FACTORS INFLUENCING FARMERS' ADAPTATION STRATEGIES TO CLIMATE CHANGE IN BOPHLOI DISTRICT, KANCHANABURI PROVINCE, THAILAND

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Abstract

Thailand is very vulnerable to droughts and floods and has experienced several extreme climatic events. Thai farmers have usually developed coping strategies to adapt to or reduce the negative impacts of climate change on their farming operations. This study aims at identifying the strategies that Thai farmers adopt in relation to the ongoing changes in climatic events and to determine the factors influencing farmers' adoption of adaptive strategies. The present study drew upon a survey of 364 farmers in Bophloi district, Kanchanaburi province of Thailand. Results showed that a majority of the farmers self-reported as having employed in adaptive behavior. The use of drought tolerant varieties was the most common adaptation strategy used. Whilst zero tillage was the least common adaptation strategy employed among the farmers. Using binary logistic regression, the results found that younger, more educated respondents with larger household size, access to credit, and possessing smaller land size, and/or contact with agricultural extension agents were more likely to employ adaptation strategies to climate change. These results provide a policy insight that government should facilitate infrastructure, support financial access, and encourage agricultural extension services to the farmers, all in order to promote adoption of coping strategies so as to tackle the adverse effects of climate change.

Keywords: Factors influencing; adaptation strategy; climate change; Thai farmers

Introduction

Southeast Asia is generally acknowledged to be a region most vulnerable to the impacts of climate change. The observed climate change trends in Southeast Asia include increases in temperature, decreases in rainfall, sea level rise, increased frequency, duration and intensity of extreme weather events such as droughts, storms, floods, typhoons, and heat waves, significant increases in heavy precipitation events and more tropical cyclones (Cruz et al., 2007). In the tropics generally, and especially in Southeast Asian countries, changes in climate are expected to be destructive to agricultural livelihoods. The Food and Agricultural Organization (2008) argues that many countries worldwide are facing food crises due to conflict and disasters, while food security is being adversely affected by many factors including droughts and floods linked to climate change.

Thailand is one of a number of Southeast Asian countries that is highly vulnerable to droughts and floods and has experienced several extreme climatic events in the recent past (CHRR, 2005). Even though future climate change scenarios are still being debated, it is likely that Thailand will be markedly affected by the consequences of climate change. Around 38 percent of Thailand's population currently relies on agriculture for their livelihood, with 25 million people in 2015 working in the agricultural sector (DOAE, 2016). Agricultural products are highly dependent on specific climate conditions. Drought and flood-affected agricultural lands have experienced various degrees of crop loss (MOAC, 2012) and agricultural production, which is dominated by small-scale family farms engaged in cash crops, is in continuous decline over the past 30 years due to declining or degrading natural resources (UNDP, 2010). Crop productivity is also expected to be influenced by changing precipitation and temperature levels which are associated with agricultural pests and diseases and declining crop yields. Given this, climate change is expected to influence crop and livestock production, hydrologic balances, input needs and other components of the Thai agricultural sector. However, the nature of these biophysical effects and the human responses to them are complex and uncertain.

Climate change is a transnational issue but adaptation strategies are usually developed at the regional, national, and local levels. This trend is being

more frequently witnessed in developing countries. Adaptation to climate change is the adjustment in natural or human systems in response to actual or expected climatic condition or effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). Several studies have indicated farmers do perceive that climate is changing and have developed coping strategies to adapt or reduce the negative impacts of climate change on their farming operations (Deressa and Rashid, 2010; Mertz et al., 2009; David et al., 2007). The goal of adaptation is long-term resilience, to create the conditions in which society and ecosystems are largely able to reduce the impact from climate change, such that any enduring impacts beyond their coping capacity remain within acceptable limits of risks. Adaptation strategies to climate change have often been pursued in many countries in order to reduce negative effects. A consensus has emerged that developing countries are more vulnerable to climate change than developed countries because of the predominance of agriculture in their economies and the scarcity of capital available for adaptation strategies (Fischer et al., 2005).

Previous studies on adaptation strategies to climate change have found the major determinants including 1) various individual and household characteristics, and 2) infrastructure and institutional factors (Deressa et al., 2008; Maddison, 2006). The most common factors are gender, age, marital status, education, farm income, farm size, and access to credit and extension services (Asfaw and Admassie, 2004; Maddison, 2006; Deressa et al., 2008) Most of these factors can also be linked to poverty which obstructs farmers from getting the necessary resources and technologies and information that could assist adaptation strategies to climate change.

Given the importance of adaptation strategies in response to climate change, it is valuable to explore adaptation strategies to climate change in a Thai context since the agricultural sector here is still so important to the national economy and climate change is expected to adversely impact on this in the future. There is a necessity to identify the strategies that Thai farmers adopt in relation to the continuous and unpredictable changes in climatic events in order to determine the factors influencing the adoption of adaptive strategies. The present study focuses on determining socio-economic factors likely to be influential in adaptive behavior.

Literature Review

Types of Adaptation Strategies to Climate Change

The social and physical systems of the world can respond to climate change through adaptation. Such responses may be unintentional spontaneous changes or can be deliberate adaptive strategies. Adaptation involves managing the risk posed by climate change and variability. Adaptation strategies to climate change can be grouped into private and public sector adaptation strategies. Private adaptation strategies involve action taken by non-state agencies such as farmers, communities, or organizations. Private adaptation strategies include, for example, switching crops, shifting crop calendars, changing irrigation systems and selecting different cropping technologies (Bruin, 2011). Public adaptation involves activities taken by governments (at any level) to provide infrastructure and institutions to reduce the negative climate change effects. Public adaptation strategies include, for example, improvement of new irrigation infrastructure, transport or storage infrastructure, land use arrangement, and property rights (World Bank, 2010).

Bruin (2011) proposed adaptation strategies can be either proactive or reactive depending whether it happens before or after climate change. Reactive adaptation strategies address the effects of climate change after they have been experienced, while proactive adaptation strategies are engaged in anticipation of climate change. Reactive adaptation strategies include control of soil erosion, construction of irrigation dams, improving soil fertility, use of improved varieties, shifting planting and harvesting time. Proactive adaptation strategies involve the development of tolerant cultivars, research development, policy measures on taxation and incentives.

Determinants of Adaptation Strategies to Climate Change

Previous studies have reported that farmers' adaptation strategies were determined by several factors. Oyekale and Oladele (2012) found that farmers' adaptation strategies are positively influenced by male headship, larger household size, higher education level, and larger farm size. Yesuf et al., (2008) found that age, access to credit and extension information, geographical location have effected on farmers' adaptation of climate change adaptation strategies.

Obayelu et al. (2014) proved the results that factors explaining farmers' choice of climate change adaptation include age, gender, years of education, years of farming experiences, household size, farmers information on climate change, access to credit, farm income, non-farm income, livestock ownership and extension contact.

The present study hypothesized that farmer who were male, of younger age, unmarried, of higher education, within larger households, of higher income, with access to credit and larger land size, had land owned by themselves, and with more agricultural work experience and contact with agricultural extension agents had a greater probability to engage in adaptive strategies than farmers of other kinds.

Methods

Kanchanaburi is a large province located in the western part of Thailand. The province shares a long border with Myanmar and is also quite close to Bangkok. Bophloi district is one of thirteen districts in Kanchanaburi province and situated in the centre of the province (which is located north of Kanchanaburi city by about 47 kilometers). Bophloi district is one of the most climate-affected areas compared to other parts of the country due to prolonged drought hazards. Consequently, farming activities in this area are highly influenced by adverse climatic events.

The sample was drawn from a listing of registered farm-operating households collected by Thailand's Department of Agricultural Extension of the Ministry of Agriculture and Cooperatives. The present study used three-stage sampling procedure in selecting the households surveyed in the study area. At the first stage, two sub-districts were randomly selected. The second stage involved the random selection of two villages proportional to population size while the third stage was the random selection of households proportionate to the size of the selected villages. Using Krejcie and Morgan's sample size calculation (1970), about 364 respondents from registered farm operating households were interviewed by using a structured questionnaire. One of the sample selection criteria which should be mentioned was that the present study selected only those who were residing in the study area more than 10 years which was a reasonable amount of time to observe climate change.

Components of the structured survey questionnaire collected information on (1) socio-economic factors of farmers and their household; (2) farmers' perception of long-term temperature, rainfall, and season changes for 10 years; (3) self-reported adoption of climate change mitigation strategies by the farmer.

Adaptation is a dependent dichotomous variable, which is determined by assigning a value of 1 for farmers who indicated that they employed adaptive measures in response to climate change and a value of 0 for those who indicated they did not employ any adaptive measures at all in response to climate change. If a farmer employs at least one adaptive measure to control the negative effects of climate change, they are considered to have "adapted". Respondents were asked about climate change adaptive behaviors which comprise with amount of simple dichotomous questions about whether or not they adapt any behaviors for reducing negative effects of climate change.

Adaptation strategies to climate change depend on the socio-economic characteristics of farmers, which regarded as independent variables. Independent variables in the present study are sex, age, marital status, years of schooling, household size, household status (whether they were head of the household), household income, access to credit (whether they can access to credit outside the household), land size (in acres), land ownership (whether they owned their land), years of agricultural experience, and contact with agricultural extension agents.

SPSS (a statistical software package) is used to analyze the collected data including descriptive statistics and multivariate analysis. Multivariate analysis is used to assess the complex impact of independent variables. In the present study, since the dependent variable – adaptation is a dichotomous variable, binary logistic regression is employed. It is used for making prediction of adapting the strategies probability.

Results and Discussion

Table 1 presented description of socio-economic characteristics of farmers, which were all of independent variables. It was found that there were more women than men and the mean age of the samples was 51 years. About

85% of them were married and the average years of schooling of the samples were 6.7 years which was about the length of time it takes to finish primary school. The average household size was 4 people per household. Two-third of the samples were head of the household. The average monthly household income was 12,765 baht (about 385 US dollar) and about 83% of the sample can access to credit from outside household for investing in agricultural works. The average land size for agriculture was 8.4 acres per household and more than 80% of the samples owned the agricultural land. The average years of agricultural work experience was 26 years. More than 75% of the farmers had contact with agricultural agents.

Table 1: Description of Socio-economic Characteristics of the Farmer Respondents (n = 364)

Independent variables		
Description	**Mean/ Percent**	**S.D.**
Women (take the value of 1 if women and 0 otherwise)	62.5%	
Age (continuous)	51.5	11.1
Ever married (takes the value of 1 if ever married and 0 otherwise)	84.7%	
Years of schooling (continuous)	6.7	3.2
Household size (continuous)	4.5	1.7
Head of the household (takes the value of 1 if being head of the household and 0 otherwise)	66.3%	
Household income (continuous)	12,765	12,870
Access to credit (takes the value of 1 if access and 0 otherwise)	83.0%	
Land size (continuous)	8.4	8.8
Land ownership (takes the value of 1 if owned and 0 otherwise)	83.0%	
Years of agricultural work experience (continuous)	43.1	17.1
Contact with agricultural extension agents (takes the value of 1 if had contact and 0 otherwise)	76.0%	

All the respondents were asked several questions about their perceived experience in relation to a series of climatic events in the study area within the past 10 years. They could respond that they had experienced either a decrease, increase, or no change, or to respond that not such event occurred. Table 2 reported their responses for each climatic event. Most respondents indicated that they had experienced increases in temperature, decreases in rainfall, increases in drought, decreases in flooding, decreases in storming, short winter season, long summer season, and decreases in monsoon season. It is clear that most of them reported having experienced climatic shifts, especially drought, which are likely to have a negative impact on agricultural activity.

Table 2: Distribution of Responses to Perceived Changes in Specific Climatic Events (n = 364)

Climatic Event	Percent of farmers indicating of what level they have experienced the climatic event over the last 10 years		
	Increased	**No Changes**	**Decreased**
Temperature	97.5	2.3	0.3
Rainfall	1.8	8.0	90.3
Occurrence of drought	71.5	16.5	12.0
Occurrence of flood	6.0	21.0	73.0
Occurrence of storm	27.0	32.0	41.0
Short winter season	94.8	3.2	2.0
Long summer season	96.8	3.2	0.0
Unpredictable rainfall	69.0	15.5	15.5
Changes of monsoon season	2.0	8.5	89.5

Figure 1 presents the adaptation to climate change employed by respondents. A majority of farmer respondents (82%) indicated that they had employed at least one of the adaptive strategies, while 18% indicated no employment of any adaptive strategies. This reflects several previous studies that the majority of farmers do tackle the negative effects of climate change (Idrisa et al., 2012; Oyekale and Oladele, 2012).

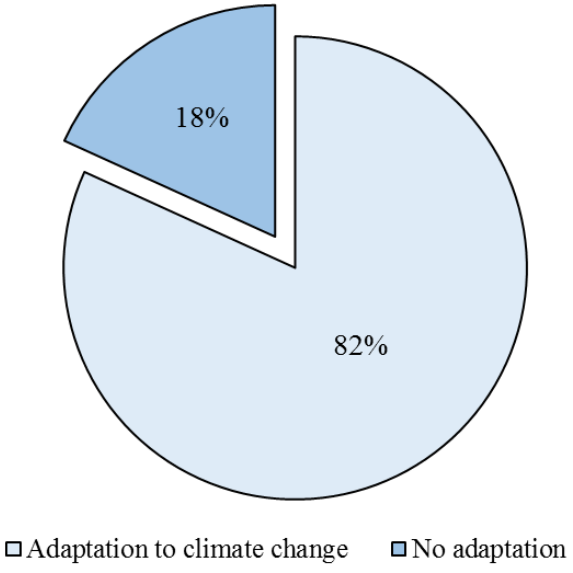

Figure 1: Percentage of Adaptation to Climate Change by Farmer Respondents (n = 364)

Among those who have adopted one or more of the adaptation options (Figure 2), it was found that use of drought tolerant varieties (69%) was the most used, followed by use of salinity tolerant varieties (65.8%). As drought was the most common disaster in this district where the study was conducted, farmers were more likely to use drought tolerant varieties which were suitable for the drier condition of their agricultural land. Also, more use of drought tolerant varieties as adaptation could be linked with the less expense and ease of access by farmers (Deressa et al., 2008). It was found that the least adaptation strategy employed among the respondents was zero tillage. Zero tillage was regarded as a sustainable agricultural practice contributing to increased yield, decreased soil erosion and reduced carbon emissions. Although zero tillage is widely used in agricultural production worldwide, especially in the Western Hemisphere (Brown, 2008), only 6 % of the farmers who adapted to climate change in the present study reported that they used zero tillage as an adaptive strategy.

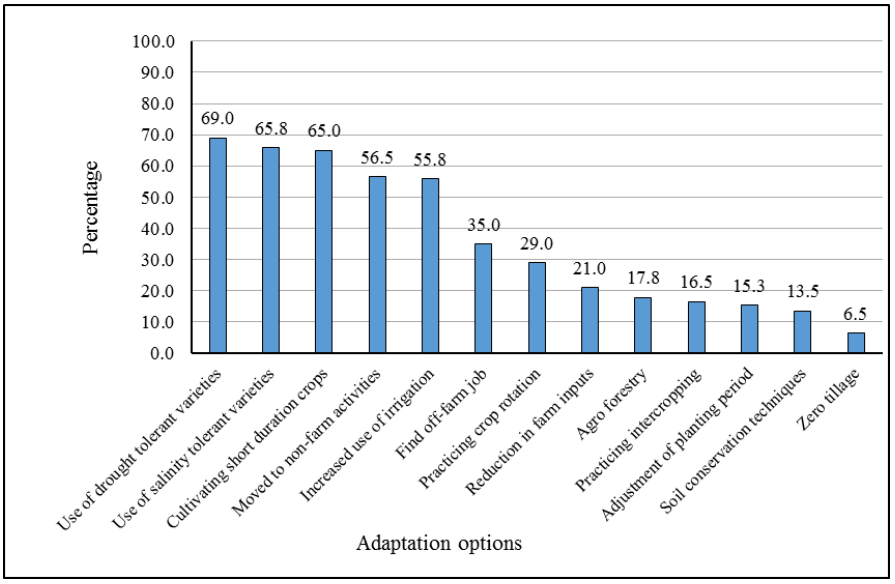

Figure 2: Percentage of Adaptation Options Adapted by Farmer Respondents Who Reported Adaptation to Climate Change (n = 298)

Table 3 displays the binary logistic regression model to determine factors influencing the farmers' adaptation strategies to climate change effects. The findings of the regression model indicate that age was negative and significantly related to farmers' adaptation strategies to climate change effects. This denoted that increases in the age of the farmers decrease the probability of adaptation. It can be explained that older farmers may follow traditional methods familiar to them rather than apply the modern farming techniques (Oyekale and Oladele, 2012). Years of schooling significantly positively affected the farmer's adaptation to climate change. This implied that the probability of adaptation to climate change is greater for those who have higher educational attainment compared to less educated or illiterate farmers. This result indicated that education levels are linked to greater access to climate change information, the employment of improved technologies, and also with the generation of higher agricultural productivity (Deressa et al., 2008).

There was a positive and significant relationship between household size and adaptation. Results showed that increasing size of the family increases the probability of farmers' adoption of adaptive strategies. Household size was

significant in influencing the use of adaptation measure among the respondents. Household size could be a measure of available labour for farming activities. Previous studies found that large household size makes more labour which can keenly engage in work, better facilitating the adoption of adaptive measure against negative climate change effects (Deressa et al., 2008; Oyekale and Oladale, 2012).

Access to credit was positive and significantly related to adoption of adaptation strategies, implying that the probability of adaptive strategy adoption in higher for those farmers who can access to credit compared to farmers cannot access to credit. This is consistent with findings by Nakuja et al. (2012) which found that access to credit facilities was the primary determinant of farmers' adaptive capacity.

Land size was negative and significantly related to farmers' adaptation strategies to climate change effects. The results indicated that increasing land size decreases the probability of farmers' adaptation strategies to climate change. It can be denoted that those who had large land size tend to employ traditional methods rather than modern farming techniques. Large land size requires greater level of investment to deal with negative climate change effects, consequently, large land size failed to invest compared to small land size because it was too costly to invest in large farms for preventing negative climate change effects (Acquah, 2011).

The regression model results explained that the probability of adaptation to climate change is greater for those who had contact with agricultural extension agents compared to those who never had contact with agricultural agents. Bryan et al., (2009) indicated that access to extension services had a strong positive influence on adapting to climate change. It can be interpreted that engagement in agricultural extension agents involved about sharing knowledge, discussing problems with others, and engaging in collaborative practices (Obayelu et al., 2014). Contact with agricultural extension agents might encourage adaptation to climate change among farmers.

Nevertheless, gender, ever married, head of household, household income, land ownership, and years of agricultural work experience were not statistically significant in the model, which was not support the hypotheses. These results were surprisingly different from previous hypothetical

considerations. The reasons might be that the insignificant statistical results had derived from the small sample size in the present study. Further research with larger sample size could provide the different results and give solution to consider other factors that are suitable for Thai context in further analysis.

Table 3: Estimates of Binary Logistic Regression Model Based on Farmers' Adaptation Strategies to Climate Change Effects (n = 364)

Variables	Adaptation		
	Coefficient	**S.E.**	**p-value**
Constant	1.242	1.093	0.256
Women	0.259	0.308	0.400
Age	-0.003**	0.014	0.005
Ever married	0.510	0.366	0.064
Years of schooling	1.209*	0.601	0.044
Household size	0.247**	0.088	0.005
Head of the household	0.264	0.321	0.411
Household income	0.000	0.000	0.473
Access to credit	0.297*	0.362	0.013
Land size	-0.034*	0.016	0.036
Land ownership	-0.278	0.399	0.487
Years of agricultural work experience	-0.007	0.011	0.247
Contact with agricultural extension agents	1.634**	0.494	0.001
Pseudo R^2	0.355		

Note: *p<0.05, **p<0.01, ***p<0.001

Conclusion and Recommendations

The majority of farmer respondents reported that they had experienced climate change effects within a past decade before the present study. More than 80 percent of farmer respondents indicated that they had employed at least one of the adaptive strategies to cope with climate change effects. Various

adaptation strategies were used by the farmer respondents. Due to the drought prevalence in the study area, use of drought tolerant varieties was the most adaptation strategy used, while zero tillage was the least adaptation strategy used among the farmers who reported they adopted strategies. The binary logistic regression model explained that farmer respondent who was younger, higher educational attainment, having larger household size, access to credit, having smaller land size, and had contact with agricultural extension agents were more likely to adapt the adaptation strategies to climate change effects.

In the policy recommendations, according to farmers' response about adaptation strategies to climate change, it was found that the majority of farmers seems to be using improved varieties while a few of farmer practices soil conservation techniques and zero tillage. This study revealed the need for promoting soil conservation measures, such as crop rotation, cover crop, zero tillage, among Thai farmers in order to prevent soil less erosion or degrading fertility. Future agricultural policies should focus on farmer awareness of such techniques in sustainable adaptation.

Policy makers in Thailand should focus on the policy that support infrastructure development, facilitate inexpensive access to agricultural inputs, and subsidize fundamental investment by providing credit market interventions. Since the results revealed that those who was able to access to credit had higher probability of adoption of the adaptation measure to climate change, access to credit by all farmers is to be ensured at all levels through financial institutions who are managing of credit to farmer-based organizations. Access to credit should be implemented at lower interest rates and be cashless to reduce farmers' expenses on farm inputs and boost commercialization of farmers.

Policies which ensure adequate dissemination of information and research on climate change and appropriate adaptive strategies should be promoted among farmers who were older, less-educated, having small household sizes, and having larger land sizes, all of which had lower probability of adaptive strategy adoption. Since involvement in agricultural extension provided greater chance of adaptive strategy adoption, the government should strengthen the establishment of extension services by ensuring increased contact between farmers and extension officers possibly through the training and field visits. Information about climate change should timely deliver to farmer through

extension officers to facilitate them more informed decisions and decrease uncertainty and let them to better prepare for severe weather conditions. Thai government through extension officers should encourage farmer-to-farmer extension services where farmers can exchange information about their adaptation to climate change experiences in order to take the valuable knowledge and practices from experienced farmers.

The present study provides the preliminary step in studying the factors influencing farmers' adaptation strategies to climate change in Thai context. Further investigations using qualitative studies or longitudinal studies would be helpful in order to identify factors influencing farmers' adaptation strategies to climate change accurately which can inform policy makers – both in Thailand and across the Southeast Asian countries – on how to shape interventions across the variation of negative climate change effects.

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