Environment for Development

Discussion Paper Series

February 2024 ■ EfD DP 24-02

Gender differences in adaptation strategies to salinity intrusion in the Mekong Delta, Vietnam

An intra-household analysis

Hoa Le Dang, Thuyen Thi Pham, Nhung Thi Hong Pham, and Nam Khanh Pham

Environment for Development

Central America
Research Program in Economics and Environment for Development in Central America Tropical Agricultural Research and Higher Education Center (CATIE)

Chile
Research Nucleus on Environmental and Natural Resource Economics (NENRE)
Universidad de Concepción

China
Environmental Economics Program in China (EEPC)
Peking University

Colombia
The Research Group on Environmental, Natural Resource and Applied Economics Studies (REES-CEDE), Universidad de los Andes, Colombia

Ethiopia
Environment and Climate Research Center (ECRC), Policy Studies Institute, Addis Ababa, Ethiopia

Ghana
The Environment and Natural Resource Research Unit, Institute of Statistical, Social and Economic Research, University of Ghana, Accra

India
Centre for Research on the Economics of Climate, Food, Energy, and Environment, (CECFEE), at Indian Statistical Institute, New Delhi, India

Kenya
School of Economics
University of Nairobi

Nigeria
Resource and Environmental Policy Research Centre, University of Nigeria, Nsukka

South Africa
Environmental Economics Policy Research Unit (EPRU)
University of Cape Town

Sweden
Environmental Economics Unit
University of Gothenburg

Tanzania
Environment for Development Tanzania
University of Dar es Salaam

Uganda
EfD-Mak, School of Economics and Department of Agribusiness and Natural Resource Economics, Makerere University, Kampala

USA (Washington, DC)
Resources for the Future (RFF)

Vietnam
University of Economics
Ho Chi Minh City, Vietnam

Gender differences in adaptation strategies to salinity intrusion in the Mekong Delta, Vietnam: An intra-household analysis

Hoa Le Dang, Thuyen Thi Pham, Nhung Thi Hong Pham, and Nam Khanh

Abstract

There has been a growing interest in gender differences in adaptation strategies to climate change, due to the significant disparity in both knowledge and access to various resources between male and female farmers. The existing studies on gender differences have mostly examined the adaptation strategies of male-headed and female-headed farm households. Fewer studies have looked at the coping strategies of wives and husbands in response to climate change. This study investigates the opinions of wives and husbands in farm households concerning desirable adaptive responses to salinity intrusion. Data were collected via a survey of farm households in three coastal provinces in the Mekong Delta, Vietnam. The sample includes 117 married couples who have been growing rice for several years. The findings indicate that wives and husbands have different opinions on adaptation strategies. Different factors affect wives' and husbands' choices of adaptive measures as well as the number of adaptive measures that they would consider taking. We focus on the role of wives' access to education, participation in formal institutions, and training on adaptation to salinity intrusion because those factors affect both the type and number of adaptive measures that wives indicate they would take. To equalize women's access to information, wives in farming households should be given timely and adequate support, be encouraged to join more social activities and associations, and receive learning opportunities equal to those for their husbands.

Keywords: Adaptation; Gender; Intra-household; Mekong Delta; Salinity intrusion

* We are grateful to the Swedish International Development Cooperation Agency (Sida) through the Environment for Development Initiative (EfD) at the University of Gothenburg for financial support through Research Grant MS-890. We would like to express our gratitude also to local authorities of Tien Giang, Ben Tre, Soc Trang Provinces, Go Cong Tay, Ba Tri, Long Phu Districts, and Dong Thanh, An Binh Tay, Chau Khanh communes for generously supporting the field trips, expert interviews, and farm household surveys. We would like to thank all farmers in the study site for taking their time helping us to complete the survey. Special thanks to 10 students and lecturers for their support during the interviews in the Mekong Delta.

Gender differences in adaptation strategies to salinity intrusion in the Mekong Delta, Vietnam: An intra-household analysis

Abstract

There has been a growing interest in gender differences in adaptation strategies to climate change, due to the significant disparity in both knowledge and access to various resources between male and female farmers. The existing studies on gender differences have mostly examined the adaptation strategies of male-headed and female-headed farm households. Fewer studies have looked at the coping strategies of wives and husbands in response to climate change. This study investigates the opinions of wives and husbands in farm households concerning desirable adaptive responses to salinity intrusion. Data were collected via a survey of farm households in three coastal provinces in the Mekong Delta, Vietnam. The sample includes 117 married couples who have been growing rice for several years. The findings indicate that wives and husbands have different opinions on adaptation strategies. Different factors affect wives' and husbands' choices of adaptive measures as well as the number of adaptive measures that they would consider taking. We focus on the role of wives' access to education, participation in formal institutions, and training on adaptation to salinity intrusion because those factors affect both the type and number of adaptive measures that wives indicate they would take. To equalize women's access to information, wives in farming households should be given timely and adequate support, be encouraged to join more social activities and associations, and receive learning opportunities equal to those for their husbands.

Keywords: Adaptation; Gender; Intra-household; Mekong Delta; Salinity intrusion

1. Introduction

Adaptation to climate change has become crucial in countries where agriculture, a climate-sensitive sector, is a major contributor to the economy. The impacts of climate change have often been more severe for agrarian areas in developing countries and especially for female farmers, since they often have limited access to various resources that are important to climate change adaptation (Jost et al., 2016; Mitchell et al., 2007). The literature has revealed that climate-related risks have affected women and men differently in several ways, including food security, access to resources, and with regard to education, health and welfare (Huynh & Resurreccion, 2014; Pham et al., 2016). Climate change impacts have been observed not to be gender-neutral since gender disparity has been significant in both knowledge of climate change and access to resources for climate change adaptation (Al-Amin et al., 2019; Jin et al., 2015;

McCright, 2010). Women have also been seen to be more vulnerable to climate change due to their limited mobility and involvement in household decision-making process (Jin et al., 2015). In Vietnam, our study area, men have more economic opportunities and better access to information technologies, while women spend most of their time on housework and are discouraged from participating in village meetings or public events (Pham et al., 2016).

While there is a growing body of literature on gender differences in adaptation to climate change, studies on this theme have been highly reliant on context (Aryal et al., 2020; Ojo & Baiyegunhi, 2020). Some studies have used qualitative approaches to examine gender differentiation in climate change adaptation (Arora-Jonsson, 2011; Pham et al., 2016). Those studies show that gender differences affect responses to climate change (Arora-Jonsson, 2011). Some studies on climate change adaptation strategies have investigated gender as a single variable in the adaptation model and the analysis of gender is not the main focus of the studies (Below et al., 2012; Bryan et al., 2013; Deressa, et al., 2009).

Other studies have examined gender differences by focusing on male-headed and female-headed households (Andersen et al., 2016; Guloba, 2014; Pérez et al., 2014; Tibesigwa et al., 2015; Wrigley-Asante et al., 2019). According to these studies, female farmers favor early harvesting and mixed cropping as adaptation strategies because they need financial resources for their families. They also prefer traditional crops and use existing crop varieties since household food security is their priority and they are not likely to take risks (Wrigley-Asante et al., 2019). Such studies have shown that gender differences shape the way farm households are able to adapt to climate change. However, there is a lack of understanding of how farm households' adaptation to climate change is affected by intra-household gender differences.

There have been fewer studies of the adaptive responses and influencing factors for wives and husbands in a household (Al-Amin et al., 2019; Mishra & Pede, 2017; Ngigi et al., 2017). Previous studies have indicated that the roles and responsibilities of wives and husbands have influenced their adaptive responses. A study on climate change adaptation in rural Kenya showed that wives and husbands differed in the time frames of their decisions. Wives preferred to employ crop-related strategies, while husbands were more likely to choose strategies associated with livestock and agroforestry (Ngigi et al., 2017). In Bangladesh, wives' and husbands' perceptions of climate change have been significantly different, and the adaptation choices have been substantially affected by intra-household decision making (Al-Amin et al., 2019). A study by Mishra and Pede (2017) in the Mekong Delta, Vietnam found that wives have been more likely to employ financial strategies for climate change adaptation, while husbands selected both farm and financial strategies as adaptive measures.

While salinity intrusion is an emerging and pressing concern, little research effort has been paid to gender-differentiated adaptation to salinity intrusion through intra-household analysis, especially in Vietnam. The Mekong Delta, the major rice-producing region of Vietnam, has faced extensive sea level rise and salinity intrusion (Nachmany et al., 2015) and is also one of the most vulnerable areas to climate change in Southeast Asia (Yusuf & Francisco, 2009). Local authorities have implemented measures to help farmers to adapt to salinity intrusion (e.g. training on adaptation measures and agricultural extension services). However, gender-specific measures remain limited and the involvement of female farmers in such activities has not received proper attention in the Mekong Delta. Local policies targeting income-generating activities for farm households have been gender-neutral and context-reliant. Understanding gender differences in adaptation to salinity intrusion in this climate change prone area can enrich our understanding of how wives and husbands differ in their adaptation to salinity intrusion and the influential factors, and suggest appropriate gender-sensitive adaptation strategies.

This study aims to investigate the gender differences in intra-household adaptation choices in response to salinity intrusion and factors affecting the choices. It highlights the roles of wives and husbands in adaptation strategies. These findings can inform policies to effectively empower both husbands or wives in response to salinity intrusion in the Mekong Delta, Vietnam.

2. Materials and methods

2.1 Sampling and data collection

The Mekong Delta is the major rice-producing region of Vietnam. Rice is the main cash crop of most provinces in the Delta. The Delta is also one of the most vulnerable areas to climate change in Southeast Asia (Yusuf & Francisco, 2009). Sea level rise and salinity intrusion are pressing issues in the Mekong Delta (Nachmany et al., 2015; Smajgl et al., 2015) and have increased in both frequency and magnitude (Nguyen et al., 2019). Salinity has encroached further inland and increased in concentration (Bergqvist et al., 2012). Drought and salinity intrusion have significantly impacted agricultural production and rural livelihoods in the Delta. The majority of people in the Mekong Delta have farmed for several years and live mostly on farm income. Salinity intrusion is affecting their livelihoods. Farmers in the Delta have attempted to adapt to salinity intrusion with measures such as changing farming practices, changing their choice of crop varieties, crop diversification, changing planting calendar, and water management practices (Nhung et al., 2019; Tran et al., 2019; Trang et al., 2018).

This study was conducted in three coastal rice-producing provinces in the Mekong Delta, Vietnam, namely, Tien Giang, Ben Tre and Soc Trang. In these provinces, agricultural production, including rice farming, has been seriously affected by salinity intrusion. There are three rice crops per year in the research sites. The first crop is from May to August. The second crop is from September to December. The third crop is from December/January to March/April of the following year. We conducted the survey from August to October 2020. We asked local farmers about their rice production for three rice crops from May 2019 to March 2020.

The three communes (each commune in one of the three provinces) selected for the household survey are presented in Table 1. Male household heads and their wives were randomly selected from a list of households obtained from local authorities. We planned to interview 40 male household heads and their wives in each commune to obtain the total sample of 120 couples. However, due to difficulties in approaching a few male household heads and their wives in Soc Trang and Ben Tre, we finally completed 117 interviews of male household heads and 117 interviews of their wives, with 29 couples in Soc Trang, 26 in Ben Tre and 62 in Tien Giang. Although a larger sample would provide more fruitful insights, the current sample is acceptable for the analysis. Household heads and their wives were interviewed separately and were not able to discuss their responses to the questions before being interviewed. They were encouraged to share their own perceptions and knowledge of salinity intrusion and adaptation issues.

Insert Table 1 here

We used a structured questionnaire for the farm household survey. There were three in-depth interviews with agricultural officers in the three surveyed provinces and 10 households that were randomly selected for pre-testing. We used information from expert interviews and the pre-test to finalise the questionnaire. Household heads and their wives were interviewed separately using a questionnaire which collected data on which adaptation strategies, and how many they planned to use to respond to salinity[1]. Those are the dependent variables. The explanatory variables of interest have to do with married women's formal and informal

[1] We recognize that an individual spouse's intention or plan is subject to intra-household bargaining to arrive at a final decision on the choice of adaptation measures in upcoming planting seasons, but we did not collect data on such bargaining.

acquisition of information about supporting services for agricultural production. The questionnaire included questions on training and support services for agricultural production, as well as on education, and participation in social and community organizations. The questionnaire also included questions on the farmer's experience and perception of salinity intrusion, previous adaptive measures to salinity intrusion undertaken at both the community and household level, household characteristics, agricultural production, and household income and expenditure.

2.2 Theoretical background

The purpose of salinity adaptation is to mitigate the negative impacts of salinity intrusion and maximise farm household profit. The assumption underlying this analysis is that farmers will adopt an adaptive measure as long as they perceive the benefit of this measure to exceed its cost, including opportunity costs. Farmers' adaptive responses can be analysed via the choices they make.

Previous empirical studies have indicated that some demographic variables (age, gender, ethnicity, education, number of children, agricultural labor) have affected farmers' adaptive responses to climate change and salinity intrusion. Farmers' age is probably associated with their farming experience, which could contribute to better farming and adaptation decisions. Highly educated farmers may have better access to information and credit for effective adaptation. Other influential factors are farm size, land ownership, experience, off-farm work, irrigation, salinity, revenue, credit, training, extension, and institutions (SeinnSeinn et al., 2015; Szabo et al., 2016; Trang et al., 2018; Paik et al., 2020). Some of the disparity in adaptive measures between husbands and wives may arise due to differences in socio-economic factors (Chaudhury et al., 2012; Goh, 2012; Huynh & Resurreccion, 2014; McKinley et al., 2016; Pham et al., 2016).

The literature has shown that the impacts of climate change are different for male and female farmers (Jin et al., 2015; Mishra & Pede, 2017; Ngigi et al., 2017). Due to gender inequality, female farmers have often been more vulnerable to climate-related risks (Aryal et al., 2020). In Bangladesh, labour shortages in female-headed households are shown to make them less likely to adapt to climate risks by changing their farming practices. The intensive involvement of women in household responsibilities and the burden of unpaid family work limit their opportunities for additional jobs and diversified livelihoods (Aryal et al., 2020). Female farmers face different risks due to their limited access to various resources and their household responsibilities. Those limitations contribute to their reduced ability to adapt to climate risks.

The differences in social capital, experience, and perspectives between male and female farmers have resulted in their differentiated adaptive responses (Akter et al., 2016).

2.3 Empirical model

The empirical models generally used to identify factors affecting farmers' choice of adaptive measures are binary logit, probit, multinomial logit, and multivariate probit (Al-Amin et al., 2019; Aryal et al., 2020; Esfandiari et al., 2020; Jin et al., 2015; Trinh et al., 2018). The choice of model depends on whether the farmer's adaptive choices is dichotomous, or whether many possible adaptive measures are available that may not be mutually exclusive. Mishra & Pede (2017) use probit and negative binomial regression to investigate the choice and number of adaptive measures of farm households. In this study, we also examine both the choice and number of adaptive measures. The number of adaptive measures that farmers select is one of the dependent variables. Since this dependent variable is discrete and includes non-negative integers, count data models are used (Greene, 2003). These models estimate the probability that the number of adaptive measures that farmers intend to use takes specific non-negative integers. Both Poisson and negative binomial models, which assume Poisson distribution for the dependent variable, can be employed. However, when there is concern of overdispersion – that is, the variance is greater than the mean of the dependent variable–negative binomial models are the more appropriate approach (Hoffmann et al., 2009; Lawless, 1987). This study employs the negative binomial model using maximum likelihood estimation. The negative binomial model results from the generalization of the Poisson model by adding an individual, unobserved effect (u_i) into the conditional mean (λ_i). Thus, the conditional mean μ_i is then defined as follows (Greene, 2003).

$$ln(\mu_i) = x'_i\beta_i + \varepsilon_i = ln(\lambda_i) + \ln(u_i) \qquad (1)$$

where x_i is a vector of independent variables, including demographic variables, farm and household characteristics, and farmers' perceptions of salinity intrusion and β_i is a vector of the estimated coefficients. ε_i is the specification error. y_i is the number of adaptive measures that farmers intend to use. The distribution of y_i conditioned on x_i and u_i is Poisson with conditional mean and variance μ_i.

$$f(y_i|x_i, u_i) = \frac{e^{-\lambda_i u_i}(\lambda_i u_i)^{y_i}}{y_i!} \qquad (2)$$

The negative binomial model is estimated separately for the samples of wives and their husbands.

A binary logit model was used to identify factors affecting farmers' choice of adaptive measure. The farm household questionnaire listed twelve adaptive measures identified from the literature and expert interviews. This study focuses on choices related to three commonly used adaptive measures out of those twelve: (1) changing from rice to other crops, (2) saving rainwater for daily use, and (3) seeking other income sources. The binary logit model for farmers' adaption choice is specified as follows.

$$Y_i = log\left(\frac{P}{1-P}\right) = \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \varepsilon_i \qquad (3)$$

Y_i is the dependent variable representing whether farmers (wives or their husbands) intend to use a particular measure in the upcoming season. X_i is a vector of demographic variables, farm and household characteristics, and farmers' perception of salinity intrusion. All β_i are the estimated regression coefficients. ε_i is the error term. n is the number of explanatory variables. The models for wives and their husbands are separately estimated to obtain the difference between factors affecting their preferences for adaptation to salinity intrusion.

2.4 Explanatory variables

The literature has identified several variables as determinants of farmers' adaptation strategies to salinity intrusion. They can be categorised into different groups: demographic variables (age, gender, ethnicity, education), socio-economic characteristics (number of children, off-farm work, community meetings), farming characteristics (agricultural labor, diversified crops, farm size, experience, land ownership, yield, revenue, irrigation), institutional conditions (institution, extension, training, credit), salinity-related variables (Almaden et al., 2020; Paik et al., 2020; SeinnSeinn et al., 2015; Szabo et al., 2016; Trang et al., 2018), farmers' perception, and adaptive capacity (Aryal et al., 2020). In this study, controls for socio-economic and farm characteristics include farm income, farming experience, farm size, land tenure, and the percentage of time allocated for farming, livestock, and other jobs (Almaden et al., 2020; Paik et al., 2020; SeinnSeinn et al., 2015; Szabo et al., 2016).

Two dummy variables related to institutional conditions are participation in extension services and training on adaptation to salinity intrusion. Other studies have used these variables to investigate farmers' choice of adaptation to salinity intrusion (Paik et al., 2020; SeinnSeinn et al., 2015; Trang et al., 2018). The participation of farmers in local formal institutions (e.g. Farmers' Unions, Women's Unions, Veterans Associations) was employed in the model as a dummy variable. Two salinity-related variables used in the models are farmers' perceptions of salinity intrusion and the percentage of rice yield loss caused by salinity. Farmers were asked about their households' yield loss in the year 2019, when salinity intrusion was severe in the Mekong Delta. To obtain information on their perceptions of salinity intrusion, farmers were asked to share the extent of their agreement with five statements regarding the status of salinity intrusion in local areas, using a 7-point Likert scale. The average value of the answers to those five questions was used to represent farmers' perceptions regarding salinity intrusion.

3. Results and discussion

3.1 Descriptive statistics of variables in the models

Table 2 shows descriptive statistics of variables used in the binary logit and negative binomial models. The age of husbands and wives is similar, with a mean of 53 for husbands and 52 for their wives. The average level of education of husbands is 7.3 years, higher than that of their wives, at 5.8 years. The farmers' level of education is generally low in the research sites, and access to education is likely to be even more limited for female farmers. The annual average farm household income is about 72 million VND (about 2,800 EUR or 3,200 USD), with a maximum of 396 million VND (about 15,400 EUR or 17,600 USD). The percentage of time that husbands and wives allocate for farming, livestock, and other off-farm jobs was in turn approximately 50% and 40%.

The percentage of husbands who have participated in extension services is nearly 83%, but only 47% for their wives. Those figures indicate the major social role of husbands in the farm households, which may affect the adaptive responses of husbands and wives to salinity intrusion. Nearly 26% of wives who had not participated in extension services, said they have not had access to the services, and about 73% chose reasons including their belief that participating in extension services was their husband's role, no time, no transport, sickness, no invitation, or being illiterate. Wives perceived their roles as related to housework rather than social activities. The proportion of farmers who have attended training on adaptation strategies to salinity intrusion is low, 35% for husbands and only 17% for wives. The percentage of farmers who participate in local formal institutions (e.g. Farmers' Unions, Women's Unions, Veterans Associations) is higher for husbands, at 56%, and 41% for their wives.

Both husbands and wives in the sample perceived the seriousness of salinity intrusion in local areas. The mean score is 6 on the 7-point Likert scales for both. The average rice yield loss in 2019 (compared to a year without salinity intrusion) for farm households in the sample was more than 45%. Some households lost their entire crop.

Insert Table 2 here

3.2 Wives' and husbands' perceptions of salinity intrusion and its impacts

Wives and their husbands were interviewed separately and asked to respond to five statements on a 7-point scale about the level of salinity intrusion in their areas. The statements covered (1) the increased encroaching of salt water on rivers, creeks and land, (2) the longer time that water is salty during the year, (3) the erratic annual salinity period, (4) the increased salinity of river water and creeks, and (5) the overall seriousness of salinity intrusion. Responses showed that salinity intrusion seems to be increasing in both frequency and magnitude. Both wives and husbands strongly agreed (around 6 on the 7-point scale) to the seriousness of salinity intrusion in their areas.

Insert Table 3 here

Wives and their husbands were asked if they were aware of the influence of salinity intrusion on their agricultural production and lives for the years 2015 to 2019. They were also asked to rate the extent of that influence, on a 7-point scale (ranging from 1 - little influence to 7 – much influence). The findings, shown in Table 4, were that, on average, more than half of the sample thought salinity intrusion has influenced their farming and livelihoods. Farm households were most severely affected by salinity intrusion in the year 2019, with a 100% positive response. The extent of influence is also highest for 2019, at nearly 6 for husbands and 6.2 for their wives. Wives perceived salinity impacts to be more serious than their husbands did.

The three aspects of farming affected the most by the salinity intrusion in 2019 were reported as irrigation water for crop cultivation and livestock, agricultural production, and total household income. Salinity intrusion also affected fresh water for cooking and bathing, family expenses (e.g. food, medicine, electricity, water, gas, essential goods), and social life and entertainment (e.g. meeting relatives, friends, parties, movies, concerts). Wives thought the impacts of salinity were more serious than their husbands did on all aspects, but the differences were not statistically significant.

Insert Table 4 here

Insert Table 5 here

3.3 Wives' and husbands' adaptation strategies to salinity intrusion

Table 6 presents the difficulties that wives and their husbands have encountered while conducting adaptation strategies. Lack of capital is the highest-ranked obstacle for both wives (79.49%) and their husbands (80.34%). Other difficulties include lack of labor, lack of access to technology, difficulties in selling rice, and lack of information about adaptive measures. Husbands and wives had similar concerns related to these difficulties. The inclusion of these obstacles suggests a role for local authorities and agricultural associations in providing technological and financial support and adaptation information.

Insert Table 6 here

To capture the differences in adaptation strategies that wives and their husbands would apply, they were asked to select from the list of twelve adaptive measures. These measures were identified from the literature and expert interviews in the research sites. Husbands and wives chose similar adaptive measures. The most commonly selected measures were changing the planting calendar, reducing the number of rice crops per year, using salt-tolerant rice varieties, using short-term rice varieties, saving rainwater for daily use, and purchasing agricultural input for later payment. The most significant difference between husbands and wives in the choices was for using part of the rice farm for the cultivation of other crops, with 63.25% and 44.44%, respectively.

Insert Table 7 here

3.4 Factors affecting wives' and husbands' adaptation to salinity intrusion

The correlation matrix of all independent variables used in the negative binomial models and binary logit models is presented in Table 8. It indicates no multicollinearity problem. The negative binomial regression was used to investigate the impacts of demographic factors and farming characteristics on the number of adaptive measures that wives and husbands intend to use. The estimation results are in Table 9. Intra-household differences exist in the factors affecting the number of adaptive measures chosen by wives and their husbands.

In the husbands model, rice yield loss increases the number of adaptive measures, while income and age decrease it. Older farmers perhaps are less willing to make use of new information because they are more set in their ways. The impact of income is opposite to the results of Mishra and Pede (2017) who find that high-income households are able to diversify their assets, thereby increasing the number of adaptive measures open to them. In this study context, farmers' current income may curtail the number of adaptive measures they are able to apply. Farmers with lower income are more likely to use more adaptive measures. They may believe that the more adaptive measures they apply, the more benefit they could gain from each of the measures.

In the wives model, education level as well as participation in formal institutions and training on adaptation to salinity intrusion positively influence the number of adaptive measures that wives choose. Well-educated farmers are often capable of accessing and utilizing sources of support for adaptation and may be more confident in using adaptive measures that require intensive technical support. They are therefore more likely to choose more adaptive measures. In the study of Mishra & Pede (2017), respondents' level of education was found to influence the number of adaptive measures to climate change that farm operators would employ, while no impact was seen for the spouses' choice. The impact of education on adaptation strategies appears to be gender-specific. Wives who have participated in training on adaptation to salinity intrusion and formal institutions were more likely to choose more adaptive measures. Information received from such training and the involvement in formal institutions may provide farmers with timely support for adaptation. This could explain the increase in the number of adaptive measures they indicate they will take. However, participation in training and formal institutions was not statistically significant for husbands. The participation in such events and institutions is normal for husbands but uncommon for wives in the research sites.

Interestingly, factors affecting the number of adaptive measures chosen by husbands and wives in the study are quite different. Household economic-related factors are statistically significant for husbands, while institutional/social support and education are significant for their wives. Although wives have limited access to social activities, associations and education opportunities, their participation in social activities, training and associations appears to significantly affect the number of adaptive measures they choose. Providing additional support for wives to participate in those activities may therefore promote the adoption of more adaptive measures.

Insert Table 8 here

Insert Table 9 here

The binary logit models explore factors that affect the choice of both wives and husbands for particular adaptive measures. These include changing part of rice farm to other crops, saving rainwater for daily use, and seeking other income sources. The literature has emphasized education as an important determinant of farmers' decisions on adaptation to climate change, extreme climate events and salinity intrusion (Aryal et al., 2020; Le et al., 2015; Paik et al., 2020; SeinnSeinn et al., 2015; Trang et al., 2018; Trinh et al., 2018). Studies assert that educated farmers have more knowledge and information on adaptation practices that could allow them to effectively respond to climate stressors. The literature finds the impact of education on adaptation choices to be adaptive measure-specific (Jin et al., 2015). In this study, we find an increase in education levels significantly increases wives' intention to apply each of the three adaptive measures. The average education level of wives in our sample is lower than grade 6, while that of husbands is about grade 7. This emphasizes the importance of enhancing access to education for farmers, especially female farmers.

As seen in Table 10, age negatively affects wives' choice of seeking other income sources. In developing countries and rural areas, wives are responsible for housework and taking care of children. As a result, they lack knowledge and skills to take off-farm jobs (McKinley et al., 2016). When getting older, it is much more difficult for female farmers to absorb new knowledge, thereby resulting in an obstacle for them to seek other income sources.

Wives who participate in local formal institutions (e.g. Farmers' Unions, Women's Unions, Veterans Associations) are more likely to choose to use some of the rice farm land to cultivate other crops. These women are also more likely to seek other income sources. Activities of these associations could provide farmers with different types of support and networking opportunities. Such associations can be effective sources of social capital, which is important during the adaptation process. Actively participating in those associations, either as a member or a leader, could assist farmers to learn about adaptation to salinity intrusion, thereby broadening their choice of adaptation strategies.

Wives who have participated in training related to adaptation to salinity intrusion are more likely to change part of their rice farm to other crops as an adaptive response. Such training can provide farmers with updated information on adaptation issues and strategies.

Survey findings were that participation in social activities (e.g. community meetings, unions) was low for both wives (4.61%) and their husbands (9.72%). This limited time for social activities may restrict both husbands and wives from accessing and implementing adaptation strategies since formal institutions are shown to be direct and effective sources of information for wives.

The time allocated to farming, livestock rearing and other jobs significantly increases wives' intention to change part of their rice farm to other crops, while decreasing the likelihood they will choose to save rainwater for daily use, though these effects were small. More time spent on farming and livestock may suggest a greater comfort with switching crops. While resources are limited, farmers may choose the alternative they believe to be the most effective measure. In this case, saving rainwater for daily use seems to become less of a priority.

Wives with higher household farm income are more likely to select the option to save rainwater for daily use and are less likely to seek other income sources. Saving rainwater for daily use could be a wise choice since the shortage of water is serious in the research sites during periods of more salinity. The literature finds the impacts of income on adaptation behavior to be varied. Household income was found to be insignificant in a study on adaptation to climate change in China (Jin et al., 2015), while farm income was a significant factor increasing the number of adaptive measures of farm operators and their spouses in Vietnam (Mishra & Pede, 2017). The impact of income on adaptation may be measure-specific and mostly contextual.

Insert Table 10 here

In the husbands logit models, three factors affecting husbands' intention to seek other income sources are the percentage of rice yield loss in 2019, education, and farm income. Farmers who experienced a greater rice loss in 2019 are more likely to choose to seek other income sources to minimise the impacts on their lives. More educated farmers are also more likely to seek other income sources, perhaps because they are in a better position to do so. Seeking other income sources appears to be less attractive to farmers with higher farm income. Those farmers may think they do not need income from other sources, or they may be involved in other adaptation measures that would make it impossible to seek other income sources. The other two models explaining factors affecting husbands' intention to save rainwater for daily use and to change part of the rice farm to other crops were not statistically significant.

These results suggest a disparity between the determinants of wives' and husbands' intention to choose particular adaptive measures. Wives had a relatively low level of and limited access to education. This restricts them from accessing information, technical support, and social networks to help their adaptation strategies. The findings show that education and its contribution to increased participation in training and institutions may have a bigger impact on adaptation strategies of wives than those of their husbands. Gender-specific policy formulation may enhance farmers' adaptive capacity and contribute to an increase in adaptation strategies related to salinity intrusion.

Insert Table 11 here

4. Conclusions and policy implications

The Mekong Delta, Vietnam, has been identified as vulnerable to climate change and extreme climate events. Salinity intrusion resulting from climate-associated sea level rise has emerged as one of the pressing concerns for agriculture in this area. In this context, the role of gender in intra-household climate change adaptation strategies has become an important issue as gender-related factors may influence farmers' adaptation behavior.

The findings suggest that wives and husbands may have different preferences for adaptation strategies. Different gender-related factors affect their choices, and they tend to select different adaptive measures. Thus, policies to affect farmer behavior may be more effective if gender roles are considered in climate change policy design. Information dissemination strategies regarding adaptation to salinity intrusion should consider gender-appropriate themes and approaches. Training initiatives related to adaptation to salinity intrusion should be organised at flexible schedules and convenient places to allow the participation of more wives. Wives should be encouraged to attend such training activities. Gender-sensitive adaptation information channels that consider gender-related information access constraints should be designed.

Wives have limited time and access to education, training, and resources. However, they appear to benefit more from participation in social activities and institutions, in terms of preferences for adaptive measures. We find that if wives receive more education, attend more training on adaptation and participate more in formal institutions, they are willing to adopt more adaptive measures. Thus, increased access for wives to education and training and more options for them to participate in formal institutions may contribute to an increased interest on their part in adopting adaptive measures.

Acknowledgements

We are grateful to the Swedish International Development Cooperation Agency (Sida) through the Environment for Development Initiative (EfD) at the University of Gothenburg for financial support through Research Grant MS-890. We would like to express our gratitude also to local authorities of Tien Giang, Ben Tre, Soc Trang Provinces, Go Cong Tay, Ba Tri, Long Phu Districts, and Dong Thanh, An Binh Tay, Chau Khanh communes for generously supporting the field trips, expert interviews, and farm household surveys. We would like to thank all farmers in the study site for taking their time helping us to complete the survey. Special thanks to 10 students and lecturers for their support during the interviews in the Mekong Delta.

References

Akter, S., Krupnik, T. J., Rossi, F., & Khanam, F. (2016). The influence of gender and product design on farmers' preferences for weather-indexed crop insurance. *Global Environmental Change*, *38*, 217-229.

Al-Amin, A. A., Akhter, T., Islam, A. H. M. S., Jahan, H., Hossain, M., Prodhan, M. M. H., Mainuddin, M., & Kirby, M. (2019). An intra-household analysis of farmers' perceptions of and adaptation to climate change impacts: empirical evidence from drought prone zones of Bangladesh. *Climatic Change*, *156*(4), 545-565.

Almaden, C. R. C., Diep, T. T., Rola, A. C., Baconguis, R. D., Pulhin, J. M., Camacho, J. V., & Ancog, R. C. (2020). Factors influencing measure-based adaptation of rice farmers for slow-onset hazard: the case of saltwater inundation in the Philippines and Vietnam. *Environmental Management*, *66*(4), 629-643.

Andersen, L. E., Verner, D., & Wiebelt, M. (2016). Gender and climate change in Latin America: an analysis of vulnerability, adaptation and resilience based on household surveys. *Journal of International Development*, *29*(7), 857-876.

Arora-Jonsson, S. (2011). Virtue and vulnerability: Discourses on women, gender and climate change. *Global Environmental Change*, *21*(2), 744-751.

Aryal, J. P., Sapkota, T. B., Rahut, D. B., Krupnik, T. J., Shahrin, S., Jat, M. L., & Stirling, C. M. (2020). Major climate risks and adaptation strategies of smallholder farmers in coastal Bangladesh. *Environmental Management*, *66*(1), 105-120.

Below, T. B., Mutabazi, K. D., Kirschke, D., Franke, C., Sieber, S., Siebert, R., & Tscherning, K. (2012). Can farmers' adaptation to climate change be explained by socio-economic household-level variables? *Global Environmental Change*, *22*(1), 223-235. https://doi.org/10.1016/j.gloenvcha.2011.11.01.

Bergqvist, A., Eitrem Holmgren, K., & Rylander, P. (2012). Impacts of saline water intrusion on the daily lives in the Mekong Delta Viet Nam. *Swedish University of Agricultural Science (SLU), minor field study*.

Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S., & Herrero, M. (2013). Adapting agriculture to climate change in Kenya: Household strategies and determinants. *Journal of Environmental Management*, *114*, 26-35. https://doi.org/10.1016/j.jenvman.2012.10.036.

Chaudhury, M., Kristjanson, P. M., Kyagazze, F., Naab, J. B., & Neelormi, S. (2012). Participatory gender-sensitive approaches for addressing key climate change-related research issues: Evidence from Bangladesh, Ghana, and Uganda. *Working Paper 19. Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).*

Deressa, T. T., Hassan, R. M., Ringler, C., Alemu, T., & Yesuf, M. (2009). Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change, 19*(2), 248-255. https://doi.org/10.1016/j.gloenvcha.2009.01.002.

Esfandiari, M., Khalilabad, H. R. M., Boshrabadi, H. M., & Mehrjerdi, M. R. Z. (2020). Factors influencing the use of adaptation strategies to climate change in paddy lands of Kamfiruz, Iran. *Land Use Policy*, *95*, 104628.

Goh, A. H. (2012). A literature review of the gender-differentiated impacts of climate change on women's and men's assets and well-being in developing countries. *International Food Policy Research Institute, CAPRi Work*, 1-44.

Greene, W. H. (2003). *Econometric analysis* (5^{th} ed.). Pearson Education, Upper Saddle River, New Jersey, USA.

Guloba, M. (2014). Adaptation to climate variability and change in Uganda: Are there gender differences across households? *WIDER Working Paper*.

Hoffmann, V. H., Sprengel, D. C., Ziegler, A., Kolb, M., & Abegg, B. (2009). Determinants of corporate adaptation to climate change in winter tourism: An econometric analysis. *Global Environmental Change*, *19*(2), 256-264.

Huynh, P. T., & Resurreccion, B. P. (2014). Women's differentiated vulnerability and adaptations to climate-related agricultural water scarcity in rural Central Vietnam. *Climate and Development*, *6*(3), 226-237.

Jin, J., Wang, X., & Gao, Y. (2015). Gender differences in farmers' responses to climate change adaptation in Yongqiao District, China. *Science of The Total Environment*, *538*, 942-948.

Jost, C., Kyazze, F., Naab, J., Neelormi, S., Kinyangi, J., Zougmore, R., Aggarwal, P., Bhatta, G., Chaudhury, M., & Tapio-Bistrom, M.-L. (2016). Understanding gender dimensions of agriculture and climate change in smallholder farming communities. *Climate and Development*, *8*(2), 133-144.

Lawless, J. F. (1987). Negative binomial and mixed Poisson regression. *The Canadian Journal of Statistics/La Revue Canadienne de Statistique*, *13*(3), 209-225.

Le, T. D. P., Vo, D. H. V., & Huynh, T. D. X. (2015). Estimating the economic impacts of climate change on crop production in the coastal provinces of the Mekong Delta, Vietnam. *EEPSEA SRG Report*(2015-SRG1).

McCright, A. M. (2010). The effects of gender on climate change knowledge and concern in the American public. *Population and Environment*, *32*(1), 66-87.

McKinley, J., Adaro, C., Pede, V., Rutsaert, P., Setiyono, T., Thanh, C. T., Balangue, Z., Bandyopadhyay, S., Sheinkman, M., & Wassmann, R. (2016). Gender differences in climate change perception and adaptation strategies: the case of three provinces in Vietnam's Mekong River Delta. *CCAFS Report. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)*.

Mishra, A. K., & Pede, V. O. (2017). Perception of climate change and adaptation strategies in Vietnam: are there intra-household gender differences? *International Journal of Climate Change Strategies and Management*, *9*(4), 501-516. https://doi.org/10.1108/IJCCSM-01-2017-0014

Mitchell, T., Tanner, T., & Lussier, K. (2007). 'We know what we need': South Asian women speak out on climate change adaptation. *Institute of Development Studies and Action Aid International*.

Nachmany, M., Fankhauser, S., Davidová, J., Kingsmill, N., Landesman, T., Roppongi, H., Schleifer, P., Setzer, J., Sharman, A., Singleton, C. S., Sundaresan, J., & Townshend, T. (2015). The 2015 global climate legislation study: a review of climate change legislation in 99 countries: summary for policy-makers. Grantham Research Institute on Climate Change and the Environment.

Ngigi, M. W., Mueller, U., & Birner, R. (2017). Gender differences in climate change adaptation strategies and participation in group-based approaches: An intra-household analysis from rural Kenya. *Ecological Economics*, *138*, 99-108.

Nguyen, M. T., Renaud, F. G., Sebesvari, Z., & Nguyen, D. C. (2019). Resilience of agricultural systems facing increased salinity intrusion in deltaic coastal areas of Vietnam. *Ecology and Society*, *24*(4), 19. https://doi.org/10.5751/ES-11186-240419

Nhung, T. T., Le Vo, P., Van Nghi, V., & Bang, H. Q. (2019). Salt intrusion adaptation measures for sustainable agricultural development under climate change effects: A case of Ca Mau Peninsula, Vietnam. *Climate Risk Management*, *23,* 88-100.

Ojo, T., & Baiyegunhi, L. (2020). Determinants of climate change adaptation strategies and its impact on the net farm income of rice farmers in south-west Nigeria. *Land Use Policy*, *95*, 103946.

Paik, S., Le, D. T. P., Nhu, L. T., & Mills, B. F. (2020). Salt-tolerant rice variety adoption in the Mekong River Delta: Farmer adaptation to sea-level rise. *PLOS One*, *15*(3), e0229464.

Perez, C., Jones, E., Kristjanson, P., Cramer, L., Thornton, P., Förch, W., Barahona, C. (2014). How resilient are farming households, communities, men and women to a changing climate in Africa? CCAFS Working Paper no. 80. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Pham, P., Doneys, P., & Doane, D. L. (2016). Changing livelihoods, gender roles and gender hierarchies: The impact of climate, regulatory and socio-economic changes on women and men in a Co Tu community in Vietnam. *Women's Studies International Forum*, *54*, 48-56.

SeinnSeinn, M., Ahmad, M., Thapa, G., & Shrestha, R. (2015). Farmers' adaptation to rainfall variability and salinity through agronomic practices in lower Ayeyarwady Delta, Myanmar. *Journal of Earth Science & Climatic Change*, *6*(2), 1-12.

Smajgl, A., Toan, T. Q., Nhan, D. K., Ward, J., Trung, N. H., Tri, L., Tri, V., & Vu, P. (2015). Responding to rising sea levels in the Mekong Delta. *Nature Climate Change*, *5*(2), 167-174.

Szabo, S., Hossain, M. S., Adger, W. N., Matthews, Z., Ahmed, S., Lázár, A. N., & Ahmad, S. (2016). Soil salinity, household wealth and food insecurity in tropical deltas: evidence from south-west coast of Bangladesh. *Sustainability Science*, *11*(3), 411-421.

Tibesigwa, B., Visser, M., Hunter, L., Collinson, M., & Twine, W. (2015). Gender differences in climate change risk, food security, and adaptation: a study of rural households' reliance on agriculture and natural resources to sustain livelihoods. *Economic Research Southern Africa Working Paper 545*.

Tran, T. A., Nguyen, T. H., & Vo, T. T. (2019). Adaptation to flood and salinity environments in the Vietnamese Mekong Delta: Empirical analysis of farmer-led innovations. *Agricultural Water Management*, *216*, 89-97.

Trang, N. T., Tu, V. H., Khai, H. V., & Yabe, M. (2018). The determinants behind changes of farming systems and adaptation to salinity intrusion in the coastal regions of Mekong Delta. *Journal of Faculty of Agriculture, Kyushu University*, *63*(2), 417-422.

Trinh, T. Q., Rañola Jr, R. F., Camacho, L. D., & Simelton, E. (2018). Determinants of farmers' adaptation to climate change in agricultural production in the central region of Vietnam. *Land Use Policy*, *70*, 224-231.

Wrigley-Asante, C., Owusu, K., Egyir, I. S., & Owiyo, T. M. (2019). Gender dimensions of climate change adaptation practices: the experiences of smallholder crop farmers in the transition zone of Ghana. *African Geographical Review*, *38*(2), 126-139.

Yusuf, A. A., & Francisco, H. (2009). Climate change vulnerability mapping for Southeast Asia. *International Development Research Centre (IDRC). Singapore*, viewed 13 September 2010. http://www.idrc.ca/eepsea/ev-149302-201-1-DO_TOPIC.html

Table 1. The surveyed communes in the Mekong Delta, Vietnam

Provinces	**Districts**	**Communes**
Tien Giang	Go Cong Tay	Dong Thanh
Ben Tre	Ba Tri	An Binh Tay
Soc Trang	Long Phu	Chau Khanh

Table 2. Explanatory variables used in the husbands' and the wives' adaptation models

Variables	Descriptive	Husbands					Wives				
		Percentage[a] (%)	Mean	St.dev	Min.	Max.	Percentage[a] (%)	Mean	St.dev	Min.	Max.
Demographics											
Age (G1)	Age of respondents		53.81	9.63	27	75		52.06	9.61	28	72
Education (G6)	Number of schooling year of respondents		7.32	3.75	0	16		5.86	3.69	0	17
Socio-economic characteristics											
Farm_livestock_other time allocation (H1a)	Percentage of time allocation for farming, livestock and other jobs		49.67	16.99	0.30	80		39.74	19.24	0	80
Farm_income (I1)	Total annual farm income (million VND/year)		71.77	77.30	0.33	395.80		71.77	77.30	0.33	395.80
Institutional conditions											
Extension (Ea1)	Attending extension services		0.83	0.38	0	1		0.47	0.50	0	1
	1 = Yes	82.91					47.01				
	0 = No	17.09					52.99				
Training_salinity (E4)	Attending the training of responding to salinity intrusion		0.35	0.48	0	1		0.17	0.38	0	1
	1 = Yes	35.04					17.09				
	0 = No	64.96					82.91				
Social capital											
Formal_institutions (E3)	Attending the formal institutions		0.56	0.50	0	1		0.41	0.49	0	1
	1 = Yes	56.41					41.03				
	0 = No	43.59					58.97				
Salinity degree											
Per_salinity (A5)	Respondents were asked to identify the extent to which they agree with the corresponding statements about perception on salinity intrusion based on seven-point Likert scale (from 1—strongly disagree to 7—strongly agree)		6.01	0.99	1.50	7		6.04	0.70	3.60	7
Loss_yield (A3e)	Percentage of yield lost due to salinity in 2019 (%)		45.36	21.86	0	100		45.36	21.86	0	100

Note: [a] The percentage is not presented for continuous variables

Table 3. Intra-household perception of the status of salinity intrusion in local areas

Statements	Level of agreement (1-7)	
	Husband	Wife
Saltwater is increasingly encroaching on rivers, creeks and land.	6.000	6.128
The time the water gets salty during the year is getting longer and longer.	5.889	5.949
The time when the water is salted is increasingly erratic, difficult to predict.	5.761	5.752
The salinity of river water, creeks are increasing.	6.103	6.068
The salinity intrusion is getting worse.	6.308	6.291

Table 4. Intra-household perception of the influence of salinity intrusion on agricultural production and their lives

Year	% perceived the influence		The perceived extent of influence (1-7)	
	Husband	Wife	Husband	Wife
2015	42.74	51.28	4.300	4.350
2016	67.52	58.12	4.747	4.824
2017	37.61	41.88	3.818	4.367
2018	35.90	38.46	4.143	4.733
2019	100.00	100.00	5.940	6.179

Table 5. Intra-household evaluation of the influence of salinity intrusion in the salinity intrusion period at the end of 2019 to the beginning of 2020

Aspect	The extent of influence (1-7)	
	Husband	Wife
Total income	5.368	5.701
Agricultural production (rice, other crops, livestock,…)	5.675	5.897
Freshwater (cooking, bathing)	4.274	4.496
Irrigation water (cultivation, livestock)	5.838	5.957
Family expenses (food, medicine, electricity, water, gas, essential goods,…)	4.915	5.162
Mental life and entertainment (meeting relatives, friends, parties, movies, concerts,…)	4.214	4.581

Table 6. The difficulties of husbands and wives in using adaptive measures for salinity intrusion

No.	Difficulties	% Husband	% Wife
1	Lack of capital	80.34	79.49
2	Lack of labor	50.43	51.28
3	Accessibility to technology	48.72	40.17
4	Selling	49.57	44.44
5	No or lack information about adaptive measures	38.46	38.46
6	Other reasons	3.42	1.71

Table 7. **Adaptation practices that husbands and wives intend to use**

Farm households' adaptive measures	% Husband	% Wife
Group 1 – Changing farming practices		
Changing rice farm to other crops (partly)	63.25	44.44
Changing rice farm to livestock (partly)	9.40	9.40
Crop rotation (Ex: 2 rice crops and 1 vegetable crop)	23.93	23.93
Group 2 – Water use and management		
Saving rainwater for daily use	81.20	82.91
Digging ponds for water storage (in the garden)	37.61	34.19
Using economical irrigation technology (vegetable, fruit)	26.50	22.22
Group 3 – The choice of rice varieties		
Using salt-tolerant rice varieties	93.16	91.45
Using short-term rice varieties	88.03	89.74
Group 4 – Planting calendar		
Reducing the number of rice crops per year	93.16	90.60
Changing planting calendar	96.58	91.45
Group 5 – Other measures		
Seeking other income sources	58.97	47.86
Purchasing agricultural input (payment when harvesting)	79.49	75.21
Others	6.84	5.13

Table 8. Correlation matrix for all explanatory variables in the adaptation models

Variables	A3e	A5	Ea1	E3	E4	G1	G6	H1a	I1
Husbands									
A3e_loss yield	1.000								
A5_perception	0.173	1.000							
Ea1_extension	-0.012	0.018	1.000						
E3_ formal_institutions	0.047	0.291	0.221	1.000					
E4_training_salinity	0.075	0.053	0.233	0.083	1.000				
G1_age	-0.012	-0.007	0.198	0.229	0.115	1.000			
G6_education	-0.034	-0.012	0.085	0.203	0.178	-0.161	1.000		
H1a_farm_livestock_other time allocation	-0.029	0.125	0.001	-0.092	-0.108	-0.097	-0.237	1.000	
I1_farm_income	-0.055	0.091	0.058	0.206	0.105	0.051	0.056	0.018	1.000
Wives									
A3e_loss yield	1.000								
A5_perception	0.006	1.000							
Ea1_extension	-0.079	-0.056	1.000						
E3_ formal_institutions	0.154	-0.055	0.189	1.000					
E4_training_salinity	0.057	0.047	0.391	0.083	1.000				
G1_age	0.040	0.144	-0.108	-0.034	0.009	1.000			
G6_education	-0.012	0.028	0.198	0.116	0.239	-0.309	1.000		
H1a_farm_livestock_other time allocation	-0.044	-0.009	0.058	-0.001	-0.018	-0.202	0.133	1.000	
I1_farm_income	-0.055	-0.083	-0.009	0.071	-0.007	0.089	0.010	-0.057	1.000

Table 9. Count negative binomial regression on the number of adaptation strategies to salinity intrusion

Variables	Husbands (n=117)			Wives (n=117)		
	Coefficients	**P > z**	**Marginal effects**	**Coefficients**	**P > z**	**Marginal effects**
Constant	2.2269 (0.1671)	0.000		1.7819 (0.2625)	0.000	
Loss_yield	**0.0016 (0.0007)	0.024	0.0121 (0.0053)	-0.0010 (0.0011)	0.355	-0.0074 (0.0080)
Per_salinity	-0.0012 (0.0189)	0.950	-0.0091 (0.1441)	0.0158 (0.0309)	0.609	0.1126 (0.2198)
Extensions	-0.0373 (0.0571)	0.514	-0.2851 (0.4370)	0.0306 (0.0503)	0.543	0.2181 (0.3593)
Formal_institutions	0.0584 (0.0415)	0.159	0.4467 (0.3183)	***0.1366 (0.0452)	0.002	0.9750 (0.3204)
Training_salinity	0.0428 (0.0352)	0.224	0.3269 (0.2687)	**0.1228 (0.0594)	0.039	0.8767 (0.4223)
Age	**-0.0043 (0.0018)	0.016	-0.0327 (0.0135)	-0.0014 (0.0024)	0.554	-0.0099 (0.0167)
Education	0.0035 (0.0047)	0.465	0.0265 (0.0362)	***0.0173 (0.0054)	0.001	0.1232 (0.0382)
Farm_livestock_other time allocation	-0.0007 (0.0009)	0.434	-0.0053 (0.0068)	0.0002 (0.0012)	0.879	0.0014 (0.0089)
Farm_income	**-0.0005 (0.0002)	0.013	-0.0039 (0.0016)	-0.0001 (0.0002)	0.952	-0.0001 (0.0017)
Number of observations	117			117		
LR chi-squared (9)	36.4800			38.7100		
Prob > chi-squared	0.0000			0.0000		
Log likelihood	-243.1070			-248.4571		
Pseudo R^2	0.0103			0.0277		

Note: The values in parentheses are Robust Standard Errors; *, **, *** indicate significance at 10%, 5%, and 1%, respectively

Table 10. Logit model of the factors affecting adaptation strategies that wives intend to use

Explanatory variables	Changing rice farm to other crops (partly)				Saving rainwater for daily use				Seeking other income sources			
	Coef.	Odds ratio	P > z	ME	Coef.	Odds ratio	P > z	ME	Coef.	Odds ratio	P > z	ME
Constant	-4.510 (0.026)	0.011	0.062		-0.545 (1.789)	0.580	0.860		3.052 (53.205)	21.144	0.225	
Loss_yield	0.001 (0.010)	1.001	0.930	0.0002	0.021 (0.018)	1.021	0.256	0.0025	-0.007 (0.011)	0.993	0.521	-0.001
Per_salinity	0.056 (0.339)	1.058	0.860	0.0105	-0.001 (0.371)	0.992	0.983	-0.0009	-0.134 (0.297)	0.875	0.695	-0.023
Extensions	-0.383 (0.333)	0.682	0.433	-0.0712	*-1.115 (0.201)	0.328	0.068	-0.1334	0.674 (0.913)	1.962	0.147	0.116
Formal_institutions	*0.842 (1.061)	2.321	0.066	0.1566	0.358 (0.824)	1.430	0.535	0.0430	**1.193 (1.573)	3.295	0.013	0.205
Training_salinity	*1.109 (2.006)	3.032	0.094	0.2063	0.185 (1.079)	1.203	0.837	0.0222	-0.269 (0.567)	0.764	0.716	-0.046
Age	0.023 (0.028)	1.023	0.394	0.0043	0.027 (0.029)	1.027	0.350	0.0032	***-0.070 (0.023)	0.932	0.005	-0.012
Education	***0.278 (0.092)	1.320	0.000	0.0516	**0.163 (0.097)	1.177	0.047	0.0196	**0.049 (0.086)	1.161	0.043	0.026
Farm_livestock_other time allocation	*0.020 (0.012)	1.020	0.094	0.0036	*-0.024 (0.014)	0.976	0.092	-0.0029	0.014 (0.013)	1.014	0.291	0.002
Farm_income	-0.001 (0.003)	0.999	0.918	-0.0001	***0.008 (0.003)	1.008	0.010	0.0010	*-0.001 (0.005)	0.992	0.073	-0.001
Number of observations	117				117				117			
LR chi-squared (9)	30.20				18.53				29.69			
Prob > chi-squared	0.000				0.030				0.001			
Log likelihood	-64.536				-45.082				-60.439			
Pseudo R^2	0.197				0.158				0.254			

Note: The values in parentheses are Robust Standard Errors; *, **, *** indicate significance at 10%, 5%, and 1%, respectively

Table 11. Logit model of the factors affecting adaptation strategies that husbands intend to use

Explanatory variables	Changing rice farm to other crops (partly)				Saving rainwater for daily use				Seeking other income sources			
	Coef.	**Odds ratio**	**P > z**	**ME**	**Coef.**	**Odds ratio**	**P > z**	**ME**	**Coef.**	**Odds ratio**	**P > z**	**ME**
Constant	-2.703 (0.095)	0.067	0.055		2.262 (17.644)	9.601	0.218		1.056 (4.610)	2.872	0.511	
Loss_yield	0.012 (0.011)	1.012	0.263	0.003	0.003 (0.013)	1.003	0.831	0.001	**0.029 (0.012)	1.029	0.012	0.0053
Per_salinity	**0.454 (0.345)	1.574	0.039	0.097	-0.054 (0.239)	0.947	0.831	-0.008	-0.196 (0.198)	0.822	0.415	-0.0361
Extensions	-0.084 (0.508)	0.919	0.879	-0.018	-0.978 (0.307)	0.376	0.231	-0.144	-0.952 (0.234)	0.386	0.117	-0.1748
Formal_institutions	0.399 (0.655)	1.491	0.363	0.085	0.635 (1.054)	1.887	0.256	0.093	-0.550 (0.313)	0.577	0.312	-0.1010
Training_salinity	-0.030 (0.435)	0.970	0.946	-0.006	-0.019 (0.581)	0.981	0.974	-0.003	0.451 (0.774)	1.570	0.360	0.0830
Education	0.018 (0.059)	1.018	0.759	0.004	0.052 (0.079)	1.053	0.492	0.008	**0.150 (0.088)	1.162	0.049	0.0275
Farm_livestock_other time allocation	-0.004 (0.012)	0.996	0.771	-0.001	-0.007 (0.019)	0.993	0.713	-0.001	-0.001 (0.013)	0.999	0.965	-0.0001
Farm_income	-0.001 (0.003)	0.999	0.658	-0.001	-0.001 (0.003)	0.999	0.672	-0.001	***-0.012 (0.004)	0.988	0.004	-0.0022
Number of observations	117				117				117			
LR chi-squared (8)	9.310				4.730				19.020			
Prob > chi-squared	0.317				0.786				0.013			
Log likelihood	-71.999				-54.357				-63.577			
Pseudo R^2	0.064				0.039				0.197			

Note: The values in parentheses are Robust Standard Errors; *, **, *** indicate significance at 10%, 5%, and 1%, respectively