DOI: http://dx.doi.org/10.25181/jppt.v22i2.2405
Jurnal Penelitian Pertanian Terapan Vol. 22 (2): 124-130
Website: http://www.jurnal.polinela.ac.id/JPPT
pISSN 1410-5020
eISSN 2407-1781

Analisis Tingkat Adopsi Petani Terhadap Benih Padi Hasil Iradiasi BATAN di Kabupaten Musi Rawas

Analysis of Farmers' Adoption Rate of BATAN Irradiated Rice Seeds in Musi Rawas District

Zaini Amin[1*], Andry[1], dan Edy Humaidi[2]

[1]Program Studi Agribisnis, Fakultas Pertanian Universitas Musi Rawas
[2]Program Studi Agribisnis, Jurusan Ekonomi & Bisnis Politknik Negeri Lampung
[*]E-mail : zaini_amin@ymail.com

ABSTRACT

The adoption of innovations for superior mutant rice varieties is expected to help people overcome hunger and food insecurity by providing easy access to food for the poor in rural areas. The purpose of this study was to determine the level of farmers' adoption of irradiated rice and to analyze the factors that influence farmers' adoption of irradiated rice. This research was conducted from October to November 2018 in Musi Rawas Regency using a survey method. Sampling in this study used saturated sampling, all the population of 75 farmers in this study were sampled (saturated samples). Data analysis in this study used Structural Equation Models (SEM). The results showed that the level of technology adoption of irradiated varieties reached the experimental stage; and There are three latent constructs that have a significant positive correlation (ρ <0.01), namely: farmer's preference (X2) to adoption rate (Y1), extension support (X5) to farmer's characteristic (X1) and farmer's preference (X2).

Keywords: *Adoption Rate, Irradiated Rice Seeds*

Disubmit : 31 Januari 2022, **Diterima:** 23 Juni 2022, **Disetujui :** 21 Juli 2022;

INTRODUCTION

Increasing population, land-use change, decreasing land ownership, and global warming are the main issues in the food supply in Indonesia, especially rice. This condition, if not anticipated wisely, will cause major problems, threatening food availability. The innovation adoption of mutant rice variety is expected to help the community in overcoming hunger, food insecurity, and bringing access to food for the poor in rural areas closer.

Mutant rice variety had superiority in productivity compared to rice seed resulted from breeding used by the majority of farmers (Sobrizal, 2016) and this advantage was expected to anticipate food shortage issues due to lack of land, at least in the short term. However, the desire to adopt mutant rice varieties by farmers is still slow due to the community's limited understanding of nuclear.

There are two factors that influence farmers in deciding the innovation adoption i.e. internal factors related to the farmer characteristics as recipients of innovation, and external factors related to the innovation characteristics (Rogers, 2003). The decision of farmers to adopt superior varieties is not only influenced by agronomic factors but also influenced by non-agronomic factors such as the level of family members, age of farmers, availability of seeds and information about the seeds (Sánchez-Toledano *et al.*, (2018); Elagab Elsheikh, (2018). Another study shows that farmers' knowledge and experience are very influential in adopting technology, as well as external factors such as counseling and institutions at the farm level. He further explained that the adoption of superior seeds is directly influenced by farmers 'perceptions of seeds and the availability of superior seeds and indirectly influenced by external factors and farmers' characteristics. Furthermore, the decision to adopt superior seeds is significantly influenced by the price of the seeds. Farmers are very responsive to changes in seed prices (Chandio and Jiang, 2018).

In 2010, superior mutant rice variety was introduced in Musi Rawas District, and it has been applied by 450 farmers controlling 200 ha of land spread in five districts of rice production centers (Peternakan, 2018). Looking at the areas, distribution, and users, it showed that the application of irradiated varieties with high productivity potential was quite significant. However, the decision process in adopting superior irradiated mutation technology requires further research to be used as a reference and consideration in the diffusion of innovations. The purpose of this study is to determine the level of adoption of farmers for irradiated rice and analyze the factors that influence farmers in adopting irradiated rice.

MATERIALS AND METHODS

This research was conducted from October to November 2018 in Musi Rawas Regency. The location of the research was selected purposively, with a consideration that this area is one of the centers of rice production in South Sumatra Province, and this area is one of the three regencies in Indonesia which becomes the location of Agro Techno Park (ATP) BATAN adopting the mutant rice variety. The target population is farmers who have implemented mutant rice varieties in Musi Rawas Regency. The determination of the number of samples from the population was carried out purposively with the consideration that the samples were farmers who had used irradiated varieties in the two harvest seasons so that 75 farmers were obtained as samples.

Data Analysis. Data obtained using a questionnaire with a Likert Scale 1-5, processed qualitatively and quantitatively. Data were qualitatively processed using descriptive analysis, which includes farmer characteristics, farmers' preferences, seed prices, seed availability, extension support, and innovation adoption rate. While the quantitative data are processed using Structural Equation Models (SEM).

Structural Equation Models (SEM). Structural Equation Model (SEM) Used to analyze factors that influence the rate of adoption of irradiated rice. Ghozali (I. Ghozali dan H. Latan H, 2015), explained that the application of SEM for model development and less than 200 samples can utilize the SMART-PLS program. SEM analysis can explain the relationship of variables in a complex way, and both direct and indirect effects of one or several variables on other variables.

The use of structural equation models in this research consisted of 7 latent variables and 26 manifest variables. The relationship of these variables was described in the form of a path diagram. Mathematically the path diagram model is as follows:

a. Exogenous Variable :

$\mathbf{X_1}$ ($\mathbf{X_{1.1}} = \lambda_1\xi_1 + \delta_1$; $\mathbf{X_{1.2}} = \lambda_2\xi_1 + \delta_2$, $\mathbf{X_{1.3}} = \lambda_3\xi_1 + \delta_3$; $\mathbf{X_{1.4}} = \lambda_4\xi_1 + \delta_4$; dan $\mathbf{X_{1.5.}} = \lambda_5\xi_1 + \delta_5$);

$\mathbf{X_2}$ ($\mathbf{X_{2.1}} = \lambda_1\xi_2 + \delta_1$, $\mathbf{X_{2.2}} = \lambda_2\xi_2 + \delta_2$, $\mathbf{X_{2.3}} = \lambda_3\xi_2 + \delta_3$, $\mathbf{X_{2.4}} = \lambda_4\xi_2 + \delta_4$, dan $\mathbf{X_{2.5}} = \lambda_5\xi_2 + \delta_5$);

$\mathbf{X_3}$ ($\mathbf{X_{3.1}} = \lambda_1\xi_3 + \delta_1$, dan $\mathbf{X_{3.2}} = \lambda_2\xi_3 + \delta_2$);

$\mathbf{X_4}$ ($\mathbf{X_{4.1.}} = \lambda 1\xi_4 + \delta 1$, $\mathbf{X_{4.2.}} = \lambda 2\xi 4 + \delta 2$;

$\mathbf{X_5}$ ($\mathbf{X_{5.1}} = \lambda_1\xi_5 + \delta_1$, $\mathbf{X_{5.2}} = \lambda_2\xi_5 + \delta_2$, $\mathbf{X_{5.3}} = \lambda_3\xi_5 + \delta_3$, dan $\mathbf{X_{5.4}} = \lambda_4\xi_5 + \delta_4$);

b. Endogenous Variable:

$\mathbf{Y}$ ($\mathbf{Y_{1.1}} = \lambda_1\,\varepsilon + \varepsilon_1$, $\mathbf{Y_{1.2}} = \lambda_2\,\varepsilon + \varepsilon_2$, $\mathbf{Y_{1.3}} = \lambda_3\,\varepsilon + \varepsilon_3$, $\mathbf{Y_{1.4}} = \lambda_4\,\varepsilon + \varepsilon_4$, dan $\mathbf{Y_{1.5}} = \lambda_5\,\varepsilon + \varepsilon_5$)

in which, ξ_1 = Farmer Characteristics; ξ_2 = Farmer preferences; ξ_3 = Seed price; ξ_4 = Seed Availability; ξ_5 = Extension Support; η = Farmer Adoption Rate; λ = Weight of Variable Latent Factor with its Indicators δ = Indicator Measurement Error of *Exogenous Latent Variable* ε = Indicator Measurement Error of *Endogenous Latent Variable*

Model Evaluation. The PLS evaluation model is based on predictive measurements that have non-parametric properties. The loading factor size on each manifest variable is said to be high if it correlates more than 0.70 with latent variables. However, for the early stages of research, the development of a measurement scale of loading factor 0.5 to 0.60 is considered sufficient (I. Ghozali dan H. Latan H, 2015).

RESULT AND DISCUSSION

Adoption Rate of Irradiated Rice Seeds. The results of the research showed the respondents' responses to the questionnaire presented in Table 1.

Table 1. Adoption Rate of Mutant Rice Variety

Variable Indicators of Adoption Rate	Numbers of Respondents				
	Strongly Disagree	Disagree	Slightly Disagree	Agree	Strongly Agree
Do you know about mutant rice variety?	0%	11%	60%	13%	16%
Are you interested in using mutant rice variety?	0%	0%	27%	53%	20%
Have you tried to use mutant rice variety?	0%	0%	33%	53%	13%
What do you think about mutant rice variety? (It is good and you will keep using it)	0%	0%	27%	62%	11%
Do you think the use of mutant rice variety should be applied widely and continuously?	0%	4%	64%	19%	13%

Source: Processed Data on Research Results, 2018

Table 1 indicated that most farmer adoption rates were at the trialability rate. This was because 62% of farmers agreed to use mutant rice variety and stated that they continued to evaluate rice production, both its quantity and quality. However, the potential to reject innovation is still quite large, indicated by 27 % of farmers who disagreed that irradiation variety was widely and continuously used, and only 11 % had adopted the innovation of irradiated variety.

Innovation has five characteristics in which they also influence the pace of innovation adoption. These five characteristics include: (1) relative advantage i.e. when innovation is more profitable than the old one; (2) compatibility i.e. when innovation is still consistent with existing cultural values; (3) complexity i.e. when an innovation has complex characteristics which are difficult to understand and follow; (4) trialability, a situation where innovation can be easily tested according to local conditions, and (5) observability, a situation where innovation can immediately be seen or visible, and the results can be perceived (E. M. Rogers, 2003). The important essence of this notion in relation to data on the innovation adoption rate of mutant rice variety explained that the adoption rate had entered the trialability rate as the adopter tried the mutant rice variety. The more benefits achieved, the greater the chances of farmers to adopt the intended innovation. This means that continuous assistance from a change agent is needed so that farmers can attempt to apply the innovation appropriately so that they can obtain maximum benefit for their livings.

Factors that influence the rate of adoption of irradiated rice seeds. There were three criteria used to analyze data by using the outer model i.e. convergence validity, discriminant validity, and composite reliability. In terms of convergence validity, once the value of outer loading <0.05 was issued (X1.1, X1.2, X1.4, X4.1and X5.3), there were no problems encountered. Similarly, the discriminant validity and composite reliability have seen from the square value of Average Variance Extracted (AVE)> problems. To reveal the factors that influence the adoption of innovation, mutant rice was carried out by evaluating the inner model. The model assessment of the PLS began by looking at R^2 (Table 2).

Table 2. R Square Test Results

Construct	R Square
X_1	0.683
X_2	0.223
Y_1	0.386

Source: Processed Data on Research Results, 2018

Table 2 showed that R2 value of farmer characteristics (X_1) = 0.683 which means that the extension support (X_5) was able to exemplify X_1 variable by 68 percent, while the remaining 32 percent was explained by other variables outside the model designed; for farmer preferences (X_2), the R Square value was 0.223 indicating that the extension support (X_5) was able to explain X_2 variable by 22 percent, and the remaining 78 percent was explained by other variables outside the research model. Moreover, construct variable of adoption rate (Y_1) has R^2 value by 0.386 which indicated that the construct variables in this research, X1, X2, X3, X4, and X5, were able to explain Y1 variable by 38 percent, and the remaining 62 percent was explained by other variables outside the research model. Meanwhile, the hypothesis testing results indicated that the main analytical method in this research was carried out by using the Structural Equation Model (SEM). Testing was conducted by using the Smart PLS program. The test results are shown in Figure 2.

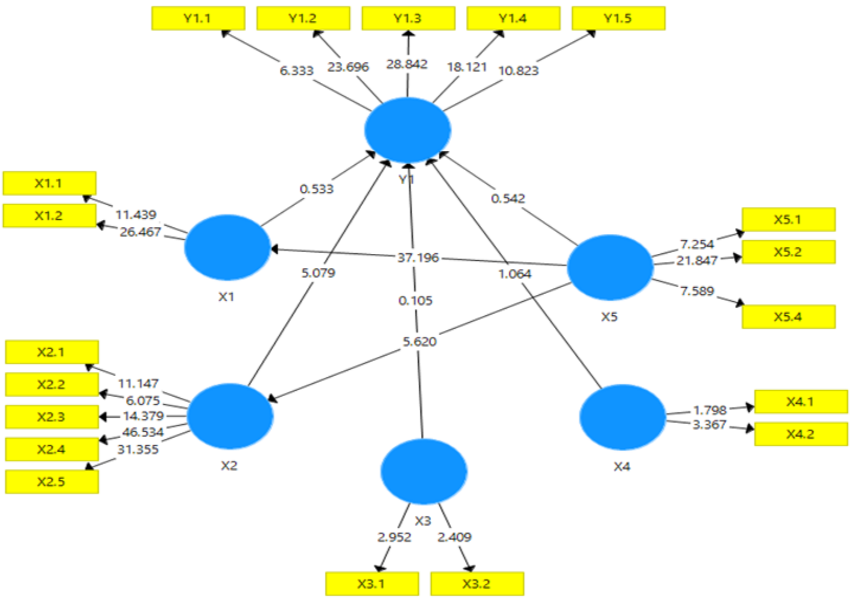

Figure 1. The Output of SEM Full Model on Innovation Adoption Rate of Mutant Rice Variety

Furthermore, a Microsoft program (PLS-Smart) was utilized to examine the factors correlating with the innovation adoption of mutant rice variety by using the path diagram above. The results of the inter-construct test analysis can be seen in Table 3

Table 3 showed that farmer preferences(X2) were positively and significantly correlated with the innovation adoption of irradiated varieties (ρ <0.01). With a path coefficient of 0.618, it highlighted that if the farmer preferences for irradiated rice seed increased, the adoption rate of the irradiated seed would increase by 0.618%. Furthermore, two other variables mutually correlated were extension support (X5) with farmer characteristics (X1) and preference (X2), and with each path coefficients by 0.826 and 0.472

indicating that an increase in extension support would encourage changes in characteristics by 0.826% and preference by 0.472%.

Table 3. Test Results among Constructs

	Original Sample	Sample Mean	ST. DEV	T Statistic	P Value
X_1->Y_1	-0.111	-0.099	0.208	0.533	0.595
X_2->Y_1	0.618	0.604	0.122	5.079	0.000
X_3->Y_1	-0.013	0.021	0.123	0.105	0.916
X_4->Y_1	0,146	0,143	0.137	1.064	0.288
X_5->X_1	0.826	0.833	0.022	37.196	0.000
X_5->X_2	0.472	0.480	0.084	5.620	0.000
X_5->Y_1	0.097	0.102	0.179	0.542	0.588

Source: Processed Data on Research Results, 2018

Table 3 showed that farmer preferences(X2) were positively and significantly correlated with the innovation adoption of irradiated varieties ($\rho < 0.01$). With a path coefficient of 0.618, it highlighted that if the farmer preferences for irradiated rice seed increased, the adoption rate of the irradiated seed would increase by 0.618%. Furthermore, two other variables mutually correlated were extension support (X5) with farmer characteristics (X1) and preference (X2), and with each path coefficients by 0.826 and 0.472 indicating that an increase in extension support would encourage changes in characteristics by 0.826% and preference by 0.472%.

The farmer preference depended on the characteristics of the superior variety introduced (R. Ghimire, H. Wen-Chi, 2015). The characteristics of mutant rice variety in the forms of productivity, resistance, harvest time, and ease of maintenance had encouraged farmers to adopt innovation, this is in line with research Suryati (Amin, et.al 2019), which shows that the productivity of mutant rice variety is higher than non-irradiated seeds so that farmers' incomes increase.

The explanation above showed that extension support was not correlated with the adoption rate directly. In contrast to Ghimire et al, (R. Ghimire, H. Wen-Chi, 2015) and Moremedi et al, research (G. Moremedi, K. Hulela, 2018) suggest that extension support in the form of methods, the materials and intensity of counseling was significantly correlated with adoption rate.

In this research, referring to the path analysis, the correlation of extension support and the adoption rate indirectly occurred. Differences occurred due to the chosen analytical method. The path analysis was complete and accurate in analyzing the relationship stages of variables to the innovation adoption rate as the goal in the diffusion of innovations. The extension which is a process of communication with various methods and media, including face-to-face, information distribution of innovation through printed media, and plot demonstration related to characteristics material or attributes inherent in the innovation of mutant varieties had encouraged farmers to understand the characteristics of innovation. Understanding the characteristics of innovation encouraged farmers to logically apply it, this condition is in line with research Zaini et al, (Amin et al., 2020) understanding or positive perception of a new product, especially related to health will increase consumer interest.

Extension support also had a positive correlation with the farmer characteristics. However, farmer characteristics were negatively correlated with the adoption rate. Even though it was statistically insignificant ($\rho < 0.01$), observations important as the diffusion process of innovation had only reached the trialability rate.

To explore this problem, path analysis can be examined (Figure 3). In the analysis, the farmer characteristics consisted of two variables i.e. the age of the farmer and motivation to improve their living standards. Several studies of age problems in relation to innovation had been carried out, some of which were Smollo et al, and Chandio et al, (D. O. Smollo, R. O. Mosi, 2017) (Chandio and Jiang, 2018), explaining that age was negatively correlated with innovation adoption.

Moreover, to understand the negative relationship of motivation and innovation adoption was performed by looking at the motivation theory. Motivation can be perceived as a cognitive decision making to achieve behavioral goals through initiation and monitoring (R. M. Badubi, 2017),(A.Buchanan, 2017). Maslow's motivation theory was based on the desire of people to achieve goals, so motivation was a hierarchy of needs to be achieved at that time. Maslow's hierarchy of needs included physical needs (food, shelter, and clothing), safety and security (physical protection), social needs (relating to others), appreciation needs (respect from others), and self-actualization (T.Brevis and P.J. Smit, 2005). Referring to the innovation adoption rate, the negative correlation between motivation to improve living standards and innovation adoption seemed to be related to security needs.

The innovation adoption rate of new mutant rice variety reached the trialability rate. As they tried to adopt it, users were unsure that the product was safe. This means that the use of mutant rice variety still had a small problem with farmers' doubts about food security for mutant varieties. This condition reinforces the previous recommendation that assistance is still needed in the process of adopting mutant rice seed varieties in the diffusion of the innovation process to ensure that varieties with nuclear technology are safe for consumption.

From the description above it appears that the Smart PLS method used is able to answer the research objectives validly, this condition is because PLS is a powerful analytical method that can be applied at all data scales, does not require a lot of assumptions and the sample size does not have to be large, which in this study itself the number of samples used is 45 respondents, further Smart PLS can also be used to build relationships that do not yet have a terrorist basis or for testing propositions, obviously, Smart PLS is more reliable and valid when compared to LISREL which requires a sample size greater than 200 and must be supported by many assumptions (Asyraf and Afthanorhan, 2013)

CONCLUSION

The level of technology adoption of mutant rice varieties reached the trying stage, which indicated that 62% of farmers agreed to use mutant rice variety , with 27% of farmers disagreeing that irradiated varieties are used widely and continuously. The rest, 11% have applied mutant rice variety.

There are three latent constructs that are significantly ($\rho < 0.01$) positively correlated, namely: farmer preference (X_2) to adoption rate (Y_1), extension support (X_5) to farmer characteristics (X_1) and farmer preference (X_2).

Extension support does not correlate directly with the level of adoption, but rather through the channel of farmers 'preferences and farmers' characteristics. This condition illustrates that the diffusion process of innovation still leaves doubts related to food safety. Therefore, this research recommends the need for assistance in the process of innovation diffusion to ensure that varieties with nuclear technology are safe for consumption

ACKNOWLEDGMENT

We would like to express our gratitude to National Nuclear Energy Agency (BATAN) Jakarta and colleagues in Agro Techno-Park (ATP) in Musi Rawas District for the cooperation so that we were able to to conduct the research of technological innovation of diffusion process in Nuclear Science and Technology.

REFERENCES

A.Buchanan, and A. H. (2017) *Organization Behavior. Nith Edition*. 9th edn. Harlow: Pearson Publishing.

Amin, Z. *et al.* (2020) 'Consumers' perceptions and willingness to pay (WTP) organic rice', *Journal of Critical Reviews*, 7(1), pp. 48–51. doi: 10.22159/jcr.07.01.08.

Asyraf, W. M. and Afthanorhan, B. W. (2013) 'A comparison of partial least square structural equation modeling (PLS-SEM) and covariance based structural equation modeling (CB-SEM) for confirmatory factor analysis', *International Journal of Engineering Science and Innovative Technology (IJESIT)*, 2(5), pp. 198–205.

Chandio, A. A. and Jiang, Y. (2018) 'Factors influencing the adoption of improved wheat varieties by rural households in Sindh, Pakistan', *AIMS Agriculture and Food*, 3(3), pp. 216–228. doi: 10.3934/AGRFOOD.2018.3.216.

D. O. Smollo, R. O. Mosi, and A. O. W. (2017) 'Analysis of Factors Influencing Sustainable Adoption of Improved Maize Technologies among Smallholder Farmers in Ugenya Sub-County, Kenya.', *Int. J. Agr. Ext. & Rural Dept. Studies*, 4 (1), pp. 23–30.

E. M. Rogers (2003) *Diffusion of Innovations*. Fifth Edit. New York: The Free Press.

Elagab Elsheikh, S. (2018) 'Factors Affecting Adoption of Improved Varieties of Sorghum, Millet, Groundnut and Sesame in North Kordofan State', *Agricultural Research & Technology: Open Access Journal*, 13(4). doi: 10.19080/artoaj.2018.13.555889.

G. Moremedi, K. Hulela, and T. L. M. (2018) 'Factors Perceived To Influence The Adoption Of Improved Technologies In Arable Farming In The Southern District Of Botswana', *Int. J. Agr.*, 6(3), pp. 193–202.

I. Ghozali dan H. Latan H (2015) *Partial Least Squares Konsep, Teknik, dan Aplikasi Menggunakan Program Smart PLS 3.0. Ed. 5*. 5th edn. Semarang: Badan Penerbit Universitas Diponegoro.

Listyati, D., Sudjarmoko, B. and Hasibuan, A. M. (2015) 'Identifikasi Faktor Penentu dalam Peningkatan Adopsi Benih Unggul Kakao oleh Petani', *Jurnal Tanaman Industri dan Penyegar*, 2(3), p. 123. doi: 10.21082/jtidp.v2n3.2015.p123-132.

Peternakan, D. P. dan (2018) *Laporan Tahunan. (2018)*. Musi Rawas.

R. Ghimire, H. Wen-Chi, and R. B. S. (2015) 'Factors Affecting Adoption of Improveed Rice Farming', *Rice Science*, 22 (1), pp. 35–43.

R. M. Badubi (2017) 'Theories of Motivation and Their Application in Organizations: A Risk Analysis.', *Int. J. Innovation. And Economics Dept*, 3 (3), pp. 44–51.

Sánchez-Toledano, B. I. *et al.* (2018) 'Determinant factors of the adoption of improved maize seeds in Southern Mexico: A survival analysis approach', *Sustainability (Switzerland)*, 10(10). doi: 10.3390/su10103543.

Sobrizal (2016) 'Potential of Mutation Breeding in Improving Indonesian Local Rice Varieties. J. Ilmia AI & R (2016). 12(1): 23-35.'

Suryati Nila, Zaini Amin, A. and Humaidi, E. (2019) 'Pendapatan Petani Padi Varietas Hasil Iradiasi Badan Tenaga Nuklir', *Jurnal Penelitian Pertanian Terapan*, 19(3), pp. 205–211.

T.Brevis and P.J. Smit (2005) *Management Principles: A Contemporary Edition for Africa. Thirth Ed*. South Africa: Lansdowne Publishing.