Climate Change Perceptions and Adaptation in Agriculture: a Study of Rural Ghana modulation

論 文 内 容 の 要 旨

Climate change poses numerous uncertainties on the livelihoods of farming communities that depend on climate. In recent times, the increasing incidences of droughts, late rains, floods, decreasing annual precipitation and increasing temperatures in northern Ghana have become a major concern. Studies have shown that increasing rainfall variability results in droughts, this leads to a reduction in soil moisture causing a decline in agricultural productivity thereby affecting household incomes. In view of the fact that agriculture remains the largest employer of the Ghanaian workforce and constitutes the main source of food and income, the consequences of climate change on the agricultural sector cannot be underestimated. Considering that farmers are more likely to be highly affected by the effects of climate change, a clear understanding of the trends of climatic variables, risk, adaptation and farmers' perceptions could provide useful information to assist local famers make informed adaptation decisions in order to improve their livelihoods. It would also guide governments to formulate appropriate climate change policies and programs. This study therefore investigates historical rainfall variability and its relationship with annual crop production. Farmers' perceptions about long-term trends in climatic variables, climate change risks and adaptation practices are also investigated. The study also investigates the socio-economic determinants of climate change risks and adaptation. Finally, the study proposes a set of indicators for evaluating and choosing appropriate adaptation practice to predicted extreme climate change event.

The study comprises eight chapters. In chapter one, the global, regional and country-level perspective of climate change and adaptation practices in agriculture are discussed. Based on this discussion, the problem statement of this research is derived. Subsequently, the goal, objectives, outline and contribution of the research are presented and discussed. Chapter two outlines the study area, types of data and methods of data collection. The statistical and empirical methods used to analyze data are also presented. Lawra district of the Upper West Region of Ghana is selected for the study. The selection is based on the fact that the district lies within the driest part of the Guinea Savannah Zone and also reported by the Ghana Statistical Service as one of the poorest in the country. Secondary data include historical rainfall and crop production figures (1980-2012), governmental reports and literature review. Primary data is collected based on cross-sectional surveys and focus group discussions (FGDs) conducted in four communities (i.e., Brifo-chaa, Methuo, Kalsagri, and Oribili) in February and November, 2014. Twenty-five households were randomly selected from each community and the household' heads individually interviewed. A total of 100 farmer households were interviewed using semi-structured questionnaires. The FGDs were carried out to double check the household survey data. The participants included community leaders, men, women, youth and children. The discussions in each community focused on perceptions regarding climatic and agro-ecological changes, possible effects on agriculture, adaptation practices being used, barriers to adaptation and household characteristics. Also, face-to-face interviews with key stakeholders were conducted.

In Chapter three, farmers' climate change perceptions are assessed and their perceived long-term trends of climatic variable and causes of climate change are identified. The rate of occurrence of extreme weather events (i.e. dry spell, drought and floods) is determined. Also, based on focus group discussions, a new approach of classifying farmers' perceived effects of climate change is proposed (i.e., agriculture production, socio-economy, environment and psychology). The results showed that 87% of respondents perceived a decrease in rainfall amount, while 82% perceived an increase in temperature over the past 10 years. Results of the weighted average index indicate that dry spell and drought have higher rate of occurrence annually than flood. Most farmers attribute climate change to human-related causes such as bush fires (51%) and deforestation (14%). While deforestation is largely perceived as being for the purposes of fuel wood, charcoal, and farm expansion, bush fires are believed to be caused by the 'negligence' of hunters and cigarette smokers. About 9.3% of respondents also claim that traditional gods and ancestral spirits were responsible for the perceived changes in rainfall and temperature trends. About 23.3% of respondents claim climate change is caused by multiple factors while 2.4% could not give any cause.

In chapter four, an empirical analysis is conducted and the historical distribution and variability of rainfall is determined by using the precipitation concentration index (PCI) method. Using rainfall variability as an indicator, a correlation analysis is conducted to identify the key crops that are negatively affected. This is done to verify farmers' perceptions about long-term trends of climatic variables and their effects on crop production. The precipitation concentration index and coefficient of variation (CV) are used to determine rainfall distribution and variability respectively. The results indicate that rainfall is very erratic in the month of June

(CV=53%) which could result in dry spells. Rainfall volumes are also very high in the month of August which could pose threats of floods. Also, the results show high rainfall variability rather than a clear decreasing trend in precipitation as perceived by farmers. The correlation results show that production of sorghum, millet and cowpea are negatively affected by the rainfall situation for the period investigated. The outcome of results and discussions in chapters four and five is expected to contribute knowledge to formulating relevant climate change policies.

The findings in chapters three and four clearly indicate the need for effective adaptation to climate change. However, since adaptation practices in agriculture are generally location-specific, it is important to understand the risk faced by farmers so as to develop tailor-made adaptation options to mitigate the risks. Knowledge about climate change risk and impacts is also relevant in producing appropriate content for climate change risk communication. Therefore, in chapter five, farmers' climate change risk perceptions are assessed. Firstly, various climate change risk phenomena are identified and classified based on risk impacts. Based on annual average income, farmers are classified into three wealth categories (i.e., poor-resource, moderate-resource and rich-resource farmers). Subsequently, the levels of perceptions about climate change risk of each category of farmers are identified. This is done in order to identify how different farmers perceive climate change risks. Finally, the determinants of climate change risk perception are evaluated based on demographic characteristics, climatic variables, biodiversity and forestry factors, agricultural production related variables, and health and socio-economic factors. The results show that 93% of respondents have perceived risk while 7% are not sure if they have perceived. While 66% of the respondents have highly perceived climate change risk, 4% has less perceived. Also, 23% of farmers have moderately perceived climate change risk. In addition, poor-resource farmers (91%) perceive risk highly than moderate (58%) and rich-resource farmers (48%). The findings reveal that farmers in Lawra district generally perceive climate change risk impacts in terms of agricultural production, biodiversity and forestry, health and socio-economy, and climatic variables. Results of the climate change risk perception index (CRPI) show that poor-resource and moderate resource farmers are much concerned about climate change risk impacts on agricultural production (i.e., CRPI = 0.99) and climatic variables (i.e., CRPI=0.96) respectively, while rich-resource farmers are concerned about risks impact on health and socio-economy (i.e., CRPI = 0.96). The results of regression analysis indicate that factors related to impacts on climatic variables and agricultural production are significant determinants of climate change risk perception. Although not statistically significant, psychological factors (i.e., perceived ability to control risk) and biodiversity and forestry related factors are also found to be predictors of climate change risk perception. However, health and socio-economic factors are not found to be determinants of climate risk perception in Lawra district. Finally, demographic features such as income and age are significant predictors of risk perception while gender, marital status and educational status are not. The outcome of the results and discussions in this chapter are expected to contribute to climate change risk communication in agriculture.

In view of the fact that most farmers are already aware of climate change and its risks, it is crucial to identify the adaptation options needed to mitigate the risks. Thus, chapter six presents a portfolio of adaptation practices to climate change in agriculture. Also, farmers' reasons for using adaptation options are identified. Subsequently, a ranking system is conducted to identify farmers' perceived most important practices. The results are then compared to the actual adaptation practices being implemented currently. The problem confrontation index method is used to identify the constraints to use of adaptation measures. To provide a better understanding of farm-level adaptation, a new method of classification of adaptation practices is proposed based on responses from farmers (i.e., crop production improvement practices, soil management, irrigation water conservation and environmental improvement practices). Finally, to propose strategies to facilitate the development and promotion of appropriate adaptation options, the socio-economic determinants of adaptation is also investigated. Empirical results of the weighted average index analysis show that farmers rank improved crop varieties and irrigation as the most important adaptation measures. It also revealed that farmers lacked the capacity to implement the highly ranked adaptation practices. Regarding reasons for adaptation, an overwhelming majority (95%) of respondents use adaptation measures to cope with dry spell effects on crop plants. Also, 94% and 75% of farm households adapted to cope with drought effects and improve crop production, respectively. The results also show that 74% of respondents used adaptation practices to improve soil fertility while 34% adapted to cope with effects of floods. Empirical results of the logistic regression model show that education, household size, annual household income, access to information, credit and membership to farmer-based organization are the most important factors that influence farmers' adaptation to climate change. Results of the problem confrontation index show that unpredictability of weather, high farm input cost, lack of access to timely weather information and water resources are the main inhibiting factors to climate change adaptation. The results, discussions and recommendations in this chapter are expected to contribute to design, development and promotion of appropriate adaptation options.

Results of chapter six clearly show that farmers possess a portfolio of adaptation practices to climate change. The key challenge, however, lies in how to evaluate and select the most appropriate adaptation option. Chapter seven therefore focuses on the development of a set of indicators for evaluating the practices. In addition, a new model is proposed for the development of relevant decision-making indicators. The proposed model involves a six-step process (i.e., identifying stakeholders, setting the goal, setting the components, developing the indicators, setting alternative practices, and calculating, integrating results and making a decision). Based on survey data, extensive literature review, focus group discussions and face-to-face interviews with key experts, seventeen indicators were developed. The finalized indicators were further validated by key experts. It is expected that at each pre-season planning stage, various adaptation practices to a predicted climate event (i.e., drought or flood) are identified and prioritized based on the components and indicators. Since results in chapters three and four reveal a high rate of occurrence of drought and dry spell, the developed indicators are applied to evaluate and select the most feasible and effective adaptation practices to drought. The AHP decision support model is applied. The empirical results of AHP show that the feasibility component has higher weight (0.5730) than the effectiveness component (0.4270). Four indicators in the feasibility component (i.e., culture and tradition, cost, resource availability and timeliness) obtained the highest weight among the seventeen indicators. The results of prioritization of alternative adaptation practices to drought show that drought-tolerant and early maturing varieties are most feasible and effective (i.e., 0.279 and 0.169, respectively). Irrigation and agroforestry are ranked lowest in the priority set up (i.e., 0.135 and 0.118, respectively). The outcome of the results and discussions in this chapter is expected to improve farmers' capacity to adapt to climate change through effective and efficient decision making.

Chapter eight presents the overall conclusion of the study. The policy implications of the study and recommendations are also discussed. Finally, issues for further studies pertaining to this research area are also proposed.