DRF-373
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RESEARCH ARTICLE Asian Journal of Dairy and Food Research

Factor Affecting of Food Security in Organic Rice Farming Households: A Finding in Sleman Yogyakarta, Indonesia

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10.18805/ajdfr.DRF-373

ABSTRACT

Background: Extensive research has been conducted on organic rice farming, but its impact on the food security of farmer households has not been thoroughly investigated. Thus, the purpose of this study is to assess the degree of food security and identify the factors influencing the food security of organic rice farmers in Sleman Regency.

Methods: The investigation took place in four districts: Sleman, Cangkringan, Pakem and Berbah. Data collection techniques were conducted by observation and interviews using direct questionnaires with seventy farmers as respondents in the Sleman Regency area. The analysis of food security in this study used a food expenditure share approach. The study utilized multiple linear regression to examine the various factors impacting food security.

Result: The findings indicated that farming households, in general, faced food insecurity due to a significant portion (60%) of their expenses being allocated to food, along with insufficient energy sufficiency (less than 80%). The factors affecting food security in these households, specifically in terms of the proportion of food expenditure, included the age of the family's leader, educational background, non-farming income and food expenses. While the influenced factors in the energy adequacy level were age, number of family member and food expenditure.

Key words: Energy sufficiency, Food security, Organic farm, Share of food expenditure.

INTRODUCTION

Almost all food needs in Indonesia can be met from domestic potential, except for imported meat and soybeans which are still in short supply, while rice, corn, chickpeas, sweet potatoes, eggs, chicken and milk are still in surplus condition (Rusdiana and Maesya, 2017). As a staple food, rice can meet 56-80% of the caloric needs of the population in Indonesia that is consumed to meet their food needs every day. This makes the rice plant have spiritual, cultural, economic and political values for the Indonesian nation because it can affect the lives of many people (Ishaq *et al.,* 2017). In fact, the government provides rice subsidies for the poor to meet the food and nutrition of low-income people (Amrullah *et al.,* 2023).

For fulfillment people's food, food production and quality and the environment are the issues that need attention. Therefore, organic farming has become a growing trend in various countries that consider it healthier and more nutritious. Thus, organic farming is holistic production management system promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity (Singh *et al.,* 2023).

Food production data of Sleman Regency serves as a valuable resource for further enhancing rice production, particularly organic rice. Sustaining the growth of rice production in Sleman Regency is crucial to ensure agricultural systems they have run. The food security status of cassava farmers can be described as vulnerable, food insecure, less safe, with only 18.18% of households classified as food secure (Murniati *et al.,* 2020). These challenges encompass pests, diminished market opportunities, inadequate processing methods, societal attitudes and limited awareness and understanding (Reincke *et al.,* 2018).

The 'salome' agricultural system, found in South Central Timor (SCT) district of East Nusa Tenggara (ENT) province, incorporates a unique food called 'catechetical maize' and has successfully enhanced food security by satisfying the local ethnic community (Levis *et al.,* 2017). Conservation initiatives enhance the productivity of corn and bolster the grain availability for households, with a particular focus on those headed by females (Siziba *et al.,* 2019). The utilization of improved maize varieties has played a significant role in ensuring food security for smallholder

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How to cite this article: Triyono, Azzahra, N.A. and Kamarudin, M.F. (2024). Factor Affecting of Food Security in Organic Rice Farming Households: A Finding in Sleman Yogyakarta, Indonesia. Asian Journal of Dairy and Food Research. doi: 10.18805/ajdfr.DRF-373.

Submitted: 20-11-2023 **Accepted:** 03-07-2024 **Online:** 21-08-2024

farmers engaged in corn production, confirming that crop enhancement plays a crucial part in supporting the food security of rural households (Jaleta *et al.,* 2018). Similarly, the utilization of sweet potato for both culinary and agricultural purposes brings about beneficial effects on the food security of those who embrace it (Danso-Abbeam *et al.,* 2021). Smallholder farming households experience beneficial outcomes when they employ certified seed potatoes (CSP) (Okello *et al.,* 2017).

In relation to climate change, the insufficient availability of food in rural households signifies their limited ability to adjust to the impacts of climate change (Savari and Zhoolideh, 2021). When agricultural households employ strategies to adjust to unfavorable weather conditions, their food security situation tends to improve considerably (Ogundeji, 2022). Farmers who implemented a greater number of adaptive techniques enjoyed increased levels of food security (Ali and Erenstein, 2017). Enhancing food security requires the advancement of institutional capabilities, the effective execution of measures and the widespread sharing of information on climate change and strategies for adaptation (Bairagi *et al.,* 2020).

Taking this into consideration, when there is a growing awareness about climate change, efforts to empower women-led households to generate income and the enhancement of current adaptation measures, it results in a beneficial influence on food security (Mekonnen *et al.,* 2021). The food security of farming households is influenced by climate change adaptation strategies which is crucial for ensuring sustainable food security (Murniati and Mutolib, 2020). The relationship between climate change adaptation, household expenditure, marital status and food security status is both statistically significant and influential (Samuel and Sylvia, 2019). Mean while, geographical location, household size and socioeconomic infrastructure appeared as shared factors influencing food security in Botswana and South Africa (Ndhleve *et al.,* 2021).

In general, previous research has addressed farmers' food security in various environmental conditions and agricultural systems. However, there has been no discussion about organic farming systems related to food security. This paper aims to address the food security situation of households engaged in organic rice farming; a case found in Sleman Regency.

MATERIALS AND METHODS

The selection of the study's location was done intentionally, assuming that Sleman Regency possesses the most extensive paddy fields in the Special Region of Yogyakarta, as well as the highest number of certified organic rice farmer groups. This area in the Java Island part of Indonesia as presented in Fig 1.

Sleman Regency is part of the Special Region of Yogyakarta which is located at the top or upstream of all irrigation sources. This environment is relatively good for the development of organic farming because the upstream part is far from pollution sources so that rice production is higher quality. However, the population of organic farmers in Sleman is still small, considering the constraints in organic farming are low production at the conventional to organic transition stage and the high cost of certification. Therefore, there are only 103 organic farmers spread across four sub-districts. The sampling method employed in this study was a simple random technique. A total of 70 organic rice farmers from five farmer groups in four districts within Sleman Regency (Sleman=https://s.id/Loc2Sleman, Cangkringan =https://s.id/Loc2Cangkringan, Pakem= https://s.id/Loc4Pakem and Berbah=https://s.id/Loc3Berbah) were included in the study. The location of each area can be seen in Fig 2.

The study employed a descriptive research method to investigate the food security of organic rice farmer households in Sleman Regency, regarding a quantitative approach. By using a food expenditure share approach, the study aimed to provide an overview of the organic rice farmer households' food security in Sleman Regency. The total household expenditure of farmers can be known by calculating food and non-food expenditures. The formula used is as follows:

$$TE = FE + NFE \quad ...(1)$$

Information:
TE = Total expenditures (IDR).
FE = Food expenditures (IDR).
NFE = Non-food expenditures (IDR).

Additionally, the assessment of food security among organic rice farming households in Sleman Regency can be conducted by examining the relationship between the proportion of food expenses and the level of energy sufficiency (LEA) within these households. The determination of household energy consumption is derived from the calculation of the Food Expectation Pattern (FEP). To calculate the ratio of food expenses to the total expenses of farmer households, the following formula can be applied.

$$SFE = \frac{FE}{TE} \times 100\% \quad ...(2)$$

SFE= Share of food expenditure (%).
TE = Total expenditures (IDR).
FE = Food expenditures (IDR).

Therefore, the calculation of the level of energy adequacy of farmer households can be calculated using the following formula:

$$LEA = \frac{\text{Energy consumption}}{\text{Recommended LEA}} \times 100\% \quad ...(3)$$

Information:
LEA = Energy adequacy level (%).

The indicators mentioned in Maxwell *et al.* (2000), which employ the Jonsson and Toole methods, are combined in a cross-sectional manner to assess the Share of Food Expenditure (SFE) and the level of energy adequacy (LEA). The combination involves utilizing the following indicators.

Multiple linear regression equations were employed to examine the various factors that influence the food security of households belonging to organic rice farmers in Sleman Regency.

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + e \quad ...(4)$$

Information:
Y_1 = Share of food expenditure.
Y_2 = Energy adequacy level.
a = Constant.
$b_1..b_6$ = Regression coefficient.
X_1 = Age (Year).
X_2 = Education (Years).
X_3 = Number of family members (Person).
X_4 = Farmers' food expenditure (IDR/Month).
X_5 = Farm income (IDR/Month).
X_6 = Non-farming income (IDR/Month).

RESULTS AND DISCUSSION

Food security of organic rice farmers

The method employed to assess the food security status of organic rice farming households in Sleman Regency involves utilizing the food expenditure share approach. This approach utilizes an indicator developed by Jhonson and Thole, which measures the proportion of household expenditure allocated to food (Maxwell *et al.,* 2000). To put it differently, it involves combining both the proportion of Food Expenditure (SFE) and the Energy Adequacy Rate (LEA) (Pradnyadewi *et al.,* 2021).

According to the data provided in Table 1, the average proportion of food expenditure in Sleman Regency is 62.44%, which means that food insecurity can be seen from 4 districts, namely Sleman, Cangkringan, Pakem and Berbah Districts. However, when it is viewed based on the

Fig 1: Java Island part of Indonesian Indonesian archipelago.

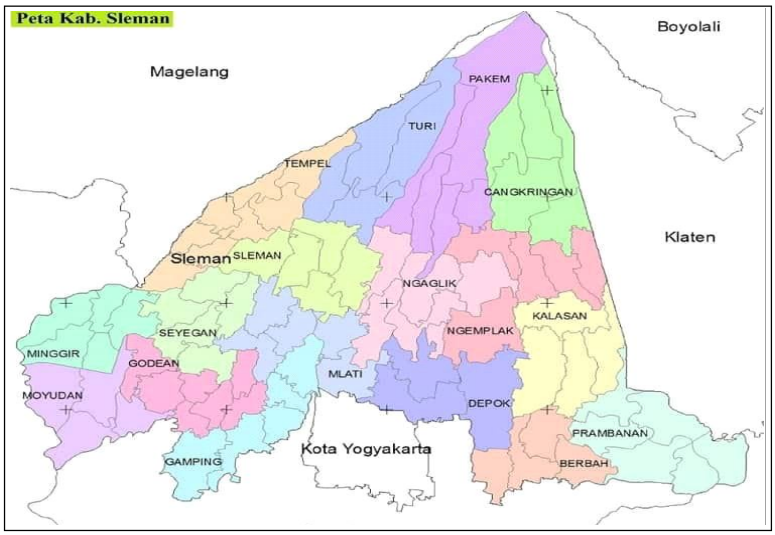

Fig 2: Sleman map, part of Yogyakarta Indonesia.

distribution of each district, there is one district with a percentage of 57.77%, namely Pakem District. In Pakem District, this can be interpreted as a district that is included in the food security category, because the percentage of the district is less than 60%. This condition shows that organic food production has not been able to support food security. Therefore, food security needs to be supported by significant growth in food production (Verma *et al.,* 2024).

An increase in the proportion of expenditure in the food group can be an indicator of the decline in the welfare of a household. The economic well-being of households has an impact on the food consumption of food-deprived households, affecting both the quality and quantity of their food. When household welfare is low, priority is given to fulfilling their food requirements rather than non-food necessities. Conversely, households with high levels of welfare are more capable of meeting non-food needs, in addition to their food needs. In fact, they already have the awareness to choose quality, safe and healthy food (Krishnasree *et al.,* 2018).

The findings are consistent with Engel's law and Bennet's law, which indicate that as a household's wealth increases, the proportion of their spending allocated to food decreases (Miranti *et al.,* 2016). The richer a household is, the richer they will change the pattern of food consumption from before which was dominated by vegetables with simple nutrition to be more varied, namely by consuming vegetables, fruit, milk and meat. In addition, with a high household income, it can make the household buy better food needs that can meet the nutritional needs of these household members (Sandra Yofa Zebua, 2020).

The level of energy adequacy is obtained from the household nutrition adequacy rate which is calculated based on the calculation of the Food Expectation Pattern (FEP), namely the amount of energy consumption from various food sources every day. Households can be said to be sufficiently of food if their energy consumption is more 80% of the established nutritional adequacy rate. Table 2 present the organic rice farming households in Sleman Regency have an average Energy Adequacy Level (LEA) of 69.83% smaller than the average energy efficiency level (LEA) of 80%. This can be interpreted that the Energy Power Level (LEA) in Sleman Regency is included in the category of less. However, when viewed from the distribution of each sub-district, Pakem is a district that is included in the sufficient category, which is 89.79% of the average energy adequacy level (LEA) of 80%. The low level of Energy Adequacy is caused by the average income earned by the households in Sleman Regency, which is IDR.1,603,761 which is lower than the regional minimum wage (RMW) in force in Sleman Regency, which is IDR. 2,100,000 according to Statistical data of Yogyakarta Province. With a sufficient income, the households will find it easier to determine food choices according to their tastes. Vice versa, if income is less, households will be limited in determining food choices.

This study examines the food security level by analyzing two key indicators: the proportion of food expenditure and the level of energy adequacy. The household's food security level is determined by assessing whether each member has access to enough food to meet their needs and if the household has the financial capability to purchase an adequate amount of food. The table below presents the distribution of food security levels based on Jhon and Thole indicators (Maxwell *et al.,* 2000).

The largest distribution of organic rice farming households in Sleman Regency with food insecurity status is depicted. This shows that most organic rice farming households in Sleman Regency have a high proportion of food expenditure (SFE ≥ 60%) of the total expenditure and lack of energy adequacy level (LEA≤ 80%). A different research study indicated that merely 28.12% of farmers enjoyed a relatively high level of food security. Families classified as having marginal food security are at risk but have not yet faced hunger. On the other hand, those with low food security status are no longer considered to be at risk (Yunus *et al.,* 2020).

One recommendation is to enhance local rice production by utilizing the currently available agricultural land. This approach aims to ensure an adequate supply of rice for both short-term and long-term food security (Suriani and Sartiyah, 2020). Nevertheless, it is crucial to develop a production system that is centered around sustainability and market principles in order to enhance both household food security and well-being (Dube and Ozkan, 2022). More market access equals more food security for farmers, but market access also ensures greater food security (Corsi *et al.,* 2017).

Table 1: Classification of Food Security of Farmer Households.

Categories food security	SFE	LEA
Food-secure	<60%	>80%
Shortage of food	<60%	≤80%
Food vulnerability	≥60%	≥80%
Food insecurity	≥60%	≤80%

Table 2: Classification of household food security levels among organic rice farmers in sleman regency.

District	SFE	LEA	Category
Sleman	61.27	67.57	Food Insecurity (SFE ≥ 60%); (LEA≤80%)
Cangkringan	62.58	55.79	Food Insecurity (SFE ≥ 60%); (LEA≤80%)
Pakem	57.77	89.79	Food Security (SFE<60%); (LEA>80%)
Berbah	68.14	66.21	Food Insecurity (SFE ≥ 60%); (LEA≤80%)
Average	62.44	69.83	Food Insecurity (SFE ≥ 60%); (LEA≤80%)

In sub-Saharan Africa, the impoverished and vulnerable ethnic groups can adopt agroecological techniques to significantly enhance food security and nutrition (Bezner Kerr *et al.,* 2019). By employing local resources from a variety of sub-sectors that work in tandem with technology as a new source of revenue for the community through empowerment to secure food security, Integrated Farming System will develop optimally (Rachmawatie *et al.,* 2019). Thus the role of counseling and changes in farmer behavior is a factor that needs to be considered, because the better the characteristics of the farmers, the better the behavior of the farmers to meet food needs (Molaei, 2019). The availability of the agricultural skills can improve the household food security and that interventions can increase the agricultural productivity of smallholder farmers (Maziya *et al.,* 2017). Additionally, cooperative participation makes it easier for women farmers to access beneficial resources like loans, which helps to improve the situation of food security (Ingutia and Sumelius, 2022).

Factors affecting farmer households' food security

One of the methods utilized in this study to determine the variables influencing the food security of the households engaged in organic rice farming in Sleman Regency is multiple linear regression analysis. The percentage of food expenditure and the level of energy sufficiency serve as the dependent variables (Y) in this analysis. The age of the family head (X_1), the level of education of the head of the household (X_2), the number of family members (X_3), farm income (X_4), non-farming income (X_5) and food expenditure (X_6) are the six factors that make up the independent variable (X). The following table shows the findings of the analysis of the variables that affect the food security of households engaged in organic rice growing.

According to Table 3, the corrected R^2 value is 0.391, meaning that independent variables can only account for 39.1% of the food security of the organic rice farmers in Sleman Regency, leaving another factor outside the model to account for the remaining 60.9%. With a 99% degree of confidence, the F test results demonstrate that independent variables collectively impact the food security of the organic rice producers in the Sleman District.

The affecting of each independent variable on the dependent variable is partially examined using the t-test. Based on Table 3, there is a 90% degree of confidence that the head of the household's age influences the food security of the households who grow organic rice. Given that the regression co-efficiency is negative, food security tends to decrease as age rises and vice versa. According to the analysis's findings, farmers' resilience in terms of their share of food spending is significantly harmed by the variable degree of farmer education. Wife's education has a positive coefficient that shows that a wife's education has an influence in the same direction as food access, resulting in low education levels, access to food is also low (Hannavi, 2018).

According to the analysis's findings, non-farming income has an influence on food security in terms of the proportion of expenditure that goes toward food. Given that the regression coefficient is negative and equal to 2,083, it follows that as non-farming income rises, food security will also fall. The study's findings are consistent with earlier studies in that the non-farming income variable has a detrimental affecting on the food security of farmer households (Pradnyadewi *et al.,* 2021). In general, households with high income levels will use more income for the expenditure of the quality of the food needs with a fixed amount and use more income to meet the non-food expenditure needs. As a result, the income has a big impact on how much money a household spends on food. If income rises, more of it will be spent on non-food expenses, pushing the proportion of food expenses in households to an unsustainable level (Mirzaei and Natcher, 2021).

A step used to determine a proportion of food spending is calculating the ratio between the amount of food expenditure and the sum of household expenditures. The proportion of household food spending would increase if the amount spent on meeting its food needs does, increasing the household's food insecurity. As a result, the share of household food spending that goes toward food expenditure has an impact on food security (Pradnyadewi *et al.,* 2021).

Table 4 shows the findings of the examination of the elements influencing the level of energy sufficiency of

Table 3: The findings of the examination of the variables influencing food security in terms of the percentage of food expenditure.

Variable	Regression Coefficient	Significance
Constant	75.797***	0.000
Age (X_1)	-0.172*	0.083
Education Level (X_2)	-3.214**	0.014
Number of families (X_3)	-1.488	0.145
Farm Income(X_4)	-3.501E-007	0.538
Non-Farm Income (X_5)	-2.083E-007***	0.006
Food Expenditure (X_6)	1.344E-006***	0.000
R^2	0.391	
F test	6.732	0.000

Table 4: Results of the analysis of factors influencing food security in terms of adequate levels of energy.

Variable	Regression Coefficient	Significance
Constant	47,854**	0,033
Age (X_1)	0,657**	0,017
Education Level (X_2)	3,468	0,319
Number of families (X_3)	-18,143***	0,000
Farm Income(X_4)	2,146E-009	0,160
Non-Farm Income (X_5)	-1,369E-007	0,499
Food Expenditure (X_6)	2,821E-006***	0,000
R^2	0.496	
F test	10.351	0.00

organic rice farmer households in Sleman Regency in terms of food security. The level of energy sufficiency was the dependent variable in this study and up to six independent variables were also used, including the family head's age, education level, number of family members, farm income, non-farming income and food distribution. The level of energy adequacy of organic rice farmers in Sleman Regency can be explained by independent variables to a degree of 49.6%, according to the R-Square coefficient of determination of 0.496, while the remaining 50% is explained by other variables that are not explained by the studied model.

The F-test results demonstrated that all independent variables simultaneously affect the dependent variables' level of energy sufficiency. The number of family members, the age of the family head, farm revenue, non-farming opinions and household expenses are the independent factors.

According to Table 4, the age factors of the head of family have an effect on the food security of households of organic rice farmers in Sleman Regency when considered in terms of the level of energy adequacy. According to the regression coefficient, which has a positive value of 0.657, an increase in age will typically result in a 0.657-unit improvement in food security. The age of the family's head of household influences food security based on the level of energy sufficiency.

The number of family members is another element that influences the food security of the households engaged in organic rice growing in Sleman Regency. According to the analysis's findings, there is a 99% probability that the changing number of family members has an impact on food security. The monthly income, family size and family structure were important determinants for food security of household (Yousaf *et al.,* 2018).

The level of energy sufficiency has an impact on the food security of the households of the organic rice producers in Sleman Regency. According to the investigation, factors affecting food expenditures have a favorable impact on food security. Because the energy demands will be met equally if the food expenditure is large, it will have an impact on food security. These findings corroborate previously conducted studies related to climate change adaptation strategies (Samuel and Sylvia, 2019).

Studies in Nigeria reveal that the factors influencing technical efficiency and food security in the study area are farming experience, education, age, cassava output, number of dependents, access to loans, access to extension workers, distance to agriculture and agricultural size. Therefore, it is necessary to improve technical efficiency through agricultural extension services and Agricultural Credit Schemes with low interest rates so that the food security can be achieved (Ajayi and Olutumise, 2018). The best methods for enhancing food security include technical, health and safety-related and production-optimization-related (Morshedi *et al.,* 2017). Consequently, suggestions that can help to strengthen the synergy between food security and smallholder farmers' productivity in South Africa (Oluwatayo, 2019).

Our future food security depends on smallholder farmers and other chain members managing their environmental impact and economies well (Nissen, 2018). With access to markets and extension services, conservation agriculture must embrace a value chain strategy to cash crops in order to significantly reduce food insecurity and poverty over the long run (Mango *et al.,* 2017). Participation in contemporary markets and food security are related. This study also demonstrates how the establishment of a new food supply chain system might boost smallholder farmers' incomes by stabilizing prices and demand (Toiba *et al.,* 2020).

A potential solution for Malaysia's food security is the rice farmers' use of GFT Green fertilizer technology (Adnan *et al.,* 2017). However, there are still insufficient conditions for the increase in CSA (climate-smart agriculture) adoption to improve food security because other farmer factors, such as personal education, pond size, animal ownership and market challenges, have a significant impact on food security (Hasan *et al.,* 2018). Access to agricultural technology is difficult for those who are food insecure because of the tools and hand tools (Mutea *et al.,* 2020). Therefore, farmer-friendly agricultural innovation platforms support farmer households' income and food security (Mdemu *et al.,* 2020).

The goal of an integrated farm business management pattern is to optimize each actor's potential (resources) in order to enhance food production and generate value for individual farmers and fishermen as well as for groups of farmers and fishermen or the community. Additionally, the development of food security can be steered in a sustainable direction with an emphasis on technological advancement and innovation. To increase productivity, it is important to upgrade the crop farming system, post-harvest handling, food processing and distribution handling (Wasino *et al.,* 2017). Enhancing the possibility for diversification is intended to increase smallholder farmers' access to food and their standard of living (MacLaren *et al.,* 2022). Therefore, it is necessary to improve agricultural practices such as diversification of crops and improvement of extension services. However, such options will require the right eco-friendly technology in an environment that is possible both locally and nationally (Gwambene *et al.,* 2023) by water management and conservation strategy well (Hafif, 2016).

The ways in which household members negotiate and balance their preferences for resource allocation and as a result, the results of the household's food security, might vary depending on the decision-making structures in place. Therefore, household decision-making procedures must be carefully considered in programs that aim to alleviate food insecurity and other socioeconomic difficulties in such circumstances (Mohammed *et al.,* 2022). Thus, stronger forms of participation significantly impact food security

(Beyuo and Anyidoho, 2022). The extension service, on the other hand, is a very involved and comprehensive supporter, playing a significant role in promoting sustainable glutinous rice production and assisting in maintaining local culture and food security (Sattaka *et al.,* 2017).

CONCLUSION

Energy consumption, which evaluates the percentage of household food spending in situations of food insecurity, determines the level of food security for the homes of organic rice farmers. The age of the family head, education level, non-farming income and food spending are all factors that have an influence on the food security of households of organic rice farmers in Sleman Regency. Age, the size of the family and food spending all affect food security when evaluated from the energy adequacy level.

By enhancing the integrated agricultural system in local varieties, boosting the application of conservation technology and expanding sustainable market access, efforts can be made to increase family food security through organic agriculture. Therefore, a comprehensive study of the supply chain aspects of organic rice marketing is needed which can be a reference for strategies for developing the organic rice market.

Conflict of interest

All authors declare that they have no conflicts of interest.

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