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APPLICATION STRATEGY OF SMART FARMING TECHNOLOGY 4.0 IN UTILIZING RITX SOIL AND WEATHER SENSOR

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ABSTRACT

Research design is predictive and descriptive involving several concepts. Partial least squares, research and development tests are used in developing the application of smart farming technology. The results analysis prove the direct influence of variables X_1 (genetic factors) to Y_1 (farmer behavior in the application smart farming) of -0.269. It show does not have a positive impact on the contrary reducing the behavior of farmers in implementing smart farming. The relationship between X_2 (individual external factors) to Y_1 is 0.392 show that individual external factors give positive impact on increasing farmer behavior in the application of smart farming by 39.2%.

Keywords: *Farmer Behavior, Smart Farming, Farming*

ABSTRAK

Desain penelitian adalah prediktif dan deskriptif yang melibatkan beberapa konsep. Kuadrat terkecil parsial, uji penelitian dan pengembangan digunakan dalam mengembangkan aplikasi teknologi pertanian pintar. Hasil analisis membuktikan pengaruh langsung variabel X_1 (faktor genetik) terhadap Y_1 (perilaku petani dalam penerapan smart farming) sebesar -0,269. Hal tersebut menunjukkan tidak berdampak positif sebaliknya mengurangi perilaku petani dalam menerapkan smart farming. Hubungan antara X_2 (faktor eksternal individu) terhadap Y_1 adalah 0,392 menunjukkan bahwa faktor eksternal individu berpengaruh positif terhadap peningkatan perilaku petani dalam penerapan smart farming sebesar 39,2%.

Kata Kunci: *Perilaku Petani, Bertani Cerdas, Bertani*

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INTRODUCTION

Indonesia's geographical position, which is located in a wet tropical volcanic area, is a spatial resource with great potential for agricultural development. Nevertheless, agricultural activities still face many obstacles in developing competitive and profitable farming. Existing natural resources have not been fully utilized optimally. The availability of technology has not been able to specifically accommodate regional potential. According to Ningsih (2013), businesses in the agricultural sector are in a situation of uncertainty, as a result they never have definite results. An important source of uncertainty in the agricultural sector is fluctuations in agricultural yields (production) and price fluctuations. Smart farming is believed to be able to bring about change and reduce negative externalities, control and reduce production costs and minimize environmental damage (Braun et al., 2010).

The application of technology in the conservation system is aimed at building a production process in agriculture so that the results from agriculture are still running and sustainable. The implementation of this agricultural technology has been in use for more than 40 years and this technology provides a great contribution value in monitoring and maintaining supply lines in the form of agricultural products or the distribution of other supporting tools, including agriculture, animal husbandry, fisheries, food crops, plantations and others. If these several businesses are combined carefully and planned, they can provide more results than similar businesses, especially for small and medium farmers.

Smart farming is an agricultural concept using modern technology to increase the quantity and quality of agricultural products. The use of Smart Farming 4.0 technology in the form of the use of RITX Soil & Weather Sensors are used to record real-time land conditions and predict weather. Smart Farming technology is an agricultural concept using modern technology to increase quantity and

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quality. The Smart technology used is RITX Soil & Weather Sensor which is used to record land conditions in real time and predict precise weather so that farmers in Kadungora village can optimize their commodity production. Through Smart Farming technology, the cultivation process is more effective and will result in increasing production and improving the welfare of farmers. The advance in agricultural technology has revolutionized the agricultural farming environment in recent years. Internet of Things (IoT), drones, robots, big data, cloud and artificial intelligence are new resources which is expected to be applied to new agricultural practices (Wolfert et al., 2010). The pace of change triggered by the creation of new technologies such as the Internet of Things (IoT) and Cloud systems is expected to enhance this development by introducing artificial intelligence and robots in agriculture (Schwab, 2017).

The application of Smart Farming technology is expected to maintain food security. Food security is a major thing in development in order to achieve community welfare. Effort to achieve food security have become a concern in the national and international scope. Vulnerability to food can result in the low quality of life of the community, both in the physical-health, social and economic aspects. The concept of modern agriculture in question is how to increase the number of agricultural products and not be affected by conditions and weather, global changes will have an impact on plant development and types of pests that are likely to come (Rosegrant et al, 2002).

One of the causes of poverty in Garut is the undeveloped agricultural sector. One of the causes of poverty is the undeveloped agricultural sector. The land in Garut is around 90,000 hectares, while the remaining 320,000 hectares of Garut Regency are owned by Perhutani, PTPN, BKSDA and private plantations. The agricultural sector is very important in all lands in Indonesia, including in Garut Regency. The agricultural sector plays an important role in improving the economy so that it can reduce poverty.

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The application of smart farming technology needs to be supported by the behavior of farmers in adequate farming management. Attitudes and behavior of farmers that need to be changed for the better are land cultivation, fertilization. The behavior of farmers in processing farming through smart farming with ethnic cultivation processes so that it is more effective and will result in increasing production.

Kulsum and Jauhar (2014) define behavior as an activity that exists in individuals as a result of the stimulus received, both external and internal stimuli. Behavior is an observable human action (activity/action/horn). Hungerford and Volk (1991) say that behavior is influenced by strategies to apply knowledge, knowledge of issues, personal factors, such as attitudes, motivation and so on, as well as situational factors. Bandura (1997) states that behavior is a function of individual and environmental characteristics. Carry (1993) tells that environmental behavior is influenced by various factors such as subjective norms, behavioral beliefs, opportunities, and self-control. Furthermore, behavioral and behavioral theories have been widely applied and tested in various fields (Cheung, 2000).

Farmer behavior includes processing, seeding, fertilization, irrigation, weeding, pest and disease control, weeding, agricultural extension, and preventing erosion and landslides. Agricultural land management is reflected in the behavior of farmers in cultivating and maintaining paddy fields. Management behavior that is environmentally sound will not trigger natural disasters, while behavior that is not environmentally sound will trigger natural disasters that can harm human life. Farmer's behavior in farming management becomes important in the progress of farming.

The efforts to increase farmer production must also be accompanied by the sustainability of the technology introduced and depend on factors that affect the level of farmer technology adoption. Transfer of knowledge, technology and information to farmers is one of the strategic keys to encourage

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the growth of independent farmers and no longer dependent on external intervention. To eliminate this way of thinking of farmers requires a strategic approach and methods to implement self-reliance for farmers (Gaib et al, 2017). These recommended strategies are also needed to support the successful implementation of agricultural programs.

To achieve progress in farming and encourage the adoption of appropriate technology, it is necessary to approach strategies and recommendations from both the government and academics.Therefore, it is important to conduct research on farmer behavior so that recommendation strategies can be drawn up for the successful application of Smart Farming 4.0 technology in Kadungora District, Garut Regency, West Java.

MATERIALS AND METHODS

This research is to examine the behavior of farmers in farming management using the application of smart farming 4.0 technology. Then it will be analyzed whether the behavior of farmers in farming management with the application of smart technology has an influence on the progress of community farming. The design of this research is predictive and descriptive research which involves several concepts. This study uses sample data as part of the population to be studied. A sample of 80 farmers..

This research is a research and development (R&D) that develops the application of smart farming technology. Then an analysis is carried out whether the application of smart farming technology can result in the R & D having a significant influence on farmers' awareness to utilize technology. This study uses the partial least squares (PLS) test as a general method for estimating the path model using a latent construct with multiple indicators. Partial least squares is a factor indeterminacy of a powerful analytical method because it does not assume the data must be with a certain scale measurement, the number of samples is limited. PLS can also be used for theory confirmation. For prediction purposes, PLS is more

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suitable and this approach assumes that all variance measures are useful variances to explain (Ghozali, 2014).

The dependent variables in this study were genetic factors (X1) and external factors (X2). The independent variable in this study is Behavior Change (Y). This study uses multiple linear regression to measure the influence of behavioral factors on changes in farmer behavior in terms of knowledge, attitudes, and skills. Regression analysis is to measure the effect of more than one independent variable (x) on the dependent variable (Y). Regression equations are used to predict the value of Y for a certain value of X (Nazir 2011). The results of the regression test will be measured on the SPSS statistic 20. The framework of thinking in this study.

RESULTS

The descriptive analysis stage begins by looking at the frequency distribution and the percentage of answers for each statement submitted. The following is displaying a summary of the respondents' answers to the research question items:

Respondent Identity (Genetic Factors)

Table. 1 Respondent Identity

No	Respondent Identity	Persentage	Description
1	Sex	91%	Men
2	Age	56.25 %	Up 56 years old
3	Etnicity	99%	Sundanese
4	Main Occupation	93%	Farmer
5	The Status of Farming Activity	53%	Cultivator
6	Education	48%	Elementary Graduated
7	Marital Status	86%	Married
8	Years of farming (duration of farming)	58%	More than 10 years
9	The commodity of farming	98%	Paddy

Table 2. External Factors

No	Individual External Factors	Perssentage	Description
Environment			
1	Financial Support	63.75%	Not enough
2	Training support	55%	Not much
3	Facility of infrastructure	45%	Not much
4	Capital support	58.75%	Not available
5	Group effectiveness rate	68.75%	Not enough
6	Availability of farming input	41.25%	Not available
7	Production Result	36.25%	Available
Religion			

1	'Pengajian' Activity	57.50%	Active
2	The activeness of 'pengajian' activity	57.50%	Active
3	The role of religious leaders	85%	Inactive
Social and Culture			
1	The activeness of farmers group	50%	Not really active
2	Face to face meeting	61.25%	Seldom
3	Communicating via mobile phone within groups	75%	Seldom
4	Communicating via social media	48.75%	Never
5	Using internet	68.75%	Never
6	Communicating with others	57.50%	Seldom
7	Using internet to communicate with others	46.25%	Seldom

Table 3. Farmer Behavior in Farming with the Application of Smart Farming 4.0

No	Farmer Behavior	Persentage	Description
Cognitive			
1	How weather sensor technology works	70%	Know nothing
2	How ground sensor technology works	77.5%	Know nothing
3	How to read ground sensor results	83.7%	Know nothing
4	Amount of fertilizer dose	65%	Know nothing
5	The right time to plant	75%	Know nothing
6	How that the sensor device is having trouble	95%	Know nothing
7	How to fix sensor tool	97.5%	Know nothing
8	Land condition	78.75%	Know nothing
Affective			
1	Access of Capital	38.75%	Disagree
2	Very Cheap Capital	35%	Not really appropriate
3	Easiness of technology	38.75%	Not really appropriate
4	Efficiency of technology	40%	Not really appropriate
5	Technology improves farming productivity	36.25%	Not really appropriate
6	Technology for farming	37.50%	Very appropriate
7	Feeling great following discussion	50%	Very appropriate
8	Feeling great getting support	56.25%	Appropriate
	Skill		
1	Joining discussion	82.50%	Never
2	Following accompaniment regularly	70%	Never
3	Access of Capital	76.25%	Never
4	Applying of farming technology	83.75%	Never
5	Observing ground condition	86.25%	Never
6	Observing weather condition	83.75%	Never
7	Monitoring harvest	88.75%	Never

DISCUSSION

Respondent Identity (Genetic Factors)

In this study, research questionnaires were distributed to 80 respondents. The following is information presented in relating to the

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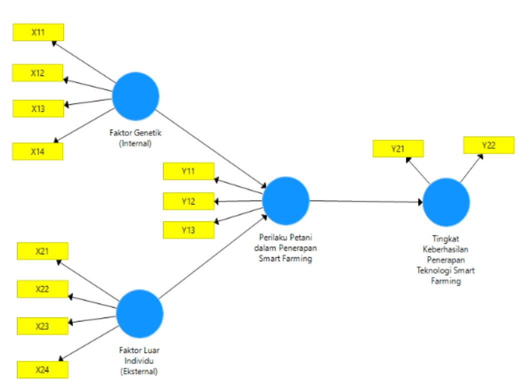
identity of the respondents described based on the specified categories:

1) In terms of gender, 91% of respondents in this study were male, while only 9% female respondents.
2) In terms of age, the average age of the respondents is 54.19 years with a standard deviation of 11.01. This describes that the age of the respondent is still in the productive age but the age range of the respondent is quite wide, namely 11.01.
3) In terms of ethnicity, 99% comes from the Sundanese while 1% from the Javanese.
4) In terms of main occupation, 93% of respondents is farmers are while 7% of farming is not their main job.
5) In terms of status in agricultural activities, 28% are land-owning farmers, 53% are sharecroppers, and 20% are farm laborers.
6) In terms of education, sequentially from not graduating from elementary school, graduating from elementary school, graduating from junior high school, graduating from high school, and graduating from university, the percentages were 8%, 48%, 10%, 33% and 3%, respectively.
7) In terms of marital status, respondents are dominated by married status by 86%, while the rest are distributed among unmarried (5%), divorced (3%), and divorced (6%).
8) From the duration of farming, < 3 years 4%, 3-6 years by 15%, 6-10 years 24%, and more than 10 years by 58%.
9) Of the agricultural commodities cultivated, 98% are rice commodities while horticulture and others are 1% each.

Linear relationship model of the factors that affect the success rate of empowerment "X", to the success rate of empowerment "Y1" and then to the success rate of development "Y2". This study uses the partial least squares (PLS) test as a general method for estimating the path model using a latent construct with multiple indicators.

Partial least squares is a factor



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indeterminacy of a powerful analytical method because it does not assume the data must be with a certain scale measurement, the number of samples is small. PLS can also be used for theory confirmation. As a first step, first a model diagram is formed according to the design of this study. The following is the diagram in question.

Figure 1. Diagram of the relationship model between the independent variable and the dependent variable.

*Genetic factors (internal)
*Individual external factors (external)
*Famers' behavior in applying smart farming
*Success rate in applying the smart farming technology

By using the Smart PLS program package, the estimated value of the parameter estimates from the model structure in Figure1 is obtained.

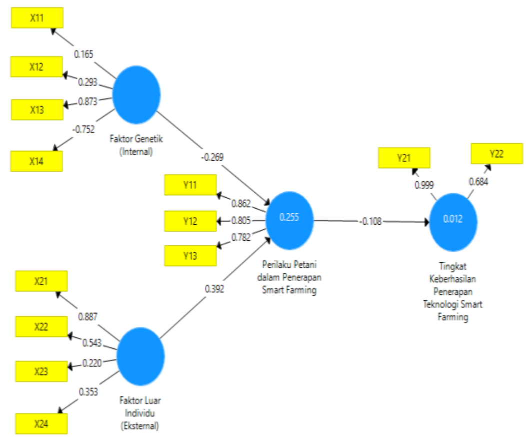

Figure 2. Diagram of the relationship model between the independent variable and the dependent variable and their parameter values.

From Figure 2, we get the estimated value of the direct, indirect, and total effects of the relationship between the independent and dependent variables. But before having the value, the results of the measurement model will be described using reliability and validity testing.

For reliability testing, it can be seen from the composite reliability value, as shown in Figure 3 below:

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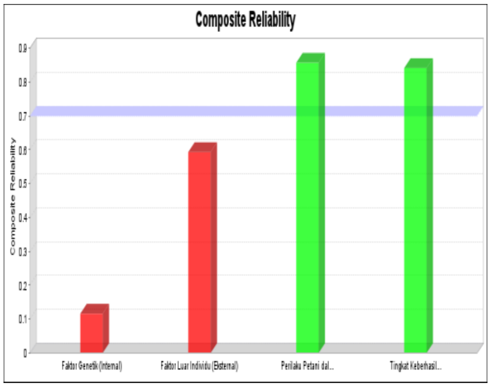

Figure 3. Diagram of the composite reliability value of the analyzed model.

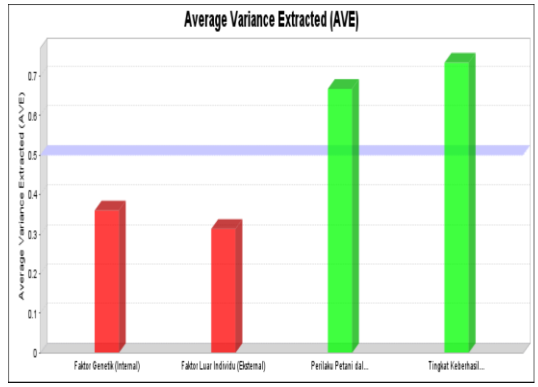

Figure 4. Diagram of the Average Variance Extracted from the analyzed model.

The two dependent variables have a composite reliability value of more than 0.7 which reflects all indicators in the reliable model. However, for the two independent variables, namely genetic factors and external factors, the composite reliability value is less than 0.7. In other words, there are several indicators in the variables that are less reliable. However, in this study, these indicators are still used in the model according to the theoretical basis used.

Furthermore, in testing the validity, in this study using the average variance extracted (AVE). The following is the output of the AVE graph in question.

The AVE value is at least 0.5. Based on Figure 4, only 2 dependent variables meet these criteria, while the two independent variables have an AVE value below 0.5. The initial conclusion is that in the independent variable there are indicators that are less valid.

Furthermore, if it is seen that the R2 value is only 0.255, the endogenous variable is categorized as almost moderate. Meanwhile, if we look at the chi-square value, which is 137,527, it shows that the observed values have been modeled well.

The indicator of contribution in each modeled variable, for the X1 variable, the indicator that has a fairly large and significant contribution is X13 of 0.873 while the other 3 indicators have values below 0.5. For variable X2, indicators with values above 0.5 are X21 (0.887) and X22 (0.543). For the dependent variable Y1, the three indicators have a significant contribution (above 0.5) in explaining the characteristics of the Y1 variable, respectively, the three indicators have values of 0.862, 0.805, and 0.782. For the last variable, Y2 the two indicators are able to explain the characteristics of the variable well with the values for indicators 1 and 2 being 0.999 and 0.684.

The results of the interpretation of several values of the model parameters are shown in Figure 2. The direct effect that occurs between the X1 to Y1 and X2 to Y1 variables has contradictory values where the X1 to Y1 variable is negative (-0.269) which means that the genetic factor is, the type of race, gender, age and education of farmers have a negative impact on increasing farmer behavior in the application of smart farming technology. In other side, X2 to Y1 has a positive value of 0.392 where factors outside the individual namely, environmental factors, education, religion, socio-culture have a positive impact on increasing farmer behavior in the application of smart farming technology. The more social interactions of farmers, the more experience, observation and knowledge of farmers will affect the behavior of farmers in the application of smart farming technology. This is supported by Rahman (2017) which states that external factors such as environment, belief/religion and socio-culture contribute to behavior.

The results of the analysis of the direct influence from Y1 to Y2 have a negative value of -10.8% which means that farmer behaviors such as knowledge, attitudes and skills in the application of smart farming have a negative relationship to the success rate of implementing smart farming technology which can be increasing business and agricultural productivity. Increased behavior of farmers in applying smart farming technology that is not supported by a good level of perception will result in a decrease in the success of increasing business and

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agricultural productivity. This is related to cognitive behavior, such as the ignorance of farmers in reading the results of soil sensors on smartphones reaching 83.75%, ignorance of farmers if the sensor equipment is disturbed and cannot be used reaches 95%, even ignorance of how to repair the sensory device if it is disturbed reaches 97.50%.

Furthermore, the indirect effect of X1 to Y2 is obtained by a value of 0.029 where genetic factors namely, race, gender, age of farmers have a positive impact on increasing farmer behavior in the success rate of implementing smart farming technology. The relationship between X2 and Y2 is -0.042, i.e. external factors, namely, environmental, educational, religious, socio-cultural factors, have a negative impact on increasing farmer behavior in the success rate of implementing smart farming technology. The negative relationship between increasing farmer behavior in the success rate of implementing smart farming technology is due to the lack of farmer participation in attending workshops, mentoring, access to capital, applying agricultural technology, monitoring land conditions, monitoring weather conditions, and harvesting based on observations. This can be seen from the percentage of farmers who "never" carry out these activities by 70% to 88.75%. So it is known that the negative relationship is caused by other factors such as the lack of participation, knowledge, perception and motivation of farmers. This is in line with a study conducted by Chuang (2020) which has identified a relationship between agricultural practices and behavior, attitudes, and other psychological factors such as perceptions and motivations related to agricultural policies.

From the identification of farmer behavior towards the implementation of Smart Farming 4.0, the strategies that can be recommended so that the application of Smart Farming 4.0 technology is more effective and efficient in this study, can be seen in the table below.

Table 4. Recommended Strategy for the Implementation of Smart Farming 4.0

No	Farmer behavior	Persentage (%)	Description	Recommendation

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Cognitive				
1	How weather sensor technology works	70	Know nothing	Providing training on how to work, practice, and mentoring. If farmers are technologically savvy, it is possible for each training/assistance to be advised to bring/ include technology-savvy relatives so that learning can be more effective and efficient.
2	How ground sensor technology works	77.5	Know nothing	
3	How to read ground sensor results	83.7	Know nothing	
4	Amount of fertilizer dose	65	Know nothing	Increasing farmers' knowledge by providing manual guides, assistance and training to farmers regarding the right amount of fertilizer, planting time and land conditions as well as intensive assistance to identify damage if the sensor device is damaged.
5	The right time to plant	75	Know nothing	
6	How that the sensor device is having trouble	95	Know nothing	
7	How to fix sensor tool	97.5	Know nothing	
8	Land condition	78.75	Know nothing	
Affective				
1	Access of Capital	38.75	Disagree	Monitoring and evaluating as well as equalize perceptions, in order to know the needs and constraints of farmers so as to create synergy which is the key to the successful adoption of a technology program.
2	Very Cheap Capital	35	Not really appropriate	
3	Easiness of technology	38.75	Not really appropriate	
4	Efficiency of technology	40	Not really appropriate	
5	Technology improves farming productivity	36.25	Not really appropriate	
6	Technology for farming	37.50	Appropriate	
7	Feeling great following discussion	50	Appropriate	Establishing relationships and communicate with village officials, leaders or agricultural institutions that can support and increase farmer participation in implementing Smart Farming 4.0 technology.
8	Feeling great getting support	56.25	Appopriate	
Skills				
1	Joining discussion	82.50	Never	To increase farmer participation in adopting technology applications that meet these criteria, it is necessary to evaluate through participatory pilots according to the conditions of local farmers, so that farmers' trust is greater which will impact on the adoption process more effectively and efficiently.
2	Following accompaniment regularly	70	Never	
3	Access of Capital	76.25	Never	
4	Applying of farming technology	83.75	Never	
5	Observing ground condition	86.25	Never	
6	Observing weather condition	83.75	Never	
7	Monitoring harvest	88.75	Never	

CONCLUSION

From the linear model analyzed, it can be seen that there is a direct effect of the variable X_1 (genetic factor) to Y_1 of -0.269. In other words, it does not have a positive impact on the contrary reducing the behavior of farmers in the application of smart farming. Furthermore, for the

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relationship model between X_2 (individual external factors) to Y_1 of 0.392, namely individual external factors have a positive impact on increasing farmer behavior in the application of smart farming by 39.2%. The last relationship, namely Y_1 to Y_2 (Success Rate of Application of Smart Farming Technology) has a direct effect of -0.108. For the indirect effect of the variable X_1 to Y_2, it is obtained by 0.029 while X_2 to Y_2 is obtained by -0.042.

Each indicator of the variable X_1 (genetic factor) is perceived with varying proportions. For X_11, X_12, X_13, and X_14 against X_1 respectively by 16.5%, 29.3%, 87.3%, and -75.2%. Meanwhile the indicators of the variable X_2 (external factors of the individual) are perceived with the following proportions: for X_21, X_22, X_23, and X_24 to X_2 respectively 88.7%, 54.3%, 22%, and 35.3%.

In this research, there are 2 dependent variables. For Y_1, there are 3 indicators Y_2 there are two indicators. For the dependent variable Y_1, the indicators Y_11, Y_12, and Y_13 were quite significant in measuring perceptions of the Y1 variable, namely 86.2%, 80.5%, and 78.2%, respectively. As for Y_2, Y_21 and Y_22 were able to measure the perception of 99.9% and 68.4%, respectively.

Strategies that can be recommended to make the application of Smart Farming 4.0 technology is more effective and efficient. Moreover, it needs more intensive assistance, equalizing perceptions with farmers, needing cooperation with leaders and institutions that can support farmer participation, and participatory pilots are needed according to the conditions of local farmers, so that greater farmer confidence which will impact on a more effective and efficient adoption process.

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