



## A STUDY OF THE IMPACT OF IMPLEMENTING AN INNOVATIVE APPROACH-BASED VEGETABLE CULTIVATION PROGRAMME WITH THE USE OF IOT-BASED SMART FARMING TECHNOLOGY ON INCREASING THE WORK PRODUCTIVITY OF FARM WOMEN GROUP MEMBERS

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### Abstract

Farmer groups often face various obstacles in the production process, one of which is low labour productivity. This low productivity can lead to a waste of resources, which in turn has an impact on reducing profits. In response to these problems, PIKMa Universitas Putra Bangsa initiated a program entitled Innovative Approaches to Vegetable Cultivation with the Utilisation of IoT-Based Smart Farming Technology aimed at the Women Farmers Group in Jatimulyo Village. This programme was submitted as part of the PPK ORMAWA activity funded by DIKTI. In order for the implementation of the programme to run optimally and the use of government funds not to be wasted, a comprehensive evaluation of the impact of the programme is needed. This study aims to assess the effect of an innovative vegetable cultivation programme based on smart farming technology on increasing the work productivity of the Women Farmers Group in Jatimulyo Village, Alian District. All members of the women's farmer group in the village were sampled. Primary data were collected and analysed using the simple linear regression method, after first conducting validity and reliability testing. The results showed that the IoT-based smart farming programme had a significant effect on increasing labour productivity in the target group.

Keywords: Productivity of Farmer Group Members, Technology-Enabled Vegetable Cultivation Approach Programme

### 1. Introduction

Currently, Indonesia's agricultural system is rapidly developing towards a more modern direction. Various production activities now rely heavily on technology to significantly increase crop yields. The transformation towards modern agriculture began in the era of the First Green Revolution in 1950, which was an important milestone in the transition from traditional farming methods to more sophisticated approaches. These changes aim to address the food crises and hunger plaguing many developing countries. Modern agriculture is also expected to drive economic growth through increased labour productivity in the agricultural sector. With this increased productivity, production costs can be reduced, which in turn contributes to budget efficiency and improved farmer welfare.

Problems in the agricultural sector are influenced by various factors, including climate change, water supply constraints, declining soil fertility, uneven rainfall, and farmers' lack of understanding of the challenges they face. Population growth also puts pressure on food availability, which must continue to increase to meet the needs of the community. Amidst this situation, the national agricultural sector faces major challenges in continuing to meet domestic food needs, despite facing various environmental and technical constraints. To overcome this, innovative cross-sector breakthroughs are needed to maintain the resilience and sustainability of food production in Indonesia.

According to Dida Gardera, Senior Advisor for Connectivity, Service Development, and Natural Resources at the Ministry of Coordinating Economic Affairs, there are three main areas that Indonesia must focus on as the Chair of ASEAN in 2023, namely recovery and rebuilding, the digital economy, and sustainability. One strategic step that can be taken is to adopt a Smart Farming system and improve technology integration



in the agricultural sector. Smart Farming is a technology-based agricultural approach designed to improve operational efficiency and production output. This concept leverages digital technology, agricultural automation, and digital marketing systems to create a smarter and more responsive agricultural system. The successful implementation of Smart Farming heavily relies on adequate technological infrastructure, with the primary objective of accelerating and enhancing production processes in the agricultural sector.

In response to these challenges, the Student Activity Unit PIKMa (Student Information and Counselling Centre) of Universitas Putra Bangsa is implementing a PPK ORMAWA programme titled 'Innovative Approach in Vegetable Cultivation Using Technology to Enhance Production Process Effectiveness by Women Farmers' Groups in Jatimulyo Village.' This programme is designed to support the Jatimulyo Women Farmers Group (KWT) in conducting agricultural activities more efficiently and productively through the use of technology, thereby expected to have a positive impact on the welfare of its members and the surrounding community.

The technology used in this activity is an IoT-based Smart Farming system equipped with solar panels as an energy source. This technology harnesses solar energy converted into electricity, which is then used to operate equipment such as automatic sprinklers, automatic lights, and water pumps controlled through a timer system. The primary objective of this innovation is to simplify the planting and maintenance processes, particularly vegetable irrigation.

This Smart Farming approach directly addresses the specific needs of female farmers by reducing the heavy physical workload, such as manually watering plants every day, which previously consumed time and energy. With the automated watering and lighting system, female farmers can be more flexible in dividing their time between household chores and agricultural activities. Additionally, the use of simple technology combined with training and mentoring addresses the limitations in access to information and technical skills, which have long been major challenges for female farmers. As a result, this approach directly enhances the capacity and working conditions of female farmers while ensuring the sustainability of agricultural activities despite the constraints they face.

Furthermore, the initiative includes the construction of seedling houses as a solution to the KWT's land constraints and to protect seedlings from weather conditions, particularly rain. Another innovation developed in this programme is the use of organic liquid fertiliser produced from rice washing water. Previously, the KWT only used compost, which is good, but its effectiveness can be enhanced by adding fertiliser from rice water. This liquid fertilizer is beneficial for fertilising the soil, increasing nutrient content, strengthening plant resilience, and accelerating growth. In addition to being environmentally friendly, the use of this fertilizer is also believed to increase overall crop yields.

This programme is considered successful if the programme indicators are achieved. The following are the programme success indicators: 1) The existence of an integrated farming system design based on alternative technology. 2) Changes in the knowledge and skills of integrated farming partners, particularly the PPK ORMAWA and KWT groups. 3) Changes in the way the integrated farming system is managed. 4) Changes in the

community and Women Farmers' Groups (KWT) in implementing vegetable farming based on technology.

When the programme is successful, it should also increase the productivity of the work carried out. Tota Suhendrata (2008) in a successful study demonstrated that Agricultural Technology Innovation has a significant impact on increasing farmers' productivity. Research by Destri Nugrahni Halawa (2024) states that smart agricultural technology can help simplify farmers' work in farming and for young people who want to become entrepreneurs in the agricultural sector. Additionally, smart agricultural technology can minimise production costs and have the potential to generate greater profits. Several researchers define smart agriculture, sometimes also referred to as precision agriculture, as an agricultural management system aimed at improving productivity and resource use, either through increased crop yields or reduced inputs and harmful environmental impacts by leveraging information technology (Balafoutis et al. 2017).

According to Hasibuan in Busro (2018, p. 340), productivity is the ratio between output (results) and input (inputs). Thus, productivity is defined as how efficiently concrete results or products (output) are produced compared to the labour used (input). This means that productivity will improve the efficiency of time, materials, labour, work systems, production techniques, and enhance the skills of the workforce. According to Sutrisno (2019, p. 104), to measure work productivity, whether in the context of company evaluation or research, several indicators or concrete symptoms that can be observed are required, including: 1) Ability, 2) Improvement in results achieved, 3) Work enthusiasm, 4) Self-development, 5) Quality, 6) Efficiency.

In line with this, this study is an evaluation of the implementation of activity programmes to ensure that the objectives of the activities have been achieved.

## 2. Methods

This study used a quantitative approach with a focus on the Technology-Based Vegetable Cultivation Innovative Programme and the work productivity of members of the Women Farmers Group. The research subjects included all members of the Women Farmers Group in Jatimulyo Village, Alian Sub-district, Kebumen Regency, with a total of 33 participants. As the total population was less than 100 people, this research was categorised as population research by applying the saturated sampling technique. The data obtained were analysed using the simple linear regression method. Prior to regression analysis, the research instrument first went through the validity and reliability testing stages.

### Validity Test

The validity test is carried out to measure the extent to which the instrument (questionnaire) used in the study can be trusted in collecting data. The purpose of this validity test is to determine whether each item in the questionnaire can actually describe and clearly reveal the things that are the focus of the research. According to Sugiono, 2011 the method used is item analysis, where each value on each item of question / statement for a variable using the *product moment* correlation formula. The minimum requirement to be considered valid is the value of  $r_{count} >$  from the value of  $r$  table.

The calculation of *product moment* correlation, with the formula as stated by Arikunto (2002) is as follows:

$$r = \frac{n \sum XY - (\sum X) (\sum Y)}{\sqrt{[n \sum x^2 - (\sum X)^2][n \sum Y^2 - (\sum Y)^2]}}$$

Description:

$r$  = correlation coefficient of independent variable and dependent variable

$n$  = number of samples / number of respondents

$X$  = score of each item in question

$Y$  = total score of the variable

### Reliability test

While the reliability test is used to determine the consistency of the measuring instrument, whether the measuring instrument used is reliable and remains consistent if the measurement is repeated (Priyatno, 2009). According to Priyatno, (2009) the test that is often used by student research is to use the Alpha (Cronbach's) method. in this study the authors used the Alpha (Cronbach's) formula, as follows:

$$r_{11} = \left( \frac{k}{k-1} \right) \left( 1 - \frac{\sum \sigma b^2}{\sigma \tau^2} \right)$$

$$\sigma = \frac{\sum x^2 - \frac{\sum x^2}{N}}{N}$$

Description

$r_{11}$  = instrument reliability

$k$  = number of question items

$\sigma b^2$  = item variance

$\sigma \tau^2$  = total variance

The instrument is said to be reliable if Cronbach alpha > 0.60.

### Classical assumption test

The classical assumption test serves as a prerequisite test in the analysis. For the simple linear regression model in this study, only normality test, linearity test, and heteroscedasticity test are required. Meanwhile, autocorrelation test, multicollinearity test are not required in this study. The autocorrelation test aims to show the correlation of members of observations sorted by time or space (Ajija, 2011). Autocorrelation is only done on time series data and does not need to be done on cross section data such as in questionnaires where the measurement of all variables is done simultaneously at the same time. Therefore, this research does not use the aukorelasi test because this research does not use timeseries data. This study did not use the multicollinearity test because this study only used one independent variable ( $X$ ). Multicollinearity test is conducted to see the relationship/correlation between each variable. A good regression model should not have a

correlation between the independent variables (Ghozali Imam, 2005).

### **Normality Test**

The normality test (Ghozali, 2009) aims to test whether in the regression model both the dependent variable and the independent variable have a normal distribution or not. A good regression model is to have a normal data distribution. As for testing it, it is done by graph analysis, namely by looking at the normal *probability plot*. If the regression model fulfils the assumption of normality, then the model plot graph will show data or points spreading around the diagonal line or on a normal distribution. If the regression model does not fulfil the assumption of normality, then on the normal plot graph, the data or points spread far from the diagonal line and or do not follow the direction of the diagonal line.

### **Heteroscedasticity Test**

The heteroscedasticity test can be done with the *heteroscedasticity scatterplot* method (Gujarati in Ghozali, 2009). Detection of heteroscedasticity problems can be done quickly by looking at the graph of the distribution of standardised *residual* values. If the distribution forms a certain pattern (wavy, widening, narrowing) then it can be concluded that a problem occurs. Imam Ghozali also argues that the heteroscedasticity test aims to test whether in the regression model there is an inequality of *variance* and *residuals* or observations to other observations. If the *variance of the residuals* or other observations is constant, it is called homoscedasticity and if it is different it is called heteroscedasticity. A good regression model is that heteroscedasticity does not occur.

### **Linearity test**

The linearity test is used to determine whether the X and Y variables have a linear relationship or not. A good research model must occur linearity. The linearity test is accepted if the *deviation from linearity*  $\text{sig} > 0.05$  and  $F \text{ count} < F \text{ table}$ . F table is seen from the df value of *deviation from linearity*.

### **Simple Linear Regression Analysis**

Simple Linear Regression Analysis is used to measure the influence between one predictor variable (independent variable) on the dependent variable. The formula is as follows:

$$Y = a + b x + e$$

Description:

Y1= Labour Productivity

X = Innovative approach programme for vegetable cultivation using technology

a = constant

b= regression coefficient of variable X

e= error

The external validity of the simple linear regression method in the context of community-based interventions is strengthened through several approaches. First, this

study used a full population (census) of all female farmers targeted by the intervention, so that the results reflect the actual conditions of the communities involved. Second, non-econometric variables such as social aspects, technological literacy, and women's availability of working time were also considered during programme implementation, although not all of them were measured quantitatively in the regression model. External validity is further supported by the fact that the intervention programme was implemented in a real-world setting within the community, and measurements were taken after the technology had been in use for a certain period of time. As a result, the regression analysis findings can be cautiously generalised to other communities with similar characteristics, particularly in terms of socio-demographic factors and local agricultural structures.

### Partial Hypothesis Test (t test)

This test is used to determine whether the independent variable regression model partially has a significant effect on the dependent variable (Priyatno, 2009). The hypothesis formulation using the t test is as follows:

$$H_0: b_1 \neq b_2 \neq b_3 \neq b_4 \neq 0$$

This means that the independent variable cannot explain the independent variable (bound) and there is an influence between the two variables tested.

$$H_a: b_1 = b_2 = b_3 = b_4 = 0$$

This means that the variation in the independent variable can increase the independent variable (dependent variable) and there is an influence between the two variables tested.

Testing is done through t test by comparing  $t_{(calculate)} (t_h)$  with  $t_{(table)} (t(t))$  at  $\alpha = 0,05$ . If the calculation result shows :

$$t_h > t(t) \text{ then } H_0 \text{ is rejected and } H_a \text{ is accepted}$$

This means that the variation in the independent variable can explain the independent variable (dependent variable) and there is an influence between the two variables tested.

$$t_h < t(t) \text{ then } H_0 \text{ is accepted and } H_a \text{ is rejected.}$$

This means that the variation in the independent variable cannot explain the independent variable (dependent variable) and there is an influence between the two variables tested.

### Research hypothesis

H1: The innovative approach to vegetable cultivation by utilising IOT-based Smart Farming technology has a significant effect on the labour productivity of the Jatimulyo Women Farmers Group

### Coefficient of Determination

The coefficient of determination is used to find the percentage contribution of the independent variable to the dependent variable by looking at the *R square* value (Ghozali, 2009).

### 3. Results and Discussion

#### Descriptive Analysis

This study consisted of 33 respondents. The questionnaires that have been collected are then grouped by age category, latest education level, and number of family members. The following presents data on the characteristics of respondents based on age.

**Table 1.** Characteristics of respondents by age

Age	Total	percentage
18-25 years old	3	9.09
26-30 years old	2	6.06
31-35 years old	3	9.09
36-40 years old	6	18.18
41-45 years old	11	33.33
> 45 years	8	24.24
Total	33	100

Source: Primary Data Processed, 2025

Based on the table above, it is known that the majority of farmer group members are 41-45 years old. This is because the agricultural sector can accommodate workers of all ages. Someone who is no longer able to work in the formal sector can still work in the agricultural sector.

#### Characteristics of Respondents Based on the Last Level of Education Completed

The following presents data on the characteristics of respondents based on the Last Education Level Completed

**Table 2.** Characteristics of respondents based on the last education completed

Last Education	Total	Percentage
HIGH SCHOOL	20	60.60
S1	3	9.09
SMP	8	24.24
SD	2	6.06
Total	33	100

Source: Primary Data Processed, 2025

Based on the table above, it can be seen that most members of the Jatimulyo Village Women Farmers Group have a high school education. This shows that the quality of farmers in the village is not low, they are relatively quick to adapt to changes and are open to education provided by other parties.

#### Statistical Analysis

##### Instrument Test

##### Validity Test

The validity test is used to test the validity of the research questionnaire questions. The question items are said to be suitable for collecting research data if  $r_{count} > r_{table}$  and significance value  $< 0.05$ . The  $r_{table}$  value is calculated by setting the degree of freedom or  $df$ .  $Df = n - 2 = 33 - 2 = 31$ . With a sig level of 5%, the  $r_{table}$  is 0.3440. the following are the results of the validity test that has been carried out.

- 1). Test the validity of the variable Innovative Approach to Vegetable Cultivation Program by Utilising Technology (X). The following are the results of the validity test of the

variable Innovative Approach to Vegetable Cultivation Program by Utilising Technology (X).

**Table 3.** Validity test of innovative approach to vegetable cultivation program by utilising technology (X)

Question Item	r table	r count	Sig max	Sig gain	Ket
There is a design on the system Alternative technology-based integrated cultivation techniques	0.3440	0,979	0,05	0,00	Valid
There are changes in the knowledge and skills of the integrated cultivation partners, especially the Women Farmers Group (KWT).	0.3440	0,950	0,05	0,00	Valid
There are changes in managing the integrated farming system	0.3440	0,860	0,05	0,00	Valid
Changes in technology-based vegetable cultivation carried out by the community and Women Farmers Group (KWT)	0.3440	0,950	0,05	0,00	Valid

Source: Primary Data Processed, 2025

Based on the table above, it can be concluded that all variable instruments of the Innovative Approach to Vegetable Cultivation Program by Utilising Technology (X) are valid because  $r \text{ count} > r \text{ table}$  and  $\text{sig value} < 0.05$ .

2) Validity test Work productivity (Y). The following is a validity test of work productivity (Y).

**Table 4.** Validity test of work productivity (Y)

Question Item	r table	r count	Sig max	Sig gain	Ket
I am able to work according to my field of expertise	0.3440	0,804	0,05	0,00	Valid
I Strive to Improve the Results Achieved	0.3440	0,856	0,05	0,00	Valid
My Morale at Work Has Increased Over Time	0.3440	0,849	0,05	0,00	Valid
My work has improved over time	0.3440	0,705	0,05	0,00	Valid
I Always Try to Improve My Work Skills	0.3440	0,759	0,05	0,00	Valid
The quality of my work is up to standard	0.3440	0,764	0,05	0,00	Valid
The quality of the work I produce has improved over time	0.3440	0,939	0,05	0,00	Valid
Overall Product Outcomes Greater Than Costs Incurred	0.3440	0,837	0,05	0,00	Valid

Source: Primary Data Processed, 2025

The data above shows that all variables of work productivity (Y) are declared valid because  $r \text{ count} > r \text{ table}$  and  $\text{sig value} < 0.05$ .

### Reliability test

The reliability test is used to determine the consistency of the measuring instrument, whether the measuring instrument used is reliable and remains consistent if the measurement is repeated (Priyatno, 2009). The instrument is said to be reliable if Cronbach alpha  $> 0.60$ . The following reliability test was carried out.

**Table 5.** Reliability test results

No.	Variables	Minimum Cronbach alpha	Cronbach alpha gain	Information
1	Innovative Approach to Vegetable Cultivation by Utilising Technology Programme	0,60	0,953	Reliable
2	Labour productivity	0,60	0,927	Reliable

Source: Primary Data Processed, 2025

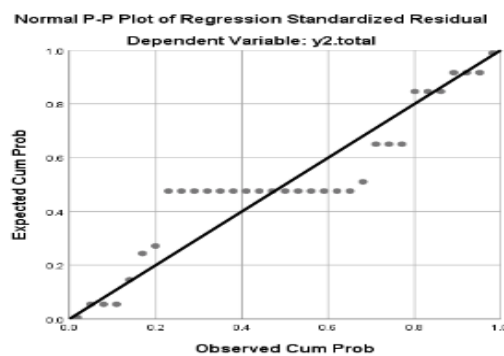
The data in the table above shows that all instruments used to collect research data are said to be reliable because the Cronbach alpha obtained is  $> 0.60$ .

## Classical assumption test

The classic assumption test is a prerequisite test. A research model is declared acceptable if it passes the classical assumption test. The classic assumption tests used in this study are only tests of normality, heteroscedasticity and linearity, because in this model, using the classic assumption tests of normality, heteroscedasticity and linearity is sufficient.

### Normality test

The data normality test is used to test whether the research data is normally distributed or not. A research assumption of normality must be fulfilled. There are several data normality test methods, the one used in this study is the normal probability plot. In this method, the data is said to be normally distributed if the bubbles in the plot move along the diagonal line and are between the diagonal lines. The following is a normality test for each research model. The following are the results of the normality test.

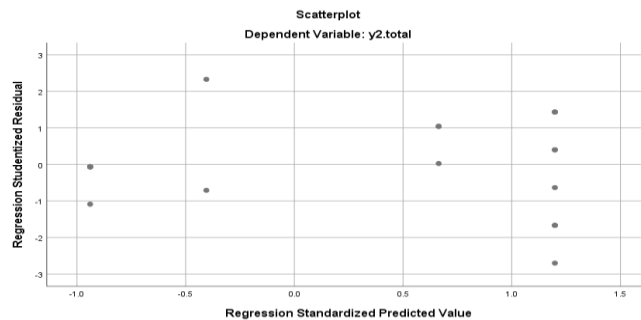


**Figure 1.** Normality test results  
Source: Primary Data Processed, 2025

Based on the picture above, it can be said that in this study the data is said to be normal because the bubbles are between the diagonal lines and the movement follows the diagonal line.

### Heteroscedasticity test

The heteroscedasticity test can be done with the *heteroscedasticity scatterplot* method (Gujarati in Ghozali, 2009). Detection of heteroscedasticity problems can be done quickly by looking at the graph of the distribution of standardised *residual* values. If the distribution forms a certain pattern (wavy, widening, narrowing) then it can be concluded that a problem occurs. Imam Ghozali also argues that the heteroscedasticity test aims to test whether in the regression model there is an inequality of *variance* and *residuals* or observations to other observations. If the *variance of the residuals* or other observations is constant, it is called homoscedasticity and if it is different it is called heteroscedasticity. A good regression model is that heteroscedasticity does not occur. The following are the results of the heteroscedasticity test.



**Figure 2.** Heteroscedasticity test results  
*Source: Primary Data Processed, 2025*

Based on the picture above, it can be said that in this study there is no heteroscedasticity problem, because the bubbles in the scatterplot are above and below 0, do not form a certain pattern, neither widened nor narrowed.

### Linearity Test

The linearity test is used to determine whether the X and Y variables have a linear relationship or not. A good research model must occur linearity. The linearity test is accepted if the *deviation from linearity sig* > 0.05 and F count < F table. F table is seen from the df value of *deviation from linearity*. The following are the results of the linearity test that has been carried out.

**Table 6.** Linearity test results

ANOVA Table			Sum of Squares	df	Mean Square	F	Sig.
y2.total * xtotal	Between Groups	(Combined)	305.146	3	101.715	110.341	.000
		Linearity	300.532	1	300.532	326.018	.000
		Deviation from Linearity	4.614	2	2.307	2.502	.099
	Within Groups		26.733	29	.922		
	Total		331.879	32			

*Source: Primary Data Processed, 2025*

Based on the table above, it can be said that there is a linear relationship between the independent and dependent variables in this study. This can be seen from the significance value obtained of  $0.099 > 0.05$  and the value of F count < F table. F count in this study is  $2.502 < F$  table in this study is 3.33. F table is determined by looking at the df value in deviation from linearity and within group. the df value in deviation from linearity in this study is 2 and the within group value is 29, so the F table is 3.33.

### Simple linear regression analysis and coefficient of determination

Simple Linear Regression Analysis is used to measure the influence between one predictor variable (independent variable) on the dependent variable. The following are the results of the regression analysis that has been carried out.

**Table 7.** Simple linear regression analysis results and coefficient of determination

Regression equation	Constant	Regression coefficient	R square result
X Y →	4.409	1.638	.906

*Source: Primary Data Processed, 2025*

Explanation:

$$Y = 4.409 + 1.638x + e$$

Based on the regression equation, it can be explained that: In the equation above the value of  $a$  = constant or fixed value of 4.409. This means that without variable  $X$  or the Innovative Approach to Vegetable Cultivation Program by Utilizing Technology, the value of labour productivity or  $y$  is 4.409. The value of  $b$  = the regression coefficient of variable  $x$  or the Innovative Approach to Vegetable Cultivation Program by Utilizing Technology of 1.638 means that each addition of one unit to the variable Innovative Approach to Vegetable Cultivation Program by Utilizing Technology ( $X$ ) will increase labour productivity by 1.638. The results of the coefficient of determination in this study can be seen in table 7. The data in the table above shows that the  $r$  square value is 0.906 or as much as 90.6% of the variable Innovative Approach to Vegetable Cultivation Program by Utilising Technology ( $X$ ) is able to explain variable  $Y$ . The rest is influenced by other variables outside the research model.

### Test t

The  $t$  test is used to determine whether the independent variable regression model partially has a significant effect on the dependent variable (Priyatno, 2009). The hypothesis is accepted if  $t \text{ count} > t \text{ table}$  and  $\text{sig value} < 0.05$ . The calculated  $t$  value is known by calculating the degree of freedom ( $df$ ) value with the formula  $df = n - k$ . In this equation  $n$  is the research sample being analysed and  $k$  is the number of variables being analysed. Therefore,  $df = 33 - 2 = 31$ , with a significance level of 5%, the  $t$  table value is 2.03951. The following are the results of the  $t$  test conducted:

**Table 8.** Hypothesis test results

Hypothesis	Sig gain	t count	t table	Description
H1: The innovative approach to vegetable cultivation by utilising IOT-based Smart Farming technology has a significant effect on the labour productivity of the Jatimulyo Women Farmers Group	0.000	17.240	2.03951	Hypothesis accepted

*Source: Primary Data Processed, 2025*

Explanation table: The data in the table above shows that the value of  $t \text{ count} > t \text{ table}$  is  $17.240 > 2.03951$  and the  $\text{sig value}$  is  $0.000 < 0.05$ . Based on this, it can be concluded that the Innovative Approach to Vegetable Cultivation Program by Utilising Technology ( $X$ ) has a significant effect on labour productivity ( $Y$ ). This means that the hypothesis in this study is accepted. This means that each addition of one unit to the variable Innovative Approach to Vegetable Cultivation by Utilising Technology ( $X$ ) will increase labour productivity by 1.638. This study supports the results of research conducted by Tota Suhendrata (2008) which successfully proved that Agricultural Technology Innovation has a significant effect on increasing farmer productivity.

### 4. Conclusion

Based on the results of the analysis conducted, it can be concluded that the Innovative Approach Program in Vegetable Cultivation with the Use of Technology has a significant impact on increasing the work productivity of the Women Farmers Group in Jatimulyo Village. In relation to these findings, the researcher recommends that the implementation of innovative programmes that utilise IoT-based smart farming technology be further strengthened. This can be done by conducting regular evaluations of the programme

implementation and continuing to find solutions to overcome the various challenges faced by farmers, which are always evolving.

In light of these findings, researchers recommend that the implementation of innovative programmes utilising smart agricultural technology be further strengthened, not only from a technical perspective but also from a socio-economic empowerment perspective. Regular evaluations of the programme's success should be conducted with the active participation of female farmers as the primary subjects, to ensure that the technology used truly addresses their real needs, including time constraints, labour limitations, and access to information.

Additionally, capacity building through continuous training, intensive mentoring, and the provision of two-way communication channels between programme implementers and the community are crucial to ensure that the programme is not short-lived but sustainable. Looking ahead, it is important to design similar interventions in other regions, taking into account the local context and the social characteristics of female farmers, to expand and accelerate the positive impacts of agricultural innovations in an inclusive manner.

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