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Rice Farmers' Perceptions and Adaptations to Precipitation and Temperature Variability in Trieu Phong District, Vietnam

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Abstract Precipitation and temperature variability (PTV) can generate considerable risks for agricultural production internationally. Agricultural production in Central Vietnam heavily depends on rice production, which is directly impacted by PTV. In order to facilitate the adoption of PTV adaptation practices by rice farmers, it is important to understand their perspectives of PTV. However, few empirical studies have considered how farmers perceive PTV in Central Vietnam. The main objective of this research is to investigate rice farmers' attitudes towards PTV and their adaptation practices in rice fields in a typical agricultural district in Central Vietnam. A random sampling strategy was used to select 182 rice farmers for interviews and a structured questionnaire was developed to collect data. Descriptive and bivariate analyses were used. The research results show that most farmers had experienced PTV. They perceived that PTV increased labour costs in rice fields, farming losses, the costs of pest/weed control and the costs of water management. This research concluded that farmers were adopting local adaptation practices to lessen negative impacts of PTV on their rice production. Adaptation practices identified include: 1) dredging and restoration of irrigation canals; 2) planting drought resistant varieties of rice; 3) planting rice earlier; and 4) using wells and water pumps for irrigation. The research results indicate that farmers' age, education, gender, agricultural practices and training participation influence their perceptions of PTV.

Keywords: *rice farmers, perceptions, precipitation and temperature variability, Trieu Phong district, Vietnam*

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1. Introduction

Agriculture plays a significant role for economic development in many developing countries. The livelihood of the majority of farmers in the developing world depends heavily on agricultural activities [1,2]. However, agricultural activities, such as cropping rice, are reliant on weather and climate [3]. The impact of precipitation and temperature variability (PTV) on agricultural activities has been a concern of scientists and agricultural policy-makers [4,5]. Precipitation change has reduced water availability and lower crop productivity, leading to the reduction of producers' incomes [6]. Adaptation to PTV is an important practice to reduce negative impacts of PVT on farming activities [7,8]. Adaptation to PTV is the harmonisation in both natural and human systems in order to respond to actual weather events, which lessens harm created by PTV [9]. According to scholars [10,11], one of the key things in agricultural adaptation to PTV is the way in which farmers update their expectations of the future climate to respond to unusual weather events. Another significant issue is how farmers' perceptions of PTV are assimilated into their decisions in relation to agricultural activities [10,12]. Farmers perceived a number of environmental impacts due to PTV such as temperature increases and precipitation decreases, and their perceptions of these impacts are formed and reinforced through their everyday experiences [13]. If we better understand farmers' views on PTV and their current adaptation practices, we will know how to propose suitable policies that are aimed at promoting successful adaptations in the agricultural sector [12,14,15].

In Vietnam, according to the General Statistics Office of Vietnam (GSO), the agricultural sector employed more than 70% of the labour force in 2016 [16]. Rice production is the important means of livelihood for millions of rural Vietnamese farmers [17,18]. Quang Tri province is the rice-growing area in Central Vietnam and, in recent years, rice production in Quang Tri has been severely affected by PTV [19]. However, Quang Tri farmers have survived and adapted in various ways over time. A full understanding of farmers' ongoing adaptation practices and their perceptions of PTV could not only enhance the performance of agricultural policies, but also

improve the farmers' ability to adapt to climate change [4,15,20]. The objectives of this study were:

1) to describe the socio-demographic characteristics of rice farmers;
2) to characterize their perceptions of PTV and their adaptation practices to PTV; and
3) to determine the relationships, if any, between rice farmers' perceptions of PTV and their socio-demographic characteristics.

2. Study Area and Methodology

2.1. Study Site and Description

This research was conducted in Trieu Phong, which is a rural district in Quang Tri province, Central Vietnam (Figure 1). Trieu Phong district covers 354.92 km^2 (35,492 ha). The agricultural sector contributed to more than 75% of the gross output of the district in 2018 [21]. About 80% of the population of Trieu Phong district reside in rural areas and are engaged in farming activities [21]. Facilitating the development of the agricultural sector is, thus, a significant component of the development programs for the district [22]. The agricultural sector in the district comprises crops, livestock and fishery, but crops are the main activity for most farmers. Rice is the main crop in the district and, hence, a focus for the development in the district [22]. Trieu Phong district was selected to study as it represents the typical agro-ecological system, with high potential representation of rice-based production systems in Quang Tri province, Central Vietnam. Such production systems are believed to be the sources of diversified information on PVT in Central Vietnam.

2.2. Sample, instrumentation, Data Collection and Data Analysis

This research employed a cross-sectional survey research design [23]. A three-part structured questionnaire was developed to collect data. The first part consisted of ten statements on PTV, measured on a five-point Likert scale which ranged from 1= *strongly disagree* to 5= *strongly agree*. The second part comprised 15 statements on adaptation practices toward PTV, measured on a five-point Likert scale which ranged from 1= *strongly disagree* to 5= *strongly agree*. The third part gathered demographic and socio-economic information. The questionnaire was reviewed by a panel of experts for face and content validity. The questionnaires were an interviewer administered mode. Three trained enumerators were hired to manage the questionnaires in the study region and the survey was conducted in 2019. Data were analysed using descriptive and non- parametric tests [24].

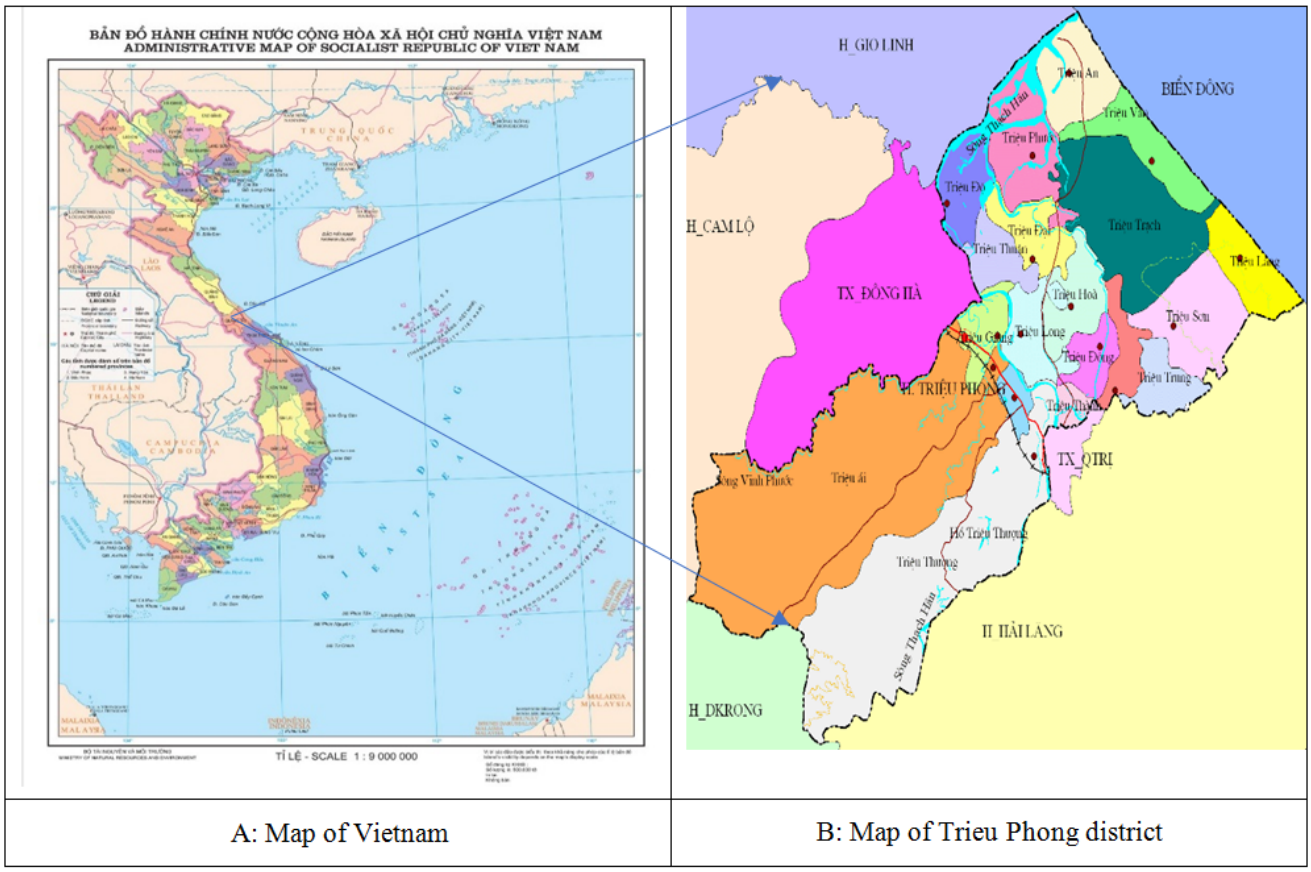

Figure 1. The study region: A is Vietnam and B is Trieu Phong district

3. Results

3.1. Rice Farmers' Socio-demographic Profiles

Table 2 reports the socio-demographic characteristics of the rice farmers in the study region. A high percentage of the farmers (35.7%) were aged between 35 and 44, followed by ages between 45-54 (31.3%) and between 25-34 (17.6%). About 47% of the farmers were male and the remaining 53% were female. The farmers' education levels as, did not go to school, primary school, junior high school, senior high school and postgraduates, were 28.6%, 29.7%, 23.1%, 18.1% and 0.5% respectively. The average family size of a rice farmer was approximately 4.4 people and ranged from two to eight members. The family size distribution for respondents is shown in Figure 2. A high proportion of the farmers (43.96%) had four members, followed by five members (18.68%) and six members (13.74%).

Table 1. Main characteristics of smallholders (N = 182)

Characteristics		**Values**[1]
Age (years)	18-24	13 (7.1)
	25-34	32 (17.6)
	35-44	65 (35.7)
	45-54	57 (31.3)
	55-64	14 (7.7)
	65 or older	1 (0.5)
Gender	Male	86 (47.3)
	Female	96 (52.7)
Education level	Did not go to school	52 (28.6)
	Primary school	54 (29.7)
	Junior high school	42 (23.1)
	Senior high school	33 (18.1)
	Postgraduates	1 (0.5)
Household size (people)	Average household size	4.4
Income/year (VND[2])	Average income	2.9[3]
Farm size (sao[4])	Average farm size	10.1
Agricultural practice	Irrigated/rain-fed agriculture	129 (70.9)
	Irrigated agriculture only	53 (29.1)
ICT[5] owns	Yes	149 (81.9)
	No	33 (18.1)
Training course participation	Yes	48 (26.4)
	No	134 (73.6)
Credit program participation	Yes	106 (58.2)
	No	76 (41.8)
CBO[6] participation	Yes	63 (34.6)
	No	119 (65.4)

[1]: Values in parenthesis are percentages and without parenthesis are numbers
[2] : 20,000 VND equal 1 USD.
[3] : 1 = nil; 2 = 1-30 VND million; 3 = 31-45 VND million; 4 = 46-60 VND million; 5 = 61-75 VND million; 6 = more than 75 VND million.
[4] : one "sao" equals 500 m^2.
[5] : Information and Communication Technologies (ICT).
[6] : Community-based organisations (CBOs).

The average yearly income of a rice farmer was about 30 VND million, but this attribute ranged from 0 to more than 75 VND million. The income distribution for the rice farmers is shown in Figure 3. A high proportion of the rice farmers had income from 31-45 VND million (37.91%), followed by income from 1 to 30 VND million (27.97%) and income from 46-60 VND million (25.27%). The average area of farmland owned by a rice farmer was 10.18 sao[7] and ranged from 3 to 23 sao. The farm size distribution for a farmer is shown in Figure 4. A high percentage of farmers had a farm size of 10 sao (11.50%), followed by 13 sao (9.20%) and 9 sao (8.50%).

The percentage of the rice farmers practising agriculture as a combination of rain-fed/irrigation and only irrigation, was about 71% and 29% respectively. About 82% of the rice farmers owned Information and Communication Technologies (ICT) and the remaining 18% did not own ICT. The proportion of the rice farmers who participated in training courses (26.4%) was less than those who did not take part (73.6%). The proportion of the rice farmers who took part in credit programs (58.2%) was higher than those who did not participate (41.8%). Similarly, the percentage of the rice farmers who were members of community-based organisations (CBOs) (34.6%) was less than those who did not take part in this type of CBO (65.4%).

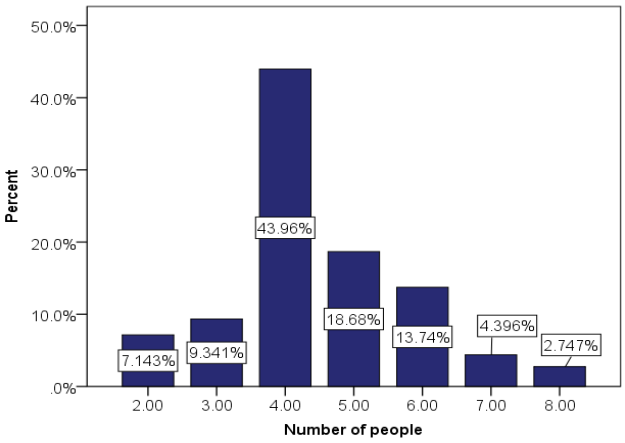

Figure 2. Family size distribution of rice farmers in the study region

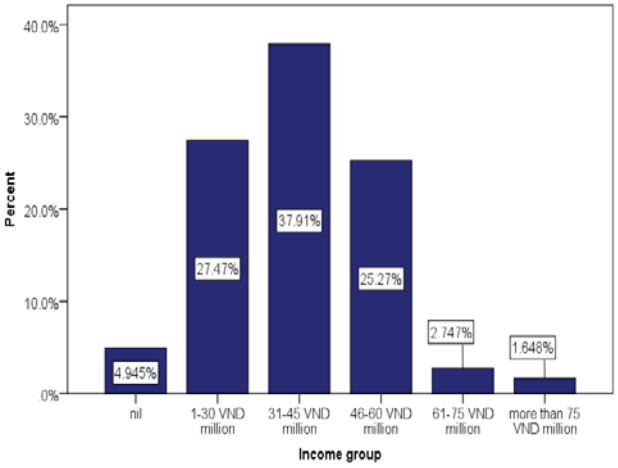

Figure 3. Income distribution of rice farmers in the study region

[7] : One "sao" equals 0.05 hectares.

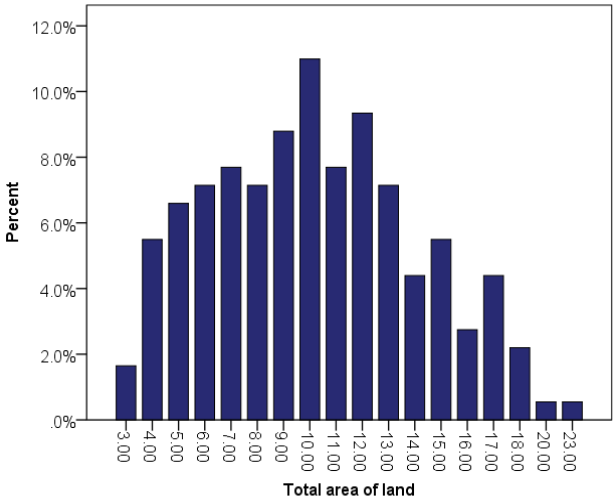

Figure 4. Area of land distribution of rice farmers in the study region

3.2. Rice Farmers' Perception of Precipitation and Temperature Variability

Table 2 describes the rice farmers' perception of PTV in the study region. In general, the rice farmers had a positive attitude toward most statements (*Mean > 2.5*). In particular, the farmers strongly agreed with four statements including: 1) PTV increases labour cost in rice fields (*M = 4.12, SD = 0.359*); 2) PTV increases farming losses (*M = 4.08, SD = 0.302*); and 3) PTV have increased the costs of pest and weed control (*M = 4.01, SD = 0.297*). The farmers agreed with the statement that PTV have increased the costs of water management (*M = 4.00, SD = 0.332*) while they tended to agree with the remaining statements ($2.67 \leq M \leq 3.58$, $0.623 \leq SD \leq 1.180$), except for the statement that temperature rise has resulted in farmers' inability to repay loans (*M = 2.31, SD = 0.573*).

Table 2. Farmers' perceptions of precipitation and temperature variability

No.	Statements	Mean	Standard Deviation
1	PTV[8] increases labour cost in rice fields	4.12	0.359
2	PTV increases farming losses	4.08	0.302
3	PTV have increased the costs of pest and weed control	4.01	0.297
4	PTV have increased the costs of water management	4.00	0.332
5	PTV have increased the application rate of chemical inputs	3.58	0.623
6	PTV have reduced rice yield	3.56	1.176
7	PTV have reduced rice quality	3.36	1.180
8	PTV have reduced rice price due to the loss of quality	3.20	1.030
9	PTV have increased the rate of rice waste	2.67	0.742
10	Temperature rise has resulted in farmers' inability to repay loans	2.31	0.573

[8] : precipitation and temperature variability (PTV).

3.3. Farmers' Adaptation Practices towards PTV

Table 3 outlines rice farmers' adaptation practices toward PVT in the study region. Overall, the major adaptation practices used by the rice farmers for counteracting the changing climate in the study region were: 1) dredging and restoration of irrigation canals (*M = 4.23, SD = 0.447*); 2) planting of drought resistant rice varieties (*M = 4.16, 0.487*); 3) early planting (*M = 4.05, SD = 0.429*); and 4) usage of wells and water pumps for irrigation (*M = 4.03, SD = 0.304*). Other adaptation practices included: 1) cultivation of early-maturing rice varieties (*M = 3.86, SD = 0.497*); 2) intermittent irrigation (*M = 3.54, SD = 0.561*); 3) increased pesticide usage (*M = 3.43, SD = 0.597*); 4) agricultural insurance (*M = 3.42, SD = 0.559*); 5) increased chemical fertilizer usage (*M = 3.41, SD = 0.576*); and 6) cultivation of high yielding varieties (*M = 3.34, SD = 0.609*) were also important adaptative measures used by the rice farmers to cope with PTV. In contrast, the adaptative practices toward PTV included: 1) direct rice cultivation, 2) stop cultivation, 3) alternative crops' cultivation, 4) cultivate in less farm area, 5) rent farm, and 6) bank loans and facilities were not used by the rice farmers ($1.46 \leq M \leq 2.00$, $0.533 \leq SD \leq 0.665$).

Table 3. Adaptation practices toward precipitation and temperature variability

No.	Adaptation practices	Mean	Standard Deviation
1	Dredging and restoration of irrigation canals	4.23	0.447
2	Planting of drought resistant rice varieties	4.16	0.487
3	Early planting	4.05	0.429
4	Usage of wells and water pumps for irrigation	4.03	0.304
5	Cultivation of early-maturing rice varieties	3.86	0.497
6	Intermittent irrigation	3.54	0.561
7	Increase pesticide usage	3.43	0.597
8	Agricultural insurance	3.42	0.559
9	Increase chemical fertilizer usage	3.41	0.576
10	Cultivation of high yielding varieties	3.34	0.609
11	Plastic wrap on borders	2.97	0.277
12	Bank loans and facilities	2.00	0.643
13	Rent farm	1.70	0.535
14	Cultivate in less farm area	1.67	0.567
15	Alternative crops cultivation	1.58	0.665
16	Stop cultivation	1.48	0.533
17	Direct rice cultivation	1.46	0.552

3.4. Relationship between Farmers' Perceptions of PTV and Their Characteristics

In order to find a relationship between rice farmers' perceptions of PTV and their socio-demographic characteristics, a reliability analysis for ten statements on the farmers' perceptions of PTV (in Table 2) was used.

The purpose of this reliability analysis is to determine the extent to which these statements are related to each other in order to construct an index of the farmers' views on PTV. The value of Cronbach's alpha reliability coefficient was found equal to 0.725, indicating that the statements are closely related to each other and reflected well enough their perceptions. An index of the farmers' perceptions of PTV was then constructed. A bivariate analysis was then used to determine relationships between the farmers' perceptions of PTV and their socio-demographic characteristics. Pearson and Eta correlation coefficients were used to assess the relationships. Pearson correlation coefficient for measurable or continuous variables, and Eta correlation coefficient for nominal variables were used. Table 4 outlines relationships between socio-demographic characteristics of the rice farmers and their perceptions of PTV in the study region. Generally, farmers' perceptions of PTV were positively statistically associated with farmers' education, farm size, gender, agricultural practices and training participation, whereas, the farmers' perceptions of PTV were negatively statistically associated with farmers' age.

Table 4. Bivariate analysis

Variable 1	Variable 2	Correlation Coefficient	Coefficients	p-value
Age	Farmers' perceptions	Pearson	- 0.205**[9]	0.005
Education	Farmers' perceptions	Pearson	0.201**	0.006
Income	Farmers' perceptions	Pearson	0.104 [NS]	0.162
Farm size	Farmers' perceptions	Pearson	0.225**	0.002
Household size	Farmers' perceptions	Pearson	0.039 [NS 10]	0.597
Gender	Farmers' perceptions	Eta	0.205**	0.006
Agricultural practice	Farmers' perceptions	Eta	0.216**	0.004
ICT own	Farmers' perceptions	Eta	0.004 [NS]	0.959
Training participation	Farmers' perceptions	Eta	0.210**	0.005
Credit participation	Farmers' perceptions	Eta	0.005 [NS]	0.942
CBO participation	Farmers' perceptions	Eta	0.079 [NS]	0.289

4. Discussion

The Vietnamese rice farmers in the study region perceived that PTV have increased labour costs in rice fields, farming losses, the costs of pest/weed control and the costs of water management. This means that most farmers are aware of PTV occurring in the study region. In the mainstream literature [8,25,26], some of the mentioned characteristics of PTV were already reported. This study found that the main adaptation practices used by the rice farmers for responding to PVT were: 1) dredging and restoration of irrigation canals; 2) planting of drought resistant rice varieties; 3) early rice planting; and 4) usage of wells and water pumps for irrigation. This suggests that most rice farmers in the study region have tried to counteract the impact of PTV by adopting local adaptation strategies.

Interestingly, a positive significant relationship was found existing between rice farmers' gender, agricultural practices and training participation and the farmers' perception of PTV, and this finding has not been reported in any previous study. It was also found that the farmers' perceptions of PTV were negatively statistically associated with their age. This finding supports [27] findings, who report that the Iranian farmers' perceptions of PTV were negatively associated with the farmers' ages, but not statistically significant. The present study found that there was a positive statistically relationship between farm size and the farmers' perceptions of PTV, which is in agreement with [27] findings.

5. Conclusions and Implications

Generally, Central Vietnamese rice farmers are aware of PTV occurring in the study region. They perceived that PTV have increased labour costs in rice fields, farming losses, the costs of pest/weed control and the costs of water management. The farmers have tried to respond to the impact of PTV by adopting local PVT adaptation practices when cropping rice. These PTV adaptation strategies include, but are not limited to: 1) dredging and restoration of irrigation canals; 2) planting of drought resistant rice varieties; 3) early rice planting; and 4) usage of wells and water pumps for irrigation. Socio-demographic characteristics of rice farmers, including age, education, gender, agricultural practices and training participation, should be considered when implementing and promoting PTV adaptation practices to the farmers.

Findings of this study should be shared with policy-makers, agricultural development program planners, agricultural extension educators and community workers to identify the most appropriate strategies for implementing and promoting PTV adaptation practices to farmers in Central Vietnam. This study should be replicated in other areas of Vietnam to better understand the farmers' perceptions of PTV. Such an understanding will help to develop a national strategy for delivering PTV adaptation practices nationwide.

Acknowledgments

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Conflicts of Interest

The author declares no conflict of interest.

[9] : ** indicate significant ≤ 1%.
[10] : [NS] indicates non-significant.

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