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Research Article

Perception of irrigation farmers' livelihood on a changing climate in the Upper West region of Ghana

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Abstract
Agriculture in the Upper West region is primarily subsistence and rain-fed, and irrigation practice is significantly furrow and the use of traditional watering can. This historical approach to agriculture is predicted to suffer severe setbacks due to climate change. This research therefore explores farmers' perception of climate change and its impact and how the farmers can cope with the changing climate. The primary data was gathered through field observation, interviews and administration of questionnaires to about 400 irrigation farmers in three districts of the Upper West region. The data was analysed using 1. Statistical Package for Social Sciences (SPSS) and basic statistical tools. It was discovered that 62% of the farmers had no formal education with majority above 50 years of age. Over 80% have observed rising temperatures and declining rainfall over the last few decades. This has led to higher evaporation and siltation of irrigation dams, higher transpiration of crops and water stress resulting in low crop yield, crop failure and food insecurity. The research also highlights anthropogenic activities that have influenced climate variability and food production in the region. The research was concluded with suggested strategies to facilitate farmers' adaptation to climate variability.

Keywords
adaptation—climate change—farmers' perception—farmers' livelihood—irrigation farming

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Contents

1. Introduction

Climate change has now become a topic of discussion on many platforms globally and poses a serious threat to agricultural production and food security in many African countries including Ghana. According to Boko et al. [1] climate change will cause a reduction of crop yields by as much as 50% by 2020 and a loss of 90% crop revenues by 2100 in some Africa countries. The evidence of climate change with its devastating effect on water resources and agriculture is now widely accepted globally [2, 3]. The Ghanaian economy is agricultural-driven [4] with about 60-70% of the population involved in agriculture. It also contributes about 35-40% to Gross Domestic Product (GDP) and 40% of foreign exchange to the country [5]. Agriculture in Ghana most especially in the Upper West region (UWR) is mainly subsistence and rain-fed and the irrigation practice is mainly furrow and the use of traditional watering can. Unfortunately, there is a considerable variation in the rainfall intensity, duration and distribution, and these fluctuations make it difficult for farmers to predict the rainfall pattern in the region [6]. Lenton [7] said that arid, semi-arid and low income countries, as in the north, where rainfall and stream flow are concentrated over a few months with high yearly variations, will be more vulnerable to climate variability. It is estimated that rain-fed agriculture covers about 80% of cultivated land and produces about 60% of agricultural output globally [8] and this situation is likely to be affected by climate change especially those in semi-arid and arid areas. Schmidhuber et al. [9] argued that the subsistence nature of farming in Africa cannot bring about the rapid economic transformation to eliminate or reduce poverty in the life of the poor even without the effect of climate change. According to FAO [10] in 2005 two and half billion people in developing countries whose livelihood hanged on agriculture and 75% of the poor people globally, live in rural areas and these people are mostly susceptible to the impact of climate change. Additionally, Ghana's population has increased

from 18,912,079 in 2000 to 24,658,823 in 2010 which is about 30.4% increment with a population growth rate of 2.5% [11] and this will result in high demand for food in the country. The population increase coupled with climate change will put much pressure on food production especially without additional infrastructure to march the increasing population.The potential impact of climate change and climate variability does not only affect specific parameters such as food security, water resources but rather encompasses wider range of factors such as the environment, socio-economic and politics that determine vulnerability and possible adaptation to climate change [12, 13]. According to Kotei et al. [15] the lack of sufficient knowledge about climate change and its impact is really a challenge for the long term sustainable agricultural production in most developing countries including Ghana. Adequate knowledge of the farmers on climate change will, therefore, lead to the development of effective, low cost, participatory and sustainable adaptation strategies in rural communities [16]. Already, farmers in Africa are reported to have very good knowledge of the climate and have clear opinions on changes in rainfall, temperature, and wind speed [17, 18, 19]. Farmers in the Sahelian region of West Africa are also said to have identified shrinking water bodies, disappearing plants and crops, and changing settlement patterns as evidence of reduced rainfall over the last three decades of the twentieth century [20, 21, 22]. The research therefore seeks to sample the views of irrigation farmers in the UWR on climate change and irrigation water resource management so that proper measures are introduced for farmers' adaptation to climate change.

2. Materials and Methods

2.1 Description of the study area

The UWR of Ghana is the youngest administrative region located in the guinea-savannah with savannah woodland or riparian vegetation which is mainly driven by the soil type and climate conditions in the area [23]. It lies between longitude $1^o\ 25''$W and $2^o\ 45''$ and latitude $9^o\ 30''$N and 11°N and is bordered to the south by the Northern region, to the north and west by Burkina Faso, and to the east by the Upper East region. It covers a geographical area of 18,476 km2 which constitutes about 12.7% of the total land area of Ghana. It has an estimated population of 702,110 in 2010 of which 587,457 (83.7%) live in the rural areas with a population growth rate of 1.9% [11]. The region is agrarian with 73.2% into agriculture which is mainly rain-fed and subsistence with few farmers engaging in irrigation farming. The major source of energy is wood fuel and charcoal with about 96.3% using wood fuel and charcoal as their main source of energy for cooking. The engagement of extensive charcoal production which is mainly exported to the south and bush burning has caused deforestation and land degradation in the region [24]. According to EPA [25] the savannah zone with low forest resources provides about 70% of Ghana's total annual firewood and charcoal requirement estimated at 16 million m^3. The climate is tropical with an average minimum temperature of 23^oC that decreases to about 18^oC in December and average maximum temperature of about 35^oC that increases sometimes to about 40^oC in March. The region has a uni-modal rainfall regime with average rainfall figures ranging between 800mm and 1100mm.

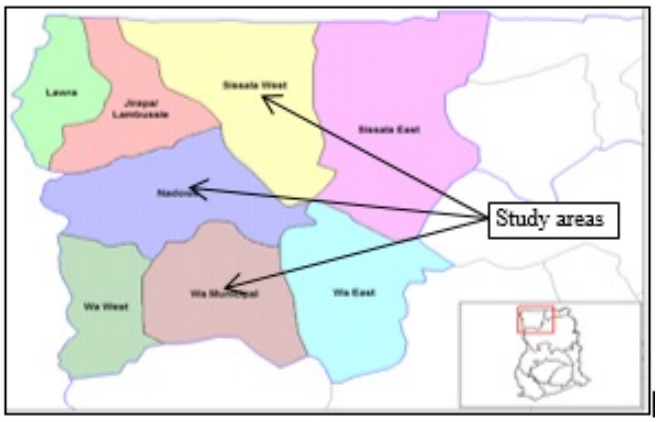

Figure 1. Map of UWR showing the study areas (Google image)

2.2 Method of data collection

The research was conducted in three districts of the UWR namely: Wa municipality, Nadowli and Lambussie districts out of the nine districts in the region. These districts were chosen because they have one of the largest irrigation dams and agricultural activities in the region. The research was carried out through field observation, interviews and administration of questionnaires with assistance from staff of the Department of Agricultural Engineering, Wa Polytechnic and extension officers from the Ministry of Food and Agriculture (MoFA). The field observation was to have first-hand information on vegetation cover, irrigation dams, irrigation practices and water use and availability in the selected districts. This was then followed by the administration of questionnaires in the three districts. The farmers were stratified by their communities and their application of the irrigation dams. About four hundred (400) farmers were randomly sampled from the three districts with 200 respondents from the Wa municipality and 100 from each of the other districts. The questionnaires were divided into three sections namely:

- **Demography of the farmers:** this is to gather bio-data such as gender, age, education, marital status, years of farming among others.

- **Irrigation system and practices** such as furrow, sprinkler, drip, watering can, land size, water availability and period of irrigation.
- **Knowledge and perception of climate variability** such as changes in temperature and rainfall pattern, rainfall duration, intensity, timing and distribution in addition to activities that influence food production and climate change.

3. Results and Discussion

3.1 Demographic information of respondents

At the end of the exercise, 330 questionnaires were cleaned for analysis of which 54.5% of the respondents were males and 45.5% were females with majority of the farmers having non-formal education (62%). Only 2% and 6% had Tertiary and Senior High School (SHS) respectively with 30% dropping out of school after Junior High School (JHS) (Figure 1). In this era of information and technological advancement, education is paramount to ensuring sustainable food production to feed the rising population in Africa. However, the results seem to indicate that farming is gradually becoming a reserve for the illiterates and school drop outs. The farmers, nevertheless, employ their indigenous knowledge in carrying out their activities.

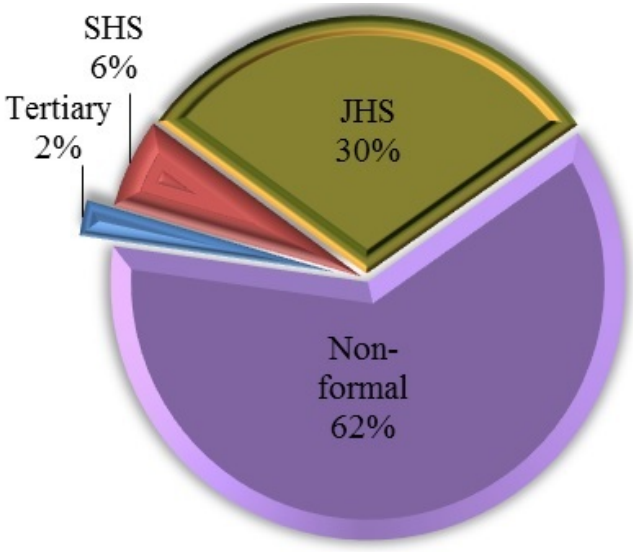

Figure 2. Educational level of the respondents

Formal education in addition to the indigenous knowledge of farmers is very important to ensure understanding and application of climate information to aid food production [26]. The level of education of farmers and access to extension services are known to be the determining factors to facilitate quick adaptation of the farmers to climate change. Besides, most of the farmers are aging as about 32.5% are above the age of 50 years. Almost 88% of the farmers are within the marriage bracket (above 30 years) that depends on farming to feed their families. Only a small portion of the youth sees agriculture as an option to improve their living conditions as compared to the majority who always seek for non-existing white collar jobs. Unfortunately, drudgery in agriculture through the continuous use of hoes and cutlasses will continue to scare the teeming youth from agriculture especially those with adequate education in agriculture. Modernization of agriculture to attract the unemployed youth is one of the best ways to reduce the rising unemployment in the country. Transforming agriculture through education and investment is the best way to attract the youth into such venture. The government's youth in agriculture programme should, nevertheless, be strengthened and diversified to encourage more of the youth into agriculture.

3.2 Farmers' perception of climate variability and change

Concerning climate variability and change, 80.9% and 80.3% out the total of 330 farmers have observed warmer temperatures and declining rainfall respectively over the last few decades (Figure 2). Also sixty-two percent (62%) of the respondents are of the view that there has been variation in the duration, timing and intensity of the rainfall. This observation of the farmers is not only limited to the Upper West region but also in Northern region [27], Ashanti region [28] and the Eastern region [30] where farmers have observed varying rainfall and temperature trends with traces of drought in some of the areas. The observation of the farmers is in line with the results of climate data gathered from 1961 to 2010 in the UWR. The data analyzed suggested a rising temperature and a declining rainfall in the region. [31]. This rising temperature will cause higher evaporation of dams and soil surfaces leading to reduction in water levels, water stress and drought as well as higher transpiration of agricultural crops. Water stress and drought of the dams coupled with higher water loss from plants will, subsequently, result in crop failure, low crop yield and food insecurity which will precipitate malnutrition, hunger, job losses and poverty in the region. Many research findings have already confirmed the impact of rising temperature and declining rainfall on water resources, agricultural yields and incomes of farmers [10, 30]. Already climate change which is evidenced by a warming atmosphere [1, 2, 31] has been observed in the region and this will have negative effect on water resources and agricultural production. According to Bates et al. [32] climate change has become a global phenomenon which may results in water stress and this situation will affect food production and result in high food prices and insecurity. It has been established that 25% of the population in Africa are presently having extreme water stress and a projected 75-250 million and 350-600 million people in Africa will experience water stress by 2020 and 2050s respectively possibly due to drought [1]. Water scarcity is also projected to become more important determinant

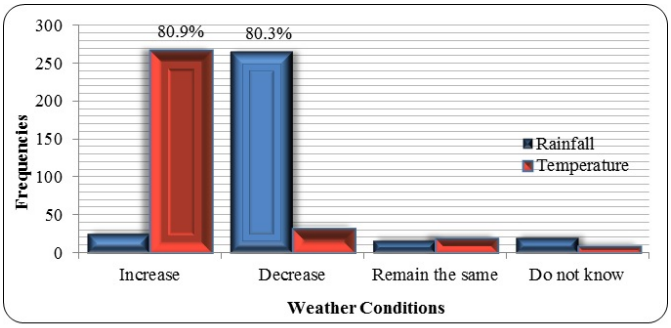

Figure 3. Irrigation farmers' perception of temperature and rainfall variations

of food scarcity than land scarcity [33] and this is really a matter of concern for irrigation farmers. Unfortunately, the farmers' knowledge in crop water requirement was very scanty with 59.9% having no knowledge at all but uses their indigenous knowledge and experience to irrigate their crops. However, this lack of knowledge will affect crop yields as suggested by Kharagpur [33] that too much irrigation water to crops affect crop yields and vice versa. Additionally, the research revealed that the farmers have very small farm sizes which is in line with [35, 36] findings that farm sizes in Ghana are very small with about 90% of farmers having farms less than two hectares in size and this may be as a result of land tenure system, cost and drudgery in agriculture. The main types of irrigation practiced in the three districts are furrow irrigation (59.4%) followed by can or bucket irrigation (35.8%) and neither of the farmers in the three districts use sprinkler nor drip irrigation and this may be as a result of cost, technical know-how, availability and accessibility of the products. These scenarios coupled with climate variability will have serious consequences on food production and affect the livelihood of farmers in the region. It is therefore necessary for farmers to ensure an integrated irrigation water resource management and best agricultural practices coupled with proper knowledge in crop water requirement as a measure to improve food production and farmers' adaptation to climate change.

3.3 Activities that influence climate variability and food production in the region

Apart from the direct impact of climate change on irrigation agriculture, there are other anthropogenic activities that influence climate change and food production in the region. These anthropogenic activities coupled with climate change will negatively affect food production and worsen the plight of the peasant farmers. Among the identified activities that could affect food production and influence climate change in the region are bush burning, deforestation and poor agricultural practices. The research conducted revealed that 50.3% have observed bush burning, deforestation (21.5%) and poor agricultural practices (10.3%) as some of the activities that have affected sustainable food production in the region (Figure 3). The region is noted for indiscriminate bush burning and cutting down of trees for charcoal production (deforestation). Among the reasons for the rampant bush burning are to drive away snakes, to catch bush meat, to satisfy the gods and to clear the area from weeds [24]. Fulani herdsmen also burn the vegetation during the dry season to invigorate the growth of grasses to feed their flocks. Rampant burning of vegetation affects soil microorganisms, initiate changes in soil temperature, moisture, nutrient and organic matter content of the soil which eventually affects the soil quality for food production. Uncontrolled bush burning and deforestation will release carbon stored in the plants into the atmosphere and the plants also can no longer remove and store carbon from the atmosphere. This situation therefore influences the climate variability and subsequently affects agriculture productivity and food security in the region. Many researchers have confirmed that deforestation, land use and land use cover change play a key role in climate variability especially in areas noted for drought such as the Sahel and its immediate surroundings [37, 38, 39]. This scenario will therefore affect farmers' livelihood and precipitate malnutrition, hunger and poverty in the region.

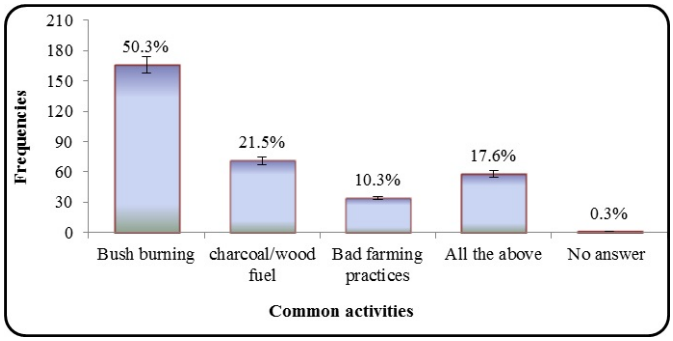

Figure 4. Anthropogenic activities that affect agricultural productivity and climate in the region

3.4 Farmers' livelihood and agriculture

In Ghana, about 2/3 of the population live in rural areas and their only source of livelihood is mainly agriculture. Irrigation agriculture is very crucial in transforming lives in the rural setting since crops produced in the dry season fetch better prices than during the rainy season. Irrigation agriculture is estimated to bring significant socioeconomic benefits to society [40] and irrigation has also played a key role in stabilizing food production and prices in addition to boosting agricultural yields and outputs in semi-arid and arids regions [41]. According to Easterling et al.[42] agriculture is the most viable sector which is likely to alleviate the plight and reduce the poverty levels of the rural folks. It is also estimated that about 70% of people living in developing countries are rural dwellers

who depend on agriculture for their livelihood (ibid) thus irrigation agriculture could play a significant role in changing the economy and livelihood of the rural poor in the region and Ghana as whole. Previous research conducted in Ghana also confirms the profitability of irrigation agriculture if given the needed attention [27, 43, 44]. The research has also revealed that the irrigation farmers make profits ranging from GHC 100 to GHC 500 (50−250) at the end of each farming season depending on the size of their farms besides what they keep for consumption. It was observed that 94.5% produce for sales and for household consumption which further suggests the total dependence of the peasant farmers on agriculture for their livelihood. The farmers produce mainly vegetables which is really very important to improve micronutrients and malnutrition to meet the nutritional requirement of the country as suggested by FAO [27]. Irrigation agriculture is therefore the best way to enhance farmers' livelihood and their ability to cope with climate variability in the region if given the required attention coupled with improved crop varieties and best farming practices. Unfortunately, the irrigation dams suffer serious challenges such as broken canals, weeds in canals and siltation. A visit to several irrigation dams in the region revealed a complete lack of maintenance and care as the dams seem to be completely left in the hands of the peasant farmers. It was also observed that there is always a wrangling between farmers and the Water Users Association (WUAs) who are mandated to repair and maintain the irrigation facilities and take records of the farmers and their activities. The farmers are to pay service fees for the maintenance of the dams but unfortunately, most of the farmers default in such payment. This lack of money prevents the WUAs from carrying out their mandate of maintaining the irrigation dams and servicing the allowances of the members as done in other places. The need for farmers to contribute in the maintenance of the irrigation dams is paramount to the development of irrigation agriculture in the region. Water is an indispensable resource in food production and the lack of it is tantamount to the loss of livelihood of the peasant farmers. In order to improve food production in the era of climate change and variability, government and other stakeholders must give the needed attention to irrigation development and expansion in the region and Ghana as a whole.

4. Conclusion

The research has revealed farmers' observation of climate variability which is in line with many research findings that the temperature has been increasing and precipitation has been decreasing. The rising temperature has resulted in higher evaporation from irrigation dams, soil surfaces and transpiration of agricultural crops. The declining rainfall has also affected soil moisture content, dam levels and underground water recharge. The erratic nature of the rainfall coupled with rising temperature will have serious implications on sustainable food production and security, and subsequently affects farmers' livelihood. The anthropogenic activities and the complete lack of maintenance of the dams are challenges that need urgent attention even without climate change. It is therefore important that measures are taken to curb the indiscriminate burning and deforestation coupled with regular maintenance of the dams. Strategic water harvesting and storage in addition to planting of trees around the dams are all important steps towards the fight against climate change. Moreover, the following are proposed to help farmers cope with the changing climate: farmers should practice sustainable agriculture through the efficient use of irrigation dams and adopt new and improved seed varieties that are climate resistance, high yielding, drought resistance, low water consuming and early maturity crops. Farmers should also employ agro-forestry practices, planting under mulching with support from extension officers; adjust planting dates, adopt improved land and water management practices in addition to erosion control and soil protection principles. With their current knowledge of climate variability, farmers should be prepared to adapt favourably to climate variability to improve their livelihood. However, such effort will require an integrated approach which should involve all the players in the water, agricultural, and the environmental sectors.

5. Acknowledgement

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