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Gauging the evidence of indigenous perceptions and strategies to climate change with introduced national agricultural programmes in the Bolgatanga district of the upper east region of Ghana

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ABSTRACT
Globally, Climate change has been recognised as a threat to agricultural production and productivity. This paper examines indigenous perceptions and adaptation strategies to climate change and National Introduced Strategies in the Bolgatanga district of the UER of Ghana. Key informant interviews, focus group discussions were held, survey questionnaires were randomly administered to 100 households in Yorogo and Gowrie in the district from September to October, 2014. Local adaptation practices due to perceived climate change were use of improved varieties (100%), land management and irrigation farming (98%), and livelihood diversification (98%). Results also showed that food security, income growth, sustainable land management, science and technology programmes were the only four of the six national introduced adaptation programmes in the agricultural sector implemented from 2009-2013 in the region. To enhance farmers' adaptation of national programmes, it is recommended that, the Ministry of Agriculture intensify more farmer education to compliment local practices.

Key words: Adaptation strategies, agriculture productivity, climate change impacts, national adaptation programmes, northern Ghana

RÉSUMÉ
À l'échelle mondiale, le changement climatique a été reconnu comme une menace pour la production et la productivité agricoles. Cet article examine les perceptions autochtones et les stratégies d'adaptation au changement climatique et les stratégies nationales introduites dans le district de Bolgatanga de l'UER du Ghana. Des entretiens avec des informateurs clés, des discussions de groupe ont été organisés, des questionnaires d'enquête ont été administrés au hasard à 100 ménages à Yorogo et Gowrie dans le district de septembre à octobre 2014. Les pratiques d'adaptation locales dues au changement climatique perçu étaient l'utilisation de variétés améliorées (100 %), gestion des terres et agriculture irriguée (98 %) et diversification des moyens de subsistance (98 %). Les résultats ont également montré que la sécurité alimentaire, la croissance des revenus, la gestion durable des terres, les programmes scientifiques et technologiques étaient les quatre seuls des six programmes nationaux d'adaptation introduits dans le secteur agricole mis en œuvre de 2009 à 2013 dans la région. Pour améliorer l'adaptation des programmes nationaux par les agriculteurs, il est recommandé que le Ministère de l'Agriculture intensifie davantage l'éducation des agriculteurs pour compléter les pratiques locales.

Mots clés: Stratégies d'adaptation, productivité agricole, impacts du changement climatique, programmes nationaux d'adaptation, Nord du Ghana

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INTRODUCTION

Agriculture is the mainstay of the Ghanaian economy- contributing approximately 30% to Gross Domestic Product (GDP) and provides livelihood to over 60% of the populace (Sarpong and Anyidoho, 2012). The Environmental Protection Agency (EPA, 2011) reported that about 70% of the Ghanaian population depends directly or indirectly on agriculture and forest sector for both timber and non-timber forest products. It has been reported in literature that Sub-Saharan Africa (SSA) is the most vulnerable region to-climate variability and change (Conway and Schipper, 2011; Siept *et al*., 2013). In Ghana for instance, it has been reported that the mean annual temperatures increased by one degree Celsius (1^{o}C) every decade since 1960 and monthly rainfall decreased by almost 2.4% per decade (De Pinto *et al*., 2012). In addition, it is expected that mean annual temperatures coupled with sporadic rainfall pattern will be experienced in future (Lodoun *et al*., 2013). These changes in rainfall distribution and temperature regime may lead to adverse repercussions on agriculture in general, food security and poverty levels of rural communities in particular. Such adverse effects are likely to be severer as agriculture is predominantly rain fed with limited irrigation schemes and facilities (Oloukoi *et al*., 2013). Even though, there is threat of climate variability (Wheeler and von Braun, 2013), evidence suggests that adaptation is occurring as a response to climate variability and change (Wiggins and Leturque, 2011). Clement *et al*. (2011) reported that innovative technologies and practices exist and/or have been developed in several parts of the world to facilitate the adaptation to climate change in the agricultural sector. These include improved weather forecast, sustainable soil and water conservation management, improved livestock management and use of improved crop varieties among others. Doss (2006) indicated that a challenge facing scientists in agricultural research is the understanding of how and when these technologies are used by farmers and with what impacts. In Ghana local and national level policy strategies adopted have been a mixture of different adaptation mechanisms like use of early maturing varieties of crops, timely planting, growing drought tolerant crop varieties, resorting to crop insurance mechanisms, irrigating crop fields, adopting short term credit facilities and implementing soil and water conservation practices (Tachie-Obeng *et al*., 2013). Several studies (Burns and Johannsson, 2017; Bielie, 2018; Fagariba and Soule, 2018; Welborn, 2018) have been undertaken with more focus on causes of climate change and its impacts on livelihood rather than adaptation mechanism to climate change in the agricultural sector. Previous studies (Rodima-Taylor *et al*., 2012; Tachie-Obeng *et al*., 2013) only focussed on adaptation options for particular crops or enterprises instead of evaluating the effects of the strategies to climate change impacts. Additionally, policy debates on climate variability in recent times have been centred on integrating adaptation with sustainable development goals (SDGs) and its benefits for building resilience across societies instead of the specific role adaptation plays (Burns and Johansson, 2017; UNCCS, 2017, Berlie, 2018). Evaluating the performance of these technologies and identifying the factors influencing the adoption of innovations is very important in technology development and dissemination process (Al-Hassan and Jatoe, 2002). The paper seeks to fill a gap in the climate change literature by evaluating the national introduced adaptation programmes and the indigenous adaptation practices on climate change in the Upper East region of Ghana.

The research questions that guide the paper are in two folds: (1) what are the implemented national introduced adaptation programmes and the indigenous adaptation strategies in the study communities? And (2) what are

the synergies between the introduced and indigenous programmes? The purpose of the paper, is to provide a basis to understand how to structure adaptation interventions to benefit the vulnerable households at the community level and also assess the acceptability of national introduced programmes and their synergies with indigenous practices. The analysis of the paper is basically considering only the specific conditions of the study communities (Yorogo and Gowrie) in the Bolgatanga District of the Upper East Region of Ghana. This requires looking at the adaptation practices of the local people in the study area within the context of the national introduced programmes in the period of 2009-2013 in which these were implemented and completed. It could be argued that, successive agricultural adaptive strategies and policies implemented to address climate change issues in the Upper East Region may not have achieved their desired results due to failure to investigate their performance at the community level, the synergies of local practices and national policies among others.

Theoretical and Conceptual Frameworks

Theoretical Framework. The Food and Agricultural Organisation (FAO, 2006) categorised adaptation strategies adopted by farming households in Bangladesh into four types as: traditional, government-supported, alternative/ innovative automatic adaptation, and technology-driven strategies. This study assessed the strategies adopted by smallholder farmers dealing with the effects of climate change and variability into two; namely indigenous adaptation strategies and national introduced agricultural adaptation strategies. The indigenous adaptation strategies are all those practices originating from the local people and are used in their communities over time, whilst the introduced agricultural adaptation strategies are those interventions introduced by the Ministry of Food and Agriculture (MoFA) for the smallholder farmers in area.

As part of government's effort to improve the food security situation and enhance the resilience of the agricultural sector to climate change effects in Ghana and the UER in particular, the Ministry of Food and Agriculture developed a policy termed the Medium Term Agriculture Sector Investment Plan (METASIP) to be operated from 2009-2015. The policy identified some priority areas that were developed into programmes with set targets. The programmes were:

i. Food Security and Emergency Preparedness
ii. Increased growth in incomes
iii. increased competitiveness and enhanced integration into domestic and international markets
iv. Sustainable management of Land and the Environment
v. Science and Technology for Food and Agricultural Development
vi. Institutional co-ordination

The performance of these programmes was the achievements after implementation against their set targets by use of performance indicators that were developed by the Ministry of Food and Agriculture as follows:

- Percentage change in the level of production of selected staple crops
- Percentage change in output/yield per unit area
- Access to production inputs (number of farmers)
- Access to improved technology and extension services (number of farmers)
- Cultivated areas under irrigation (number of hectares)
- Post-harvest losses management and food security (percentage change in losses)
- Promotion of livestock and poultry development (number of programmes, number of farmers)
- Promotion of selected crops development
- Improved institutional coordination

This study adopted these indicators in analysing the policy and programmes implemented from 2009-2013 in the case study communities in the Bolgatanga District of the Upper East Region. The study further evaluated the performance of

agricultural adaptation programmes and the synergies with local practices in the study area. This paper examines if the adaptation policies respond to climate change and variability and therefore meet the expected targets by reducing poverty and enhancing food security in the District.

Conceptual Framework. The risk-hazard model framework (Fig. 1) was adopted from Turner *et al*. (2003) for the study. The model was chosen because it assesses the possible impacts due to climatic event (ibid). Since the study assesses the performance of adaptation strategies to climate change impacts, the model is appropriate for it draws and explains the motivation (benefits derived) for certain practices, triggered by natural variability including climate change (stage 1), the effects of natural variability (exposure, sensitivity, capacity) on respondents and sustainability of their practices in minimising vulnerability or increasing the resilience to climate change impact (duration of practice and changes it brings; stage 2), the adaptation options available to respondents (number of options; stage 3), strategies adopted (types of strategies being used, stage 4) and strategies performance (implemented programmes outcomes against their set targets; stage 5). The framework relates and explains smallholder farmer adaptation activities due to climate change and performance outcomes. It has been established that climate change and variability is as a result of both internal and external factors affecting farmers. The activities of these farmers and that of other human activities as well as natural occurrences are the causes of climate change and variability (MoFA, 2013a). The choice to adopt a traditional or introduced adaptation strategy depends on a number of factors both internal and/or external to the smallholder farmer.

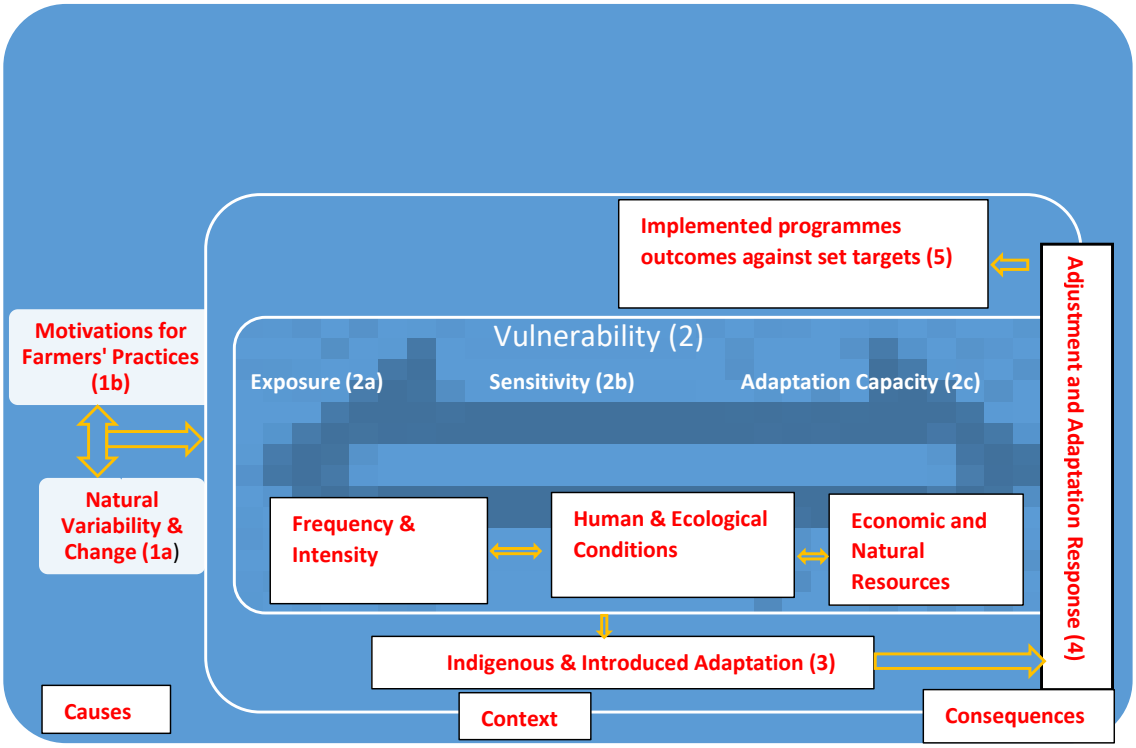

Figure 1. Risk-Hazard Model (Modified and Adopted from Turner *et al.*, 2003)

MATERIAL AND METHODS

Profile of the study area. The Bolgatanga district is located within the UER of Ghana and has an area of 729 km with a population of 141,717 people and a population growth rate of 1.2% (SRID, 2018). The district is located in the central part of the Upper East Region (see Fig 2). Majority of the people (37.7%) in the district are engaged in agriculture (Bolgatanga District, 2013). The climate of the area is tropical with two distinct seasons; a wet season that starts from May to October and a long dry season starting from October to April. Annual mean rainfall is about 950mm.

Sampling design. The study was conducted within the context of communities mostly affected by Climate Change and variability with special focus on the northern dry savannah zone (GSS, 2012). The study adopted a mixed cross sectional research approach. The target population for the study was the farming communities in the District. The three regions of the north (Upper East, Upper West and Northern) were purposively selected as they represent the northern savannah zone of Ghana. The Upper East Region (UER) was randomly selected from these three regions as a case for this study and has been targeted by several introduced policies due to its vulnerability to climate change manifested in terms of less rainfall and poor soil fertility. The region (UER) is located in the north-eastern corner of the country. It has 13 administrative districts with 213 major towns and villages (Akudugu and Laube, 2013). The region also has a total of 177,629 households (GSS, 2012).The environment and conditions (climatic conditions) of the region as well as the livelihood strategies of the people are similar (EPA, 2011). According to Holloway and Wheeler (2002), such conditions permit the study findings in one part of the population to

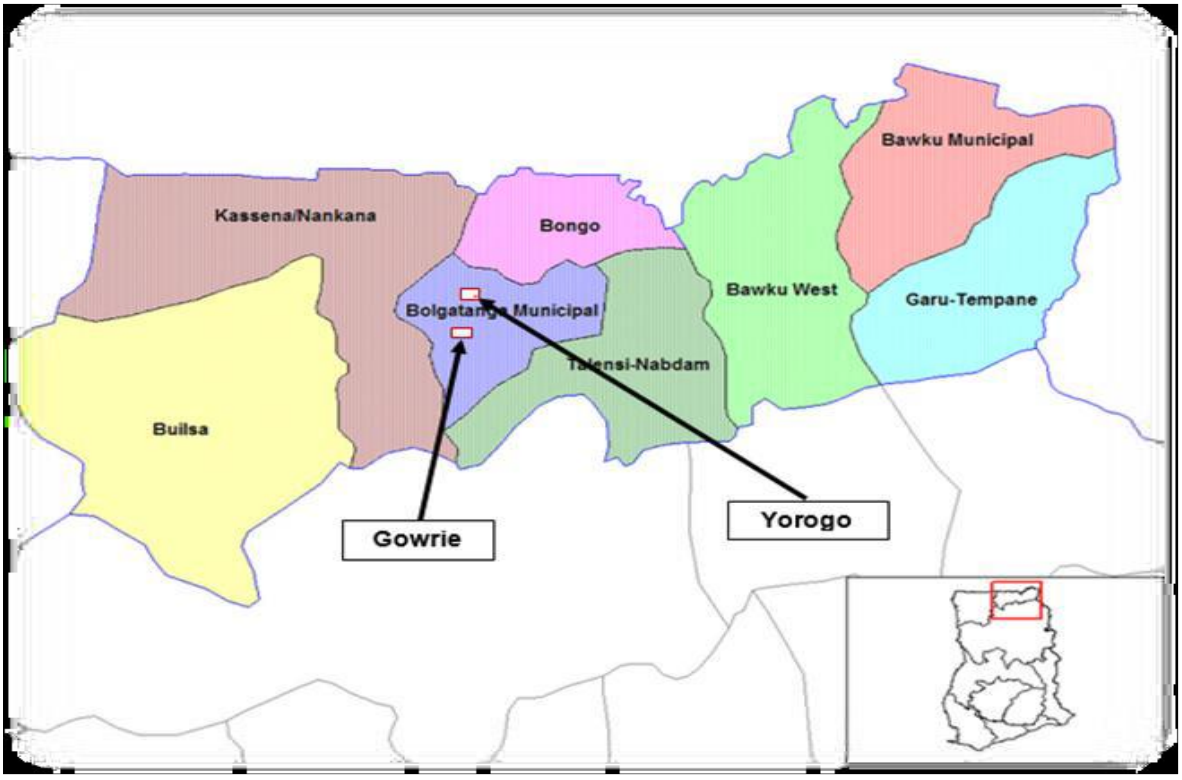

Figure 2. Map of Bolgatanga District and the Study communities in the Upper East Region (GLSS, 2014)

be conveniently applied to other parts. They concluded that, random sampling technique in a homogenous population can lead to more generalizable results. Even though the northern dry savannah zone has three or more administrative regions, with regards to climate all these administrative regions are classified under one Ecological zone (Ecological validity), (See Meteorological Climate Data 1961-2010), and for that reason one can conveniently assume to have one population which is homogenous (Population validity). A study conducted by Laube *et al*. (2012) concluded that, the region (Northern Savannah Zone) has similar segments (Demographic, Geographic, Psychographic and Behavioural).

Due to the homogenous and widely dispersed nature of the study area and population (Laube *et al*., 2012), the researchers decided to randomly select one district out of the 13 districts (District Sampling Frame). The Bolgatanga District was randomly picked from the 13 districts. This was done by writing the names of the 13 districts on pieces of paper and balloted. The Bolgatanga District has 18 major towns and villages, with 26,706 households (GLSS, 2014). In order to empirically explore community based adaptation practices and experiences on climate change and variability, the 18 major communities were also balloted and two (Yorogo and Gowrie) were randomly selected as the study sites (Fig.1). The sampling frame (26,706 households) for the district (GSS, 2012) was used to randomly select 100 households for the survey questionnaire.

It can be argued that if one out of three regions is randomly picked from a homogenous population, this would be quite representative, and again one district picked from thirteen districts gives a sample of 7.69% and two communities picked from 18 communities gives a sample size of 11% of which is also quite representative for statistical analysis. As argued by Cohen (1988), a large sample size in a homogenous population risks having repetitive data. Considering the above arguments concerning the population of the study region, the sample size was large enough to sufficiently describe the phenomenon of interest (indigenous practices and National introduced adaptation strategies). It may also be appreciated that, as the larger the sample the lesser the likelihood of the findings being biased. It is also true that diminishing returns could set in when samples are more than a certain size which need to be balanced against the researchers' resources (Gill *et al*., 2010).

Four focus group discussions were held in these two selected communities (Yorogo and Gowrie). The focus group discussions participants were 100 individuals, who were not part of the household survey questionnaire interviews. These group discussions were organized (in September and October, 2014) in each of the two selected communities (Yorogo and Gowrie) differentiated by gender and age. Between 20 and 30 members in a group were randomly selected in each community. Two female groups and two male groups in each community: one age group was 30 years and below, while another was above 30 years. This was to allow participants to objectively and freely share their experiences and perception about climate variability and impacts and their adaptation practices. It is worth mentioning that, the primary data were based on the evaluation of a policy document (METASIP policy) objective for the period of 2009-2013, and so the 2014 is an appropriate year for the evaluation exercise since the programmes years of implementation ended in 2013. These focus group discussions were held to cross check the validity of household questionnaire responses and also establish deeper understanding of the issues under study. Key informants interviews were also carried out. These were experts from various areas (Ministry of Agriculture staff, NGOs staff in the area, opinion leaders etc.) that could explain, reasons why certain practices were carried out.

Tools employed, data type and sources. Data were gathered from both secondary and primary sources. The secondary sources were, existing quantitative and qualitative data, these include; existing meteorological data for the period of 1961-2010 (Ghana Meteorological Service, Navrongo Station, 2014), MoFA reports on the implemented programmes and policies on climate change impacts in the agricultural sector, MoFA policy framework on climate change, documented climate change impacts within the study region and local people livelihood profiles of the District. Primary data collected included socioeconomic status of people in the study area, the perception of the occurrences of climate change events, the corresponding coping and adaptation strategies the people of the study area use and the reliability in sustaining their livelihoods. The tools employed for primary data collection included household questionnaire interview to examine respondents experiences, practices and knowledge towards climate change events. The questionnaire was supplemented with, participatory methods such as community focus group discussions (FGDs) to cross check the validity of the responses of the questionnaire interview, ranking and scoring to ascertain respondents' priority to climatic events occurrences and semi structured interviews for interactive communication with key informants to establish deeper understanding of the issues at stake. The mixture of instruments allows the researcher to have wider and clearer picture of an issue (Pawlak and Szubert, 2004).

Analytical methods. The survey questionnaire data were analysed using SPSS software version. The responses from the household questionnaire interviews are presented using simple percentages in tables (Tables 1 and 2). Furthermore, the data derived from the interviews and focus group discussions were reported and analysed qualitatively using tables, content analysis, key words in context where necessary. As seen in the conceptual framework (Fig. 2) above, the analysis of the responses from the questionnaire and interviews was guided by the framework. At the stage 1, the expected output was the motivation or benefits for practicing a strategy and how beneficial and significant the strategy was to respondents (Table 3). The stage two of the framework, the expected output was the strategies (both indigenous and introduced) been practiced and the duration in years (Table 2), and the strategies been used is a function of the level of respondent's vulnerability to climate change (frequency, exposure, sensitivity).

The stage three is the number of strategy options available to respondents and the expected output was the number of indigenous and introduced programmes available and been practiced or adopted. The stage four of the framework is the type of adaptation practices been used and how they complement or conflict each other. The last stage of the framework, which is stage five, is the outcome of the implemented programmes against their expected targets (Tables 4 and 5). The paper adopts the pre-determined indicators in the agricultural sector developed by MoFA (performance indicators) to measure the progress made towards achieving the set targets of the implemented programmes. The study analysis of the adaptation policies and programmes are solely based on MoFA technical reports.

RESULTS AND DISCUSSIONS

Socio-demographic characteristics of respondents. Sixty-six male (66 %) and 34 female (34 %) respondents were interviewed. Most of them (62 %) were above 30 years, representing active part of the population, engaged in farming. Persons younger than 30 years of age were 38%. According to Deressa *et al*. (2011), the age of farmers correlate with their experience in farming, and they argued in their study that, older farmers are more likely to experience climate change. This claim goes to support the data of this paper, because most of the respondents especially the 30 years and above cohort shared a lot of their farming experiences with regards to climate change over

the years.

Almost all the respondents (98%) mentioned that farming was their primary occupation, while 22 % are into trading as a secondary job. Majority (74%) of the respondents were married with only 20% been single, while 3% was divorced and another 3% widowed. Forty-two per cent (42%) of the respondents were found to have no formal education while 50% had at least basic education and 8% with secondary education and above. According to Bhardwaj (2016), education and for that matter the ability to read and comprehend enhances the understanding of concepts, theories especially those related to modern agricultural practices, technologies, among others. This claim tend to affirm the findings during the focus group discussions when some of respondents claim they were aware of the national introduced adaptation programmes but did not understand the concepts behind some of them because they could not read and understand. This assertion by respondents turns to affirm the report of Doss (2006) that, a challenge facing scientists in agricultural research is the understanding of how and when introduced technologies are used by farmers and with what impacts.

Farmers' perception about climate change. During the survey, respondents were asked their perceptions of long term climatic changes. Farmers reported the changes they have observed. Most farmers (96%) perceived an increase in average temperature, and a decrease in average precipitation (50%) over the last two decades. Respondents perception of climate change compared with the actual climate data recorded during the period 1961-2010 suggest that, respondents perception go contrary to the existing climatic data records, because they believe there is decrease in the rainfall pattern but the existing data depict a slight increase during the reported period (1961-2010). However, respondents' perception of increase in temperature affirms the actual existing meteorological data for the period 1961-2010 which records rising temperatures during the period in the study region. According to the study of Oloukoi *et al*. (2013), changes in rainfall distribution has had adverse repercussions on agriculture in general, food security and poverty levels of rural communities in particular. They concluded that, such adverse effects are likely to be severer in regions that agriculture is predominantly rain fed with limited irrigation schemes and facilities. Furthermore, respondents were asked whether they had perceived any changes in weather pattern, farmers indicated what they perceived as indicated in Table 1. A total of 100 respondents were interviewed (survey questionnaire) on each of the climate change they perceived. A percentage was generated by the number of people who responded 'yes' out of the 100.

Table 1. Respondents' perception of climatic changes they have observed

Climatic changes perceived by farmers	Percentage: N=100
Increased temperatures	96%
Weather pattern has changed significantly	56%
Decreased rainfall	50%
Weather pattern has changed very significantly	42%
Erratic rainfall	36%
Increased rainfall	14%
Decreased temperatures	4%
Weather pattern has changed but not significant	2%

Source: From field survey, 2014

Household vulnerability and adaptation strategies in the study . The study seeks to find out the adaptation strategies respondents were engaged in. Seven strategies were given as options (Table 2) and each strategy has 100 respondents to answer "yes" when respondent practiced it and "no" if they do not. A follow-up question to a 'yes' answer was how long the respondent practiced the strategy ranging from less than a year to more than five years. A percentage was generated for a 'yes' answer (number of 'Yes' out of the 100 respondents who practiced the strategy or adopted it), with a breakdown to the duration of the practice. The results showed that farmers adopted a range of practices in response to perceived climate change (Table 2). The most common practice adopted by all (the 100) respondents was changing crop varieties (100%). Twenty-four of the respondents (24%) had been practicing this strategy ranging from less than a year to 5 years while 76 % for more than 5 years. Other strategies included changing livestock breeds (96%), practicing irrigation farming (98%), ,and local traditional practice (98%) which includes terracing to check soil erosion, mulching, etc., and land management (98%) which include conservation agriculture to conserve soil moisture, were adopted strategies by respondents from the study area. They have been practicing these adopted strategies, ranging from less than one year to more than 5 years as presented in Table 2. These responses tend to support a study carried out by Asrat and Simane (2018) in north west Ethiopia. According to their studies, the use of improved crop varieties, agroforestry practices, soil conservation practices, irrigation practices, and adjusting planting dates are the most important adaptation strategies by smallholder farmers. They however added that, adaptation decision is location-specific and influenced by key drivers such as socioeconomic, environmental, and institutional factors.

The results suggest that households in the Bolgatanga district in the UER are not only dealing with tougher (or severe) climate conditions but also have more limited range of adaptation options available to them. It is worth mentioning that, since they have limited options, some of the national adaptation introduced programmes such as the food security and income growth programmes should have been adopted and integrated into the local practice to help minimise the effects of climate change as expected synergies. During the focus

Table 2. Adaptations farmers adopt in response to perceived climate change

Adaptation strategy	Perception: N=100				% of a strategy adopted N=100
	Adaptation not practised	Yes adaptation and duration			
		<1 year	1-5 years	>5 years	
Improved crop variety	-	24	76	-	100%
Irrigation farming	2	-	26	72	98%
Local traditional practice	2	-	26	72	98%
Livelihood diversification	2	20	52	26	98%
Land management	2	2	28	68	98%
Improved livestock breeds	4	34	58	4	96%
Migration	78	2	10	10	22%

Source: From field survey, 2014

group discussions (FGDs) respondents debated mitigation practices to climate change. These included both actual and desired adaptation. The discussions revealed that livelihood diversification which include non-farm and off farm activities were the most common adaptation strategy by respondents. The results tend to support the argument by Fagariba and Soule (2018), in a study carried out in Sisala West District in the Upper West region. They acknowledged that, livelihood diversification have the potential to improve climate resilience in smallholder farming systems through risk spreading. Migration as a strategy received less attention (22%) during the household survey. Other strategies mentioned during the FGDs especially by the women groups, include planting more drought tolerant crop varieties, early maturing varieties as well as improved hybrid seeds. Farmers also reported shifting towards livestock production and adopting disease and pests' resistant livestock breeds (MoFA, 2013a). Irrigation farming and water harvesting schemes were ranked at the top among the priority adaptation during the FGDs regardless of gender and age. FGDs also stressed the importance of soil and water conservation as a strategy.

Introduced agricultural adaptation programmes from farmers' perspective. Farmers' perspectives of government's introduced programmes in relation to their local strategies were also investigated. Respondents identified programmes they had adopted and their benefit to them as shown in Table 3.

The study results revealed farmers (respondents) opinions about some of the introduced agricultural adaptation programmes in their communities as presented in Table 3 above. The most adopted programme and also perceived to be beneficial and significant was the land management programme (62%), while 28% of respondents perceived this programme to be very significant and beneficial. According to the respondents, this programme (land management) is the most significant and beneficial because most of their farm lands in the district are degraded and their productivity is decreasing significantly over the years and they believe the programme will preserve their farm lands and also increase the yields per area. These claims by farmers tends to support an assertion made by Kristiansen in a study carried out in Ethiopia in 2011. According to Kristiansen (2011), land management are soil and water conservation strategies and are mainly used because of soil degradation and soil erosion, and so farmers adopt it to rehabilitate their fields. He concluded that these activities are increasingly important today because climate change to some extents is accelerating these processes.

Table 3. Benefits and Significance of Introduced Adaptation Programmes

Introduced Agricultural adaptation programmes and policies	Respondents' benefits and significance level of policy: N=100			
	Not beneficial	Beneficial but not significant	Beneficial and Significant	Beneficial and very significant
Income growth policy programmes	-	26	60	14
Land management and irrigation	-	10	62	28
Food security programmes	2	24	30	44
Science and technology policies	-	26	25	24
Market access policy programmes	58	20	10	4

Source: From Field Survey, 2014

Market access programmes were given the least attention (10%) to be beneficial and significant by interviewed farmers. According to the respondents, they are mostly subsistence farmers, and generally consume what they produce and what they sell is just little and occasional, and for that reason market was not a major challenge to them. These claims by respondents tend to conflict with assertion made by Welborn (2018), that climate change alters consumers behaviour and therefore argued that, producers access to market can increase their income and reduce their vulnerability. During the FGDs it was revealed that farmers in the study area are not obliged or compelled to adopt a local or introduced agricultural adaptation strategy in their effort to reducing the effects of climate change and variability. The adoption of some introduced strategies such as use of improved crop varieties and livestock breeds led to the abandoning of some local strategies, e.g. local crop varieties and animal breeds. On the other hand, some local and introduced strategies served as complementary, i.e. irrigation practices and use of farm yard manure. During the group discussions it was also realised that no particular individual or group was said to be using only one strategy, but a combination of strategies. Common combinations of the strategies mentioned included the use of two or more different local strategies such as mulching and terracing; the use of two or more introduced strategies such as land management and irrigation; and finally the use of several indigenous and introduced strategies together such as improved varieties, irrigation, mulching, use of animal manure, etc. These combinations in their opinion were very beneficial and significant in terms of yield increases, land conservation to mention but a few. In all the group discussions, it came to light that the use of several indigenous strategies was popular than the use of several introduced strategies together. Again, it was found out that combination of indigenous strategies like crop and livestock keeping, using manure from livestock for soil management are common in the area. The discussions however revealed that combinations of different introduced strategies were not widespread. According to the participants, irrespective of gender and age, the introduced programmes were used by farmers to complement the local strategies. According to MoFA report (2013a), farmers were expected to adopt the national introduced programmes to replace some of the local practices that were assumed outmoded such as farmers own seed as against improved seed or adopt these introduced programmes to complement some of the indigenous strategies. However, the results of this study suggests that farmers were still relying more on their indigenous strategies as compared with the national introduced programmes.

Introduced Agricultural Programmes' Performances (2009-2013)

The performance of introduced agricultural programmes was assessed based on the technical reports output of MoFA in the UER. Four programmes had data reported on them, and the analyses of the performance are based on these programmes. The four programmes include: food security and emergency preparedness, increase growth in incomes, sustainable land management, irrigation and science and technology programmes. Each of these programmes had measurable indicators to assess their progress in achieving their set targets.

Food security and emergency preparedness programme.The measurable indicators for this programme are:

- The percentage change in output per hectare of selected staple food in the study region
- Post-harvest losses to be reduced by at least 30% every year
- Land under irrigation to increase

The Medium Term Agriculture Sector Investment Plan (METASIP) policy, which operated from 2009-2015 by the Ministry of

Food and Agriculture (MoFA), set targets to be achieved within this specific timeframe (MoFA, 2007b). This study adopted this policy indicators and their set targets in the analysis of these introduced programmes implemented in the case study communities in the Bolgatanga district of the Upper East Region using the MoFA technical reports. The Ministry of Food and Agriculture (MOFA) recognises that increase in productivity of small scale farmers would increase food availability and therefore there would be food security. To be able to evaluate the performance of the indicators, targets were set. Yields of staple foods were to be increased by 50% by the year 2015 or at least increase by 10% every year from 2009-2015. The yields over the five-year period (2009-2013) as indicated in Table 4 experienced fluctuations and fell below the expected targets. For example comparing 2013 and 2012 yields of millet, soybean, groundnuts and rice recorded a decrease of – 10.0%, –12.0%, –10.0%, and –27.0% respectively. However, maize, sorghum, and cowpea recorded an increase of 8.7%, 7.9% and 5.6% respectively, but these increases were all below the 10% increase target. The productivity targets for staple crops in the study region were not met for the period (2009-2013). Some of the reasons were that some farmers did not use improved varieties and some did not apply fertilizer to their crops, and others too had failed to plant at the right time. According to the responses from the key informants' interview, there is urgent need for farmers in the area to do away with their own seeds which according to them have very low yield potentials as compared with the improved varieties introduced to them. They added that it is also imperative that farmers in the region apply fertilizer to their farm lands because generally farms lands have lost their fertility due to over cropping over the years.

One of the main objectives of MoFA was to improve food storage and distribution by reducing post-harvest losses by at least 30% during the project period for 2009-2015 along the value chain of the staple foods (MoFA, 2013b). According to the regional report (MoFA, 2013a) there was a reduction of post-harvest losses from 2009-2013 for the staple foods in the study region. Thus, an average post-harvest loses reduction of 23% for 2009, 30% for 2010, 31% for 2012 and 33% for 2013.This suggests a significant steady progress towards achieving the set target of 30% reduction in post-harvest losses by the end of 2015. The explanation for this good performance on the postharvest losses indicator, according to the key informants interview was as results of the presence of buffer stocks warehouses between 2010-2012 built for farmers in the area, and secondly most of the farmers harvested their crops at the right time as was recommended, because late harvesting was one of the major reason for post-harvest losses in the area. The third indicator under the food security programme is the increase in land area under irrigation. Increasing land area under irrigation was expected to boost food production and reduce the country's dependence on rain-fed farming. The indicator targeted increase in land area under irrigation by 22,590ha throughout the country by the year 2015. By the end of 2013, a total area of irrigated land was 21, 671.9 ha made of 11,136.2 ha and 10,541.7ha for formal and informal irrigation schemes respectively, an increase of 8.1 % over 2012 nationwide coverage (Sarpong and Anyidoho, 2012). Land area under irrigation for the UER, were 916ha in 2010, 905ha in 2011, 1849ha in 2012 and 2990ha in 2013, suggesting a steady increase in land under irrigation for both the country and the region respectively. This good performance according to the focus group discussions and key informants interviews responses, was due to government intervention of extending irrigation facilities and dugouts in some areas in the region.

Table 4. Percentage change in output/yield per unit area (Mt/Ha)

Crop indicator	2009	2010	2011	2012	2013	Progress towards target
Maize	1.5	1.54 (2.7%)	1.60 (3.9%)	1.38 (–14.0%,)	1.5 (8.7%)	Target not met
Rice	2.8	2.81 (0.4%)	1.95 (–31.0%,)	2.69 (38%)	2.00 (–27.0%,)	Target not met
Millet	1.14	0.97 (–15.0%,)	0.82 (–15.0%,)	0.90 (9.8%)	0.81 (–10.0%,)	Target not met
Sorghum	1.27	1.14 (–10.0%,)	1.10 (–3.5%,)	1.01 (–8.2%,)	1.09 (7.9%)	Target not met
Soybean	0.91	1.00 (9.9%)	0.76 (–24.0%,)	0.97 (28%)	0.85 (–12.0%,)	Target not met
Groundnuts	0.77	0.90 (17%)	0.76 (–16.0%,)	0.87 (14%)	0.78 (–10.0%,)	Target not met
Cowpea	0.88	0.80 (–9.0%,)	0.60 (–25.0%,)	0.71 (18%)	0.75 (5.6%)	Target not met

Source: MoFA Reports output, (MoFA, 2013a; MoFA, 2013b; MoFA, 2011)
*Yield/Ha is the total output per unit area cultivated. Figures in brackets are percentage change from previous year

Table 5. Average prices of major staples from 2010 to 2013

Staple item	Average Prices: GHC/MT			
	2010	2011	2012	2013
Maize	400	525	665	550
Rice	900	1134	1476	1460
Millet	510	616	905	1043
Sorghum	470	523	660	725
Soybean	No data	No data	675	1050
Groundnuts	1010	1730	2635	2274
Cowpea	960	1100	1660	1752

Source: (MoFA, 2013a) *There were no reports on 2009

Increased growth in incomes programme. According to Kristiansen (2011), climate change and poverty are deeply intertwined. He argued that climate change disproportionally affects poor people in low income communities. Welborn (2018) asserted that, introducing income growth programmes to the poor can increase their resilience to climate change impacts through increase in their disposable income. This programme was expected to increase farmers' disposable income. The indicators to measure were value of crop production and the development of farmer based organisations (FBOs) for the period (2009-2013). Data on other indicators like value of livestock, fish and cash crops was not reported. As shown in Table 5, there were fluctuations in the prices of some of the main staples in the region. There was increase in the prices of all food items from 2010 to 2012, and a decrease of prices for maize, rice and groundnuts in 2013. However, there had been modest gains in value of the other food items, suggesting modest increase in income of farmers who cultivated these crops. According to the focus group discussions and key informants, the general increase in price for all crops for the 2010-2012 period, was due to the introduction of buffer stock system in the region by government to mob up glut and prevent price falling by introducing minimum price for these crops. However, they explained that the buffer stock system was not effective after 2012, and this partly explains the decline in the prices of some of the crops in 2013. The respondents explained the ineffectiveness of the intervention in their opinion was due to government withdrawal of the mob up exercise that was carried out in 2010 and 2011, which was taken over by private individuals.

Farmer Based Organisations (FBOs) in the region consist of individual farmers who work together as members of farmer group(s) with the aim of satisfying the interest of their members. Fagariba and Soule (2018) reported that, individual farmers in Sisala West District in Northern Ghana who worked together as members of farmer groups had higher chances of accessing credit facilities from financial institutions than farmers who were not in groups. They concluded that, farmers who had access to credit facilities were able to carry out income growth activities than those who were not. The number of FBOs formed in the region were 1733 in 2009, 1671 in 2010, 1195 in 2011, 1525 in 2012 and 871 in 2013. The progress has been fluctuating from year to year and far below the set target of 2500 FBOs expected in a year as at end of 2013. This was explained during the focus group discussions that, farmers' groups in the area are not stable for number of reasons. Among these include; group members not meeting regularly causing some groups to disintegrate, inability to pay group dues as members' obligations and lack of training for group cohesion to mention but a few.

Sustainable management of land and environment. This programme was expected to enhance production, improve food security, income and livestock through sustainable land management practices such as crop management, erosion control, bush fire prevention and control, adoption of sustainable land management technologies among others. Measurable indicators included awareness creation on these activities that will address climate change in the food and agriculture sector. As indicated in Table 6, the sustainable land management activities have gained some steady progress from 2010-2012, with slight reduction in 2013. With expected beneficial target of at least 4000 farmers per year (MoFA 2013a), there was significant progress with the number of beneficiaries of these implemented activities.

Table 6. Activities on Sustainable Land Management (SLM) Practices (2010-2013)

Indicator	2010	2011	2012	2013
SLM activities carried out	40	65	82	75
Number of beneficiaries	4, 017	10, 936	7, 800	11, 475

Source: (MoFA, 2013a) *There were no data reports for 2009

Science and technology programmes. Technologies are products of research and development (R & D), where the application of science and its adoption are important for increased agricultural production and productivity. The measurable indicators for this programme include access to improved technology and extension services. The number of farmers that have access to improved technology in the region were 8,420 farmers in 2010. It went up to 11,066 in 2011, 11,334 in 2012 and shot up to 21, 200 in 2013, suggesting a significant progress towards achieving the target of 25, 000 farmers by the year 2015. With a target of extension officer: farmer ratio of 1:1000 by 2015, the reported output indicated 1:1500 in 2010, 1:1300 for the years 2011, 2012 and 2013 respectively, suggesting a 61% progress towards the set target. The reported output showed that the number of communities with access to extension services in the region improved progressively as; 740 in 2011, 989 in 2012 and 989 in 2013. This brings to the conclusion that, the yearly target of 1083 communities to access extension services in the region could not be achieved as at end of 2013.

SUMMARY AND CONCLUSIONS

The paper investigated indigenous strategies/ perceptions and introduced national agricultural programmes as means of mitigating climate change effects on agriculture in the Bolgatanga District of UER. It considered the specific conditions of the selected communities in the district in respect of the introduced programmes under METASIP from 2009-2013. It identified the indigenous strategies such as livelihood diversification, land management and small scale irrigation been practised by the farmers within the study area as adaptation strategies to climate change and variability. The study found that farmers in the communities have observed decreased rainfall pattern and in the last two decades increased temperatures. It further showed that farmers adapted four of the six national introduced programmes, which include food security, income growth, sustainable land management, science and technology programmes. However, the indigenous strategies in the area had played a key role in the adaptation process; though the scale of these strategies employed in the communities were quite limited. The results also showed that the introduced agricultural programmes at the community level were less applied suggesting the need to combine the two where feasible to improve the limited adaptation programmes available to the people in the District. During the group discussions and interviews, participants gave reasons why they carry out certain practices and not others. It came to light that farmers in the area are largely aware of government introduced adaptation programmes but were yet to benefit immensely from these programmes. This means more efforts need to be done to make these programmes beneficial to the target population. The outcomes of the introduced agricultural programmes from the analysis suggest mixed performance in terms of progress towards achieving the introduced programme set targets. It was realized that yield targets for staple foods were not met, while reduction in post-harvest losses and increase in land under irrigation made significant gains toward achieving the programme's set targets. The income growth, science and technology programmes have

recorded steady progress towards targets, but still fall short of the yearly programme targets as at the end of the evaluation period 2009-2013. There is therefore the urgent need to intensify farmers' education and motivation to adopt the national introduced programmes in order to mitigate the increasing effects of the climatic change and variability. It is also recommended that further studies be carried out in the future to find out the updates of prevailing climatic conditions and strategies in the study region.

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STATEMENT OF NO-CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this paper.

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