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Original Article

Climate-Smart Agriculture and Poverty Reduction in Ejisu-Juaben Municipality of Ghana

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ABSTRACT

Climate change has emerged as a worldwide development issue affecting many sectors of the global economy, especially agriculture. Expected effects of climate change on agriculture, food security, and poverty are raising global concerns. The increase in agricultural production over the past years has been due to land area expansion with very little change in production strategies. Agriculture is the most important economic sector of Ghana, and central to the survival of most people, especially in Ejisu-Juaben Municipality where agriculture is the mainstay of most inhabitants. However, crop cultivation in the municipality is primarily subsistence and rain-fed, but changing climate affects harvest and food production. For sustainable food security, and for agriculture to feed the world in a way that can ensure sustainable rural development, it must become 'climate-smart'. This, therefore led the researcher to assess the farmers' adaptation strategies used for climate change and to assess the climate-smart on-farm land-use and water management strategies that can be adopted by smallholder farmers in the Ejisu-Juaben Municipality. Attention would be given to farmers' climate-smart adaptation strategies and poverty reduction linkages in the municipality. The mixed approach was employed and a sample of 406 respondents was used. Mixed sampling techniques comprising stratified and multi-stage sampling methods were employed for the study. Data was analyzed using descriptive statistics embedded in SPSSv20. Results confirmed that farmers in the municipality employed several Climate-Smart Agriculture practices which helped in reducing the incidence of poverty and food insecurity.

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INTRODUCTION

The development of several areas of the world has been seriously affected by climate change. Climate change has been seen as part of the menace to sustainable development (Akinnagbe & Irohibe, 2015). There has been a record upsurge in greenhouse emissions globally, which has brought about intense effects of changes in climate (Akinnagbe & Irohibe, 2015). Agricultural activities are identified as third in the discharge of greenhouse gases which contribute to climate change. The use of fossil fuels and the manufacture of chlorofluorocarbon are first and second in greenhouse discharges, respectively (Akinnagbe & Irohibe, 2015). According to Ozor and Nnaji (2011), discharges from agronomic activities are said to have played a part in human causes of greenhouse gas secretions. Changes in the use of land from other purposes to agrarian use also significantly affect total emissions (Ozor & Nnaji, 2011).

In many developing countries, agriculture is the most significant economic area and is central to the survival of millions of people. In Africa for instance, agriculture serves as the economic backbone of most economies, contributing significantly to the GDP and also account for about 55% of exports (OECD, 2016). Crop cultivation in Africa is primarily dependent on rainfall and is also small-scale in nature, but owing to climate variability and change, unpredictable and untimely rainfall disturbs the harvest of produce. Appiah (2019) has it that, the sole dependency on rain-fed agriculture is a characteristic of countryside zones for the supply of food. So, a change in rainfall amount and timing in a season has the potential to worsen the uncertainty of resident food structures and food security (Appiah 2019; FAO, 2008). This makes Africa principally susceptible to the stimuli of changes in climate. The susceptibility of Sub-Sahara Africa (SSA) is further exacerbated by the fact that the continent experiences relatively high temperatures since it is found in the tropics (Akinnagbe & Irohibe, 2015).

Farming methods are expected to supply food for a global population, which is projected to reach 9 billion by 2050 and exceed 10 billion by the end of the century. (Lal, 2016). Farming methods need to change in order to improve the capability and consistency of smallholder farmers so as to attain a secured and sustained food security (FAO, 2010b). The Food and Agriculture Organization (FAO) further acknowledged that, for farming to feed the increasing population of the world in order to attain a viable rural development, then it should be transformed and become 'climate-smart'. Climate-smart agriculture (CSA) is defined as a methodology of bringing about new and modern ways of production, transforming programs and investment situations to attain viable development in the agricultural sector amidst a changing climate in order to achieve food security (FAO, 2010b). Considering Ozor et al. (2011) view, the incidence of climate change involves deviations in the wetness and quality of soil, crop pliability, the timing and or length of cropping season, harvest of crops and animals, atmospheric temperatures, weed insurgence, unparalleled droughts, among others (Ozor & Nnaji, 2011).

The question however is, what strategies and practices are suitable to achieve the goal of CSA? There is an extensive debate on the insufficiency of a principal strategy used for intensification so far by depending on the use of fertilizers and insecticides. The major problem of this strategy is the generation of improper heights of ecological damage and hitches of economic viability (IAASTD, 2009; FAO, 2010a). More attention, therefore, ought to be geared towards other methods of strengthening, principally by adopting sustainable land and water management strategies. Therefore, there is a need to plan immediately and implement farming adaptation and extenuation prospects in accordance with the policies of the

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government. An example of such policies by governments is the national climate change action plans (Preston et al., 2011; Conway & Mustelin, 2014). In line with this, climate-smart agriculture, which is helping to achieve global development goals such as poverty reduction and hunger eradication has led to the modification of farming systems by incorporating adaptation, extenuation and food security (FAO, 2013). Alleviating susceptibility and promoting pliability of farming systems to changing climate to protect a viable provision of food whereas reducing poverty among vulnerable groups are among the major objectives of Climate-smart agriculture (Harvey et al., 2014). Fundamental benefits of CSA strategies are accumulative food production devoid of degrading soil and water resources, improving and restoring the fertility of the soil (Gollin, 2019), improving the pliability of agricultural methods to climatic risk, and refining the ability of the strategies to sequester carbon and alleviate climate change (FAO, 2009; FAO, 2010).

The expected changes in climatic conditions and the related major impacts on many agricultural systems suggest a broad and pressing need for adaptation. For farming households, the nature of these responses will depend on their recognition that the climate is changing, and their ability to change their behaviour in response, perhaps through changing their farm management practices. Extensive studies have been conducted in Ghana on the impacts of climate variability and change on food production (Codjoe et al., 2013). The connection between climate change and food security has largely been explored in relation to impacts on crop productivity and hence, food production (Gregory et al., 2005). Little research attention has, however, been given to farmers' climate-smart adaptation strategies and poverty reduction linkages, especially in the Ejisu-Juaben Municipality. Climate variability and its stress on poor subsistence farmers in the Ejisu-Juaben Municipality (EJM), Ghana continue to worsen levels of poverty vulnerability among agrarian households in many farming communities.

Climate variability has translated into conditions of failed forecast of rainfall for growing crops (Asante, 2009). Ejisu-Juaben Municipality is one of the main food baskets of the Ashanti Region of Ghana. Erratic rainfall and rising temperature trends and their effects on smallholding agriculture warrant new adaptive strategies to contain the problem of ensuring adequate food security for households and their immediate districts, through left-over sales of farm produce in the selected communities. In spite of farmers' indigenous adaptation strategies, diverse conditions of poverty, due to climate-dependent farming persist. The use of inorganic fertilizers, herbicides, and pesticides by smallholder farmers in the Municipality is associated with food insecurity and diverse conditions of poverty since there is low crop yield. There is further, little scientific analysis of climatic (rainfall and temperature) data available to inform knowledge, in their on-farm subsistence farming activities. Again, in a society at risk, the well-resourced are well-insured in readiness for any long-term and range of short-term options offered (Mortimore, 2010).

However, evidence on the ground proves otherwise in the case of subsistent farmers in the Ejisu-Juaben Municipality; as farmers invariably, do not use on-farm climate-smart agricultural methods such as sustainable land and water management, to improve crop yields that would ensure food security due to poor resource base of these farmers at the household and community levels. The main aim of this paper is to equip smallholder farmers with techniques of on-farm land use and water management against climate change in the Ejisu-Juaben Municipality.

The specific objectives are:

- To explore on-farm climate-smart land-use and water management strategies
- To assess the viability of these climate-smart adaptation strategies for poverty reduction

RESEARCH METHODS

Research Design

The study made use of the cross-sectional case study design with subsistent farmer households as

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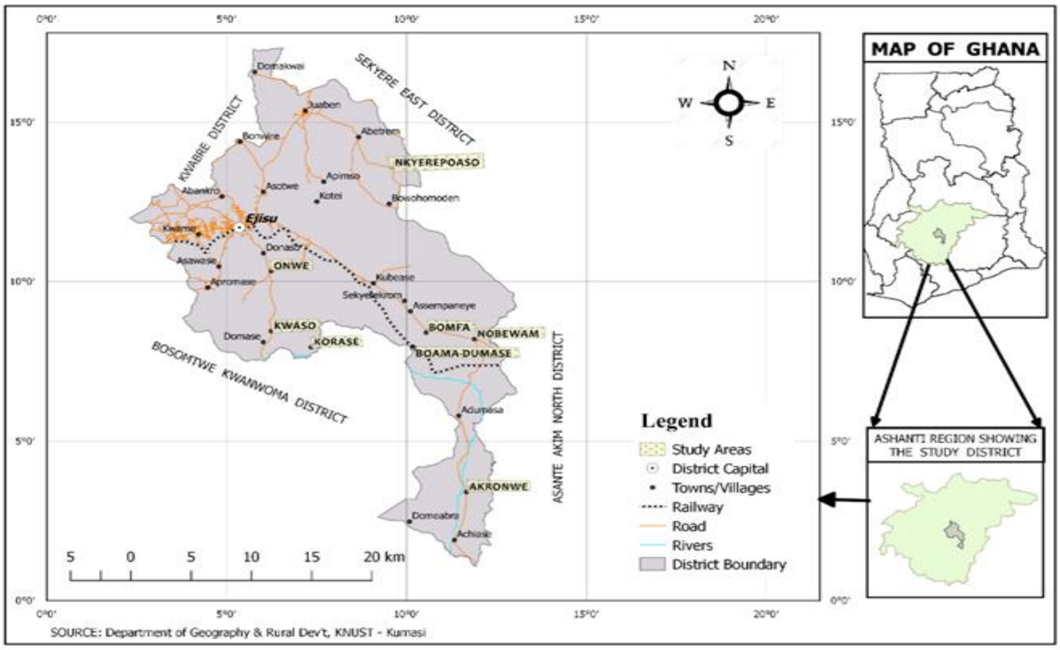
the unit of analysis using both quantitative and qualitative approaches. The quantitative approach was used because it provided the numbers and figures while the qualitative approach added value to it through explanation and ensured direct involvement of the researcher in data collection and to have direct contact with respondents. The qualitative approach on the other hand uses words and critical observations to express a reality describing people in ordinary situations (Polkinghorne, 2005). Using the qualitative method created the opportunity to assess the perceptions of respondents on climate variability and climate change, their definition, manifestation and causes as well as their effects on the lives of the respondent.

Study Area

The study area is the Ejisu-Juaben Municipality with specific communities such as Akronwe, Boama Dumase, Bonfa, Kwaso, Korase Nobewam, Nkyerepoaso and Onwe (shown in Figure 1). The Municipality is located within the Ashanti Region of Ghana. The climate and vegetation of these areas show tropical bi-modal (Nicholson & Grist, 2003) rainfall patterns of the wet semi-deciduous forest zone, with suitable soil that supports subsistent agriculture. It has two peak rainfall in March and September; the mean annual rainfall is 1300 mm. The maximum temperature is 32˚C in March. Ideally, the supply of temperature and rainfall trends enhanced the cultivation of food and cash crops, making the Municipality food sufficient in times past. The same cannot be said of today due to the incidence of climate variability and partly due to land ownership being customary and family inheritance, self and hiring, and small farm sizes which are still reducing due to high demand. The 2010 population and housing census shows that the population of the Municipality is 143,762 comprising 68,648 (47.8%) males and 75,114 (52.2%) females. The census revealed that the majority 104,197 (72.5%) of the population are in rural areas while 39,565 (27.5%) of the population are in urban areas.

Figure 1. Map of the Study Area



Sample Size and Sampling Procedures

A purposive sampling technique was used to select a total of eight (8) peri-urban and rural farming communities from the Municipality. Multi-stage (purposive, Quota, and snowball) sampling was used to select four hundred and six (406) smallholder farmers based on the respective community population for the administration of household questionnaires to male and female

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farmers, identified from the rural and peri-urban prefecture.

Research Instrument

The study made use of data from both primary and secondary sources. The primary source of data involved first-hand field data from respondents. This data was collected from smallholder farmers as well as other stakeholders such as chiefs, assembly members, and various committee leaders from the selected communities using field reconnaissance, focus group discussions, key informant interviews, and questionnaire methods. Secondary data, on the other hand, was collected from reports of the Department of Rural Development, Department of Planning, and Department of Food and Agriculture in the Municipality.

Data Collection and Ethical Consideration

Permission was sought from the officials of the Municipal Assembly to consult the subsistence farmers from the selected communities. Besides, contacts were made with traditional rulers and assemblymen of the selected communities to inform them of the purpose of the study and to seek their consent. All participants gave their consent prior to being interviewed and participation was strictly voluntary. With the participant's permission, each interview was recorded and treated as confidential. To protect the identity of respondents, the study made use of special, labels to identify each particular respondent.

Data Analysis Procedure

The quantitative data was analyzed using inferential and descriptive tools embedded in analytical packages such as R software, and the Statistical Package for Social Sciences (SPSS) v.20 for Windows application; while the qualitative data was analyzed using thematic classification and content analysis of the main trending issues.

RESULTS AND DISCUSSIONS

Distribution of Respondents

The purpose of this section is to present the socio-demographic profile of the farmers in Ejisu-Juaben Municipality. Distributions of the characteristics are presented with frequencies. The choice of adaptation strategies could be influenced by numerous factors, some of which are socio-demographic (Deressa *et al*., 2011). For this reason, 406 farming households across eight communities in the Ejisu-Juaben Municipality were sampled for the study. Table 1 shows the distribution of farmers.

Table 1. Percentage Distribution of Farmers by Community

Community characteristics	Frequency	Percent
Akronwe	39	9.6
Boamah Dumasi	51	12.6
Bomfa	60	14.8
Korase	40	9.9
Kwaso	50	12.3
Nkyerepoaso	46	11.3
Nobewam	60	14.8
Onwe	60	14.8
TOTAL	**406**	**100.0**

Source: Field Survey (2020)

It can be noted from Table 1 that Onwe, Nobewam, and Bomfa formed higher proportions of respondents selected for the study with a representation of 14.8% in each community. This is a result of their large farmer population compared to the others. Akronwe on the other hand formed the least proportion of respondents (9.6%) due to its small farmer population. Generally, respondent farmers in the Ejisu-Juaben Municipality engage in the cultivation of different crops as shown in Figure 2.

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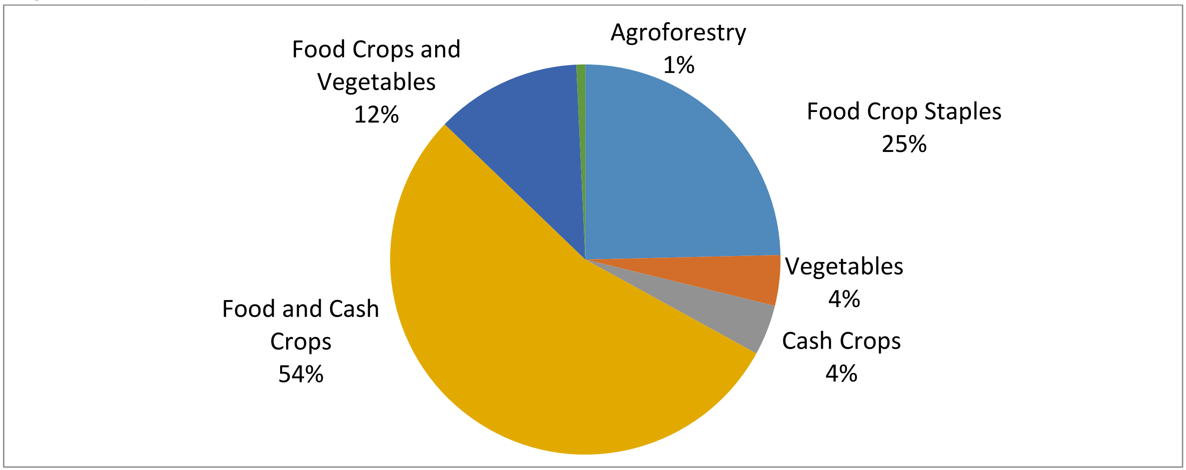
Figure 2. Types of Crops Cultivated



Source: Field Survey (2020)

Knowledge of Climate Variability and Climate Change

Changes in climate have been attributed to human activities that have an impact on global atmospheric composition and natural variations in climate based on periodical observations (Solomon, 2007). A change in climate is identified with statistical tests which are shown through changes in the mean climate over decades while climatic variability involves disparities in the mean of extreme climatic events on all temporal and spatial scales (Solomon, 2007). To understand the purposes for which farmers choose adaptation strategies, it is imperative to obtain their understanding of climate variability and climate change. Farmers in the Ejisu-Juaben Municipality engaged in the cultivation of different crops as shown in Figure 2**.** As such, their level of knowledge and understanding of climate variability and change are important as they stand to face to worst of climate variability, and climate change without understanding the phenomenon. Generally, the study revealed a 39.4% of the respondents had a good knowledge of the phenomenon, while an equal percent had poor knowledge as shown in Table 2.

Table 2. Knowledge and Understanding of Climate Variability and Change

Climate Variability and Change	Frequency	Percent
Level of Knowledge		
Very Good Knowledge	11	2.7
Good Knowledge	160	39.4
Don't Know	72	17.7
Poor Knowledge	160	39.4
Very Poor	3	0.7
Total	**406**	**100.0**
Understanding of Climate Variability		
Change in seasonal rainfall characteristics	42	10.3
Change in Temperature characteristics	9	2.2
Frequent Flooding	3	0.7
Strong winds	8	2.0
All the above	78	19.2
Changes in rainfall and temperature, as well as frequent flooding	55	13.5
Frequent flooding and strong winds	4	1.0
Changes in rainfall and temperature, as well as strong winds	150	36.9
Changes in rainfall and temperature	57	14.0
Total	**406**	**100.0**
Understanding of climate change		
Long-term irreversible change in seasonal rainfall characteristics	45	11.1
Long-term irreversible change in Temperature characteristics	11	2.7

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Climate Variability and Change	Frequency	Percent
Strong winds	19	4.7
Long-term irreversible changes in temperature and rainfall, as well as frequent flooding and strong winds	100	24.6
Long-term irreversible changes in temperature and rainfall, as well as frequent flooding	40	9.9
Strong winds and frequent flooding	3	0.7
Long-term irreversible changes in temperature and rainfall, as well as strong winds	137	33.7
Long-term irreversible changes in temperature and rainfall	51	12.6
Total	**406**	**100.0**
Human causes of climate change		
Emission of vehicular fumes	1	0.3
Removal of vegetation (deforestation)	79	25.2
Bush burning	41	13.1
All the above	39	12.4
Emission of vehicular fumes and vegetation removal	21	6.7
Bush burning, emission of vehicular fumes and vegetation removal	54	17.2
Vegetation removal and bush burning	79	25.1
Total	**314**	**100.0**
Observed effects of climate variability and climate change		
Reduced rainfall	82	20.2
Flooding	2	0.5
Rising Temperature	9	2.2
Shift in crop growing season	3	0.7
Drought	4	1.0
All the Above	38	9.4
Reduced rainfall, rising temperature and flooding	41	10.1
Reduced rainfall and rising temperature	88	21.6
Reduced rainfall, rising temperature, flooding and shift in crop growing season	12	3.0
Rising temperatures and flooding	3	0.7
Rising temperature and shift in crop growing season	2	0.5
Reduced rainfall, rising temperature, drought and shift in crop growing season	42	10.3
Reduced rainfall, rising temperature and shift in crop growing season	75	18.5
Reduced rainfall, rising temperature, flooding and drought	5	1.2
Total	**406**	**100.0**
Effects of climate change on crops		
Premature loss of crops	66	16.3
Crop failure and low yield	73	17.9
Introduction of some disease pest	10	2.5
All the above	129	31.8
Premature loss of crops, crop failure and low yield	77	19.0
Crop failure, low yield and pest introduction	29	7.1
Premature crop loss and pest introduction	22	5.4
Total	**406**	**100**

Source: Field Survey (2020)

Knowledge of climate variability is informed by the understanding of farmers on the climatic variations. For this reason, the understanding of farmers on climate variability was sought for the purpose of the study. It can be noted from Table 2 that respondents indicated an understanding of the phenomenon. However, the understanding is based on their own observation and not based on any scientific proof or knowledge.

The observations made by respondent farmers in relation to climate variability are evident in the following Focus Group Discussions held.

On rainfall, this is what a respondent said:

> *"You can no longer tell when the rains will start. The start of the farming season has turned out to be so unpredictable that you just have to prepare your lands and hope that the rains will come for you to start sowing your*

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> *seeds. What is more worrying, is the erratic nature of the rains throughout the farming season. It rains today and then the rains stop for some weeks and this negatively affects crop growth"* (Female participant FGD, Akronwe 2018).

> On drought, a respondent had this to say:

> *"the continued periods (days and months) without rain have become a common phenomenon here. The farming season is shortening due to drought. When I started farming in this village for the past 30 years, farmers could start sowing and planting by late February or early March. This is not the case in recent years, since we now start sowing and planting in late April or mid-May because of drought"* (Male participant FGD, Onwe 2018).

> Temperature and floods were not left out:

> *"These days the place has become hotter such that our crops are negatively affected. When the crops begin to grow or flower and the temperature is high, they wilt, and this negatively affects yield and intend affects food security"* (Male participant FGD, Nobewam 2018)

> *"It is now too disheartening that sometimes you wait too long for the rains to come and after planting and the crops begin to bear fruits, then suddenly you have excessive rains and this destroys our crops. The last time this occurred, all our crops were flooded and this adversely affected household food supply. In the failure of rain, there is trouble and when there are rains, you have it in excess and this creates problems for crops"* (Male participant, Onwe FGD 2018).

Climate variability is also attributed to human activities such as bush burning, vehicular emissions and cutting of vegetation among others. Respondents confirmed this with their experience as seen in;

> "*some years past, this place was full of forest and so the place was cool and we have rains in late February but these days the place is very hot, dry and the rains are unpredictable due to the destruction of the forest and bush burning"* (Female participant FGD, Nobewam 2018).

It can be noted from Table 2 that farmers demonstrated some knowledge of the phenomenon with about 42.1% indicating that they have a very good and good knowledge and 57.9% indicating that they don't have knowledge of the phenomenon. Such limited knowledge could be attributed to the lack of education and technology that are noted among smallholder farmers (Boko et al., 2007). Respondent farmers indicated that they have witnessed changes in rainfall (reduction) and temperature (increased) characteristics, with an accompanied rise in flooding as well as strong winds. This confirms Antwi-Agyei et al. (2018) findings of increasing temperature and decreasing rainfall. The study by Antwi-Agyei et al. (2018) focuses on the impacts of climate variability and change on smallholder farmers in Sub-Saharan Africa, specifically Ghana. The research highlights observed trends of increasing temperatures and decreasing rainfall over recent decades. It explores how these climatic changes affect agricultural productivity, food security, and farmers' vulnerability. The study emphasizes the need for adaptation strategies to address these challenges and ensure sustainable farming practices in the face of climate change.

This shows that farmers in their desire to reap the full fruits of their efforts over the years gave them this kind of experience on the occurrence of climate change and variability. It has therefore confirmed the findings of Appiah (2019) that inadequate information and education on climate variability and change by farmers prolong the starting of the traditional seasons of cultivation and therefore affect their production (Appiah, 2019; Anaafo, 2019).

From this, drought as an extreme event affects the cultivation and harvest of farm produce since it is difficult to tell when the rains will start and or end so as to manage time and resources in order to maximize output. This confirms the assertion of

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Solomon (2007) that changes in the mean climate over decades are what is termed climatic change, while climatic variability involves variations in the mean of extreme climatic events on all temporal and spatial scales.

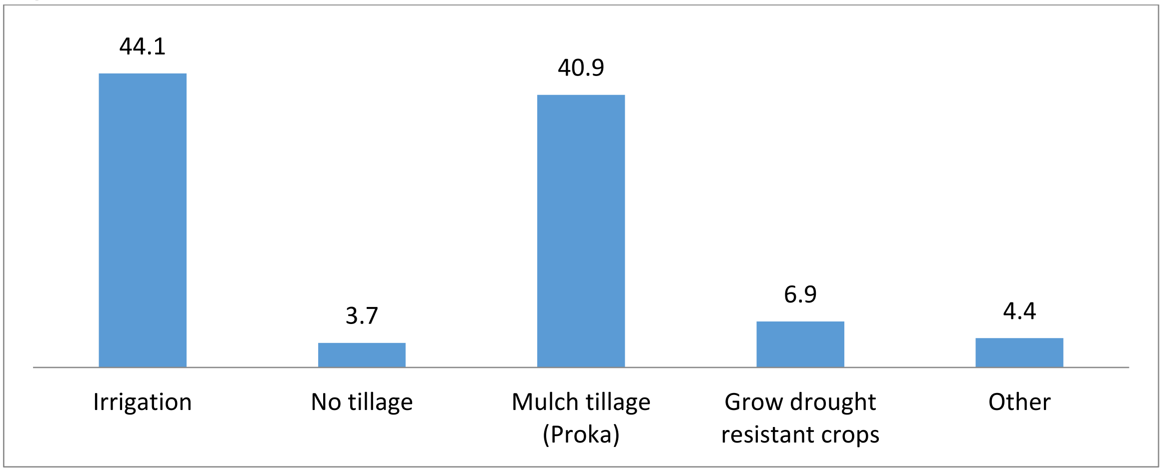
Although knowledge of the phenomenon may be limited due to their educational level, experiencing the phenomenon could inform a farmer about the variations in the atmosphere, which further informs their adaptation strategies. The understanding of farmers also confirms the estimate of Belay et al (2017) that climatic variations would lead to warming with a change in rainfall patterns. However, there is a slight difference between these findings and that of Mwalusepo et al. (2015), whose findings indicated changes in rainfall to vary between years or seasons. They also indicated that others perceive the change in rainfall between the short and long rainy seasons. These slight differences in findings can be attributed to the methods they used and the methods used in this research, as well as the differences in ecological zones.

Climate variability has been attributed to human activities, and so information was sought from respondent farmers who perceived the phenomenon to be a result of human activities. Some of the human-induced causes of climate variability listed by the respondents were the removal of vegetation, bush burning, and emission of vehicular fumes. Some of these have led to shifts in crop growing season, rising temperatures, reduced rainfall, droughts and flooding in some cases. This finding is in line with Herrero et al. (2010) and Antwi-Agyei et al (2018) who posit that climatic variations usually materialize as droughts, floods and reduced rainfall among others. For farmers dependent on rain-fed agriculture, this could lead to crop failure, low yield and an increase in pests (McCarthy et al., 2008) as expressed by the farmers. Ultimately, the knowledge, understanding, causes and effects of climate variability and change affect the adaptation strategies of farmers. The knowledge of the phenomenon by farmers as indicated above will inform their adaptation to the effects of the phenomenon and will therefore lead to the achievement of SDG 13 which talks about taking urgent action to combat change and its effects.

On-Farm Climate-Smart Land Use and Water Management Strategies of Farmers

There is a need to put in place cogent methods to promote sustainable agricultural activities. One of the ways through which this can be achieved is through the practice of Climate-smart agriculture. Climate-smart agriculture (CSA) is the approach that seeks to address the challenges of food security in changing climate through sustainable resilience systems for the increase of food production to boost productivity (FAO, 2013). Farmers in Ejisu-Juaben Municipality made use of strategies presented in Figure 3.

Figure 3. CSA Practices by Farmers



Source: Field Survey (2020)

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The goal of the use of CSA is to ensure that there is proper use of land, soil and water conservation and residual management since agricultural productivity is determined by these strategies (Branca et al., 2011). From the Figure above, farmers in the Municipality made use of irrigation, no-tillage, mulch tillage (Proka) and growing drought-resistant crops among others as CSA practices to combat the negative effects of climate change and variability.

As indicated above irrigation forms the dominant CSA practice with 179 (44%) of respondents using the method though in a primitive way as indicated below.

A focus group discussion at Korase revealed that;

> *'We do not have rivers here so we depend on abandoned illegal mining (galamsey) pits to fill our knapsack spray machines and spray the water on the crops'* (Male participant FGD, Korase 2020).

Close to irrigation is mulch tillage with 166 (41%) of respondents in the study area using the strategy. The study, however, revealed that no-tillage is the least CSA strategy practised where only 15 (4%) of respondents responded positively to its use. It should be noted that some respondents do not practice no-tillage as a CSA practice. This was evident in a Focus Group Discussion where a participant at Onwe responded to the question of why they do not practice no-tillage,

> '*If I cut the grasses and shrubs I have to gather them at a place and burn so that I can have direct access to the soil so as to sow without stress. It takes so long a time to sow crops when the cut vegetation is on the field… the seeds find it difficult to germinate through the piles of residues of vegetation'* (Male participant FGD, Onwe 2020).

From Figure 3, it can be noted that a high proportion of the farmers make use of irrigation facilities to combat rainfall reduction. Also, mulch tillage is used by the farmers to boost soil fertility. According to Boa (2017), the best climate-smart or conservation agriculture is mulch tillage and or no-tillage. These climate-smart agricultural practices come with several benefits if practised well (Boa, 2017). The benefits include;

♦reduction in labour, time and cost of farm operations

♦more stable yields, especially in dry years (slash and burn plot 5.11t/ha in 4 years and 19.50t/ha for no-till plot in the same period)

♦increased profit (in some cases from the first year and in all cases after a few years)

♦ cleaner water due to less soil loss (soil loss in slash and burn 17,787.40kg/ha and 77.80kg/ha in no-till land)

♦Less flooding

♦Enhance soil life

♦Soil moisture conservation (soil moisture % at 5cm soil depth for slash and burn land is 17.0 and that of no-till land stands at 40.3)

♦Moderation of soil temperature

The predominant CSA practiced in the study area is irrigation where close to half the respondent population are engaged in the practice of irrigation. It should however be known that the irrigation practised the use of a knapsack spray machine in applying water to the crops. This confirms the finding of Appiah (2019) that, food crop staple production in Ghana, depends mainly on rainfall with little low-cost irrigation technologies (Appiah, 2019), which makes the production vulnerable to the effects of climate variability and the threats of future crop failures. This form of irrigation practised by the farmers is not only tiresome and time-consuming but might also introduce harmful chemicals like mercury or cyanide since the water sources are abandoned 'galamsey' pits.

The next CSA practised is mulch tillage (Proka). However, the study reveals that the least practised CSA is no-tillage. The latter (no-tillage) practice and mulch tillage as well as crop rotation and associates, are the most effective CSA practices according to the three central principles of CSA/CA such as; minimal soil disturbance over a

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long period, maintaining permanent organic soil cover by leaving the previous year's residue on the field and integration of cover crops, and crop diversification through rotation and/or intercropping to improve soil fertility and to control pest and diseases (Boa, 2017). However, the findings of this research revealed irrigation as the dominant practice CSA followed closely by mulch tillage, while no-tillage is the least practised. These findings are contrary to the findings of Antwi-Agyei et al (2018) where planting drought-tolerant crops was the most practised CSA practised in their study area. This could be the case due to differences in ecology since their findings were based on two ecological zones comprising the Savanna and semi-deciduous ecological zones while my findings are based on the semi-deciduous ecological zone.

The practice of CSA in the communities, table 4 clearly indicates that all the study communities are engaged in the practice of more than two CSA strategies. This shows that farmers in the municipality are prepared and ready to reduce the negative effects of climate change and variability in their own way. However, respondent farmers in Kwaso do not practice no-tillage but most respondent farmers in the community practice mulch tillage while almost all respondents from Akronwe are practising irrigation, mulch tillage and no-tillage. A little over 92% of respondent farmers in the community are practising CSA.

This difference in response to climate variability effects through CSA practices in the various communities confirms the assertion by Neufeldt et al. (2013) where they argued that due to variability between geographical locations in terms of the risks expected and the capacities to withstand such risks, climate-smart helps to take into consideration the context-specific and locally adapted actions and interventions in the whole agricultural chain.

Effectiveness of Climate Smart Agriculture

On the effectiveness of the CSA practice, it has been established that the majority of farmers in the municipality responded that the CSA practices have been effective as indicated in Figure 4. The overall effectiveness level of CSA by farmers is 82.4% as against 17.6% of both respondents who said the practice of CSA has not been effective and those who neither know the practice has been effective nor ineffective as indicated in Figure 3.

This was also made evident in FGD where a male focus group participant indicated this,

> *"in the past four to six years I do harvest cocoa once in a year but since I was introduced to using the knapsack sprayer in irrigating my farm by a friend, I harvested cocoa twice in a year for the past two years while the quantity has also increased tremendously"* (Male participant FGD, Akronwe 2020).

Other FGD participants also made the following observations:

> *"In the past five years, I harvested less than one bag of maize per acre but since I started practising mulch tillage (Proka) in the last three years I have seen an increase in the crop yield since I now harvest two bags per acre"* (Female participant, FGD Onwe 2020).

> *"we have always run into losses but since some of us started using irrigation we now have vegetables all year round and also get good harvest"* (Female participant FGD, Korase 2020).

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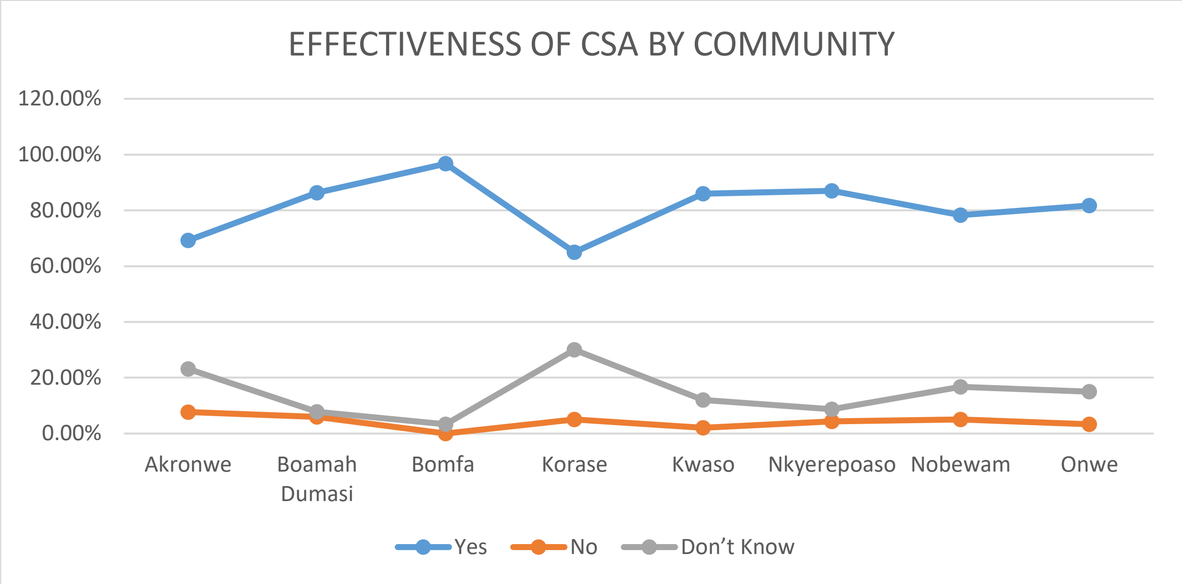
Figure 4. Effectiveness of Climate Smart Agriculture Practices by Community



Source: Field Survey (2020)

Figure 4 revealed that respondent farmers in the study area have seen some improvements in yield after practising CSA and have therefore confirmed the effectiveness of CSA. The effectiveness of CSA was also confirmed in FGDs where the majority of respondents attested to the fact that they have increased crop yields from the same piece of land since they started practicing CSA though not in the best way. For instance, the irrigation method practised by respondent farmers is based on filling knapsack sprayers with water and spraying on the crops.

This indicates that if farmers are taken through some form of training and education on the best ways of implementing CSA strategies, there will be an improvement in food security and increased income for small farmer households. This when done will be in line with the statement that the practice of Climate Smart Agriculture is implemented through empowerment and capacity building of the farmers (Branca et al., 2011).

Increased crop yield as indicated by the farmers in the FGDs shows how effective the CSA practices have been since respondent farmers adopted them as a way of eliminating food insecurity and improving the income levels of farmers thereby meeting the demands of SDGs 1 and 2 which are end extreme poverty in all forms and end hunger, achieve food security and improved nutrition and promote sustainable agriculture respectively.

Relationship Between Climate-Smart Adaptation Strategies and Poverty Reduction

This section uses a binary logistic regression model with poverty status as the dependent variable to analyse the effect of the main independent variable (CSA). Table 4 considers the estimated coefficients and statistics from the logistic regression model. In the table, the logistic coefficient (β), Exp (β) and the significance of the relationship between CSA and Poverty Status are shown.

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Table 4. Binary Logistic Regression Model of Poverty Status by Independent Variable in Ejisu-Juaben Municipality

	Sig.	Exp (β)
Irrigation (RC)	0.000	
No tillage	0.467	0.68 [0.24, 1.94]
Mulch tillage (Proka)	0.000	3.00 [1.86, 4.84]
Grow drought-resistant crops	0.032	2.83 [1.10,7.32]
Other	0.405	1.55 [0.56, 4.30]
Model Chi-square (df)	25.855(4)	
Significance	P-value <0.05	
Nagelkerke R-Square	0.086	

Source: Field Survey (2020)

A Nagelkerke R-Square of 0.086 implies that approximately 9 percent of the variation in poverty status among farmers is explained by the CSA strategies adopted. This implies that poverty status could have numerous factors which may serve as an explanation for the variations in the explanation of poverty. The results of the analysis shown in Table 4 reveal that CSA has a statistically significant effect on the poverty status of a farmer.

From Table 4 farmers practicing no tillage are poorer than those practicing irrigation. However, farmers practising mulch tillage, as well as those that grow drought-resistant crops are less poor than farmers practising irrigation. Also, farmers practising other forms of CSA are less likely to be poorer as compared to their counterparts using irrigational facilities. In contrast to this finding, no-tillage is a practice that increases crop output and intends to increase the income of farmers practising it (Boa, 2017). According to him, maize yield from 2013 to 2016 for no-till land and 'normal' (slash and burn) land show a tremendous performance of no-till land in terms of yield as shown in the statistics below; No-till against Slash and burn 2013 (4.50 t/ha against 1.50 t/ha), 2014 (5.20 t/ha against 1.35 t/ha), 2015 (4.80 t/ha against 0.86 t/ha) and 2016 (5.00 t/ha against 1.40 t/ha). This evidence shows that respondent farmers within the Municipality only practice those CSA strategies based on their knowledge of climate change and variability and the need to adapt to strategies that will improve their crop yield in the midst of the phenomenon but not based on any scientific or well informed from a professional body like MoFA.

Farmers who prepare the land to conserve moisture and those practising mulch tillage have a lower odd of being poor compared to irrigation because the former (soil moisture conservation and mulch tillage) retains soil moisture and also adds humus to the soil while the latter (irrigation) is practised using contaminated water from abandoned 'galamsey' pits. This confirms the (IPCC, 2007) assertion that farmers have a higher odds of being poor because their practice might not been properly done due to inadequate appropriate local institutions coupled with insufficient financial resources.

Though it is worth noting from the table that, CSA and adaptation strategies to climate variability have the potential of reducing poverty among smallholder farmers, the comments of farmers in FGDs indicated that poverty among them still persists due to poor access to market, poor or low prices of farm produce and poor or lack of storage facilities among others. This confirms FAO's work on climate change in the 2016 United Nations Climate Change Conference that, **o**ne-third of all food produced is either lost or wasted. The global costs of food wastage amount to about USD 2.6 trillion per year, including USD 700 billion in environmental costs and USD 900 billion in social costs (FOA, 2016).

To further examine the contribution of CSA to poverty reduction, a cross-tabulation was performed between CSA strategies employed against farmers' household income levels since farming is a major occupation and also gives their main household income. Another cross-tabulation was performed between CSA strategies and the

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poverty status of households. This was done to see the relationship between their poverty level and the CSA strategies adapted to combat the negative effects of climate change and variability.

Table 5. Climate-Smart Agriculture by Households' Average Monthly Income

Climate-smart agriculture practised by respondent	Households' average monthly income							
	GhC 1-200	GhC 201-400	GhC 401-600	GhC 601-800	GhC 801-1000	GhC 1001-1200	GhC 1201+	Total
Irrigation	27	55	23	13	18	13	30	179
No tillage	0	7	3	1	0	1	3	15
Mulch tillage (Proka)	8	16	14	34	33	26	35	166
Grow drought-resistant crops	0	0	2	6	6	5	9	28
Other	4	2	1	3	7	0	1	18
Total	39	80	43	57	64	45	78	406

Source: Field Survey (2020)

From Table 5, it can be seen that the majority of households have an average monthly income of GhC 201 and above especially those that practice irrigation and mulch tillage (proka). Irrigation is the number one contributor to household income from GhC 1 to GhC 600. However, the households whose average monthly income is GhC 601 to GhC 1201+ practice mulch tillage.

As indicated in Table 5, mulch tillage as a CSA practice has higher odds of reducing poverty among smallholder farmers since it doesn't only retain soil moisture but it also increases soil fertility through the addition of humus. Irrigation on the other hand might not be contributing to higher household income in the study area due to their lack of knowledge on appropriate irrigation methods and or the source of water used since the water is from abandoned 'galamsey' pits.

It should be noted that the overall model shows a relationship between farmers' CSA on-farm adaptation strategies and income and for that matter poverty reduction since their main occupation and source of income is farming. This confirms the World Bank, (2008), assertion that agricultural production is very important for food security as it serves as the main source of income for the majority and the poor who are living in rural areas especially due to the variable nature of domestic crop production.

Table 6 CSA by Poverty Status of Households

Climate-smart agriculture practised by respondent	Poverty Status of Households		Total
	Poor	Not Poor	
Irrigation	78	101	179
No tillage	8	7	15
Mulch tillage (Proka)	34	132	166
Grow drought-resistant crops	6	22	28
Other	6	12	18
Total	132	274	406

Source: Field Survey (2020)

From Table 6, it can be noted that in all the CSA strategies adapted it is only those who practice no-tillage are more likely to be poor. In the remaining CSA strategies those who responded to not being poor far outnumber those who responded positively to being poor. Table 6 indicated clearly that 101 respondents out of 179 practising irrigation are not poor compared to 78 of the total

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for irrigation being poor. Households practicing mulch tillage have 132 out of 166 not being poor while 34 out of the 166 are poor. Growing drought-resistant crops as well as others (crop rotation, intercropping, mixed cropping etc) have more respondents not being poor than those being poor.

According to Table 6, CSA strategies contributed to the lowering of poverty levels among smallholder farming households in the study area. From Table 6 a total of about 67% of respondents practicing CSA are not poor. The overall model therefore indicated that there is a positive relationship between CSA and poverty reduction among smallholder farming households in the study area and for that matter Ghana and the rest of the developing world.

It should however be noted that being poor and not being poor is in the ability of the household to meet basic needs like three square nutritious meals, portable water, decent clothing, shelter, basic health needs and ability to pay school fees. This confirms the definition of poverty by HSRC, (2006) that poverty focuses on exploring people's access to adequate income and food for the provision of all the required household needs and hence poverty can be defined as the measure of someone's ability to secure the basic necessities in social life.

CONCLUSION AND RECOMMENDATIONS

Climate variability and change have several effects on the global economy, especially agriculture. This makes it imperative to find ways of adapting to the phenomenon. However, to be able to adapt to the change, there is a need for farmers to have knowledge of climate change and variability. On this, results from the study indicated that farmers have some knowledge of climate change and variability and have therefore taken steps to reduce the adverse effects of the phenomenon by practising several CSA practices so as to increase crop yield and improve food security and reduce poverty in the Ejisu-Juaben Municipality and Ghana at large.

The researchers also recommend that the government through the Ministry of Food and Agriculture should help farmers through training to fully adopt and implement Climate-Smart Agriculture to be able to make the government's flagship programme of Planting for Food and Jobs a success in both the medium and long term. Also, Farmers should have periodic capacity-building workshops with support from Municipal MoFA and other governmental and non-governmental agencies to disseminate the best adaptation practices to apply, what kind of crops to cultivate, when to cultivate and the specific on-farm activities that improve crop yield. The government and other corporate bodies should also come in and buy farm produce directly from farmers in order to stop the activities of middlemen who worsen the poverty situation among farming households by buying their produce at their (middlemen) own prices and selling at higher prices to final consumers.

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