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Article

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Suggested Citation: Ho, Tien D. N.; Tsusaka, Takuji W.; Kuwornu, John K. M.; Lam, Lan M. T.; Vu, Thuong T. (2024) : Does livelihood capital influence the livelihood diversification strategies of smallholder rice farmers? Evidence from the Mekong Delta of Vietnam, Cogent Economics & Finance, ISSN 2332-2039, Taylor & Francis, Abingdon, Vol. 12, Iss. 1, pp. 1-25, https://doi.org/10.1080/23322039.2024.2397456

This Version is available at:
https://hdl.handle.net/10419/321582

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ISSN: 2332-2039 (Online) Journal homepage: www.tandfonline.com/journals/oaef20

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To cite this article: Tien D. N. Ho, Takuji W. Tsusaka, John K. M. Kuwornu, Lan M. T. Lam & Thuong T. Vu (2024) Does livelihood capital influence the livelihood diversification strategies of smallholder rice farmers? Evidence from the Mekong Delta of Vietnam, Cogent Economics & Finance, 12:1, 2397456, DOI: 10.1080/23322039.2024.2397456

To link to this article: https://doi.org/10.1080/23322039.2024.2397456

Published online: 06 Sep 2024.

COGENT ECONOMICS & FINANCE
2024, VOL. 12, NO. 1, 2397456
https://doi.org/10.1080/23322039.2024.2397456

DEVELOPMENT ECONOMICS | RESEARCH ARTICLE

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Does livelihood capital influence the livelihood diversification strategies of smallholder rice farmers? Evidence from the Mekong Delta of Vietnam

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ABSTRACT

Climate and other shocks threaten the livelihoods of rice farmers in Vietnam, forcing them to diversify their livelihoods. This study investigates the diversification strategies of rice farmers in the Mekong Delta of Vietnam. Based on 405 rice farming households in Tien Giang, Dong Thap, and Can Tho provinces, the results of the Hausman test showed that the four strategies, namely rice farming only, on-farm activities (rice farming and other farming activities), rice and non-farm activities, and on-farm and non-farm activities, were used in this study. A multinomial logit regression was used to measure the influence of rice farmers' livelihood capital on their adaptive strategies. The results show that human capital (gender, household size, dependency ratio), social capital (extension visits, cooperatives' membership), natural capital (farm size, land rent, access to water for farming), physical capital (distance to markets, distance to district capital), and financial capital (fixed asset, access to credit, and government support) are significant factors affecting households' diversification decisions. Intervention programs should encourage farmers, especially women, to participate in cooperative and extension visits to improve their skills, access to credit, and income opportunities.

IMPACT STATEMENT

Vietnamese rice households in the Mekong Delta are forced to diversify their sources of income due to the threat posed by climate change. The diversification tactics used by rice households in Vietnam's Mekong Delta are examined in this study. The Hausman test results, based on 405 rice households in the provinces of Tien Giang, Dong Thap, and Can Tho, indicated that four strategies were employed in this study: rice farming only, on-farm activities (rice farming and other farming activities), rice and non-farm activities, and on-farm and non-farm activities. The impact of livelihood capital on the adaptive strategies of rice farmers was assessed using a multinomial logit model. The findings showed that all major forms of capital—financial, social, physical, and natural—play substantial roles in influencing households' decisions to diversify. In order to increase farmers' skills, credit availability, and income prospects, intervention programs should urge farmers—especially women farmers—to take part in cooperative and extension visits.

ARTICLE HISTORY
Received 29 March 2024
Revised 28 June 2024
Accepted 13 August 2024

KEYWORDS
Rice, livelihood capital; Mekong Delta; Hausman test; multinomial logit regression

SUBJECTS
Development Studies; Rural Development; Environment & the Developing World; Economics; Environmental Economics

1. Introduction

According to previous studies, livelihoods are a means of living, involving a combination of necessary capital, activities, and choices, including the development of portfolio of income-generating strategies that households select to meet living standards, self-insurance, and reduce risks (Asravor, 2018; Barrett

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et al., 2001a, 2001b; Ellis, 2000; Loison & Loison, 2016; Roy & Basu, 2020; Scoones, 1998, 2009; Tong et al., 2024). Livelihood capital includes stock of human, social, natural, physical, and financial capitals that are significant in coping with the stresses caused by social, economic, and environmental events. Each household has different access to livelihood capital or assets that are vital for its survival and resilience to all stresses (Chambers & Conway, 1991; The Department for International Development (DFID), 1999; Ellis, 2000). Poor and small-scale rice farmers may diversify their income sources by adopting crop diversification, raising livestock, or engaging in nonfarm work (Albore, 2018; Amevenku et al., 2019; Phung & Hermann, 2009; Tizazu et al., 2018). Generally, it refers to a combination of both agricultural and non-agricultural activities to not only persist but also upgrade the living standard (Roy & Basu, 2020). By providing alternatives, livelihood diversification helps farmers reduce their dependence on natural resources and decrease the adverse effects of climate change (Ho et al., 2022a, 2022b; Roy & Basu, 2020). In developing countries, livelihood diversification is beneficial for reducing risks, enhancing resilience, ensuring food security, lowering rural poverty, improving livelihood sustainability, and promoting regional sustainable development (Dai et al., 2020; Roy & Basu, 2020; Tong et al., 2024).

As one of the world's top rice producers and exporters, Vietnam suffers adverse impact of changing climate, according to the General Statistics Office of Vietnam (GSO) (2024). The Mekong Delta (MD) is the largest in Vietnam, and the rice area occupies approximately 47% of the MD, contributes 56% of the national rice production, and rice exports from the whole region account for 90% of the total rice productivity (General Statistics Office of Vietnam (GSO), 2024). Most households in rural areas are small-scale farmers and mainly depend on agriculture for their livelihoods, especially rice farming activities. However, agricultural activities of rice farmers are highly dependent on the climatic conditions (General Statistics Office of Vietnam (GSO), 2024; Nguyen, 2021). Climatic shocks have caused negative effects on household livelihoods in this area, especially in smallholder farming households (Nguyen, 2021; Ho et al., 2022a, 2022b; Tong et al., 2024; General Statistics Office of Vietnam (GSO), 2024). Numerous natural disasters, such as storms, floods, sea-level rise, droughts, and salinity intrusion, have caused serious risks to their livelihoods. Each year, thousands of hectares (ha) of cash crops are damaged; hundred thousand cattle and poultry die; and thousands of houses collapse (General Statistics Office of Vietnam (GSO), 2024). Farmers are forced to diversify their agricultural activities to cope with climate-driven hazards. Considering the potential of climatic shocks, which occur frequently in the MD, farmers need to make decisions based on their capacity to adapt to the impact of different kinds of shocks (Vietnam Chamber of Commerce and Industry (VCCI), 2020; Nguyen, 2021; General Statistics Office of Vietnam (GSO), 2024).

The Vietnamese Government also emphasizes the promotion of livelihood diversification by farmers in the MD to adapt to climate change, especially in the field of agricultural reform, shifting towards increasing seafood and fruit while reducing rice (General Statistics Office of Vietnam (GSO), 2024; Nguyen, 2021). Popular upland cash crops include maize, mung bean, sugar cane, tubers (e.g. sweet potato, yam), and fruit trees (e.g. dragon fruit, mango, durian, pineapple, jackfruit, and coconut). In fact, those cash crops generate higher income than rice monoculture (Nguyen, 2021). To date, the MD is the largest fruit growing area, accounting for 34.5% of the entire country (Vietnam Chamber of Commerce and Industry (VCCI), 2020; Nguyen, 2021). However, the transformation activities of rice farmers to diversify their livelihood are carried out in different ways, including on-farm, off-farm, and non-farm work. Therefore, understanding the current situation of diversification in the MD may help policymakers identify proper strategies for households in the study area and assess the factors that should be promoted to enhance the benefits of livelihood diversification strategies.

In the context of the MD, some studies have been conducted to investigate the determinants of livelihood strategies of rice farming households (Ho et al., 2022a, 2022b; Tran et al., 2018; 2020). In addition, several studies have focused on farmers' decisions regarding adoption of adaptation strategies (Ghyselinck, 2013; Jiao et al., 2020; Waibel et al., 2018). Most of the studies were based on rural communities in Africa, such as Ghana, Nigeria, Ethiopia, and Malawi (Albore, 2018; Alhassan et al., 2019; Teshome and Anshiso, 2019; Mumuni & Oladele, 2016; Tizazu et al., 2018); a few studies were in Asia (Dai et al., 2020; Ding et al., 2018; Roy & Basu, 2020; Sujakhu et al., 2018; Tong et al., 2024; Zeng et al., 2018); and very few in Southeast Asia (Ghyselinck, 2013; Ho et al., 2022a, 2022b; Jiao et al., 2020; Phung & Hermann, 2009; Waibel et al., 2018). Besides, most current research emphasizes a certain characteristic of farmers that affects their implementation decision-making. It has been observed that households' characteristics, including gender, dependency ratio, access to credit (Abera

et al., 2021; Shan & Ahmed, 2020), age, educational level (Abera et al., 2021; Roy & Basu, 2020; Shan & Ahmed, 2020), number of family labors, social network, and government aid (Roy & Basu, 2020), farming experience (Akhtar et al., 2019), technical support, financial assistance, and household assets (Afodu et al., 2020; Ho et al., 2022a, 2022b), land size and market distance (Abera et al., 2021), extension services (Zakaria et al., 2019) have a significant impact on the adoption of livelihood diversification.

Recent studies have indicated that the five types of capital also play an essential role in promoting climate change adaptation and mitigation by farmers (Tong et al., 2024; Tran et al., 2022). However, these studies categorize farmers' production behaviors to investigate the various impacts of livelihood capital from the perspective of agricultural production factors, including seed, fertilizer, pesticide, soil, and water (Tong et al., 2024). Thus, our primary focus is on investigating the key factors to discover the potential impacts of household capitals on the adoption of livelihood diversification. Using econometric techniques, this study fills the gap in the existing literature by examining the effects of livelihood capital of rice producers on the choice of livelihood diversification in the MD of Vietnam. In particular, it will be useful for policymakers to construct regional and national projects for sustainable development in the MD of Vietnam.

2. Materials and methods

2.1. Study area

The study was conducted in certain provinces in Southwest of Vietnam, known as the Mekong Delta (MD). The delta has flat topography with a coastline of 700 km and is affected by the monsoon climate. Thus, many areas in the MD are inundated during the rainy season, whereas some areas are exposed to drought and salinity intrusions during the dry season. Owing to the effects of the El Niño phenomenon, many areas of the MD face increasingly severe climatic events, resulting in land degradation, crop failure, and loss of net income (Vietnam Chamber of Commerce and Industry (VCCI), 2020; General Statistics Office of Vietnam (GSO), 2024). As unpredictable climatic changes occur, rice production faces water shortages, especially during the spring-autumn crop (Ho et al., 2022a, 2022b; Nguyen et al., 2020; Tran et al., 2020).

In order to analyze differences in livelihood diversification of smallholder rice farmers in the context of various ecological conditions in the MD, a household survey was conducted in three provinces in the MD (i.e. Tien Giang province, Dong Thap province, and Can Tho province), representative of various specific socio-economic conditions. These three provinces were selected for this study because of their significant volume of rice production (Figure 1) (General Statistics Office of Vietnam (GSO), 2018/2022; Ho et al., 2022a, 2022b).

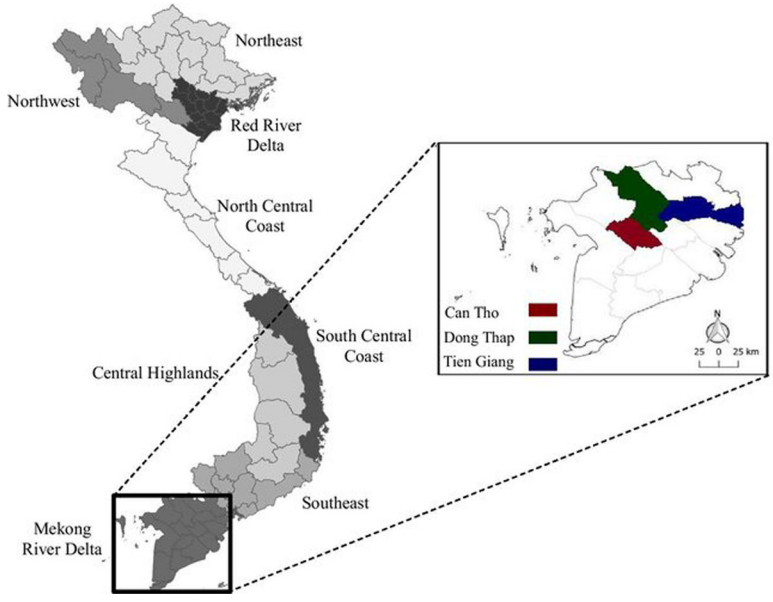

Figure 1. Tien Giang province, Dong Thap province and Can Tho province in the Mekong Delta Region of Vietnam.
Source: Adapted from Ho et al. (2022a).

2.2. Sampling technique and data collection

A structured questionnaire was used for conducting the survey in the study sites (see Appendix A). In this study, there were several criteria for the selection of participants. First, participants were heads of rice farming households. In case the household heads were absent, their spouses were employed for the interview. Second, their age must be at least 18 years old. Third, they participated voluntarily to provide adequate information during the interview and the consent to research activities. Before conducting the household survey, the data collection instrument was approved by the Research Ethics Review Committee of authors' institution.

Following that, a pilot survey was conducted from November to December 2019 in the three provinces. Based on the suggestions from the participants, the questionnaire was modified to improve clarity and be more friendliness to the participant. The survey was conducted from June 2020 to January 2021.

Table 1 presents the sample distribution across the selected districts.

The respondents were selected using a multi-stage sampling method. First, three provinces were selected to represent the various ecological conditions. Second, two districts were selected from each of the Tien Giang and Can Tho provinces, whereas three districts were selected from the Dong Thap province because of the high population of rice farmers in these districts. Third, a proportional simple random selection was conducted to select 400 smallholder rice farmers for the study.

Adapting the formula by Yamane (1967), the sample size was determined as follows:

$$n = \frac{N}{1 + N(e^2)} = \frac{350,018}{1 + 350,018(0.05)^2} = 400 \quad (1)$$

where n is the sample size, N is the population, and e is the margin of errors ($e = 5\%$).

In total, 405 responses were used for data analysis, implying a margin of error of less than 5%.[1]

2.3. Methods of analysis

Both descriptive statistics and econometric analysis were used to analyze the data. Initially, the socioeconomic characteristics of rice farmers were presented using minimum, maximum, mean, percentages, and standard deviation. Furthermore, this study employed a multinomial logit model (MNL) to examine the effects of livelihood capital on the choice of livelihood strategies.

This study adopted the random utility model as its theoretical framework (Greene, 2003). It is assumed that the household heads choose among different strategies to obtain maximum utility (Amevenku et al., 2019; Doyo et al., 2018; Ho et al., 2022b; Kuwornu et al., 2014). Greene (2003) indicates that utility includes observed and unobserved components, specified as follows:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (2)$$

where U_{ij} denotes the utility of the i^{th} household choosing alternative j ($j = 1$: rice farming only, $j = 2$: on-farm activities, $j = 3$: rice farming and non-farm activities, $j = 4$: rice farming, other farming activities, and non-farm activities … J), V_{ij} denotes the deterministic component of the utility, and ε_{ij} denotes the random component of the utility.

Following Greene (2003) and Kuwornu et al. (2014), the probability of smallholder rice farmers' choice of strategies is assumed to be a function of five types of capital: human, social, natural, physical, and financial capital. Thus, the MNL model is specified as

Table 1. Sample size determination for the study.

Provinces	Population	Proportional sample	Districts	Sample size
Tien Giang	122,845	(122,845/350,018)*400 = 140	Cai Be	70
			Go Cong	74
Dong Thap	156,679	(156,679/350,018)*400 = 179	Chau Thanh	46
			Thanh Binh	90
			Thap Muoi	43
Can Tho	70,494	(70,494/350,018)*400 = 81	Co Do	37
			O Mon	45
Total	350,018	400		405

$$Pr(Y_i = j) = \frac{exp(\beta_j' X_i)}{\sum_{j=0}^{J} exp(\beta_j' X_i)} \text{ for } j = 1, 2, 3, \ldots J \quad (3)$$

where $Pr(Y_i = j)$ is the probability of choosing one of the livelihood strategies j, β_j' is a vector of explanatory factors of the j^{th} option, β_j is a vector of the parameters to be estimated.

The base category was used to compare other choices by restricting the parameters of the base category to zero ($\beta 1 = 0$). Option 1 ($j = 1$: Rice farming only) was used as the base category. To eliminate indeterminacy in the model, a convenient normalization method that solves the problem is β_0=0. Therefore, the general form of the probability that the household i^{th} chooses alternative j^{th} is specified as follows:

$$Pr(Y_i = j|X_i) = \frac{exp(\beta_j' X_i)}{\sum_{j=0}^{J} exp(\beta_j' X_i)} \text{ for all } j > 0 \quad (4)$$

Therefore, the choice of any strategy is log-odds in relation to the base alternative (rice farming only). According to Greene (2003), the coefficients of MNL are difficult to interpret, and marginal effects are usually derived to explain the effects of the independent variables on the dependent variable in terms of probabilities. The marginal effects were derived as follows:

$$\theta_j = \frac{\partial P_j}{\partial X_j} = P_j \left[\beta_j - \sum_{j=1}^{J} P_j \beta_j \right] = P_j \left[\beta_j - \overline{\beta} \right] \quad (5)$$

Marginal effects measure the expected change in the likelihood of choosing a particular diversification strategy with respect to a unit change in an explanatory variable, given the base strategy (Greene, 2003). The overall significance of the model was measured using the likelihood ratio (LR) statistic. The maximum likelihood method was used to estimate these parameters. Following Greene (2003), the model was tested for the validity of Independence from IIA, which is also based on the assumption that the disturbance term is independent and homoscedastic. Given the four alternative choices (rice farming only, rice farming and other farming activities (i.e., on-farm activities), rice farming and non-farm activities, and on-farm and non-farm activities), the Hausman test was applied to test the IIA assumption in this study. The IIA assumption suggests that the probability ratio of smallholder farmers choosing among the four strategies does not depend on the availability of other alternatives. Besides, the seemingly unrelated post-estimation procedure (SUEST), and the Small-Hsiao tests are used to diagnose the model for the validity of the independence of the irrelevant alternatives (IIA) assumptions. Moreover, the variance inflation factor (VIF) value of the independent variables was generated to check for the multicollinearity problem (Hoq et al., 2022). STATA version 17 was used to analyze the data.

Table 2 presents the variables, definitions, measurements, a priori expectations, and the relevant literature.

3. Results and discussion

3.1. Socio-demographic characteristics of rice farmers in the MD

Table 3 presents the socioeconomic characteristics of the sampled smallholder rice farmers in the study area. The results showed that approximately 89% of the household heads were male. All household heads had formal education; however, approximately 67% of the household heads had completed secondary school or above. Approximately 12% of the rice farmers were members of agricultural cooperatives. Most households (87%) had adequate access to water sources for agricultural activities, and only a few households reported that they lacked water for farming during the dry season (March–April). Approximately 11% of the households reported that they needed to rent land for agricultural activities. Most of the smallholder rice farmers possessed small landholdings with an average farm size of 1.14 ha, whereas the minimum and maximum values were 0.1 ha and 13 ha. Only approximately 18% of the households had access to credit.

Household membership ranged from two (2) persons to ten (10) persons, while the number of dependent members within the sampled households ranged from zero (0) to four (4). The average

Table 2. Definition of variables, explanation, measurement scale, expected sign, and relevant literature.

Variable	Definition	Measurement scale	A priori expectation	Relevant literature
Human capital				
Gender	Sex of household head	Dummy variable: 1 = Male; 0 = Female	+/−	Jansen et al. (2007); Asravor (2018)
Household size	Number of persons in the households	Persons	+	Asravor (2018); Amevenku et al. (2019); Asravor (2018)
Dependency ratio	Ratio of dependent household members (members > 65 years old and members < 18 years old) to independent household members	Ratio	+	Jansen et al. (2007); Amevenku et al. (2019)
Farming experience	Years of rice farming	Years	+	Amevenku et al. (2019); Mumuni and Oladele (2016)
Education	Level of education	Dummy variable: 1 = Secondary school or above; 0 = Otherwise	+	Ding et al. (2018); Amevenku et al. (2019)
Social capital				
Extension visits	Agricultural extension visits per years	Number of times	+	Asravor (2018); Amevenku et al. (2019)
Cooperative membership	Participation of the household in cooperatives	Dummy variable (1 = yes, 0 otherwise)	+	Ding et al. (2018); Manlosa et al. (2019); Dinku (2018)
Natural capital				
Farm size	The total agricultural area for farming	Ha	+	Manlosa et al. (2019); Dinku (2018)
Access to water for farming	Availability of water source for farming	Dummy variable (1 = yes, 0 otherwise)	+	Mumuni and Oladele (2016), Jiao et al. (2020)
Land renting	Payment for land if rented	Dummy variable (1 = yes, 0 otherwise)	+	Mumuni and Oladele (2016); Asfaw et al. (2019)
Physical capital				
Distance to district capital	Distance of district capital from their residence	Km	−	Phung and Hermann (2009); Amevenku et al. (2019)
Distance to market	Distance of market center from their residence	Km	−	Asravor (2018); Amevenku et al. (2019)
Financial capital				
Fixed asset	Fixed asset of household	USD 1,000	+	Ding et al. (2018); Asravor (2018); Asfaw et al. (2019)
Access to credit	Access to formal credit by household	Dummy variable (1 = yes, 0 otherwise)	+	Ding et al. (2018); Manlosa et al. (2019); Amevenku et al. (2019)
Government support	Time of receiving support per year from government	Number of times	+	Gebru and Beyene (2012); Dinku (2018); Dai et al. (2020)

Table 3. Socio-demographic and economic characteristics of rice farming households.

Variable	Percent	Mean	Min	Max	SD
Gender (1 = Male; 0 = Female)	88.64				0.32
Education (1= Secondary school or above; 0= Otherwise)	66.67				0.47
Cooperative membership (1 = yes, 0 otherwise)	11.85				0.32
Access to water (1 = yes, 0 otherwise)	87.16				0.33
Land renting (1 = = yes, 0 otherwise)	11.11				0.31
Access to credit (1 = yes, 0 otherwise)	17.78				0.38
Household size (Persons)		4.15	2	10	1.20
Dependency ratio (Ratio)		0.33	0	4	0.46
Farming experience (Years)		27.11	1	60	11.23
Extension visits (Times)		7.47	0	90	19.98
Farm size (Ha)		1.14	0.1	13	1.28
Distance to district capital (Km)		8.72	1	30	4.81
Distance to market (Km)		1.76	0	9	1.66
Fixed asset (USD 1,000)		5.83	0.00	35.18	2.24
Government support (Times)		0.75	0	12	2.32

Source: Authors' computation from household survey (2019).

farming experience of the rice farming household heads was approximately 27 years. The average number of agricultural extension visits to rice farming households was approximately seven (7) times per year. Most households lived far away from the district capital, but others lived near the market at an average distance of 8.72 km and 1.76 km, respectively. The average value of fixed asset was approximately USD 5,830. Some poor households had no fixed asset. Some households received a monthly remittance approximately once, while others did not.

3.2. Livelihood strategies of rice farmers in the MD

The Hausman test was employed to check the IIA assumptions by omitting each of the strategies (rice farming and other farming activities (i.e., on-farm activities), rice farming and non-farm activities, and on-farm and non-farm activities), whereas 'rice farming only' is the base. Additionally, the seemingly unrelated post-estimation procedure (SUEST), and the Small-Hsiao tests were used to diagnose the model for the validity of the IIA assumptions (Hoq et al., 2022).

In Table 4, the Chi-square was 2.36 (p-value = 1.000) for the test excluding the last category, namely, on-farm and non-farm activities, and this does not satisfy the IIA assumption, whereas the results of excluding other categories satisfied the IIA assumption. Under the IIA assumption, we would expect no systematic change in the coefficients if we excluded one of the outcomes from the model (Table 4).

In Tables 5 and 6, the tests accept the null hypothesis of the independence of the livelihood strategy choice options, indicating that the MNL specification is appropriate to livelihood diversification strategy options practices by the household. It was evident from the Chi-square value ranging from 19.175 to 24.397 in the case of SUEST-based Hausman tests (Table 5), and the Chi-square value ranging from 46.993 to 63.769 in the case of Small-Hsiao tests (Table 6), which indicates there is no evidence that the IIA assumption was violated.

The VIF value of the independent variables was less than the critical value of VIF (10) which justifies that there is no severe multicollinearity among the variables (Table 7) (Hoq et al., 2022).

Primary data from 405 smallholder farmers was used for the test. After dropping the dataset of 49 smallholder rice farmers who adopted 'on-farm and non-farm activities' as a livelihood strategy, there was no evidence that the IIA assumption had been violated. Finally, the entire data from the 356 observations was used for the final estimation of the MNL regression model. Thus, the model includes three

Table 4. Hausman test of independence of irrelevant alternatives (IIA) assumption (N = 405).

Omitted	Chi-square	p-value
Rice farming only	−39.830	–
On-farm activities	−4.95	–
Rice farming and non-farm activities	−4.32	–
On-farm and non-farm activities	2.36	1.0000

Ho: Odds are independent of other alternatives.

Table 5. SUEST-based Hausman tests of IIA assumption (n = 405).

Omitted	Chi-square	p-value
Rice farming only	24.397	0.830
On-farm activities	19.762	0.955
Rice farming and non-farm activities	20.203	0.948
On-farm and non-farm activities	19.175	0.964

Ho: Odds are independent of other alternatives.

Table 6. Small-Hsiao tests of IIA assumption (n = 405).

Omitted	lnL(full)	lnL(omit)	Chi-square	p-value
Rice farming only	−107.524	−79.056	56.935	0.004
On-farm activities	−154.340	−122.455	63.769	0.001
Rice farming and non-farm activities	−133.850	−110.353	46.993	0.042
On-farm and non-farm activities	−156.396	−131.356	50.078	0.022

Ho: Odds are independent of other alternatives.

Table 7. Multicollinearity test for the independent variables.

Variable	VIF	1/VIF
Gender (1 = Male; 0 = Female)	1.10	0.908
Household size (Persons)	1.23	0.812
Dependency ratio (Ratio)	1.16	0.861
Farming experience (Years)	1.32	0.757
Education (1= Secondary school or above; 0= Otherwise)	1.15	0.869
Extension visits (Times)	1.44	0.694
Cooperative membership (1 = yes, 0 otherwise)	1.23	0.815
Farm size (Ha)	1.18	0.845
Land renting (1 = yes, 0 otherwise)	1.15	0.872
Access to water (1 = yes, 0 otherwise)	1.12	0.893
Distance to market (Km)	1.61	0.621
Distance to district capital (Km)	1.50	0.666
Fixed asset (USD 1,000)	1.39	0.718
Access to credit (1 = yes, 0 otherwise)	1.63	0.613
Government support (Times)	1.14	0.878
Mean VIF	1.29	

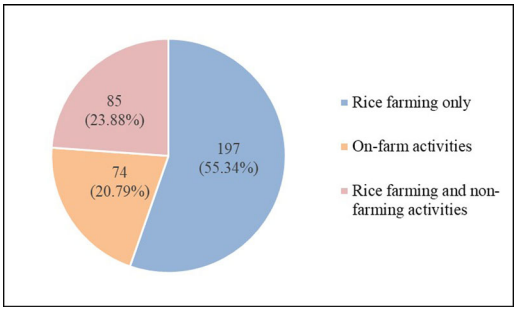

Figure 2. Livelihood strategies of rice farmers in the MD.
Source: Authors' survey in 2021.

categories: rice farming only (i.e. the base category), rice farming and other farming activities (i.e. on-farm activities), and rice farming and non-farming activities.[2]

In Figure 2, there are three groups of livelihood diversification strategies adopted by smallholder rice farmers to achieve their livelihood outcomes. The results showed that the rice farmers whose intensification strategy was adopted by more than half of the sample size (55.34%), followed by rice farming and non-farming activities (23.88%), rice farming and other farming activities (i.e., on-farm activities) (20.79%).[3]

Besides rice farming, other farming activities of households include growing other crops, (like maize, yam, sweet potato, and beans) and raising livestock (cows, goats, pigs, chickens, and ducks). On-farm activities have been adopted by implementing rotation of rice and upland crops (maize or mung bean) to improve soil quality and fertility and to allow farmers for diversifying their products (Ghyselinck, 2013). Households often keep some of their products for their own consumption and sell the remaining (Debele & Desta, 2016). Non-farm strategies include selling foods, handicrafts, or offering labor services. Other households that graduated from secondary school or above earned a monthly salary by working at a local factory or an organization. Non-farm activities have the potential to help farming households reduce their poverty levels by reducing the need for land due to limited natural resources and environmental degradation (Kassie, 2017).

3.3. Choice of livelihood strategies of rice farmers in the MD

Table 8 presents the coefficients, standard errors, marginal effects, and corresponding *p*-values estimated from the MNL regression. The overall model was highly significant, as indicated by the likelihood ratio test chi-square statistic of 166.02, implying that the model is a good fit for the dataset. The results indicated that out of the 15 explanatory variables included in the model, 13 were significant at the 1%, 5%, and 10% significance levels.

Table 8. Multinomial logit regression estimates of choice of livelihood strategy by smallholder rice farmers in the MRD of Vietnam.

Explanatory variables	Rice farming and other farming activities (On-farm activities)				Rice farming and non-farm activities			
	Coefficient	Standard error	Marginal effects	*p*-value	Coefficient	Standard error	Marginal effects	*p*-value
Gender (1 = Male; 0 = Female)	1.3647***	0.6801	0.1151	0.002	−0.1962	0.4380	−0.0570	0.450
Household size (Persons)	−0.0705	0.1539	−0.0157	0.384	0.2845**	0.1334	0.0445	0.021
Dependency ratio (Ratio)	0.6965***	0.3301	0.1359	0.001	−2.0728***	0.5935	−0.3292	0.000
Farming experience (Years)	0.0088	0.0159	0.0006	0.740	0.0170	0.0164	0.0023	0.335
Education (1= Secondary school or above; 0= Otherwise)	−0.1174	0.3696	−0.0165	0.708	0.0900	0.3285	0.0164	0.727
Extension visits (Times)	0.0352***	0.0100	0.0053	0.000	−0.0428***	0.0204	−0.0073	0.009
Cooperative membership (1 = yes, 0 otherwise)	1.9695***	0.5768	0.3488	0.005	0.3481	0.6262	−0.0387	0.593
Farm size (Ha)	−1.1294***	0.3172	−0.1215	0.000	−0.5163*	0.2010	−0.0488	0.095
Land renting (1 = yes, 0 otherwise)	−1.4483***	0.7808	−0.1110	0.008	−0.3992	0.5422	−0.0338	0.633
Access to water (1 = yes, 0 otherwise)	0.7116	0.4870	0.1279	0.136	−0.9118**	0.5620	−0.1230	0.011
Distance to market (Km)	−0.0123	0.1247	0.0076	0.594	−0.3550***	0.1226	−0.0530	0.004
Distance to district capital (Km)	−0.0350	0.0475	−0.0071	0.194	0.1144***	0.0385	0.0181	0.002
Fixed asset (USD 1,000)	0.0702**	0.0285	0.0074	0.020	0.0399	0.0287	0.0042	0.301
Access to credit (1 = yes, 0 otherwise)	1.3254*	0.5324	0.1529	0.089	1.0609	0.5001	0.1257	0.167
Government support (Times)	−0.1930**	0.0838	−0.0241	0.015	0.0432	0.0690	0.0114	0.263
	Regression Diagnostics							
Number of observations	356							
LR $\chi^2(30)$	166.02 (*p*-value = 0.0000)							
Pseudo R^2	0.2341							
Log likelihood	−271.5463							

Note. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

The results showed that, compared to households in the base category (rice farming only), the household head being male had a positive effect on the probability of farmers' choice of on-farm activities by 11.51% points. This indicates that male-headed households are more likely to adopt on-farm activities than female-headed households. This is likely because female-headed households are less adaptive than male-headed households as they lack access to livelihood strategies and resources than male-headed households (Alhassan et al., 2019; Sujakhu et al., 2018).

Household size had a positive effect on farmers' choices of rice farming and non-farming activities. Specifically, an increase in household size by one member increased the probability of engaging in rice farming and non-farming activities by 4.45% points. This is possibly because large families have abundance of labor force and more opportunities to engage in non-farm work, unlike small-sized families, who have limited members and need to focus on rice farming only (Amevenku et al., 2019; Anshiso & Shiferaw, 2016; Asravor, 2018).

The dependency ratio had a positive effect on farmers' choice of on-farm activities, as an increase in the dependency ratio by one significantly led to a rise in the probability of engaging in on-farm activities by 13.59% points and a negative effect on farmers' choice of rice farming and non-farm activities as the probability of adoption of rice farming and non-farm activities decreased by 32.92% points. A possible explanation is that families need to pay for the expenses for dependent members, such as education for those who are less than 18 years old and health care services for those who are greater than 65 years old, though they do not contribute much to the family income. Owing to the characteristics of rice farming activities, dependent members can partially fulfill household needs by performing some of the activities on the farm, whereas they cannot engage in some non-farm activities because of the limitations of their age and health (Amevenku et al., 2019; Anshiso & Shiferaw, 2016).

Extension visits had a positive effect on diversification into on-farm activities (i.e. a 0.53% point increase in probability) and a negative effect on rice farming and non-farm activities (i.e. a 0.73% point decrease in probability). This might be because the information and knowledge provided by the agricultural extension visits may equip rice farmers to diversify farming activities in a bid to mitigate the effects of natural disasters (e.g. flood and drought). In most cases, rice farming households with access to agricultural extension visits have a higher tendency to adopt new agricultural technologies to improve their farm output and rice farming intensification than those with less access to extension visits. It is possible that most extension services offered by government agencies to farmers focus on technical training on general production practices rather than providing information and knowledge to engage in non-farm activities (Amevenku et al., 2019; Asravor, 2018; Ghimire et al., 2014).

Membership in farmer organizations had a positive influence on farmers' choice of on-farm activities. This indicates that participating in an agricultural cooperative increases the likelihood of engaging in on-farm activities by 34.88% points. This is may be because farmers' cooperation is considered one of the most popular channels for transferring information to farmers, especially those who live in rural areas. Hence, farmers who are members of cooperatives may share and learn agricultural techniques to produce and market their crops (Ghimire et al., 2014).

Farm size had negative effects on farmers' choices of both on-farm and non-farm activities. Specifically, an increase in farm size by 1 ha reduces the probability of participation in on-farm activities by 12.15% points. The farm size increase by 1 ha decreased the likelihood of choosing rice farming and non-farming activities by 4.88% points. These results imply that households with larger farms preferred to adopt rice intensification compared to relatively smaller farms. This might be because farmers possessing larger landholdings produce larger quantities for the market at a better price than those with smaller landholdings and small quantities. Therefore, farmers with large landholdings can derive enormous financial benefits by engaging in rice farming alone (i.e., Ghimire et al., 2014; Kuwornu et al., 2014; Anshiso & Shiferaw, 2016).

Land rental had a negative effect on farmers' choice of on-farm activities. This indicates that smallholder rice farmers who paid for rented land for agricultural activities were 11.10% points less likely to engage in on-farm activities. This might be because farmers often rent land for rice farming to take advantage of economies of scale, such as reducing the costs of buying farm inputs, renting machines, and transaction costs. Therefore, they preferred to engage in rice monoculture and were less likely to diversify into other farming activities (Zeng et al., 2018).

The findings also showed that access to water had a negative effect on farmers' choices of rice farming and non-farming activities. The marginal effect indicates that farmers who had access to water were 12.30% points less likely to engage in rice farming and non-farming activities. This might be because rice cultivation requires a large amount of water, and if farmers have water source availability, they are more likely to engage in rice farming only to increase crop yields and net profit (Faurès & Santini, 2008; Mumuni & Oladele, 2016). According to Jiao et al. (2020), households in Cambodia who had better access to water preferred to adopt on-farm strategies, such as changing crop varieties and crop types, to mitigate risks from climatic events and the market.

Distance to the market had a negative effect on farmers' choice of rice farming and non-farming activities. A one km increase in the distance to the market led to a 5.30% points decrease in the likelihood of participation in rice farming and non-farming activities. This is because households who live far away from the market may lack good road and transport services; therefore, they must pay relatively higher transport costs to convey their products to the market than those who live closer to the market. Furthermore, due to the poor transportation system to other communities, farmers had fewer opportunities to engage in non-farm activities. Moreover, a long distance to the market leads to weight loss or damage to the product and reduced market prices. This result is consistent with that of previous research (Dinku, 2018; Ghimire et al., 2014; Tizazu et al., 2018).

Distance to district capital had a positive effect on farmers' choice of rice farming and non-farming activities. An increase by one km in distance to district capital led to an increase in the likelihood of participation in rice farming and non-farming activities by 1.81% points. This is presumably because farmers in the study area practice rice farming and other on-farm work in the village, from which they derive their main income. To generate higher income, they have a strong preference for doing business or working for companies in urban areas that are far from their homestead. This is in line with the results of a previous study by Pal (1999). However, Phung & Hermann (2009) found that households in Dak Lak or Ha Tinh province in Vietnam, living far from the district capital, are less diversified than other households living in Hue province, where the level of urbanization is higher and highly concentrated in tourism.

Fixed asset had a positive influence on the choice of on-farm activities. An increase in the value of fixed asset led to an increase in the ikelihood of participation in on-farm activities by 0.74% points. This may be because more physical asset is required for farming activities, such as farm inputs including tractors, combine harvesters, and tillers. Compared to poor households, wealthier households play an active role in on-farm activities because the high-liquidity fixed asset items can be changed to cash when needed. This finding is supported by previous studies (e.g., Jiao et al., 2020; Makate et al., 2016). Jiao et al. (2020) found that wealthier households in Cambodia used their physical asset engaged in farming activities, whereas other households with smaller assets often adopted non-farm activities, such as doing small businesses or migration, due to a lower demand for the asset.

Access to credit had a positive influence on the choice of on-farm activities (rice farming and other farming activities). The marginal effect indicates that access to credit significantly increased the probability of households participating in rice farming and other farming activities by 15.29% points. Access to credit allows farmers to buy more agricultural input to improve crop yields. Therefore, households with better access to credit have better opportunities to generate higher income by practicing on-farm activities. Without credit, it is difficult for farmers to adapt to the stresses of climate change and variability because they are unable to buy essential inputs, such as drought-tolerant high-yielding seeds (Dinku, 2018; Jiao et al., 2020; Tizazu et al., 2018).

Government support had a negative influence on the choice of on-farm activities. Farmers who received support from the government were 2.41% points less likely to adopt on-farm activities. Government support through the provision of subsidized farm inputs and training on the use of these farm inputs enabled smallholder rice farmers to adapt to the effects of climate change and variability, thereby improving their livelihood. In the study area, farmers were encouraged by the government to adopt rice monoculture; thus, the government budgets for investment in rice farming, such as improved rice varieties, credit for small-scale irrigation, and free training courses to improve rice yield. According to Dai et al. (2020), subsidies provide an income source for many households, but they are out of smallholders' control and have negative impacts on the number of household activities.

4. Conclusion and recommendations

This study examined the effects of livelihood capital on smallholder rice farmers' choice of strategies in the MD of Vietnam. Data from 356 observations from three provinces in the MD: Tien Giang, Dong Thap, and Can Tho were used for the final estimation of the MNL model. The Hausman test of the IIA assumptions, the SUEST, the Small-Hsiao tests, and the multicollinearity test were used to diagnose the model. Three identified strategies adopted by rice producers in the MD were used for data analysis: rice farming only, on-farm activities (i.e., rice farming and other farming activities), and rice and non-farm activities.

The descriptive statistics showed that more than half of the respondents in the study area adopted rice farming only, while all households adopted diversification activities as part of their livelihoods besides rice farming. Many households had no fixed asset, while several households did not receive monthly remittances. The MNL regression revealed that gender, household size, dependency ratio, extension visits, cooperatives' membership, farm size, land rent, access to water for farming, distance to markets, distance to district capital, fixed asset, access to credit, and government support were the major factors affecting rice farming households' choice of livelihood strategies in the study area.

Based on these results, this study provides the following recommendations: First, owing to the positive effects of agricultural extension visits, future extension services should aim to improve farmers' knowledge and advanced techniques to improve their output and income. Second, local authorities and cooperatives should be concerned about providing support for non-farm activities and creating more opportunities for households to engage in both on-farm and non-farm activities. In particular, these programs should prioritize women, relatively larger families, and families with a high dependency ratio. It is imperative that the government take steps to improve road infrastructure to facilitate rural households' access to other communities in urban centers to enable them to access updated information, new technologies, and opportunities to undertake non-farm activities to improve their livelihoods.

The results of this study provide important information for researchers and policymakers working on the sustainable development of agriculture as well as rice farming communities in Vietnam. However, this study has some limitations. First, the three provinces selected for the study might not be representative of the entire MD with different topographical and cultural characteristics. Second, this study did not examine the costs and benefits of livelihood strategies. Therefore, replicating this study in other provinces in the MD and performing a cost-benefit analysis of livelihood strategies provide a great opportunity for future research. Third, the sampling technique must be strategy-wise, not district-wise; hence, future research should conduct the data collection according to the current strategy of farmers.

Notes

1. It is worth noting that 405 households were used for the preliminary analysis. This has the potential to improve the robustness and accuracy of the results. Nevertheless, due to the removal of some 49 observations based on the results of the Hausman test of independence of irrelevant alternatives (IIA) assumption, 356 samples were used for the multinomial regression analysis. Please see footnotes 2 and 3 for further details.
2. We conducted a power test for the sample size of 356 used for the MLN regression analysis. The power test is used to reject the null hypothesis assumed that the null hypothesis is false. Given the intended sample size, we can derive the resulting power of the sample. Following Yamane (1967), the derived margin of error of the sample is 5.3% given the sample size of 356 rice farming households used for the MNL regression analysis. This implies that we are 94.7% confident in the results obtained from the sample. Therefore, the sample is highly representative, and the results can be generalized for the population of rice farming households in the selected provinces in the MD of Vietnam.
3. The result of the Hausman test of independence from irrelevant alternatives (IIA) led to the removal of the last category (i.e., on-farm and non-farm activities) from the multinomial logit regression model performed in the Methods of Analysis section of this paper.

Acknowledgments

The authors thank the assistance given by the staff members of Tien Giang University, Vietnam, who participated in field activities. The authors also acknowledge the respondents who passionately responded to questions associated with the survey.

Ethical consideration

The study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Review Committee at the Asian Institute of Technology, Thailand, with the reference code RERC 2019.

Consent statement

The consent was collected in a written form (see Appendix A).

Authors' contributions

Tien D. N. Ho: conceptualization, methodology, data collection, data curation, data analysis, interpretation, writing initial draft, revision; Takuji W. Tsusaka: conceptualization, methodology, data analysis, interpretation, revision; John K.M. Kuwornu: conceptualization, methodology, revision; Lan M. T. Lam: expert comments and suggestions, revisions; Thuong T. Vu: expert comments and suggestions, revision. All authors have read and agreed to the published version of the manuscript.

Disclosure statement

The authors declare no conflict of interest regarding the submission or publication of this manuscript.

Funding

This research was supported by the Asian Institute of Technology Vietnam's 25th Anniversary Scholarship (AITCV Silver Anniversary Scholarship).

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Data availability statement

The data that support the findings of this study are available from the corresponding author, [Tien D. N. Ho], upon reasonable request.

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Appendix A. Questionnaire for assessing livelihood vulnerabilities, resilience and strategies of rice farming households

Consent statement

We would like to interview you about your rice farming and related livelihood activities. The interview is being conducted by a student at Tien Giang University, Vietnam. As part of it we are asking many people all over the Mekong Delta Region to participate in the same interview. It is voluntary and the questionnaire is to solicit data to address the objectives of the study.

If you choose not to answer any of the questions, you are free to do so. If you decide to answer some or all of the questions, we will use the information gathered for academic purpose **ONLY** and will be accorded the highest degree of confidentiality, but people will be able to learn about aspects of the rice farming along the Mekong Delta Region, but not what you personally said. Hence, your cooperation and frank responses are welcomed. Do you agree to be interviewed?

(1) Yes (2) No.

SECTION A: General information

Question	Answer
A.1.Name of respondent	
A.2.Date	
A.3.Region	[1] Tien Giang [2] Dong Thap [3] Can Tho
A.4. District	[1] Cai Be [2] Go Cong [3] Chau Thanh [4] Thanh Binh [5] Thap Muoi [6] Co Do [7] O Mon [8] others
A.5. Village	
A.6.State number of rice seasons in the community of respondent	[1] One season [2] Two seasons [3] Three seasons [4] Not clear seasonality
A.7.How long have you stayed in this community?	
A.8.Name of respondent	
A.9.Address/House No. of Respondent	
A.10.Does respondent use Mobile Phone	[1] Yes [2] No
A.11.Contact Number	
* If the respondent is not household head, what is your relation to the head … … … … … … … ….	

SECTION B: Demographics

B.1. Age of head of household (respondent) ..... (Years.)

B.2.Gender:

[1] Male [2] Female

B.3.What is the size of your household (including yourself)? ..... persons

Number of household members (>18 years)		Number of Children members (<18 years)	
B.4. Males	**B.5.** Females	**B.6**. Males	**B.7**. Females

B.8. Household Composition (Please begin with the respondent and then proceed with other members)

			Education					
Household Member (HH headfirst)	Age	Relation to HH (Code A)	Highest Level attained (Code B)	Currently in school 1= yes 2 = no	Marital Status (Code C)	Occupation (Code D)	Religion (Code E)	Ethnic Group (Code F)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Code A: 1. Self (Respondent); 2. Spouse (Wife/husband) 3. Biological Child; 4. Grandchild; 5. Nephew/niece; 6. Sibling; 7. Stepchild; 8. Non-relative; 9. Adopted Child/Foster Child; 10. Other relative.

Code B: 1. No Schooling; 2. Primary; 3. Secondary high school; 4. High School; 5. Vocational/Technical; 6. College/University.

Code C: 1. Single; 2. Married; 3. Divorced; 4. Separated; 5. Widow/widower; 6. Engaged

Code D: 1. Rice farming; 2. Other crop farming; 3. Aquaculture activities (fish or shrimp farming);4. Livestock raising; 5. Trading/doing business; 6. Salaried worker/formal employment; 7. Farm laborer; 8. Student; 9. Remittances; 10. Unemployed; 11. Other (capital earnings, pension, rent etc.) …

Code E: 1. None; 2. Christian (Catholic and Protestant); 3. Buddhist; 4 Traditional; 5. Other .....

Code F: 1. Kinh; 2. Chinese; 3. Khmer

B.9.Indicate the type of occupation in rice sector of the head of household:

[1] Rice cultivating [2] Rice processing (frying, milling, etc.) [3] Rice wage earning (land preparation, fertilizing, harvesting, processing etc.) [4] Input dealer [5] Rice trading [6] others (state) .....

B.10. How many years has the head of household worked in this occupation? .....

B.11.What income generating activities are the head of household engaged in?

[1] Rice farming; [2] Other crop farming; [3] Aquaculture activities (fish or shrimp farming); [4] Livestock raising; [5] Trading/doing business; [6] Salaried worker/formal employment; [7] Farm wage; [8] Remittances; [9] Unemployed; [110] Other (capital earnings, pension, rent etc.)

B.12.How many years has the head of household worked in this secondary occupation? .....

B.13.How many members of your household besides you are earning income? .....

B.13b. What major income generating activity is the spouse (wife/husband) of head of household engaged in?

[1] Rice farming; [2] Other crop farming; [3] Aquaculture activities (fish or shrimp farming); [4] Livestock raising; [5] Trading/doing business; [6] Salaried worker/formal employment; [7] Farm wage; [8] Remittances; [9] Unemployed; [110] Other (capital earnings, pension, rent etc.)

B.13c. How many years has the spouse (wife/husband) of the head of household worked in this occupation? …^

B.14.Are there children **less than 18 years old** from other families living in your house (that is under your care) because one or both parents are dead? [1] Yes [2] No

If yes, please indicate number: .....

SECTION C: Livelihood strategies

C.1. How many people in the household go to different communities to work? ….
C.2. Does any member of this household engage in trading? [1] Yes [2] No.
C.3. Does any member of your household grow other crops? [1] Yes [2] No.
C.4. Does any member of your household grow fruit tree? [1] Yes [2] No.
C.5. Does any member of your household raise livestock? [1] Yes [2] No.
C.6. Does any member of your household engage in fish farming? [1] Yes [2] No.
C.7. Does any member of your household engage in shrimp farming? [1] Yes [2] No.

SECTION D: Health

D.1. Does your household have access to any health service? [1] Yes [2] No
D.2. If yes, what form of health service?
[1] Hospital [2] Clinic [3] Pharmacy/Chemical shop [4] Herbal centre
[5] Other (specify) .....
D.3. Which health facility do you visit most? .....
State number of times you visited it last year .....
D.4. How long (in minutes/hour) does it take you to get to this health facility? .....
D.5. Does anybody in your family get ill very often or chronically ill? [1] Yes [2] No
D.6. Has any of your family members been so sick in the past 2 weeks that they missed school or work? [1] Yes [2] No
D.7. In which months of the year is the incidence/prevalence of "Dengue fever" particularly bad for your household? (Please tick using Code: [1] Yes [2] No)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

D.8. How many mosquito nets do you have in your household? .....

SECTION E: Social network

E.1. Did you receive remittances during 2018? [1] Yes [2] No
E.2. What are the types of help **received from** other relatives and friends for the last 6 months?

1.
2.
3.
4.

E.3. What are the types of help **given to** other relatives and friends for the last 6 months?

1.
2.
3.

E.4. Did you have to borrow money from relatives or friends in the last 6 months?
[1] Yes [2] No
E.5. Did you lend money to relatives or friends in the last 6 months? [1] Yes [2] No
E.6. In the last 12 months, have you or any member in the household benefited from the local government intervention? [1] Yes [2] No
E.7. If yes, what type of help? Specify below:

Number of times	Type of help

E.8. Are you a member of any Agricultural/Rice farmers Organization?
[1] Yes [2] No
E.9.If yes, state the major benefit derived from the group in at least the last six months .....
.....
.....
E.10.Are you a member of any other Community?
[1] Yes [2] No
E.11. If yes, state the major benefit derived from the group in at least the last six months .....
.....
.....

SECTION F: Food

F.1. Where do you get most of your food?
[1] Own farm [2] Purchases [3] Exchange with rice
F.2. Please indicate (tick) the months in a year during which you struggle to get enough food? (Please tick using Code: [1] Yes [2] No)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

F.3. Are you engaged in other crop farming? [1] Yes [2] No
IF No go to F.7
F.4. If yes, provide details concerning your crop production of the last season

				Indicate how harvest was used		
					Sold	
Type of crop (Using the codes)	Area under cultivation (ha)	Total production (kg)	The per unit price (VND/kg)	Consumption	Processed	Raw
1.						
2.						
3.						

1. Sweet potato; 2.Chilli; 3.Maize 4.Tomato; 5.Okra; 6. Cucumber; 7. Bitter gourd; 8.Beans; 9.Vegetables; 10. Others
F.5. For the major farm produce you harvested in the last season (2018), please provide the following:

Crop	Expected Yield/ha	Realized Yield/ha	Current Yield/ha	Past Yield/ha
1.				
2.				
3.				

1. Sweet potato; 2. Chilli; 3.Maize 4.Tomato; 5.Okra; 6. Cucumber; 7. Bitter gourd; 8.Beans; 9.Vegetables; 10. Coconut; 11. Dragon fruit; 12. Jack fruit;13. Durian; 14.Other

F.6. For the above farm produce you harvested in 2018, please provide the following:

Produce	Expected Price (VND)	Realized Price (VND)	Current Price (VND)	Past Price (VND)
1.				
2.				
3.				

F.7. Are you engaged in animal raising in 2018?

[1] Yes [2] No

IF No go to F.9

F.8. If yes, please provide the following:

Livestock Raised	Number of animals sold	Average Price per head (VND	Realized Income (VND)	Expected Income (VND)	Current Price (VND)	Past Price (VND)

1. Cow; 2. Pigs; 3. Goats;4. Poultry birds (Chicken, Duck, Quail) 5. Others

F.9. Are you engaged in Aquaculture activities in 2018? [1] Yes [2] No

IF No go to G.1

F.10. If yes, please provide the following:

Type of Aquaculture activities	Area (ha)	Quantity harvested (kg)	Expected P rice (VND/kg)	Realized Price (VND)	Current Price (VND)	Past Price (VND)

1. Fish; 2. Shrimp 5. Others

SECTION G: Water

G.1. What is your primary source of water?

(1) Natural sources (river/lake/stream/well/spring/borehole etc.)

(2) Treated (pipe borne, purified)

G.2. Is this water available every day?

[1] Yes [2] No

G.3. Do you drink the water collected from this source directly without first treating/boiling it?

[1] Yes [2] No

G.4. If yes, do members of your household report of ill health upon drinking it untreated? [1] Yes [2] No

G.5. Have you heard about any conflicts over water in your community?

[1] Yes [2] No

G.6. If yes, specify the type of conflict .....

G.7. How long (in minutes) does it take your household to get to your main water source? .....

Section H: Rice business's activities

H.1. What type of activity of rice farming are you engaged in?

[1] Rice cultivating [2] Rice processing (frying, milling, etc.) [3] Rice wage earning (land preparation, fertilizing, harvesting, processing etc.) [4] Input dealer [5] Rice trading [6] others (state) .....

H.2. How many of your household members (apart from you) were involved in your rice farming's activity per day during 2018? .....persons

H.3. Total landholdings: .....ha (own land .....ha; hired/borrowed ..... ha) Used for: Rice farming .....ha; others.....ha

For respondent who join rice farming please complete

H.4. Indicate the 2 major rice varieties that you grow, expected, realized and past growing

Rice varieties	Expected Quantity (kg)	Realized Quantity (kg)	Current Quantity (kg)	Past Quantity (kg)

[1] IR 50404; [2] Fragrant Rice; [3] Glutinous Rice; [4] Other

H.5. What has been your biggest harvest in the last five (5) years?

1st Rice variety .....

2nd Rice variety .....

3rd Rice variety .....

For respondent who process rice complete H.6.

Rice type	Quantity produced and sold last year	Period used to process stated quantity last year 1= days; 2= week; 3= months	Units (kg)	Average Price per unit (VND)	Realized Income (VND)	Expected Income (VND)	Current Price (VND)	Past Price (VND)

[1] IR 50404; [2] Fragrant Rice; [3] Glutinous Rice; [4] Other

H.7. What has been your biggest quantity/volume processed in the last five (5) years?

1st Rice variety .....;

2nd Rice variety .....;

3rd Rice variety .....

For rice wage earner complete H.8.

Rice variety	Number of days engaged last year	Expected wage per day last year (VND/day)	Realized wage per day last year (VND/day)	Expected wage per trip last year (VND/trip)	Expected Income (VND)	Realized Income (VND)

[1] IR 50404; [2] Fragrant Rice; [3] Glutinous Rice; [4] Other

H.9. What has been your highest wage you earned in the last five (5) years? .....

For all (rice farmers, processors or wage earners):

H.10. What were the three main rice varieties you cultivated in 2018?

Rice varieties	Quantity	Unit (kg)	Expected Price (VND)	Realized Price (VND)	Current Price (VND)	Past Price (VND)

1. IR 50404; 2. Fragrant Rice; 3. Glutinous Rice; 4. Other.

SECTION I: Natural disaster

I.1. How many times has this area been affected by flood, drought, saline intrusion/salinity intrusion or any natural disaster in the past five years (2014-2019)?

(a) Drought ..... (b) Flood .....(c) Saline intrusion .....

A. Dought

I.2. Did you receive any warning about the aforementioned drought before it happened?

[1] Yes [2] No

I.3. Did any member of your household loose his/her life due to this event?

[1] Yes [2] No

I.4. If yes, how many members? ..... (Persons)

I.5. Did any member of your household loose his/her job due to this event?
[1] Yes [2] No
I.6. If yes, how many members? ..... (Persons)
I.7. Was any one in your household injured during those events? [1] Yes [2] No
I.8. Please indicates the following if it did occur:
a. Value of rice loss due to the drought: ..... (VND)
b. Value of livestock loss due to drought: ..... (VND)
c. Value of crop loss due to drought: ..... (VND)
d. Value of fish/shrimp loss due to drought: ..... (VND)
e. Value of horticultural loss due to drought: ..... (VND)
f. Value of other stock/property loss due to drought: ..... (VND)

B. Flood

I.9. Did you receive any warning about the aforementioned flood before it happened?
[1] Yes [2] No
I.10. Did any member of your household loose his/her life due to this event?
[1] Yes [2] No
I.11. If yes, how many members? ..... … (Persons)
I.12. Did any member of your household loose his/her job due to this event?
[1] Yes [2] No
I.13. If yes, how many members? ..... … (Persons)
I.14. Was any one in your household injured during those events? [1] Yes [2] No
I.15. Please indicates the following if it did occur:
a. Value of rice loss due to the flood: ..... … (VND)
b. Value of livestock loss due to flood: ..... … (VND)
c. Value of crop loss due to flood: ..... … (VND)
d. Value of fish/shrimp loss due to flood: ..... … (VND)
e. Value of other stock/property loss due to flood: ..... … (VND)

C. Saline intrusion/Salinity intrusion

I.16. Did you receive any warning about the aforementioned Saline intrusion/Salinity intrusion before it happened?
[1] Yes [2] No
I.17. Did any member of your household loose his/her life due to this event?
[1] Yes [2] No
I.18. If yes, how many members? ..... … (Persons)
I.19. Did any member of your household loose his/her job due to this event?
[1] Yes [2] No
I.20. If yes, how many members? ..... … (Persons)
I.21. Was any one in your household injured during those events?
[1] Yes [2] No
I.22.Please indicates the following if it did occur:
a. Value of rice loss due to the Saline intrusion/Salinity intrusion: ..... … (VND)
b. Value of livestock loss due to Saline intrusion/Salinity intrusion: ..... … (VND)
c. Value of crop loss due to Saline intrusion/Salinity intrusion: ..... … (VND)
d. Value of fish/shrimp loss due to Saline intrusion/Salinity intrusion: ..... … (VND)
e. Value of other stock/property loss due to Saline intrusion/Salinity intrusion: ..... … (VND)
Please indicate by underling where appropriate whether in the last 5 years:
I.27. River water flow over where you operate had:
[1] Increased; [2] Decreased; [3] Remained same; [4] N/A
I.28. Water weed coverage over where you operate had:
[1] Increased; [2] Decreased; [3] Remained same; [4] N/A
I.29.Saline intrusion of seawater over where you operate had:
[1] Increased; [2] Decreased; [3] Remained same; [4] N/A

SECTION J: Determination of vulnerability, access to institutions and support

J.1. Do you have access to irrigation?
[1] Yes [2] No
J.2. Do you have access to electricity?
[1] Yes [2] No
J.3. Do you have access road to your rice farm all year round?
[1] Yes [2] No
J.4. Do you have access road to your other farm all year round?
[1] Yes [2] No

J.5. Please indicate the following distances:

Location	Distance (km)
District capital	
Nearest Police Station	
The nearest farming input seller(s)	
The nearest food produce market	
Distance (km) from your farm to the nearest vehicular access road	

J.6. Have you had any extension visit in the last one year? [1] Yes [2] No
J.7. If yes, how many contacts did you have in the last cropping season? ….
J.8. Is there land available to your household if you decide to do farm activities, extend your farm or building?
[1] Yes [2] No
J.9. Do you use improved seeds (e.g. Drought tolerant rice, Salt Tolerant rice, Flood-tolerant rice, High yield varieties etc.)?
[1] Yes [2] No
J.10. Does your household save some of the crops you harvest to eat during a different time of the year?
[1] Yes [2] No
J.11. Does your household save some of the seeds to grow the following year?
[1] Yes [2] No
J.12. Did you use hired labor in 2018 cropping season? [1] Yes [2] No
J.13. If yes, what was the cost of labor? …. (VND/person/day)
J.14. Do you get credit to use for your rice farming activity? [1] Yes [2] No
J.15. Do you get credit to use for your other crop farming/livestock raising/trading activity?
[1] Yes [2] No
J.16. If yes, please tick against the source and indicate the cash amount received

Sources	Tick	Amount in cash/cash equivalent (VND)
Microfinance		
Banks		
Credit Union		
Money Lenders		
Family		
Friends/Neighbours		
Other		

J.17. Have you had any credit (in-kind & cash) in the last one year?
[1] Yes [2] No
J.18. Does your household use tractor? [1] Yes [2] No
J.19. Does your household use water pump? [1] Yes [2] No
J.20. Does your household use combine harvester? [1] Yes [2] No
J.21. Do you have access to a rice storage facility? [1] Yes [2] No
Did you take insurance to cover any of the following activities in the last season (2018)?
J.22. Crop farming [1] Yes [2] No
J.23. Aquaculture farming [1] Yes [2] No
J.24. Livestock raising [1] Yes [2] No

SECTION K: Household income and expenditure sources

K.1. How many livelihood (income generating) activities are you (household head) engaged in? …^
K.2. What was the most important source of income for the household within the last season (year)?
[1] *Rice farming;* [2] *Other crop farming;* [3] *Aquaculture activities (fish or shrimp farming);* [4]. *Livestock raising;* [5] *Trading/doing business;* [6] *Salaried worker/formal employment;* [7] *Farm wage;* [8] *Remittances;* [9] *Unemployed;* [110] *Other (capital earnings, pension, rent etc.)*
K.3. Please provide information on the five main income sources of your total household income (i.e. from anybody who works and earn income for the household) in order of importance as indicated below.
Please note. Put all rice and rice related sources such as rice processing, etc. into rice farming category. Similarly, place crops, planting fruit tree, shrimp and animal related sources of income into farming category and not separated as chilli farm, fish farm, shrimp farm, vegetable farm, pig farm, cow farm, poultry, etc.

Source	Number of household members involved	Reason *1.Income for survival* *2.Supplementary income* *3.Wealth creation* *4.As a traditional practice* *5.Other (please state)*

[1] Rice farming; [2] Other crop farming; [3] Aquaculture activities (fish or shrimp farming); [4]. Livestock raising; [5] Trading/doing business; [6] Salaried worker/formal employment; [7] Farm wage; [8] Remittances; [9] Unemployed; [110] Other (capital earnings, pension, rent etc.).

K.4. What are the sources of income for the last 12 months

Rice farming Income Sources of household	Amount (VND)	Other Farm Income Sources	Amount (VND)	Non-Farm Income Sources household	Amount (VND)
1. Fresh Paddy sales		7. Cash Crops		12.Salary/Non-Farm wage income	
2. Rice sales		8. Fish/Shrimp farming		13. Trading/Doing business	
3. Rice by-products sales (rice straw, rice husk or hull, and rice bran, etc.)		9. Livestock		14.Remittances	
4. Rice consumed by household		10. Farm wages		15.Bonuses Interest Financial investments	
5. Rice farm wage		11. Others (agro processing)		16.Others (capital earning, pension, rent)	
6. Others					
Total		**Total**		**Total**	

Please indicate the income for the past 12 months of:
K4b. The spouse (wife/husband) of household head: VND .....
K4c. The combined income(s) of other members of the household who are earning income: VND .....
K4d. Total reported income of household (K4 +K4b + K4c) VND .....
K.5. Did you face any unexpected demand on your income last year? [1] Yes [2] No
K.6. How many times did it occur in the past year? .....
K.7. What was the cause of the unexpected income demand? .....
K.8. How has your household income been changing over the years (Indicate which months you will consider good, medium, and bad for your household):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

1 = Good/enough; 2. Satisfactory/medium/fairly enough; 3. Bad/unsatisfactory/insufficient/not enough/poor
K.9. Please state your household's expenditure per the stated period, tick where appropriate:

Item	Tick	Expenditure (VND)	Main source of financing
1.Food purchases (VND/daily)			
2.Education for children (uniform, books, fees & transport) (VND/term)			
3.Health (VND/year)			
4. National Health Insurance Scheme (VND/year)			
5.Rent/housing/furnishing (VND/month)			
6.Tax (VND/year)			
7.Sanitation (VND/week)			
8.Travels/transport (VND/week)			
9.Funerals & social activities (VND/month)			
10.Water (VND/month)			
11.Electricity (VND/month)			
12.Fuels - charcoal, firewood (VND/daily)			
13.Fuel -Gas (VND/month)			
14.Fuels - Petroleum (VND/week)			
15.Recreation/pleasure/festivals (VND/year)			
16.Remittances (VND/month)			
17.Clothing/footwear (VND/year)			
18.Communication/calls (VND/month)			
19.Hygienic articles/toiletries (spraying mosquito, soap, etc) (VND/month)			
20.Farming equipment (VND/month)			
21.Other (specify)			

Note: Source of financing: 1= Salary; 2= Remittance; 3 = Sales of Paddy Rice; 4= Sales of Rice –by-product; 5 = Sales of crop; 6= Sales of fish/Shrimp; 7 = Sales of livestock; 8= Income from farm wage; 9 = Income from trading/doing business; 10 = Income from non-farm activities; 11 = Other (capital bonus, pension, rent,etc)
K.10. Which expenditure items have gone over the usual expenditure during last year (2018)? .....
(Code 1= Food purchases; 2= Education; 3= Health; 4= NHIS; 5= Rent; 6= Tax; 7= Sanitation; 8= Travels/transport; 9 = Funerals/social events; 10= Water;11= Electricity; 12= Fuels (charcoal, firewood); 13= Fuel –Gas; 14= Fuel

– Petroleum; 15= Recreation/pleasure/festivals; 16= Remittance; 17= Clothing/footwear; 18= Communication/internet services; 19= Hygienic articles/toiletry; 20= Farming equipment; 21= Other (specify)

SECTION L: Assets

L.1. Please indicate which of these assets you own and their numbers: Rice farming Assets

Asset	Type	Number/ quantity owned	Unit price (VND)	Total Value (VND)
1.Tractor				
2. Water pump				
3.Combine harvest				
4. Planting machine				
5. Spraying machine				
6. Hoe				
7. Sickle				
8. Others (list below)				

L.2. Other assets (non-rice farming assets):

Assets	Type	Number/quantity owned	Unit price (VND)	Total Value (VND)
1. Cash crops (Vegetable, tomato, chilli, cucumber, etc.)				
2.Shrimp				
3. Fish				
4. Cow				
5.Goat				
6. Pig				
7. Poultry				
8. Seed in store				
9. Land				
10. Trading/ Own business				
11.Television				
12.Radio				
13. Furniture (table, chair, etc.)				
14.Cooking utensil				
15.Fridge/Freezer				
16.Fan				
17.Iron				
18. Bicycle/motorbike				
19. Mobile phone				
20.Car				
21. Rice mill				
22. Computer				
23. Building				
24. Others				

Interview end time ..... am/pm Date.....

Signature of interviewer .....