in an innovation. The average age of respondents is 46 years old, this is due to the lack of interest of young people to be involved in agriculture. However, this study is not in line with the results of the study (Ramadhani and et.al 2016), that there is no relationship between age and adoption rate. Based on the results of the study, it is known that the younger a person's age, the easier the absorption rate of innovation will be.

2. Education Level

Table 3. Distribution of Respondents Based on Education Level

No	Interval	Population (People)	Percentage (%)
1	Elementary School	30	28%
2	Junior High School	25	23%
3	Senior High school	35	33%
4	Bachelor	18	16%
	Total	108	100%

Source : Primary Data Analysis, 2024

The results of the study show that most of the farmers are elementary school graduates (30 people (28%), junior high school graduates as many as 25 people (23%), high school graduates as many as 35 people (33%), bachelor's graduates as many as 18 people (16%). The level of farmer education for the three research areas, namely Pidie, East Aceh and West Aceh. The low level of education of farmers will cause farmers to be less wise in making decisions and become a factor that hinders the smooth operation of agricultural adoption activities, so that new innovations in the field of agriculture tend to be slow to be accepted and slow changes will ultimately determine the efficiency of farmers in doing business. Education

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affects the way of thinking of farmers who will carry out their farming activities. Farmers who have received a longer formal education are more likely to be more receptive to innovations and changes in farming, especially in research sites. As stated (Sukartawi 1988), farmers with higher education are relatively faster to implement innovation adoption.

3. Nature of Innovation

New innovations can increase profits compared to previously applied methods, in this study the relative advantages are seen through 3 dimensions, namely a) Cost saving is the perception that innovation can increase profits by reducing production costs in cultivation. The results of the study show that using biosaka on rice plants provides economic advantages in reducing production costs compared to conventional methods applied previously. b) Time efficiency is the perception that innovation can increase profits by reducing the time used in the cultivation process. c) Increased income is the perception that innovation can increase profits by increasing the selling price of the grain produced. The following is a table analyzing changes in farmers' income from the results of field surveys without using biosaka and after using biosaka.

Table 4. Analysis of changes in farmers' income without using biosaka and after using biosaka

No	Without Biosaka		Biosaka Application	
	Information	Total	Information	Total
1	Land Rental Cost			
2	Labor costs - Tillage/tractor - Nursery 1 HOK @ Rp. 80.000 - Plant 5 HOK @ Rp. 100.000 - Maintenance 16 HOK @ Rp. 100.000 - Fertilization - Weeding - Pest	Rp. 750.000,00 Rp. 80.000,00 Rp. 500.000,00 Rp. 1.600.000,00	- Labor costs Tillage/tractor - Nursery 1 HOK @ Rp. 80.000 - Plant 5 HOK @ Rp. 100.000 - Maintenance 16 HOK @ Rp. 100.000 - Fertilization - Weeding - Pest	Rp. 750.000,00 Rp. 80.000,00 Rp. 500.000,00 Rp. 1.600.000,00
3	Production Facility Cost - Rice seeds 30 kg @ Rp. 8000 - Urea Fertilizer 300 kg @ Rp. 3000 - Phonska, 200kg @. Rp. 3.200 - Pesticide 4 liters @ Rp. 75.000	Rp . 240.000,00 Rp. 900.000,00 Rp. 640.000,00 Rp. 300.000,00	Production Facility Cost - Rice seeds 30 kg @ Rp. 8000 - Urea Fertilizer 300 kg @ Rp. 3000 - Phonska, 200kg @. Rp 3.200 - Pesticide 4 liters @ Rp. 75.000	Rp. 240.000,00 Rp. 300.000,00 Rp. 160.000,00 Rp. 150.000,00
4	Harvest and post-harvest cost 8 HOK @ Rp. 100,000	Rp. 800.000,00	Harvest Costs	Rp. 800.000,00
5	Productivity	7000kg	Productivity	8500kg
6	Total Operational Costs	Rp. 5.810.000,00	Total Operational Costs	Rp. 3.720.000,00
7	Gross Income @Rp. 4500.00	Rp. 31.500.000	Gross Income @Rp. 4500.00	Rp. 38.250.000,00
	Net income	**Rp. 25.190.000**	**Net income**	**Rp. 34.530.000,00**

Source : Data from POPT Biosaka Aceh

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From these results, it can be seen that the income comparison between those who do not use biosaka and those who use biosaka, farmers who do not use biosaka get a net income of Rp. 25,190,000 and those who use biosaka Rp. 34,530,000. From the results of the survey in the rice fields used, biosaka is more fertile and the leaves are greener. The results of biosaka implementation showed a real difference with an increase in yield from no biosaka treatment with a yield and income of 7 tons/ha to 8.5 tons/ha or an increase of 21.4%. And rice production has increased. Farmers' business income according to (Putra, 2015) can be divided into two meanings, namely (1) gross income, namely the income earned by farmers in the farmer's business for one year may be calculated from the proceeds of sales or exchange of production products valued in rupiah based on a heavy price unit at the time of collecting results, (2) net income, which is the total amount of income received by farmers in one year minus production costs during the production process. Production costs include real labor costs and real production facility costs.

4. Measurement Model Test Results (Outer Model)

There are three criteria in the use of data analysis techniques with SmartPLS to assess the outer model, namely convergent validity, composite reliability, and discriminant validity.

1. Convergent Validity

The convergent validity of the measurement model using reflective indicators is assessed based on the loading factor of the indicators that measure the construct. Based on the results of the analysis on the variables of Farmer Characteristics (X1), Nature of Innovation (X2), Extension (X3), Innovation Adoption (Y), the initial outer loading values obtained are as follows.

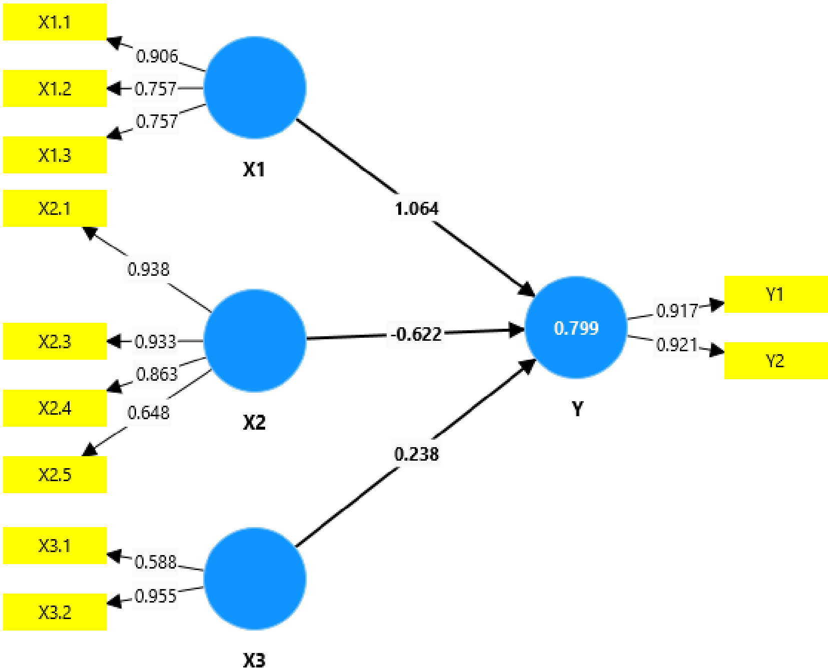

Figure 1. Initial Measurement Value
Source: Data Processing

The loading factor limit is 0.5. If the loading factor value > 0.5, the construct validity is met, but if the loading factor value < 0.5, the construct must be dropped from the analysis (Ghozali, 2014). Based on the results of Figure 4 above, it can be seen that X2.2 has a value below 0.5 so it is not eligible to be included in the next data processing process because the loading factor value is >0.5. In the convergent validity evaluation, it can be seen that almost all question items can be said to be valid because they have a value of >0.5.

After determining the loading factor value of each research variable, the values that have met the criteria will be tested for validity and reliability in order to connect the indicators

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with the latent variables in this study. The following are the steps in testing the validity and reliability of the variables in this study.

2. Composite Reliability dan Cronbach's Alpha

In addition to the construct validity test, a construct reliability test was also carried out which was measured by composite reliability and Cronbach's alpha. The following are the results of the composite reliability and cronbach's alpha test of the Smart PLS. To see the reliability results, it can be seen that the Average Variance Extract (AVE) value must be above 0.5 and the Composite Reliability must be above 0.7 (Ghozali, 2014)

Table 5. Reliability Test

Variable	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Adoption Innovation (Y)	0.822	1.259	0.850	0.655
Farmer Characteristics (X1)	0.833	0.876	0.883	0.617
Counseling (X3)	0.687	0.823	0.762	0.629
Nature of Innovation (X2)	0.817	0.817	0.916	0.845

Source: Smart-PLS Output

Based on table 5, a construct is declared reliable if it has a composite reliability value above 0.70 and Cronbach's alpha above 0.60. From the output results of the Smart PLS above, all constructs have a composite reliability value above 0.70 and Cronbach's alpha above 0.60. So, it can be concluded that the construct has good reliability. Then each variable has an Average Variance Extracted (AVE) value greater than 0.5. So that all variables in this study can be said to be valid and reliable in meeting the reliability requirements (Ghozali, 2014).

3. Discriminant Validity

The validity test of decriminalization is tested using two methods, namely by cross loading and the Furnell-Lacker criterion to compare whether each indicator and variable measures the variable or even the indicator measures other variables. In this study, the validity test of the crime uses the Furnell-Lacker criterion. The following Fornell-Lacker criteria will be displayed in the following table.

Table 9. Fornell-Lacker Criterion

Variable	(X1)	(X2)	(X3)	(Y)
X1	0.810			
X2	0.778	0.785		
X3	0.880	0.635	0.793	
Y	0.788	0.511	0.777	0.919

Source: Primary Data processed

From table 9, according to the Fornell-Lacker criterion, the square root of the AVE value of each construct must be higher than the correlation value between constructs in a model. The correlation or relationship between variables and other variables is greater than the magnitude of the latent variable itself. This shows that the latent construct in the block is superior to other blocks. In addition, the cross-loading value in the research variable has exceeded 0.5 which indicates that there is no problem in the discriminant validity in the cross-loading analysis. It can be concluded that the research instrument is able to explain the latent variables well (valid).

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4. Results of Testing the Structural Model (Inner Model)

The structural model in Smart-PLS is evaluated by using the R2 dependent variable and the path coefficient value for the independent variable. The R2 value is used to calculate the Goodness of Fit (GOF). The GOF value is used to indicate whether a model is fit. GOF reflects how much the dependent variable (Y) can be explained by the independent variable (X).

5. Variant Analysis (R-square) or Determination Test

R^2 can be used to assess the influence of independent latent variables on dependent latent variables whether they have a substantive influence. The criteria for limiting the R^2 value are in three classifications, namely 0.67, 0.33, and 0.19 where each classification indicates that the model is "good", "moderate", and "weak". The following is the R2 value in this study.

Table 6. R Square Value (R^2)

Variable	R-square	R-square adjusted
Adoption of Innovation (Y)	0.800	0.794

Source: Primary Data processed

Based on the R-square value in the table above, it can be seen that the value of the Innovation Adoption construct (Y1) is 0.800. This shows that farmer characteristics, Innovation Traits, and extension are able to explain the variables of Innovation Adoption construct by 80%, and the remaining 20% explained by other variables outside this study. Therefore, it can be concluded that the R-square value for the Innovation Adoption construct variable has a good value.

6. Results of Path Coefficient Analysis

The results of the Path coefficient analysis were carried out to see whether or not a hypothesis proposed in the study was accepted. Hypothesis testing is carried out using the Bootstrapping function on SmartPLS 4.0. The hypothesis was accepted at a time when the significance level of the P-value was less than 0.05 (Hair et.al, 2014). The following is the table and figure of the final path diagram of the results of the Path coefficient test in this study.

Table 7. Results of Path Coefficient Analysis

Variabel	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
X1 -> Y	1,064	1,038	0.221	4,824	0.000
X2 -> Y	-0.622	-0.596	0.164	3,800	0.000
X3 -> Y	0.238	0.258	0.191	1,241	0.215

Source: Primary Data processed

In this study, an equation was made based on the model structure drawings, and the following are the results of data processing using the PLS Bootstraping method.

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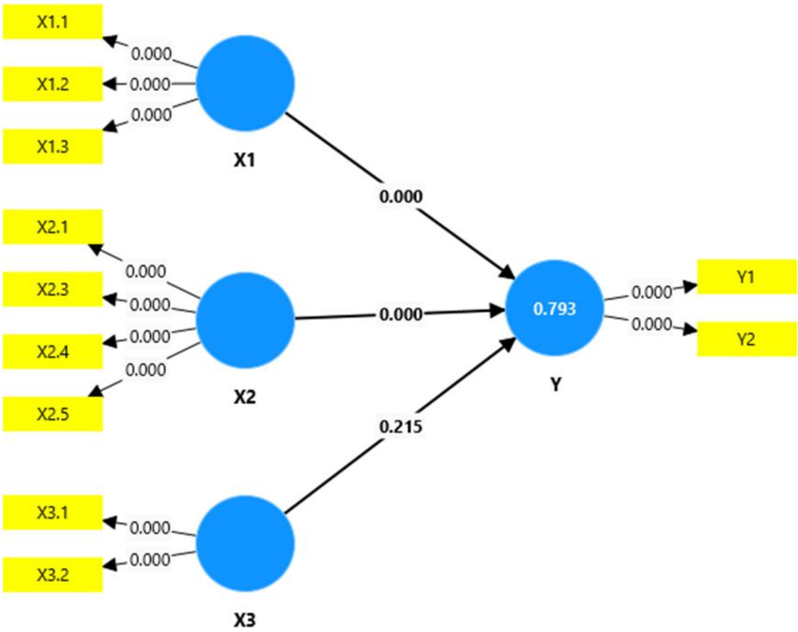

Figure 2. PLS Bootstraping
Source: Data Processing

Next, to clarify the coefficients of structural equations, consider the following equations:
Innovation Adoption = 1.064 Farmer Characteristics +(0.622) Innovation Traits
+0.238 Counseling + erorr

Based on the results of statistical testing with the condition that if the sig value is < 0.05, the hypothesis is accepted. On the other hand, if the sig value is > 0.05, the hypothesis is rejected, the explanation of each influencing variable is explained as follows:

1. Farmer characteristics have a significant effect on the adoption of biosaka innovation because the p-value of 0.000 is less than 0.05 (0.000 < 0.05)
2. The nature of innovation has a significant effect on the adoption of biosaka innovation because the p-value of 0.000 is smaller than 0.05 (0.000 < 0.05).
3. Counseling did not have a significant effect on the adoption of innovation because the p-value of 0.215 was greater than 0.05 (0.215 < 0.05).

4. Conclusion

This study shows that the characteristics of farmers have a significant influence on the adoption of innovative use of Biosaka in rice plants. This shows that farmers are fully accepting the use of Biosaka, illustrating that factors such as experience, education, and age of farmers play an important role in the acceptance of these innovations. In addition, the nature of Biosaka's innovations that provide real benefits and uses felt by farmers also has a significant effect on the adoption of these innovations. However, counseling on Biosaka does not have a significant influence on the adoption of this innovation, showing that existing counseling efforts are still ineffective in increasing farmers' understanding and interest in the use of Biosaka. The implication of these findings is the need to increase more intensive and effective extension programs to increase farmers' understanding and awareness of the benefits of Biosaka. Extension programs must be designed to better suit the characteristics of farmers, so that they can be more easily accepted and adopted. In addition, the development and dissemination of innovations must continue to be encouraged by considering the needs and experiences of farmers, so that innovations such as Biosaka can be more widely accepted and used.

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