International Journal of Agricultural Technology 2020 Vol. 16(1): 129-142
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Factors influencing the adoption of climate change adaptation samong rice growers in Doi Saket District, Chiang Mai Province, Thailand

Sirisunyaluck, R.*, Singsin, P. and Kanjina, S.

Department of Agricultural Economy and Development, Faculty of Agriculture, Chiang Mai University, Chiang Mai 50200, Thailand.

Sirisunyaluck, R., Singsin, P. and Kanjina, S. (2020). Factors influencing the adoption of climate change adaptation strategies among rice growers in Doi Saket District, Chiang Mai Province, Thailand. International Journal of Agricultural Technology 16(1): 129-142.

Abstract The factors influencing the adoption of climate change adaptation strategies among rice growers in Doi Saket district were investigated. A proportionate stratified random sampling technique was reported from 200 rice growers as respondents from 13 sub-districts of Doi Saket district. It was observed that the majority of the rice growers adopted some climate change adaptation strategy such as changing planting date and growing different types of crops. Three variables, the cost per unit of planting, revenue sources and group membership were significant influenced in the adoption of climate change adaptation strategies at $p \leq 0.05$. However, only a few adaptation strategies were adopted. Thus, information on climate change and its impact as well as adaptation strategies should be disseminated to the rice growers. Training on these issues should be organized for agricultural extension officers so that they can be actived to support the rice growers. To support these farmers, research findings to improve rice varieties with drought-tolerance, and improvement of irrigation system efficiency should be implemented.

Keywords: adoption, climate change, adaptation strategies, rice growers

Introduction

Climate change is defined by the Australian Academy of Science (2018) as "a change in the pattern of weather and related changes in oceans, land surfaces and ice sheets, occurring over time scales of decades or longer. Climate change may be due to natural processes such as changes in the Sun's radiation, volcanoes or internal variability in the climate system or due to human influences such as changes in the composition of the atmosphere or land use". Currently, countries around the globe have increasingly suffered from climate-related disasters, storms, heatwaves, and wildfire. These events are largely due to climate change, which is a major factor affecting agriculture (Chavas *et al*., 2009). Climate change will increasingly affect the yields of food

***Coressponding Author:** Sirisunyaluck, R.; **Email:** ruth.si@cmu.ac.th

crops, biodiversity, and the entire food chain. This will cause difficulties and may lead to food insecurity of the world population (Greenpeace Thailand, 2010). Impact of climate change will be strongly felt by developing countries as they are agricultural countries. With climate change, agricultural products will decline, affecting food reserves and the economy of the countries that depend mainly on the export of agricultural products (UNEP, 2018).

Thailand is one of the countries affected by climate change as the country has increasingly faced severe drought and floods while the average temperature has also increased in every season (Office of Natural Resources and Environmental Policy and Planning, 2010). This climate change has had a major impact on agricultural production, particularly on rice which is an important crop in the country. The Thailand Research Fund (2012) found that if the current rice production pattern is still practiced, an increase in temperature will result in a decrease in the country's overall rice yields. For a long-term temperature rise, it is estimated that rice yields will fall by 10 percent with an increase of every one degree Celsius.

Doi Saket is one of the districts of the northern province of Chiang Mai, Thailand. The area is affected by climate change as it has faced water shortages due to a long interval of rainfall, thus there was a reduction in the amount of water for agriculture. The average rainfall in the district has been decreasing since 2014. Due to climate change, rice growers have been affected and severely suffered as they faced yield reduction and increased pest infestation.

With the changing climate, farmers have to adapt to climatic conditions. Evidently, farmers in different areas have different adaptation methods, including planting disease-resistance crops and drought-tolerant crops, changing the cropping calendar and patterns as well as practicing multiple cropping and mulching (Kamba and Muchapondwa, 2012; Akinnagbe and Irohibe, 2014; Okpe and Aye, 2014; Iheke and Agodike, 2016). In Doi Saket district, most rice growers know about global warming and have been affected for the past ten years. Some rice growers started to adapt to climate change, while some others did not. Based on studies of farmers' adaptation to climate change, it was found that factors supporting the adaptation included financial support for inputs (Sekaleki and Sebusi, 2013), access to agricultural extension and climate information (Okpe and Aye, 2014; Temesgen and Mohamud, 2009), and credit services (Below *et al*., 2012).

The present study aims to explore factors affecting rice growers' adaptation to climate change in Doi Saket District, Chiang Mai Province. The results obtained can be used as a guideline to support rice farmers to be self-reliant, and solve problems and impacts caused by climate change.

Materials and methods

This study employed a mixed method design with an exploratory sequential approach. The qualitative data was first collected to explore the extent of climate change and adaptation strategies perceived or practiced by rice growers. The quantitative data was then gathered to explain the patterns and relationships emerged from the qualitative data (Creswell, 2012). The qualitative data were collected via in-depth interviews with seven rice growers. In addition, focus group discussions were conducted with 13 rice growers to understand their perception about climate change and how they adapted to such change.

Table 1. Variables Description

Variable	Description
Adoption	1 for adoption of climate change strategy, 0 for non-adoption
Gender	1 for male, 0 for female
Age	Age of respondents (years)
Education	Years in school (years)
Experience	Experience in growing rice (years)
Total labor force	Number of laborers
Tenancy	1 for farm owner, 0 for farm renter
Production system	1 for growing rice only, 0 for rice and other crops
Farm size	The area used to grow rice (*rai*)
Cost per *rai*	Cost of rice planting (Baht) per *rai*
Revenue sources	1 for income from rice, 0 income from rice and others
Farm income	Annual farm income (Baht)
Credit	1 for access to credit, 0 for no access
Group memberships	Number of group memberships
Extension	1 for access to extension services, 0 for no access
Information	Number of information sources on climate change

Note: 1 ha = 6.25 *rai*; 1 US$ = approximately 30 Baht (as of September 2019)

The qualitative data were analyzed by means of content analysis. Results derived were utilized for developing a questionnaire to collect quantitative data from the rice growers. There are 2,869 rice growing households residing in 13 sub-districts of Doi Saket district, Chiang Mai province (Doi Saket Agricultural Office, 2017). A proportionate stratified random sampling technique was used to select 200 rice growers representing these households from the 13 sub-districts. Structured-interviews were conducted between June and July 2018.

The quantitative data were analyzed using descriptive and inferential statistical techniques. The descriptive statistics included frequency distrubution,

percentage, and means. Binary logistic regression analysis was performed, which can be specified as

$$P(Y_i=1) = \log \frac{P}{1-P} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p \quad (1)$$

$$P = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1+\beta_2 x_2+\ldots+\beta_p x_p)}} \quad (2)$$

$$\text{Odds} = \frac{P(\text{Adoption})}{P(\text{Non-aoption})} = \text{Exp(B)} \quad (3)$$

Where P is the probability of at least one climate change adaptation strategy was practiced, ranging between 0 and 1; Y is the dependent variable (1 = adoption; 0 = non-adoption); β_0 is the Y intercept; β_1 to β_p are the coefficients of the independent variables x_1 to x_p; *e* is a natural log; and, *i* = 1 - *n* (*n* is number of observations).

The description of all variables used for this study is presented in Table 1.

Results

Socioeconomic and demographic characteristics of respondents

The socioeconomic and demographic characteristics of rice growers are shown in Table 2. The results revealed that 55.5% of rice growers were male, while 44.5% were female. The rice growers were between the ages of 51–60 years (40.5%), 61–70 years (33.5%), and more than 71 years (10%), while only 2.0% of them were aged between 30–40 years. The majority (82.5%) of rice growers had a primary education, while 5.5% had a secondary education, 9.0% had a diploma education, and only 1.0% had a university education.

A large number of rice growers had farming experiences of more than 21 years (66%) with an average farming experience of 29.24 years (Table 2). The farm size ranged from 1 to 5 *rai* (34.5%), 6 to 10 *rai* (29.5%) and 11 to15 *rai* (20.0%) with an average size of 10.31 *rai* or about 1.65 ha. In terms of land ownership, the majority (70.5%) of rice growers rented the land, while the rest had their own land. The economic background of rice growers. The result shows that 47.5% of the respondents had an annual farm income of not more than 50,000 Bahts, 43.5% had an annual farm income of between 50,001 and 100,000 Bahts with an average farm income of 83,046 Bahts (Table 2). As for revenue sources, it was found that 53.5% of the respondents got income from growing rice alone, while the rest earned from growing both rice and other crops such as green beans, garlic and shallots. It was found that 48.5% of the respondents had a production cost of between 1,001 and 3,000 Baht per *rai*, 42.0% spent between 3,001–5,000 Baht per *rai* with an average expenditure of 3,314.39 Baht per *rai*.

For credit access, 51.0% of rice growers had accessed to credit sources, while the rest had no credit access. About half (54.0%) of the rice growers also received extension services. The study found that 44.00% of rice growers received climate information from two sources, and another 18.0% obtained this information from three sources. The respondents mostly received climate change information from people in the community and neighbors.

Table 2. Socioeconomic characteristics of rice growers in Doi Saket district (n = 200)

Variable	Frequency	Percentage
Gender:		
Male	111	55.5
Female	89	44.5
Age (years):		
30-40	4	2.0
41-50	30	15.0
51-60	81	40.5
61-70	65	32.5
≥71	20	10.0
Mean = 58.88		
Education:		
No formal education	4	2.0
Primary	165	82.5
Secondary	11	5.5
Diploma	18	9.0
University	2	1.0
Experience in growing rice (years):		
1-10	31	15.5
11-20	37	18.5
21-30	67	33.5
≥ 31	65	32.5
Mean = 29.24		
Farm size (*rai*):		
1- 5	69	34.5
6-10	59	29.5
11-15	40	20.0
16-20	13	6.5
21-30	10	5.0
≥ 31	9	4.5
Mean = 10.31		

Table 2. (Continued)

Variable	Frequency	Percentage
Total labor force		
1-10	102	51.0
11-20	71	35.5
21-30	19	9.5
≥ 31	8	4.0
Cost per *rai* (Baht)		
≤ 1000	9	4.5
1,001-3,000	97	48.5
3,001-5,000	84	42.0
≥5,001	10	5.0
Mean = 3,314.39		
Annual farm income (Baht):		
≤ 5,000	95	47.5
5,001-100,000	67	43.5
100,001-150,000	16	8.0
150,001-200,000	11	5.5
≥200,001	11	5.5
Mean = 83,046		
Tenancy:		
Owner	59	29.5
Rented	141	70.5
Revenue sources:		
Rice	107	53.5
Rice and other crops	93	46.5
Extension services:		
No access	92	46.0
Access	108	54.0
Credit access:		
No access	98	49.0
Access	102	51.0
Group memberships:		
No	30	15.0
Yes	170	85.0
1	133	66.5
2	30	15.0
3	6	3.0
4	1	0.5
Climate Information sources:		
1	60	30.0
2	88	44.0
3	37	18.5
4	12	6.0
≥ 5	3	1.5
Mean = 2.06		

Table 2. (Continued)

Variable	Frequency	Percentage
Production system:		
- Grow rice only	149	74.5
- Grow rice and other crops	51	25.5

Rice Growers' perception of climate change

Result showed the rice growers' perception of climate change. The result shows that 82.0% of the rice growers perceived climate change as an unusual increase in global temperature (Table 3). There were more than half (57.0%) of the rice growers thought climate change to be a long-lasting drought or more frequent and severe floods, 19.5% of the respondents recognized to decrease annual rainfall over the past ten years and 13.0% of the respondents perceived the change as unseasonal weather.

Table 3. Rice growers' perception of climate change (n = 200)

Climate Change	Frequency	Percentage
- Unusual increase in global temperature	164	82.0
- Long-lasting drought or frequent drought	114	57.0
- Changes in the amount and distribution of rain	39	19.5
- The unseasonal weather	26	13.0

Impact of climate change in the last ten years (2006 - 2016)

Over the past ten years, climate change has appeared three major impacts on rice growers relating to the cultivated area, rice cultivation and ways of living (Table 4). For the cultivated area, the majority (71.5%) of rice growers were affected by increased disease and insect pests (Table 4). A large number (58.5%) of the rice growers were affected by arid soil, while some rice growers (23%) were faced with poor soil fertility. In terms of the impact on rice cultivation, it was found that the majority (80%) of rice growers were affected by an increase in diseases and insect pests. About half of the rice growers (53.5%) had a problem where rice could not grow and eventually died. A large number of rice growers (45.5%) also encountered a problem that rice produced less to no grains resulting in decrease in yield. For the impact on ways of living, the majority (81.5%) of the respondents claimed that their income decreased due to reduction in agricultural production, while 35.5% of the rice growers experienced health problems caused by hot weather.

Table 4. Impact of climate change in the last 10 years (n = 200)

Impact	Frequency	Percentage
Impact on farmland		
- Dry soil	117	58.5
- Poor soil quality	46	23.0
- More plant diseases and insect pests	143	71.5
Impact on rice cultivation		
- Rice cannot grow and eventually dies	107	53.5
- The rice does not produce grain, resulting in a decrease in yield	91	45.5
- Many diseases and insect pests	160	80.0
Impact on way of living		
- Income decrease due to reduced agricultural production	163	81.5
- Health problems due to weather conditions	71	35.5

Climate change adaptation strategies adopted by rice growers

The rice growers were presented with a number of climate change adaptation strategies such as changing the planting date, applying different planting methodsand finding alternative income sources. They were asked to indicate whether they had used any of the strategies. Table 5 indicates that 73.0% of rice growers in Doi Sa ket district adopted one of the adaptation strategies to overcome the climate change problem, while 27.0% of them did not adopt any adaptation strategies. For those who adopted strategies, 39.0% of them chose to change planting methods. Rice growers have changed the way they grow rice, from seedling transplant to a broadcasting method. This method required less water and rice growers can sow seed into dry soil and then wait for the rain. Some rice growers incorporated rice stubble or crop residues in order to maintain soil moisture or to reduce the cost of fertilizer and then sow the seed.

In this study, to avoid crop production risk due to rainfall variability and drought, 36.0% of the rice growers changed their planting calendar. Instead of planting at the regular time of mid-August, they postponed the planting date to the end of August or the end of September to wait for the first rain. If there was not enough rain after September, some farmers refrained from planting rice in that year. 25.0% of the rice growers chose the method of growing different types of crops, especially drought-resistant crops including soybean, green beans, and shallots since these crops need less water (Table 5).

Table 5. Rice grower' adaptation strategy to climate change impact (n=200)

Adaptation' strategy	Frequency	Percentage
Do not adopt	54	27.0
Adopt	146	73.0
Choice of adaptation strategies		
- Changing of planting methods	78	39.0
- Changing of planting dates	72	36.0
- Growing different type of crops	50	25.0

Table 6 Logistic regression of factors influencing adoption of climate adaptation strategies (n = 200)

Variables	B	S.E.	Wald	df	*p*-value	Exp(B)
Gender	-0.33	0.372	0.008	1	0.928	0.967
Age	0.029	0.025	1.403	1	0.236	1.030
Education	-0.038	0.073	0.264	1	0.607	0.963
Experience in growing rice	0.003	0.015	0.029	1	0.866	1.003
Total labor force	0.012	0.025	0.223	1	0.637	1.012
Tenancy						
- Rented	0.080	0.424	0.035	1	0.851	1.083
Production system	0.911	0.550	2.739	1	0.098	2.485
Farm size	0.036	0.029	1.594	1	0.207	1.037
Cost per *rai*	0.000	0.000	4.481	1	0.034	1.000
Revenue source	-1.246	0.414	9.041	1	0.003	0.288
Annual farm income	0.000	0.000	0.361	1	0.548	1.000
Credit Access	-0.179	0.379	0.223	1	0.637	0.836
Group memberships	0.706	0.319	4.884	1	0.027	2.026
Extension	-0.311	0.372	0.697	1	0.404	0.733
Information	0.127	0.219	0.338	1	0.561	1.136
Constant	-2.184	1.693	1.664	1	0.197	0.118

*Chi – Square = 33.863 Sig = 0.004, -2 log likelihood = 199.441
Cox & Snell R Square = 0.156, Nagelkerke R Square = 0.226
Hosmer and Lemeshow Test: Chi-Square = 10.213 Sig = 0.250

Factors affecting adoption of climate adaptation strategies

The logistic regression results of factors that determined rice growers' decision on whether to adopt a climate adaptation strategy is showed in Table 6. The Hosmer and Lemeshow test gave a Chi-Square value of 15.105, and a *p*-value of 0.057. This implies that the logistic regression model is set to explain the relation of variables. The value of the model Chi-Square statistics was 33.863, and *p*-value was 0.004 that revealed the probability for rice growers' decision to adopt climate change adaptation strategies depended on at least one

independent variable in the model. The Cox and Snell R square and Nagelkerke R square yielded the values of 0.156 and 0.226, respectively, indicating that all predictive variables supported a chance of 15.6 and 22.6 percent that rice growers would adopt climate change adaptation strategies. It suggested that the 15 variables in the logistic regression model were jointly significant in determining rice growers' decision to adopt one or more climate change adaptation strategies.

However, only three variables were statistically significant differed. These were cost per unit planting area (Baht per *rai*), revenue sources and number of group memberships of the rice growers. The cost per unit of planting area was significant at 5% level and positively related to the probability of adoption of climate change adaptation strategies. The effect of revenue sources on the adoption of climate change adaptation strategies was negative and significant at 1% level. A member of social groups had a positive and significant effect at 5% level on the adoption of climate change adaptation strategies (Table 6).

Discussion

The socioeconomic and demographic characteristics of rice growers

From the survey, it can be seen that most rice growers were older adults as their average age was about 59 years. They also had low formal education with the majority having only primary education. This reflects the current situation of farming in Thailand where the farmers are elderly as Thai society is becoming an aging society (Chanrat *et al*., 2019). With an average farm size of 10.31 *rai* (1.65 ha), this indicates that these rice growers are smallholders. Moreover, a large number of them rented the land (70.5%) which may affect the adoption of adaptation strategies as they do not own the land (Okpe and Aye, 2014; Iheke and Agodike, 2016). Rice growers have an average farm income of 83,046 Baht, implying that the respondents received a low income from their farming activities. This might influence the decision to adopt climate change adaptation strategies. It can also be seen that the rice growers have low investment in their farms (an average of 3,314.39 Baht per *rai* or only 4% of an average farm income).

Factor affecting adoption of climate adaptation strategies

Based on the survey, it was observed that the majority of rice growers adopted at least one climate change adaptation strategy. Changing planting

methods was the most popular, followed by changing planting dates and growing different types of crops like those with drought-resistance such as soybean and shallots. The factors influencing the adoption of climate change adaptation strategies, variables on cost per unit planting area (Baht per *rai*), revenue source, and number of group memberships of rice growers were statistically significant. Regarding 'cost per unit of planting area' having statistical significance and positively related to the probability of adoption of climate change adaptation strategies, it indicates that rice growers who spend more money per unit of planting area are more likely to adopt climate change adaptation strategies than those rice growers who invest less money per unit of planting area. It was reported that farmers with a large size of farm and thereby had high investment and risk, tend to adopt risk mitigation tools or be risk averse (Bashiru *et al.*, 2014; Ullah *et al.*, 2015). In this study, although farm size is insignificantly related to the adoption of adaptation strategy, rice growers with higher costs per *rai* may also be concerned with the risk of losing their investment. Thus, adopting climate change adaptation strategies may be a way to reduce this risk.

'Revenue sources' is negatively related to the adoption of climate change adaptation strategies with statistical significance. This means that the odds of adoption of climate change adaptation strategies decrease with the increase of revenue sources. Rice growers who have income from several non-farm income sources are not likely to accept climate change adaptation strategies compared to those with income from only rice cultivation. The results indicate that rice growers who have non-farm incomes have a 71.2% chance of not using the adaptation strategies (P or Exp(B) = 0.288). This might be because for rice growers who have non–farm income sources, it is easier for them to gain income from non-farm sources rather than putting an effort into finding and adopting climate change adaptation strategies. The finding was contrary to Bryan *et al*. (2013) who found that diversified income sources are supportive of farmers' adaptation to climate change, along with access to extension services and credit.

The last factor affecting the adoption of climate change adaptation strategies is 'being members of social groups'. It has a positive and significant effect on the adoption. The finding was congruent with Iheke and Agodike (2016) who observed that memberships to farmers' associations or cooperatives increase the adoption rate of mitigation measures for climate change. Similary, Bryan *et al*. (2013) discovered that these memberships positively influenced farmers to adopt agroforestry as an adaptation strategy. Moreover, it was also found that the more social groups that the rice growers were the members of, the more likely that they would adopt the climate change adaptation strategies.

That is, when the number of group memberships increases, the odds to choose adaptation strategies will increase as well. It can be deducted that rice growers who have more social group memberships are likely to adopt climate change adaptation strategies at twice the rate of those with less social memberships (Exp(B) = 2.026).

All in all, the rice growers in Doi Saket district were aware of climate change and its effects in the past decade. They have also started to adapt to climate change in order to reduce risk or to mitigate problems. However, it is noteworthy that the farmers use only three methods for adaptation, while there are many other methods that have not been used such as mixed cropping, improved irrigation efficiency and use of improved varieties of crop. Thus, information on climate change and its impacts, as well as adaptation strategies should be provided to the rice growers so that they will be well-informed about climate change and be exposed to a wide range of adaptation strategies. In Thailand, agricultural extension offices are located in every district across the country. Thus, extension officers can also be instrumental to support the rice growers in terms of climate change and adaptation strategies. However, according to the rice growers interviewed, extension officers normally provided to support the seeds and fertilizers, but no related to climate change. It might be concerned that the extension officers themselves have limited knowledge about this issue. Thus, training on climate change, its impacts, and adaptation strategies for extension officers should be organized. As rice is an important crop for Thailand, research should also be conducted to improve rice varieties with drought-tolerance. It is recommended that the government should improve the efficiency of irrigation systems, so that irrigation water can be more effectively managed during periods of drought or flood.

Acknowledgement

The authors would like to thank the rice growers in Doi Saket district, Chiang Mai province, Thailand for providing them with useful data. Our appreciation is also extended to officers from the Doi Saket Agricultural Office for their assistance during the data collection.

References

Akinnagbe, O. M. and Irohibe, I. J. (2014). Agricultural adaptation strategies to climate change impacts in Africa: A review. Bangladesh Journal of Agricultural Research, 39:407-418.

Australian Academy of Science (2018). Climate Change. (Online). Available: http://www.science.org.au/learning/general-audience/science-booklets-0/science-climate - change/1-what-climate-change (July 4, 2018).

Bashiru, M., Dumayiri, M. and Sabutey, G. T. (2014). Drivers for the adoption of risk management practices by farmers in Ghana: Critical inquiry from the Wa East district. Information and Knowledge Management, 14:95-105.

Below, T. B., Mutabazi, K. D., Kirschke, D., Franke, C., Sieber, S., Siebert, R. and Tscherning, K. (2012). Can farmers' adaptation to climate change be explained by socio-economic household – level variables? Global Environmental Change, 22:223-235.

Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S. and Herrero, M. (2013). Adapting agriculture to climate change in Kenya: Household strategies and determinants. Journal of Environmental Management, 114:26-35.

Chanrat, S., Sa-ngimnet, B., Attavanich, W. and Chenphuengpawn, J. (2019). Ageing, productivity, and Thai farm households' agricultural practices. Available at: https://www.pier.or.th/?post_type=abridged&p=6704 (in Thai) (August 30, 2019).

Chavas, D. R., Izaurralde, R. C., Thomson, A. M. and Gao, X. (2009). Long-term climate change impacts on agricultural productivity in eastern China. Agricultural and Forest Meteorology, 149:1118-1128.

Creswell, J. W. (2012). Educational research: Planning, conducting, and evaluating quantitative and qualitative research, 4th ed. Pearson, Boston.

Doi Saket Agricultural Office (2017). Registration of farming households in the production year 2017/2018. Doi Saket district, Chiang Mai province.

Greenpeace Thailand (2010). Impact of climate change. (Online). Available: http://www.greenpeace.org/seasia/th/solargen/climate-change/impacts/ (July 10, 2018).

Iheke, O. R. and Agodike, W. C. (2016). Analysis of factors influencing the adoption of climate change mitigating measures by smallholder farmer in Imo state, Nigeria. Scientific Paper Series "Management, Economic Engineering in Agriculture and Rural Development", 16:213-220.

Kamba, C. and Muchapondwa, E. (2012). Adaptation to climate change by smallholder farmers in Tanzania. ERZA Working Paper No. 229 (Economic Research Southern Africa).

Office of Natural Resources and Environmental Policy and Planning (2010). Impact of climate change in Thailand. (Online). Available:http://www.onep.go.th/index.php (July 13, 2018).

Okpe, B. and Aye, G. C. (2014). Adaptation to climate change by farmers in Makurdi, Nigeria. Journal of Agriculture and Ecology Research International, 2:46-57.

Sekaleli, T. S. T. and Sebusi, K. (2013). African technology policy studies: Farmers' response and their adaptation strategies to climate change in Mafeteng district, Lesotho. ATPS Working Paper No. 74. African Technology Policy Studies Network, Lesotho.

Temesgen, T. D. and Mohamud, Y. (2009). Determinants of Farmers'Choice of Adaptation Methods to Climate Change in the Nile Basin of Ethiopia. Global Environmental Change, 19:248-255.

Thailand Research Fund (2012). Effects of global warming on yield and grain quality. (Online). Available: https://www.trf.or.th/climate-risk/2613-2012-10-30-09-27-19 (July 18, 2018).

Ullah, R., Shivakoti, G. P. and Ali, G. (2015). Factors effecting farmers risk attitude and risk perceptions: The case of Khyber Pakhtunkhawa, Pakistan. International journal of Disaster Risk Reduction, 13:151-157.

United Nation Environment Programme (2018). Climate Change. (Online). Available: https://www.unenvironment.org/explore-topics/climate-change (July 18, 2018).

(Received: 17 June 2019, accepted: 20 December 2019)