International Journal of Sustainable Development and Planning
Vol. 19, No. 1, January, 2024, pp. 289-299
Journal homepage: http://iieta.org/journals/ijsdp

Drivers of Organic Rice Adoption Among Smallholder Farmers: Implications for Sustainable Development

Sujianto Sujianto[1*], Abdul M. Hasibuan[2], I Gusti Ayu Putu Mahendri[1], Ekwasita R. Pribadi[1], Yulia Pujiharti[1], I Ketut Ardana[3], Ermiati[3], Bedy Sudjarmoko[3], Sukamto[4], Endro Gunawan[5]

[1] Research Group of Innovation System and Agricultural Policy, Research Center for Macroeconomics and Finance, National Research and Innovation Agency, South Jakarta 12710, Indonesia
[2] Research Center for Behavioral and Circular Economics, National Research and Innovation Agency, South Jakarta 12710, Indonesia
[3] Research Center for Cooperative, Corporation, and People's Economy, National Research and Innovation Agency, South Jakarta 12710, Indonesia
[4] Research Center for Horticulture and Plantation Crops, National Research and Innovation Agency, West Java 16915, Indonesia
[5] The Planning Bureau, Ministry of Agriculture of Indonesia, South Jakarta 12550, Indonesia

Corresponding Author Email: sujianto@brin.go.id

https://doi.org/10.18280/ijsdp.190127

Received: 22 May 2023
Revised: 8 September 2023
Accepted: 26 September 2023
Available online: 31 January 2024

Keywords:
development strategies, organic rice farming, smallholder farmers, sustainability, informal education, logistic regression

ABSTRACT

Organic rice farming offers a sustainable and healthy alternative to conventional agriculture, yet its adoption remains relatively low. Accelerating its adoption requires an understanding of the factors that influence smallholder preferences for organic farming. This study aimed to identify the factors influencing smallholder farmers' decisions to adopt organic rice farming and to propose feasible strategies to accelerate its adoption globally. The study employed quantitative methods, specifically a logistic regression model, and qualitative approaches. A structured questionnaire was designed to explore the demographic characteristics and factors influencing the adoption of organic rice. At the same time, Focus Group Discussions (FGDs) were used to capture the meanings behind the findings and to formulate strategies. The analyses utilized SPSS, Gretl, and NVivo 12 software to analyze data collected from 100 organic and 103 conventional rice farmers, providing insights. The results revealed that informal education, farm profitability, rice field size, farmers' knowledge of organic farming practices, and membership in farmers' groups were positively associated with the likelihood of adopting organic farming. To promote the adoption of organic farming, this study recommends enhancing farmers' training and providing additional informal education, such as field schools, coaching, seminars, and extension programs. The training subjects should include Good Agricultural Practices (GAP), seed procurement, the production of competitive organic fertilizers, and integrated pest management (IPM) systems. Furthermore, offering subsidies to offset the costs of organic certification and strengthening farmers' institutions, especially farmers' groups, may encourage more farmers to adopt organic farming. These findings and strategies offer valuable insights for governments and stakeholders in supporting programs for global organic rice development strategies.

1. INTRODUCTION

Rice (*Oryza sativa*) serves as the staple food source globally, with a total production of 503.9 million tons (milled basis), primarily meeting the dietary needs of the world's population, exceeding 80% of total rice utilization. This demand continues to grow, driven by population expansion and despite declines in its usage in animal feed and industrial services [1]. For approximately 2.4 billion people in Asian countries, rice constitutes the primary source of carbohydrates and staple meals. Asia produces and consumes over 90 percent of the world's rice, underscoring its vital role in the economies of these countries [2].

The Green Revolution has significantly increased global rice production in Indonesia [3]. In 2022, Indonesia achieved rice production of 54.75 million tons of dry unhusked rice, equivalent to 31.54 million tons of milled rice, making it the third largest producer globally after China and India [4]. Consequently, rice has become a subsistence crop for more than 14 million Indonesian farming households, significantly influencing their income and livelihoods. In recognition of Indonesian achievement in rice production, the International Rice Research Institute (IRRI) awarded Indonesia for its achievement in Agri-food System Resiliency and Rice Self-Sufficiency during 2019-2021 through the Application of Rice Innovation Technology in 2022 [5].

However, the success of the Green Revolution has raised concerns about its negative socioeconomic and environmental impacts. These include growing socioeconomic disparities, social inequality, and environmental harm due to excessive fertilizer and pesticide use, which has triggered serious controversy [6, 7]. The Green Revolution primarily focused on using high-yield varieties responsive to fertilizer, chemical plant protection, and infrastructure improvement [8]. While increasing productivity, these high-yield varieties have led to increased chemical pesticides and fertilizers usage, diminishing soil quality, and increasing pest resistance [9, 10]. Inefficient fertilizer application, particularly excessive nitrogen, poses environmental risks [11, 12]. Imbalanced soil nutrient levels, particularly sodium, have reduced soil productivity [13]. Moreover, high nitrogen doses, especially in hybrid rice cultivation, have reduced the natural predator insect population, increasing the risk of Brown Planthopper (BPH) outbreaks [14]. Therefore, the Green Revolution has exacerbated the chemical burden on agricultural ecosystems, adversely affecting farmers and consumers [15]. To address these challenges, an advanced and sustainable approach to rice is imperative.

Organic rice farming (ORF) has gained attention due to its potential for human health [16-19] and environmental benefits [20-23]. In Indonesia, the government initiated the Program Go Organik 2010 in 2001, aiming to establish the country as a top organic food producer by 2010 [24]. Recognizing the growth of organic agricultural industries and international demand for organic products [25-27], the Indonesian government has supported organic rice farming, aligning with President Joko Widodo’s 'Nawa Cita' national development agenda to achieve food sovereignty and self-sufficient in strategic commodities such as rice [28].

The Indonesian government issued the SNI 6729: 2016 standard to regulate organic rice cultivation, replacing the previous standard from 2013. This edition comprehensively addresses the requirements on agricultural land, handling, storage, delivery, labeling, marketing, production facilities, and permissible materials. Furthermore, the Indonesian Ministry of Agriculture initiated the 1000 Organic Agriculture Villages Program 2021 to promote organic agriculture development [29].

Farmers increasingly recognize the ORF system's merits, prioritizing healthy practices, environmental sustainability, and improved market opportunities [30, 31]. Nonetheless, transitioning from conventional rice farming (CRF) to organic rice production is a complex process influenced by various technical, social, and economic factors [32]. Currently, ORF covers only 0.52% of the total rice farming in Indonesia, equivalent to 53,974 ha [33, 34]. This limited adoption [34] underscores the importance of identifying the factors that determine smallholder farmers’ willingness to embrace the ORF system.

Referring to the theory of a Model for Innovation-Decision Process (MIDP), the decision to adopt a novel technology depends on the characteristics of the decision-making unit, such as socioeconomics, personality, behavior, and perceived characteristics of Innovation, including relative advantage, compatibility and its complexity [35]. Existing agricultural technology adoption literature has consistently highlighted farmers' socioeconomic status and technology characteristics in shaping their adoption decisions [36]. Additionally, as Akimowicz et al. [37] emphasized, contextual factors introduce complexities and uncertainties into the farm business, while institutional factors involving intricate socioeconomic structures significantly influence farmers' decision-making processes. Social and cultural factors have also been underscored by studies exploring the intricate interplay of farmers' household socio-demographic characteristics, technical factors, social capital, and economic considerations in determining their decisions to embrace organic farming practices [38-41].

The primary objectives of this study are threefold. Firstly, we aim to decipher the comprehensive analysis of disparities in farmers' characteristics between organic and conventional farming practices. Secondly, we endeavor to identify the key factors that impact the adoption of organic rice cultivation. Lastly, our study seeks to formulate effective strategies to incentivize farmers to adopt organic rice farming systems, facilitating their transition and helping them overcome significant obstacles. Our comprehensive understanding of these influential factors will play a pivotal role in expediting the adoption of organic rice farming. This, in turn, will empower farmers and their communities to surmount existing challenges. Moreover, identifying viable development strategies will be instrumental in achieving widespread global adoption, with implications for the governments and various stakeholders. These insights will inform the design and implementation of support programs and strategies aimed at advancing global organic rice development. Furthermore, promoting and supporting organic rice farming adoption can significantly enhance food security by ensuring the widespread adoption of sustainable agricultural practices [42].

2. METHODOLOGY

2.1 Location of study

The study sites were selected purposively based on some primary reasons and focused on two regencies in the West Java Province, namely Subang and Tasikmalaya Regencies (Figure 1). The regencies were selected due to Indonesia's organic rice production center, which has a relatively high growth and marketing well. The population of organic farmers in the regencies was obtained from the certification boards (INOFICE), and the population of the conventional farmers was selected in a similar area to the organic respondents.

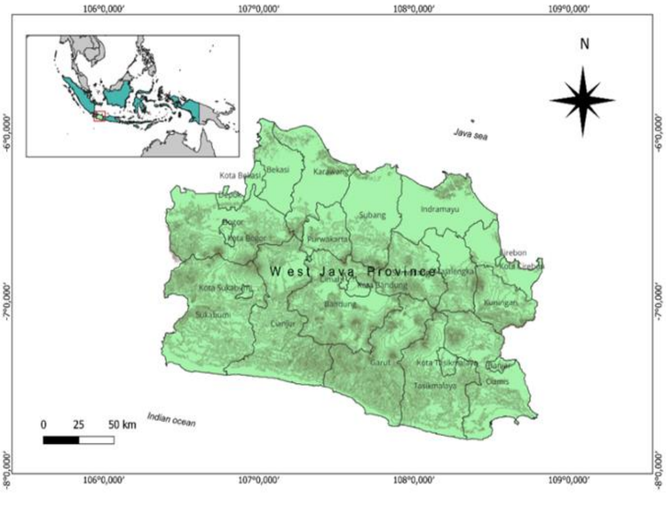

Figure 1. Research locations

2.2 Data collection and respondents

The primary data was collected by interviewing two distinct groups of farmers engaged in organic and conventional rice cultivation. Structured questionnaires were employed as a data collection instrument, supplemented by Focus Group Discussion (FGD) with relevant stakeholders. The sample size was determined by calculating West Java's total population of organic farmers. The samples were taken from the calculation based on Yamane's formula (1973), as follows:

$$n = \frac{N}{1+N(e)^2} \tag{1}$$

where, n=Sample size; N=population size; e=Level of precision or sampling of error (10%).

The sample size (n) of organic farmers:

$\frac{1,332}{1+1,332(10\%)^2}$ ≈93 organic rice farmers

The sample size (n) of conventional farmers:

$\frac{2,318,323}{1+2,318,323(10\%)^2}$ ≈100 conventional rice farmers.

Considering the calculated number of respondents, the questionnaires collected from organic and conventional farmers were 100 and 103, respectively. In addition, to deepen the findings, and to formulate precise strategies, the other data were obtained through FGD, which engaged various key stakeholders, including leaders of farmer groups, influential group members, extension officers, representatives from local government, and the Ministry of Agriculture officers. The structured questionnaire was designed to explore the demographic characteristics and the factors influencing organic rice adoption. At the same time, the FGD was used as a qualitative method to capture the findings' complexity, reason, and meaning. The collected data focus on each reason for driver's factors, describing the condition, challenges, problems, and the organic farming adoption strategies.

2.3 Data analysis

All collected data were subsequently categorized to facilitate both quantitative and qualitative analysis. The demographic characteristics such as age, household size, farm size, education, experience, and income were analyzed descriptively.

To address the first objective, we analyze the distinguished characteristics between organic and conventional farmers. The solution step for analyzing each variable was to set a null hypothesis and alternative hypotheses, then find a critical value based on the degree of freedom and α=0.05, calculate the test, and determine whether to reject or accept the hypotheses. The t-test and Chi-square statistical methods were analyzed by the statistical package for social science (SPSS) software to compare the farmers' characteristics between organic and conventional systems. The t-test is a statistical inference test used to compare the means of two groups [43]. The t-test results were calculated on the significant difference in each variable with the probability level ($p<0.05$). Meanwhile, the chi-square test was applied to see differences in the distribution patterns of categorical variables in both organic and conventional systems [44, 45]. The formula for the chi-square test is:

$$\chi^2 = \Sigma\frac{(O-E)^2}{E} \tag{2}$$

where, *O*=observed frequency; *E*=expected frequency; Degrees of freedom equal to the number of categories minus one [46].

For the testing difference between two means that assumed variances were not equal from those samples, we used the t-test statistic method. The P-value method for testing hypotheses was started by identifying the claim based on variable hypotheses, computing the test value, finding the P-value, making a decision, and summarizing the results. The formula is as follows:

$$t = \frac{\left(\overline{X}_1 - \overline{X}_2\right) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_1}}} \tag{3}$$

where,

$\overline{X}_1 - \overline{X}_2$ is the observed difference,

$(\mu_1 - \mu_2)$ is the expected difference. It is zero when the null hypotheses are $\mu_1 = \mu_2$

$\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_1}}$ is the standard error of difference [46].

Secondly, in order to identify factors that affect organic rice adoption, we employed a logit regression model, considering the dependent variable, binomial data, with null for conventional and one for organic rice system. This approach has been widely employed in studying the adoption model of the agricultural technology domain [47, 48]. Because the dependent variable (Y), adopting organic rice farming or conventional farming, is probability-limited between 0 and 1, the linear regression could not be applied to the estimated value of the parameter. Based on the variable expectation, this model measured farmers' preferences to adopt an organic rice system (Table 1).

According to Zulfiqar and Thapa [49], the main factors affecting the adoption of agricultural technology are socioeconomics (age, education, farm size, income, experience) and institutional factors (credit access, extension facilities). Kerdsriserm et al. [50] and Astuti et al. [51] considered household size, family workforce, land tenure, and profit to determine organic adoption. The logistic regression was used to identify significant factors in increasing and decreasing the likelihood of adopting organic rice farming. This model is as follows:

$$Y_i = Log_e \frac{P_i}{1-P_i} = Z_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_i X_i \tag{4}$$

where, e represents the base of natural logarithms, P_i is the probability that a farmer's household would decide to adopt an organic rice system (0=no, 1=yes), given X_1 to X_i are the set of explanatory variables that influence the adoption and β_1 to β_i are the coefficients of the explanatory variables [52, 53]. We used an open-source statistical package for the logistic regression analysis, Gretl software.

Table 1. Descriptions of variables, measurement, and prior expectation for the logit regression model for the of organic rice adoption (n=203)

Variable	Description	Measurement	Expected Sign	References
Dependent variable				
Organic rice adoption (Y)	Adoption of farmer's households to the organic rice system	1 if the household adopts organic rice, 0 if otherwise	none	
Independent variable				
Age (X_1)	Age of farmer household head	Number of years	+	[49]
Gender (X2)	Gender of the household head	1 if male, 0 if female	+	[49]
Member of the family (X3)	All members who are involved in farming	Number	+	[54]
Education (X4)	Formal education of household head	1 if an elementary school, 2 if junior high school, 3 if high school, 4 if a bachelor or higher	+	[48-50]
Informal education (X5)	Seminar, training, coaching, and extensional learning	Number	+	[47, 49]
Family labor (X6)	Adults of households who participated in the farm	Number	+	[50]
Farming experience (X7)	Number of years of experience in farming	Number of years	+	[49]
Knowledge (X8)	Understanding of agricultural practices of ORF	1 if no understanding, 2 if slightly understand, and 3 if completely understand	+	[47]
Rice field size (X9)	Size of the rice field	Hectares	+	[49]
Land tenure (X10)	Status of ownership	1 if sharing, 2 if private, 3 if village's land	+	[50]
Fragmented land (X11)	The land is separated from organic group farmers	1 if yes, 0 if otherwise	-	[63]
Profit per ha (X12)	The total profit of rice production	US$	+	[51]
Association (X13)	Member of farmer group association	1 if yes, 0 if otherwise	+	[50]
Credit access (X14)	Access of household to credit	1 if yes, no if otherwise	+	[49]
Supporting infrastructure (X15)	Infrastructure availability, such as irrigation system facilities	if yes, no, if otherwise	+	[49]

Lastly, the aforementioned analysis was employed to refine and formulate strategies for organic rice development. It was enriched the data and information from FGD. The data from FGD were transcribed into word format, then categorized or coded files, and analyzed using a computer-assisted qualitative data software, NVivo 12. The data was imported to the NVivo program, then we created structured nodes, made categories, and extracted the key points based on the FGD.

3. RESULTS AND DISCUSSION

3.1 Socioeconomic characteristics of smallholder farmers

The characteristics of organic and conventional rice farmers are shown in Table 2. However, there were marked differences in the number of families participating in rice cultivation, the number of consultations per season, formal education, non-formal education, income from rice cultivation, and gross household income between the two groups. Farmers with more family members participating in farming would be beneficial for providing a workforce, especially in planting and weeding, because these activities are conducted manually. On the other hand, organic farmers visited the extension officer more frequently to ask for a consultation at least twice per season. They used to participate in informal education, like seminars, coaching programs, and workshops to improve their farming and marketing knowledge. The curiosity of organic farmers, Good Agricultural Practices, and the extensional service institution are crucial to the success of gaining informal education.

Table 2. Socioeconomic characteristics of organic and conventional rice farmers

Variables	ORF Farmers (n=100)				CRF Farmers (n=103)				Sig.
	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.	
Age (years)	52.7	10.1	24.0	75.0	52.3	9.9	28.0	74.0	ns
Household size	4.0	1.0	2.0	7.0	3.9	1.4	1.0	7.0	ns
Farm size (ha)	0.5	0.5	0.07	2.4	0.4	0.3	0.05	1.5	ns
Participated members	1.8	0.5	1.0	4.0	1.6	0.6	0.0	4.0	**
Extension service per season	2.0	1.1	0.0	6.0	1.0	0.9	0.0	4.0	***
Experience (years)	18.6	9.9	1.0	48.0	18.2	10.8	2.0	55.0	ns
Formal education[a]	1.9	0.9	1.0	5.0	1.6	0.9	1.0	5.0	**
Informal education	4.8	3.5	0.0	25.0	1.1	2.6	0.0	15.0	***
Rice farming Income ($) per month	103.0	94.5	8.0	597.0	74.0	54.1	7.0	351.0	*
Household income per month[b]	3.9	1.2	1.0	6.0	2.6	1.2	1.0	6.0	***

Note. [a] Formal education category, elementary school=1, junior high school=2, high school=3, diploma=4, and bachelor=5
[b] Income category, 1 =<US$ 34.91, 2 =US$ 34.91-US$ 69.82, 3 =US$ 69.82-US$ 104.74, 4 =US$ 104.74-US$ 139.65, 5 =139.65-US $ 174.57, 6 =>US$ 174.57.
The variables were analyzed by t-test, except for the formal education and household income, which used the Chi-square test to see more detailed educational distribution in both systems. * Significant at the 90%, ** Significant at the 95%, *** Significant at the 99% level, and ns is for not significant

Additionally, in ORF, farmers also obtained more income and household income than the income of farmers in CRF. These conditions related to the majority of organic farming had an additional occupation, which supports the financial capital to adopt organic rice farming, especially in the conversion period. Moreover, the premium price of rice determined the high income of ORF farmers. In contrast, there were no differences between organic and conventional farms in characteristics such as age, number of household members, farm size, and farming experience of respondents.

The other critical socioeconomic factors are land ownership, farmer group membership, extension service, access to credit, and infrastructure availability. Organic and conventional rice farming was a different percentage of land tenure. Farmers generally had private rice fields in ORF, but most of the field was land-sharing in CRF. Farmers with private land had control over their rice fields, whether they would adopt organic or conventional rice farming. If farmers use a land-sharing system for organic farming, they require secure permission from landlords and certainty of the conversion period.

Another variable was group membership in ORF; it was higher than in CRF. Almost all ORF farmers was a member of the group farmer. In addition, ORF's supporting facilities, such as credit access and infrastructure, were higher than the CRF system. However, both ORF and CRF farmers still had limited credit access to formal financing due to the farmers' perception of a lack of collateral guarantee and complicated procedures. In contrast, ORF's farmers confessed they have supporting infrastructures such as a dam, an irrigation channel, and road access provided by the government.

3.2 Drivers factor of organic rice farming adoption

The logit regression aimed to determine the factors influencing farmers' decision to shift from conventional to organic rice farming. This analysis calculated the probability of choosing two possible decisions, adopting or not adopting organic rice farming.

Table 3. The descriptive statistics of variables included in the logit regression model

Variables (n=203)	Mean		Std. Deviation	Min.	Max.
	Statistic	Std. Error			
Organic adoption (Y) (1=ORF, 0=CRF)	0.49	0.035	0.501	0	1
Age (number of years) (X_1)	52.46	0.701	9.989	24	75
Gender (X_2) (1 male, 0 if female)	0.93	0.018	0.262	0	1
Family number (person) (X_3)	3.91	0.088	1.248	1	7
Education level (X_4)[a)]	1.70	0.059	0.845	1	4
Informal education (X_5)[b)]	2.92	0.253	3.611	0	25
Participated family (numbers) (X_6)	1.69	0.040	0.568	1	4
Farming experience (years) (X_7)	18.38	0.728	10.377	1	55
Rice field size (ha) (X_8)	0.45	0.027	0.382	0.05	2.11
Land tenure (X_9)[c)]	1.59	0.036	0.513	1	3
Fragmented land (X_{10}) (1=yes, 0=no)	0.61	0.034	0.490	0	1
Profit per ha (US$) ($X_{11}$)	691.29	11.374	162.062	334.8	1270.5
Knowledge (X_{12})[d)]	0.97	0.056	0.798	0	2
Farmer group member (X_{13}) (1=yes, 0=no)	0.86	0.025	0.351	0	1
Credit access (X_{14})=yes, 0=no)	0.24	0.030	0.429	0	1
Infrastructure facilities (X_{15}) (1=yes, 0=no)	0.79	0.029	0.406	0	1

Note. [a)] Formal education category, elementary school =1, junior high school =2, senior high school =3, and higher education =4; [b)] numbers of the seminar, training, coaching, and rice field school about organic farming; [c)] 1= sharing, 2= private, 3= government village's land; [d)] 0= no understanding, 1= slightly understanding, 2= ultimately understanding.

Table 4. Factors adoption of farmers' likelihood and the marginal effect of organic rice farming

Variables	Coefficient	Std. Error	z	Marginal Effect	P-Value	
Constant	−53.023	23.306	−2.275	-	0.023	**
Age (X_1)	0.027	0.138	0.197	0.003	0.844	
Gender (X_2)	0.896	1.321	0.678	0.134	0.498	
The number of involved family members (X_3)	−0.762	0.583	−1.308	−0.087	0.191	
Education level (X_4)	2.196	1.782	1.232	0.252	0.218	
Informal education (X_5)	0.497	0.174	2.858	0.057	0.004	***
Participated family member (X_6)	0.707	0.855	0.827	0.081	0.408	
Farming experience (X_7)	−0.104	0.127	−0.818	−0.012	0.413	
Rice field size (X_8)	9.896	4.688	2.111	1.136	0.034	**
Land tenure (X_9)	−0.218	1.827	−0.120	−0.025	0.904	
Fragmented land (X_{10})	−7.829	3.578	−2.188	−0.768	0.028	**
Profit (X_{11})	0.052	0.020	2.608	0.006	0.009	***
Knowledge (X_{12})	10.418	4.119	2.529	1.196	0.011	**
Membership in farmer group (X_{13})	6.181	3.460	1.787	0.909	0.074	*
Credit access (X_{14})	1.376	1.881	0.732	0.124	0.464	
Infrastructure facilities (X_{15})	0.053	1.413	0.037	0.006	0.970	
Mean dependent variable	0.492611		S.D. dependent variable		0.501181	
McFadden R-squared	0.935707		Adjusted R-squared		0.821979	
Log-likelihood	−9.045206		Akaike criterion		50.09041	
Schwarz criterion	103.1017		Hannan-Quinn		71.53667	

Number of cases 'correctly predicted' =201 (99.0%); F (beta'x) at mean of independent variables =0.501; Likelihood ratio test: Chi-square (15)=263.283 [0.0000]

All the variables' conditions were analyzed using a logit regression model presented in Table 3. Regarding the fit-model result, the logit regression obtained McFadden R-squared and adjusted R-square 0.935707 and 0.821979, respectively. The rule is that McFadden R-squared has to be close to 1, and a higher value indicates a better fit. A likelihood value is between 0 and 1, resulting in a logarithm of the likelihood is less than zero. In contrast, the decreasing value of adjusted R-squared can be attributed to the presence of variables within the model that do not sufficiently support its predictive power. McFadden and adjusted R-square indicate a significant predictive ability to the binary logit regression model. They assess what proportion of the variation in the likelihood of adopting rice farming can be explained by their independent variable. In other words, it is a fit model to explain the variables affecting organic rice adoption. They indicate that the most variation in farmers' adoption of organic rice farming is affected by included independent variables. The binary regression also has a highly significant Chi-square result due to the 15 independent variables, and this model can correctly predict 99% of respondents.

Based on the resulting model, the factors significantly affecting the likelihood of adopting organic rice farming are informal education, profit, rice field size, fragmented land, farmers' knowledge, and their membership in the farmers' group, which all predictors can be seen in Table 4.

3.2.1 Informal education

The number of informal education positively affected the likelihood of organic rice adoption. The more farmers attended informal education such as seminars, training, coaching, workshops, and field school about organic agriculture, the more their preference to adopt organic rice farming increased. The FGD informed that the extension agency and leaders are crucial in increasing farmers' knowledge about the ORF system through informal education. They had effective communication among actors. No matter their educational background, informal education will give farmers awareness to shift to an organic system. The more frequently farmers have the training, the more knowledge and propensity to adopt it. It was in line with the result of Khaledi et al. [54], who similarly found that formal education did not exert a significant influence on the probability of adoption. Instead, the primary driver appeared to be informal education, as formal education did not provide farmers with the specific knowledge required for organic rice farming. The knowledge and awareness necessary for organic farming seemed to stem mainly from the frequency of informal training sessions. A previous study stated that organic Thailand farmers received the training about ten times per year [50]. The training programs and community-based organizations give a greater tendency to the ORF system [55]. These findings contrast with other studies that highly educated farmers were likelier to be adopters [48, 56].

3.2.2 Profit

The profitability of farming positively affected the likelihood of adopting organic rice farming. Farmers argued that if the profits were high, they were more inclined to consider shifting to organic practices. However, the profit of organic farming was driven by the cost of farming and the revenue of organic products due to the premium price. Based on FGD, farmers admitted that ORF had given more profit than the CRF system, although they claimed they required a higher initial cost for organic conversion. This result supported that even though ORF costs are higher than CRF, ORF is still profitable due to the higher prevailing premium price [57].

The cost breakdown of organic rice cultivation sequentially from highest to lowest is labor and machine rental cost, seed and other inputs expenses, depreciation costs, and managerial and certification costs. The labor costs were used for the manual seed-transplanted rice systems and intensive weeding activities. To decrease costs, farmers applied a strategy to use locally sourced organic inputs, including manure fertilizers, biopesticides, and refugia plants for pest protection. However, they still need technological solutions to reduce labor costs through mechanization further.

Organic certification is also crucial for managing the cost. The organic rice farmers must collectively pay the organic certification cost, which is still considered expensive. This case is similar to the Philippines' and Iranian farmers who had difficulty obtaining organics certificates due to the associated certification and inspection costs, as well as the administrative complexities [58]. Unlike the case with the Thai government, which waives the certification fees to support farmers [59]. The Indonesian government has provided the program for fostering organic adoption through training, equipment, and inputs (seed and fertilizer), support for developing farmers' groups, except certification fee and output product subsidy [60]. Previous research stated that the certification cost was one of the crucial barriers for organic farmers [61].

3.2.3 Rice field size and land fragmentation

Farmers with higher rice field ownership tended to adopt the organic rice system. It might be due to smaller revenue in a smaller rice field, so if they had a less limited rice field, they were more alert to convert to an organic system and vice versa. According to Qiao et al. [62], small-scale farmers (<1 ha) had a minor income from agriculture, and they would not survive by merely depending on organic farming. Therefore, it was more of a burden if they had to expend more money on initial organic cost production. This result is contrary to the finding of Digal and Placencia [48], wherein farmers with more extensive landholdings are less likely to shift to an organic rice system due to the easiness of management.

The fragmented land, which means farms were separated from the other nearby organic land, also had a negative decreasing likelihood of adopting the organic system. Farmers separated from other organic rice field communities tend to be less likely to adopt an organic system because they argue that the conversion needs more effort, such as providing barrier space, pest control, and water irrigation. The fragmented land with a relatively small size is inefficient for organic farming. They should cooperate with their adjoining fields if they want to adopt ORF. For example, barrier space was used to prevent contamination of pest chemical treatment from neighbor farms. However, it decreased the cultivated organic land's total acreage and became an ineffective irrigation system that must be separated from conventional farming. Therefore, the adjoining organic farms in one group are more effective than fragmented organic land. Otherwise, the production costs incurred will be high. This reason aligns with previous studies that the fragmented lands could be linked to the increased distance between plots and the higher external condition requirements for biopesticides. Farmers must hire labor and purchase social to manage pests effectively [63].

3.2.4 Farmers' knowledge

Likewise, understanding agricultural practices positively affected the adopting of organic rice farming systems. A better farmers' knowledge increases awareness of organic farming principles, cultivation technologies, market access, and risk mitigation, improving farmers' skills and understanding to implement ORF. This finding was consistent with other research on elements required for organic farming. Increasing knowledge and awareness of agricultural practices could improve organic adoption [47, 64]. Therefore, the government, extension officers, researchers, and prominent leaders can improve farmers' knowledge of organic farming through workshops, training, field school, and a participatory approach. This co-creation of knowledge also mitigates the decreasing productivity yield gap of organic rice adoption [65, 66].

3.2.5 Membership in farmer group

Being a member of the farmer group enables farmers to persuade other members to adopt organic farming collectively. In addition, the farmer group can facilitate farmers getting more knowledge and information support, not only from discussions with other members but also the extensional occasion from the government coming to the farmer group. Joining a farmer group will give farmers advantages, such as knowledge sharing among members, solving problems, risk mitigation, sharing certification costs, marketing products, and accessing government assistance programs. Also, the flow of information and supporting facilities related to organic agriculture, including credit access, are mainly facilitated through group participation.

Furthermore, membership in a farmers' group plays a vital role in facilitating the sharing of knowledge and experience among farmers, thereby increasing their overall capacity and capability [67]. On the contrary, farmers who did not have a membership would have little chance to obtain enough information, creating an intention to convert into an organic system. Moreover, the supported other research argued that the farmers in the farmer group member performed in better economic conditions [64].

3.3 The implication strategies

Even though ORF has grown significantly in the last few years, research findings and FGD revealed that ORF adoption faces challenges such as small-fragmented land, decreasing yield in the conversion period, land ownership, lack of supporting facilities, and limited credit access. The farmers stated that adopting ORF decreased productivity, especially in the transition period, but they believe that good management practices will increase the yield gradually. The various organic sources and mineralizable manures such as vermicompost, poultry manure, green manures and bio-fertilizers, and intensive weeding practice can provide the optimum nutrients and reduce the yield gap [68, 69].

Landless farmers renting land owned by landlords have difficulty shifting to an organic system. They should get permission from the landowner because converting to organic needs a particular duration and cost. Most smallholders do not use legally binding land use agreements. Therefore, landownership is essential for organic rice development [70].

Some supporting facilities are required by farmers who want to adopt organic farming, such as an organic irrigation system separated from conventional farming, a composting fertilizer unit integrated with livestock, and a milling and packaging unit. Some farmers have been supported by those facilities by the government, especially the Ministry of Agriculture. The other barrier is that shifting to the organic system made farmers face capital challenges. The farmers need more initial cost and investment. Therefore, farmers need credit access support from financial institutions which can cover the converting program.

Based on the significant findings, some strategies can be inferred for accelerating the adoption:

1) The government can increase farmers' informal education frequency and the quality of training to improve farmers' capacity and capability for organic rice cultivation. The education can be in the form of strengthening extension services through ToT (Training of Trainer) or farmer-to-farmer extension, demonstration plots, and field schools that might attract conventional farmers to shift to organic practices. The training subjects include Good Agricultural Practices (GAP), seed procurement, making competitive organic fertilizer, integrated pest management (IPM) system, harvest-post harvest handling, and mechanization.

2) To achieve higher profits in ORF, it is essential to implement strategies that effectively reduce costs and enable the attainment of premium prices for organic rice products. The strategies include the implementation of mechanization and local resource utilization. Organic farming requires machinery units and competitive fertilizer costs from the local resources and farmers' support for organic fertilizer processing units so that the farmers can be self-sufficient in organic fertilizer. The organic farming development needs a national regulation related to a subsidy for the fabricated organic fertilizer, which production units could be a combination model of centralization and in-situ local base factory. The program should be elaborated with livestock farming. The supporting policies in the form of third-party certification subsidy programs and mechanization of cultivation support could be applied to attract farmers' intention to adopt organic farming. Farmers who successfully produce organic rice could receive incentive subsidies through government support for facilities.

3) It is necessary to encourage farmers to be involved in farmers' groups or farmers' associations so they can benefit from sharing knowledge, increasing farmers' capacity, avoiding inefficient land barriers, implementing collective action of integrated pest management (IPM), getting the lower the cost of certification, and ease of managerial process and access to supporting system.

4) Other support strategies include the risk mitigation organic rice development program through insurance, developing farmer corporations to unite the management of fragmented land, and supporting facilities such as irrigation systems and organic composting units. The conversion into organic farming requires an initial operational and investment cost. Therefore, it would be better for an affordable, inclusive credit financing market.

4. CONCLUSIONS

Adopting organic rice farming is crucial for developing organic agriculture, which is influenced by socioeconomic characteristics among both organic and conventional farmers. Notable differences in characteristics between Organic Rice Farming (ORF) and Conventional Rice Farming (CRF) encompass land ownership, family members' involvement in farming, the extent of extension services per session, participation in farmer groups, informal education, income levels, access to credit, and the availability of infrastructure. The logit regression model results demonstrate that smallholders' most significant factors driving the adoption of organic rice farming include informal education and its profitability. Farmers' participation in seminars, training programs, coaching, and school-based activities related to organic agriculture significantly influences farmers' preferences for organic rice farming. On the other hand, ORF yields greater profits than CRF, attracting farmers to make the shift. Additionally, farmers' knowledge of agricultural practices and membership in farmers' group positively affects the adoption of organic rice farming systems. ORF adoption also requires supporting facilities, access to credit, and government support. In theoretical terms, this underscores the vital role of both social and physical capital in the development of organic rice farming.

Based on the objectives and findings above, we have formulated some strategies for policymakers and stakeholders to accelerate organic rice development. The Indonesian Ministry of Agriculture and local government should enhance farmers' informal education and training, optimize local resources for fertilizer production, establish national regulations on organic fertilizer subsidies, provide support for machinery, develop farmer group corporations, and offer accessible credit financing.

Although this research has explored several aspects, it is essential to acknowledge the limitation: farmers' decisions are often influenced by cultural norms and socioeconomic factors, which vary significantly across different regions and communities. This wide variability can pose challenges to achieving comprehensive coverage. Some factors driving the adoption of organic rice farming may vary from country to country, presenting a hurdle in generalizing our findings. Some of these variations may be beneficial for formulating strategy. Future research related to the best extension program for enhancing profit through providing competitive organic fertilizer based on local resources and supporting machinery. However, we aspire for these findings to support government policy promoting organic rice production in Indonesia.

ACKNOWLEDGMENT

The authors would like to thank Mr. Dedi Mulyadi, A. Md. (National consultant of organic rice production in Indonesia-FAO, and the leader of the Farmer Group Union Bumi Mandiri) and Mr. Uu, the leader of the Farmer Group Union Simpatik, Pagerageung, Salawu Tasikmalaya's farmer group, Pringkasap, Segalaherang Subang's farmer group, and INOFICE (Organic certification body). Finally, the authors acknowledge the excellent research support received by extension officers from the local government of West Java.

REFERENCES

[1] FAO. (2018). Rice market monitor, food agriculture. organization. united nations. Food and Agriculture Organisation of the United Nations, XXI(1): 1-38.

[2] Chauhan, B.S., Jabran, K., Mahajan, G. (2017). Rice Production Worldwide. Cham, Switzerland: Springer International Publishing. https://doi.org/10.1007/978-3-319-47516-5

[3] BPS-Statistics Indonesia. (2023). Berita resmi statistik, 1 Maret 2023. https://jakarta.bps.go.id/pressrelease/2019/11/01/375/tingkat-penghunian-kamar--tpk--hotel--berbintang-dki-jakarta-pada-bulan-september-2019-mencapai-58-97-persen.html.

[4] Estudillo, J.P., Otsuka, K. (2013). Lessons from the Asian Green Revolution in rice. In An African Green Revolution Springer, Dordrecht. https://doi.org/10.1007/978-94-007-5760-8_2

[5] Setkab. (2022). Berhasil swasembada beras, Indonesia raih penghargaan dari IRRI. https://setkab.go.id/berhasil-swasembada-beras-indonesia-raih-penghargaan-dari-irri/.

[6] Clawson, D.L., Hoy, D.R. (1979). Nealtican, Mexico: A peasant community that rejected the 'Green Revolution'. American Journal of Economics and Sociology, 38(4): 371-387. https://doi.org/10.1111/j.1536-7150.1979.tb02843.x

[7] Harwood, J. (2020). Could the adverse consequences of the green revolution have been foreseen? How experts responded to unwelcome evidence. Agroecology and Sustainable Food Systems, 44(4): 509-535. https://doi.org/10.1080/21683565.2019.1644411

[8] Ramankutty, N., Mehrabi, Z., Waha, K., Jarvis, L., Kremen, C., Herrero, M., Rieseberg, L.H. (2018). Trends in global agricultural land use: Implications for environmental health and food security. Annual Review of Plant Biology, 69: 789-815. https://doi.org/10.1146/annurev-arplant-042817-040256

[9] Kumar, P. (2017). Green revolution and its impact on environment. International Journal of Research in Humanities and Social Sciences, 5(3): 54-57.

[10] Baweja, P., Kumar, S., Kumar, G. (2020). Fertilizers and pesticides: Their impact on soil health and environment. In Soil Health, vol 59. Springer, Cham. https://doi.org/10.1007/978-3-030-44364-1_15

[11] Notohadiprawiro, T. (2021). Revolusi hijau dan konservasi tanah. In Tanah, Lingkungan Dan Pertanian Berkelanjutan. Deepublish.

[12] Savci, S. (2012). An agricultural pollutant: Chemical fertilizer. International Journal of Environmental Science and Development, 3(1): 73-80. https://doi.org/10.7763/ijesd.2012.v3.191

[13] Sutton, M.A., Bleeker, A., Howard, C.M., Erisman, J.W., Abrol, Y.P., Bekunda, M., Datta, A., Davidson, E., Vries, W. de, Oenema, O., Zhang, F.S. (2013). Our nutrient world. The challenge to produce more food and energy with less pollution. In Centre for Ecology and Hydrology, Edinburgh, UK.

[14] Bottrell, D.G., Schoenly, K.G. (2012). Resurrecting the ghost of green revolutions past: The brown planthopper as a recurring threat to high-yielding rice production in tropical Asia. Journal of Asia-Pacific Entomology, 15(1): 122-140. https://doi.org/10.1016/j.aspen.2011.09.004

[15] Nicolopoulou-Stamati, P., Maipas, S., Kotampasi, C., Stamatis, P., Hens, L. (2016). Chemical pesticides and human health: The urgent need for a new concept in agriculture. Frontiers in Public Health, 4: 148. https://doi.org/10.3389/fpubh.2016.00148

[16] Berg, H., Maneas, G., Salguero Engström, A. (2018). A Comparison between organic and conventional olive

farming in Messenia, Greece. Horticulturae, 4(3): 15. https://doi.org/10.3390/horticulturae4030015
[17] Sujianto, Gunawan, E., Saptana, Syahyuti, Darwis, V., Ashari, Syukur, M., Ariningsih, E., Saliem, H.P., Mardianto, S., Marhendro. (2022). Farmers' perception, awareness, and constraints of organic rice farming in Indonesia. Open Agriculture, 7(1): 284-299. https://doi.org/10.1515/opag-2022-0090
[18] Dalcin, D.R., Leal de Souza, A.N.B., de Freitas, J.D., Padula, Â., Dewes, H. (2014). Organic products in Brazil: From an ideological orientation to a market choice. British Food Journal, 116(12): 1998-2015. https://doi.org/10.1108/BFJ-01-2013-0008
[19] Nguyen, H.V., Nguyen, N., Nguyen, B.K., Lobo, A., Vu, P.A. (2019). Organic food purchases in an emerging market: The influence of consumers' personal factors and green marketing practices of food stores. International Journal of Environmental Research and Public Health, 16(6): 1037. https://doi.org/10.3390/ijerph16061037
[20] Yanakittkul, P., Aungvaravong, C. (2020). A model of farmers intentions towards organic farming: A case study on rice farming in Thailand. Heliyon, 6(1). https://doi.org/10.1016/j.heliyon.2019.e03039
[21] Reeve, J.R., Hoagland, L.A., Villalba, J.J., Carr, P.M., Atucha, A., Cambardella, C., Davis, D.R., Delate, K. (2016). Organic farming, soil health, and food quality: Considering possible links. Advances in Agronomy, 137(2016): 319-367. https://doi.org/10.1016/bs.agron.2015.12.003
[22] Steffan, J.J., Brevik, E.C., Burgess, L.C., Cerdà, A. (2018). The effect of soil on human health: An overview. European Journal of Soil Science, 69(1): 159-171. https://doi.org/10.1111/ejss.12451
[23] Eyhorn, F., Muller, A., Reganold, J.P., Frison, E., Herren, H.R., Luttikholt, L., Mueller, A., Sanders, J., Scialabba, N.E.H., Seufert, V., Smith, P. (2019). Sustainability in global agriculture driven by organic farming. Nature Sustainability, 2(4): 253-255. https://doi.org/10.1038/s41893-019-0266-6
[24] Schreer, V., Padmanabhan, M. (2020). The many meanings of organic farming: Framing food security and food sovereignty in Indonesia. Organic Agriculture, 10(3): 327-338. https://doi.org/10.1007/s13165-019-00277-z
[25] Aitken, R., Watkins, L., Williams, J., Kean, A. (2020). The positive role of labelling on consumers' perceived behavioural control and intention to purchase organic food. Journal of Cleaner Production, 255: 120334. https://doi.org/10.1016/j.jclepro.2020.120334
[26] Le-Anh, T., Nguyen-To, T. (2020). Consumer purchasing behaviour of organic food in an emerging market. International Journal of Consumer Studies, 44(6): 563-573. https://doi.org/10.1111/ijcs.12588
[27] Mohammed, A.A. (2021). What motivates consumers to purchase organic food in an emerging market? An empirical study from Saudi Arabia. British Food Journal, 123(5): 1758-1775. https://doi.org/10.1108/BFJ-07-2020-0599
[28] Neilson, J., Wright, J. (2017). The state and food security discourses of Indonesia: Feeding the bangsa. Geographical Research, 55(2): 131-143. https://doi.org/10.1111/1745-5871.12210
[29] Laksmana, D.D., Padmanabhan, M. (2021). Strategic engagement in institutions of organic farming in Indonesia. Sustainable Life on Land, 381. https://doi.org/10.3390/books978-3-03897-879-4-14
[30] Rozaki, Z., Triyono, Indardi, Salassa, D.I., Nugroho, R.B. (2020). Farmers' responses to organic rice farming in Indonesia: Findings from central Java and south Sulawesi. Open Agriculture, 5(1): 703-710. https://doi.org/10.1515/opag-2020-0070
[31] Thakur, N., Nigam, M., Tewary, R., Rajvanshi, K., Kumar, M., Shukla, S.K., Mahmoud, G.A.E., Gupta, S. (2022). Drivers for the behavioural receptiveness and non-receptiveness of farmers towards organic cultivation system. Journal of King Saud University-Science, 34(5): 102107. https://doi.org/10.1016/j.jksus.2022.102107
[32] Aare, A.K., Lund, S., Hauggaard-Nielsen, H. (2021). Exploring transitions towards sustainable farming practices through participatory research-The case of Danish farmers' use of species mixtures. Agricultural Systems, 189: 103053. https://doi.org/10.1016/j.agsy.2021.103053
[33] AOI. (2020). Statistik pertanian organik Indonesia 2019 (Firman A.R., David W. (eds.)). Aliansi Organis Indonesia. https://www.aoi.ngo.
[34] BPS-statistics Indonesia. (2022). Paddy harvested area and production in Indonesia 2022. BPS-Statistics Indonesia. https://www.bps.go.id/website/images/BRS-Luas-Panen-dan-Produksi-Padi-Tahun-2022-eng.jpg.
[35] Rogers, E.M. (1983). Diffusion of innovations. The Free Press, A Division of Macmillan Publishing Co., Inc., New York, Vol. 10022.
[36] Akzar, R., Umberger, W., Peralta, A. (2023). Understanding heterogeneity in technology adoption among Indonesian smallholder dairy farmers. Agribusiness, 39(2): 347-370. https://doi.org/10.1002/agr.21782
[37] Akimowicz, M., Del Corso, J.P., Gallai, N., Képhaliacos, C. (2021). Adopt to adapt? Farmers' varietal innovation adoption in a context of climate change. The case of sunflower hybrids in France. Journal of Cleaner Production, 279: 123654. https://doi.org/10.1016/j.jclepro.2020.123654
[38] Malabayabas, M.L.L., Mishra, A.K., Pede, V.O. (2023). Joint decision-making, technology adoption and food security: Evidence from rice varieties in eastern India. World Development, 171: 106367. https://doi.org/10.1016/j.worlddev.2023.106367
[39] Tanko, M., Amfo, B., Shafiwu, A.B. (2023). Social norms perspective of agriculture technology adoption and welfare in Ghana: Extending multinomial endogenous treatment effect model. Technology in Society, 74: 102324. https://doi.org/10.1016/j.techsoc.2023.102324
[40] Zeleke, B.D., Geleto, A.K., Asefa, S., Komicha, H.H. (2023). The role of social capital in addressing seed access constraints and adoption intensity: Evidence from Arsi Highland, Oromia Region, Ethiopia. Heliyon, 9(2). https://doi.org/10.1016/j.heliyon.2023.e13553
[41] Ashari, Sharifuddin, J., Mohammed, Z., Terano, R. (2018). Paddy farmer's perceptions and factors are influencing attitudes and intentions to adoption of organic rice farming. International Food Research Journal, 25(2): S135-S145.
[42] Oyetunde-Usman, Z., Olagunju, K.O., Ogunpaimo, O.R. (2021). Determinants of adoption of multiple sustainable

agricultural practices among smallholder farmers in Nigeria. International Soil and Water Conservation Research, 9(2): 241-248. https://doi.org/10.1016/j.iswcr.2020.10.007
[43] Mishra, P., Singh, U., Pandey, C.M., Mishra, P., Pandey, G. (2019). Application of student's t-test, analysis of variance, and covariance. Annals of Cardiac Anaesthesia, 22(4): 407-144. https://doi.org/10.4103%2Faca.ACA_94_19
[44] Hill, I.D., Tallarida, R.J., Murray, R.B. (1982). Manual of pharmacologic calculations with computer programs. In Applied Statistics. Springer, New York, 31(3): 307. https://doi.org/10.2307/2348009
[45] Franke, T.M., Ho, T., Christie, C.A. (2012). The chi-square test: Often used and more often misinterpreted. American Journal of Evaluation, 33(3): 448-458. https://doi.org/10.1177/1098214011426594
[46] Bluman, A.G. (2015). Elementary Statistics: A step by step approach, a brief version. McGraw-Hill Education.
[47] Kuwornu, J.K., Oduro, E., Amegashie, D.P., Fening, K.O., Yangyouru, M., MacCarthy, D.S., Amoatey, C., Datta, A. (2018). Cost-benefit analysis of conventional and integrated crop management for vegetable production. International Journal of Vegetable Science, 24(6): 597-611. https://doi.org/10.1080/19315260.2018.1457585
[48] Digal, L.N., Placencia, S.G.P. (2019). Factors affecting the adoption of organic rice farming: The case of farmers in M'lang, North Cotabato, Philippines. Organic Agriculture, 9: 199-210. https://doi.org/10.1007/s13165-018-0222-1
[49] Zulfiqar, F., Thapa, G.B. (2018). Determinants and intensity of adoption of "better cotton" as an innovative cleaner production alternative. Journal of Cleaner Production, 172: 3468-3478. https://doi.org/10.1016/j.jclepro.2017.09.024
[50] Kerdsriserm, C., Suwanmaneepong, S., Mankeb, P. (2016). Factors affecting adoption of organic rice farming in sustainable agriculture network, Chachoengsao Province, Thailand. International Journal of Agricultural Technology, 12: 1227-1237.
[51] Astuti, F.K., Haryono, D., Nugraha, A. (2020). Analisis pendapatan dan sistem pemasaran padi organik dan anorganik di kabupaten pringsewu. Jurnal Ilmu-Ilmu Agribisnis, 8(1): 30-38. https://doi.org/10.23960/jiia.v8i1.4338
[52] Pindyck, R.S., Rubinfeld, D.L. (1998). Econometric Models and Economic Forecasts. Boston, Massachusetts: Irwin/McGraw-Hill.
[53] Dayton, C.M. (1992). Logistic regression analysis. University of Maryland.
[54] Khaledi, M., Weseen, S., Sawyer, E., Ferguson, S., Gray, R. (2010). Factors influencing partial and complete adoption of organic farming practices in Saskatchewan, Canada. Canadian Journal of Agricultural Economics/Revue Canadienne D'agroeconomie, 58(1): 37-56. https://doi.org/10.1111/j.1744-7976.2009.01172.x
[55] Hoang, H.G. (2021). Determinants of adoption of organic rice production: A case of smallholder farmers in Hai Lang district of Vietnam. International Journal of Social Economics, 48(10): 1463-1475. https://doi.org/10.1108/IJSE-03-2021-0147
[56] Khandker, V., Thakurata, I. (2018). Factors encouraging complete adoption of agricultural technologies: The case of hybrid rice cultivation in India. Journal of Agribusiness in Developing and Emerging Economies, 8(2): 270-287. https://doi.org/10.1108/JADEE-05-2016-0037
[57] Suwanmaneepong, S., Kerdsriserm, C., Lepcha, N., Cavite, H.J., Llones, C.A. (2020). Cost and return analysis of organic and conventional rice production in Chachoengsao Province, Thailand. Organic Agriculture, 10: 369-378. https://doi.org/10.1007/s13165-020-00280-9
[58] Maohong, B. (2018). The rise of organic agriculture in the Philippines and its development. In Environmental Resources Use and Challenges in Contemporary Southeast Asia: Tropical Ecosystems in Transition. Singapore: Springer Singapore, pp. 189-205. https://doi.org/10.1007/978-981-10-8881-0_9
[59] Hérique, O., Faysse, N. (2021). A large-scale public programme to promote organic rice farming in Thailand: Building solid foundations to enable farmers to engage? Organic Agriculture, 11(1): 27-40. https://doi.org/10.1007/s13165-020-00320-4
[60] Charina, A., Kusumo, R.A.B., Sadeli, A.H., Deliana, Y. (2018). Faktor-faktor yang mempengaruhi petani dalam menerapkan standar operasional prosedur (SOP) sistem pertanian organik di Kabupaten Bandung Barat. Jurnal Penyuluhan, 14(1): 68-78. https://doi.org/10.25015/penyuluhan.v14i1.16752
[61] Heryadi, D.Y., Noor, T.I., Deliana, Y., Hamdani, J.S. (2018). Why organic rice farmers switch back to conventional farming? Journal of Economics and Sustainable Development, 9(8): 179-185.
[62] Qiao, Y., Martin, F., Cook, S., He, X., Halberg, N., Scott, S., Pan, X. (2018). Certified organic agriculture as an alternative livelihood strategy for small-scale farmers in China: A case study in Wanzai County, Jiangxi Province. Ecological Economics, 145: 301-307. https://doi.org/10.1016/j.ecolecon.2017.10.025
[63] Wang, F., Cang, Y., Chen, S., Ke, Y. (2023). Aging, land fragmentation, and banana farmers' adoption of biopesticides in China. Environmental Science and Pollution Research, 30(35): 84742-84757. https://doi.org/10.1007/s11356-023-28358-3
[64] Sitthisuntikul, K., Yossuck, P., Limnirankul, B. (2018). How does organic agriculture contribute to food security of small land holders?: A case study in the North of Thailand. Cogent Food & Agriculture, 4(1): 1429698. https://doi.org/10.1080/23311932.2018.1429698
[65] Orlando, F., Alali, S., Vaglia, V., Pagliarino, E., Bacenetti, J., Bocchi, S. (2020). Participatory approach for developing knowledge on organic rice farming: Management strategies and productive performance. Agricultural Systems, 178: 102739. https://doi.org/10.1016/j.agsy.2019.102739
[66] Hasanah, Y., Hanum, H., Rusmarilin, H. (2019). Field school of organic farming as an effort to increase organic rice production. Journal of Saintech Transfer, 2(2): 126-131. https://doi.org/10.32734/jst.v2i2.512
[67] Sapbamrer, R., Thammachai, A. (2021). A systematic review of factors influencing farmers' adoption of organic farming. Sustainability, 13(7): 3842. https://doi.org/10.3390/su13073842
[68] Hazra, K.K., Swain, D.K., Bohra, A., Singh, S.S., Kumar, N., Nath, C.P. (2018). Organic rice: Potential

production strategies, challenges and prospects. Organic Agriculture, 8: 39-56. https://doi.org/10.1007/s13165-016-0172-4
[69] Knapp, S., van der Heijden, M.G. (2018). A global meta-analysis of yield stability in organic and conservation agriculture. Nature Communications, 9(1): 3632. https://doi.org/10.1038/s41467-018-05956-1
[70] Seerasarn, N., Miller, S.A., Wanaset, A. (2020). Transitioning to organic rice farming in thailand: Drivers and factors. Asian Journal of Agriculture and Rural Development, 10(3): 740-748. https://doi.org/10.18488/journal.ajard.2020.103.740.748