Impact of Climate change on Vegetable production in the Ashaiman Municipality of Ghana

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Abstract- ***Climate change is one of humanity's ultimate concerns in this 21st century, leading to a decrease in the fight against hunger and famine, especially in Africa. Since climate change and agriculture are interrelated processes, it is very important to look at their impact on vegetable crop yield. This study examines and analyzes the impact of climate change, specifically, rainfall and temperature on the yields of vegetable production in the Ashaiman Municipality of Ghana. The specific objectives were; to examine the vegetable farmers' knowledge and perception of climate change, to analyze factors that influence the perception of these farmers on climate change in the municipality, to determine the effect of climate change on soil moisture, vegetable yield, and livelihoods, to determine strategies used by farmers to reduce the impact of climate change on vegetable yields, and to determine factors that influence the adaptation choices of vegetable farmers in the municipality. Data were taken from one hundred (100) respondents within the Ashaiman Municipality, using open-ended questionnaires. Both qualitative and quantitative research methods were applied and data were analyzed using SPSS v.20. The study showed the following results: all respondents knew about climate change and individually had their perceptions of it, rainfall and temperature patterns, as well as contributions the Agricultural Extension Agents (AEAs), the media, and training from Civil Society Organizations (CSO) such as the African Foundation for Climate Change and Sustainable Development (AFCCSD) are some factors that affect the perception of the farmers on climate change, climate change negatively affects soil moisture thus resulting in low vegetable yield which leads to low income hence affecting livelihood. The majority of the farmers in the Municipality use fertilizers to boost their crop yield hence reducing the impact of climate change on yield.***

Indexed Terms- ***Climate Change, Crop yield, Soil, Sustainable Development, Temperature***

I. INTRODUCTION

1.1 Background of Study

The importance of vegetables in providing food and nutritional security and amelioration of nutrient deficiencies has been realized world over. [1]. They also provide opportunities for higher farm incomes apart from livelihood security through employment generation. The worldwide production of vegetables has gone up tremendously during the last two decades and the value of global trade in vegetable now exceeds that of cereals [2]. The majority of the people in Ghana, which has a largely agrarian economy, are employed as smallholder farmers. Crop yields are often low due to these farmers' reliance on old technologies, and rural poverty is widespread. Change in climatic conditions significantly affects Ghana's Agricultural growth because of the heavy reliance on rain-fed production and drought vulnerability [3]. IFAD (International Fund for Agricultural Development) (2009) has reported that climate change is expected to put 49 million additional people at risk of hunger by 2020, and 132 million by 2050.[4] Hence, more emphasis is being given to the less developed country like Ghana to promote cultivation of vegetables. Changes in agricultural incomes and prices, as well as changes in trade patterns and investment trends, are among the social and economic consequences of climate change impacts on production [5]. Changes in rainfall patterns that result in lower agricultural production and decreased food security are some of the primary long-term effects of

climate change [6]. The livelihoods of farming communities, which strongly rely on the weather and environment, are subject to severe uncertainties as a result of climate change. [7]-[8]. According to [9], climate change negatively affects the basic elements of food production such as soil, water, and biodiversity. It also has the potential to affect food availability, access, and quality [10]. According to the World Food Program (2011), climate change poses a serious threat to food security and is significantly known as the "hunger risk multiplier" [11]-[12] positions that, vegetable crops require lots of water for growth. However, according to [13] a rise in temperature and lack of rain causes water and heat stress, pest and disease outbreaks, and the loss of productive lands. Little attention has been given to vegetable crops despite their significance. The challenges posed by climate change on agriculture in Ghana have been widely discussed yet, there are few publications on vegetable production to guide farmers, especially at the local level. It is anticipated that this study will enlarge the literature and contribute to the body of knowledge in this subject area; particularly

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- This study will help other researchers with more information on the impacts of climate change on vegetable production.
- This study will provide a basis for vegetable farmers outside the Ashaiman Municipality to be more proactive in taking decisions that will affect their yields.

1.2 Research Questions

i. What is/are your perceptions of climate change?
ii. What influences your perception of climate change?
iii. How does climate change affect soil moisture, vegetable yield, and livelihoods?
iv. What strategies do you use to minimize the impact of climate change on vegetable yields?
v. What factors influence the adaptation choices used to minimize the impact of climate change?

II. LITERATURE REVIEW

2.1 Climate and Climate Change

Climate is defined by [14] as the average state of an area's atmosphere over 30 years. The climate is widely understood to be the expected weather conditions at a given location over time, according to the [15]. Climate can be measured at regional and global levels using statistics such as average temperatures, number of rainy days, and drought frequency.

Climate change refers to changes in climatic variables or elements; particularly temperature changes over time. The term "climate change" is commonly used to refer to changes in temperature, there are several other climatic variables including rainfall, clouds, humidity, and wind, among others. A change in the climate must last at least ten years, to be considered climate change. [16].

2.1.1 Historical Review of Climate Change in Ghana

The west African nation of Ghana is bordered to the north by Burkina Faso, to the east by Togo, to the west by Cote d'Ivoire, and to the south by the Gulf of Guinea. Ghana is located in the latitude range of 4.50°N and 11.50°N and the longitude range of 3.50°W and 1.30°E. There are 8520 km^2 of water and 239,460 km^2 of land in the entire nation. The country has roughly 30 million people, mostly young people, according to the 2021 census. The country experiences high temperatures, with an average yearly temperature of 24 to 30 °C and, occasionally, 18 to 40 °C in the south and north. In Ghana, rainfall tends to decrease from south to north. The double maxima regime and the single maximum regime are the two main rainfall patterns in the nation. In Southern Ghana, the two maximum seasons for the double maxima regime are from September to November and April to July. In Northern Ghana, there is a single maximum regime from May to October, followed by a protracted dry season from November to May. All of Ghana's ecological zones have experienced an increase in temperature throughout time, but the country's overall rainfall levels have decreased [17].

2.1.2 Population Size and Economic Activity

The Ashaiman Municipality has a population of 208,060, which represents 4.8% of the Greater Accra region’s total population. The majority of the populace is the youth where 1.8% are actively engaged in skilled Agricultural practices. Most households in the municipality are into crop farming [18].

2.1.3 Topography and Soil

The area is supported by Precambrian rocks of the Dahomeyan formation: metamorphic rocks largely made of granite, gneiss, and schist are assumed to have originated from sedimentary layers. The surface of these rocky formations has weathered or decomposed, and their thickness in the area does not exceed 12 meters. Typically, rainfall in this area is characterized by heavy, quick rains that cause poor soil drainage and erosion, resulting in severe flooding that destroys crops. Soils are primarily sandy clays, which are ideal for growing vegetables such as cabbage, cucumber, pepper, okra, and other similar crops. However, there are a few isolated hills that are only 65 meters high, making road and drain construction easier. Ghana's government aided by the Russian government started the construction of the irrigation dam in 1965 and ended in 1968. It has a potential area of 155 hectares and an irrigable area of 130 hectares of which 56 hectares are under vigorous cultivation. Since its construction, the dam has aided farmers in Ashaiman and its environs in the production of a variety of crops, particularly vegetables and rice for the urban market.

2.1.4 Perceptions of Climate Change

Understanding how people feel about the effects of climate change is critical for successful adaptation and mitigation measures [19]. A study, [20] explored local people's collective and public perspectives on climate change. According to the findings of this study, most individuals, particularly in industrialized countries, perceive climate change as a distant threat that is both physically and temporally separated from their lives. Meanwhile, individuals' awareness and views of climate change, as well as their willingness to modify behavior, are critical in developing policies to address the issue., as well as their willingness to change behavior. Farmers' perceptions of climate change are linked to drought, rainfall, and temperature, according to some published studies, and this is due to the significant positive effects of education, higher annual family income, media exposure, gender, and age. According to [21] research in Ghana, Ghanaians have several perceptions and conceptions about climate change that are worth exploring. One of the most common misunderstandings and beliefs about climate change is that it is caused by God rather than humans [22]. According to [23], perception influences how farmers deal with climate-related risks and opportunities, and it's a big part of how they act and react to their surroundings.

2.1.5 Climate Change and Its Impacts

[14] argues that more moisture evaporates from land and water into the atmosphere as temperatures increase and the air warms. This happens due to a climate change, which can result in rainfall (precipitation) reduction. Several direct influences change precipitation amount, intensity, frequency, and type as the climate changes. According to [24], Ghana's climate is tropical, with two distinct seasons, which are wet and dry. The rainy season in North Ghana lasts from April to mid-October, while it lasts from March to mid-November in South Ghana.

In dry lands, precipitation is usually the primary source of soil moisture [25], thus soil moisture is particularly important in linking climate, soil, and vegetation in dryland ecosystems. Soil moisture also affects soil chemicals and physical properties such as O_2 levels, pH, and the concentration of mineral nutrients in soil [26]. This affects microbial biomass activities and population dynamics consequently, and the soil may deplete over time when there is drought. Climate change has affected runoff and soil erosion by increasing precipitation concentration, volume, and intensity [27]. There will be fewer run-offs and more infiltration with less intense rainfall, whereas more intense rainfall will result in more run-offs and less infiltration. The intensity of the rains may also contribute to erosion. Soil begins to spread out after heavy rains, and soil structure is lost. Erosion depletes nutrient reserves, such as nitrogen, potassium, calcium, magnesium, and sulfur. Low soil organic matter and limited availability of plant nutrients (in the form of phosphorus and nitrogen) are the main constraints to agricultural productivity in Ghana. The soil content, surface texture, water-holding capacity, and pH levels all change as a result. The soil becomes less fertile as nutrients leave it. Changes in the rate of plant growth, transpiration, respiration, and photosynthesis are likely to affect future global agricultural production as carbon dioxide concentrations in the atmosphere rise and the climate shifts as a result of global warming.

2.1.6 Climate Change and Vegetable Production

Agriculture has played a critical role in poverty reduction because it is the principal source of income for the majority of rural households in developing countries. In Ghana, smallholder farmers cultivate 1-2 hectares of land on average and produce 80% of the country's agricultural output. Despite its importance, the agricultural sector is the most vulnerable in developing countries to climate change since it relies significantly on rainfall for the majority of its operations. As a result, climate change has the potential to harm food security and agricultural production in Africa. [28], [29]. [30], [31] state that the most significant contemporary threat to the production of food crops, particularly in developing nations like Ghana. Vegetables are the edible parts of plants that can be eaten raw or partially cooked. They are the best source for overcoming micronutrient deficiencies because they are known as protective foods and provide the human body with essential nutrients, vitamins, and minerals [32] say vegetable production is an agricultural commodity and a source of income for a large portion of the population, both rural and urban since they are readily available throughout the year, simple to prepare and grow quickly in the wild. However, climate change threatens to aggravate smallholder farmers' vulnerability and jeopardize their development prospects. Low soil moisture and high temperatures can be detrimental to vegetable production, resulting in low yields [33]. Climate change is expected to have several negative effects on the production of vegetables. Crop productivity is reduced as a result of more inconsistent rainfall patterns and unpredictably high temperatures. “It's real, and it's happening faster than we thought, wreaking havoc on developing countries, particularly in Africa” [31].

2.1.7 Environmental constraints effect on vegetable production.

The biggest cause of crop losses is environmental stress, which reduces average yields for the majority of the world's major crops. Climate change may also have an impact on vegetable harvests. Salt, floods, decreased irrigation water availability, and rising temperatures are all significant hurdles to maintaining and increasing vegetable productivity.

2.1.8 Temperature

The rate of plant growth and development is regulated by environmental temperature, and each species has a temperature range with a minimum, maximum, and optimum temperature [34]-[35]. Because many plants' physiological, biochemical, and metabolic activities are temperature dependent, changes in daily mean maximum and lowest temperatures are the principal effect of climate change that has a negative influence on vegetable production. Extremely high temperatures affect agriculture in general and horticulture in particular, according to [32]-[36]. Crops demand for water increases as atmospheric temperature rises. According to [37], even a small increase in average daytime or nighttime temperatures can affect the yield and quality of vegetables. Other research shows that high temperatures affect the flavor, firmness, and physical, and physiological disorders that occur during the growth of vegetables [38]. Warmer temperatures in temperate climates result in more types and populations of insects; this is likely to affect insect pest populations in a variety of ways. Insect pest ecology and biology are also influenced by climate change [39].

2.1.9 Rainfall and Flooding

The regular growth and development of plants at several stages of development, from vegetative growth to fruiting, might be altered by increased temperature and rainfall uncertainties [38]. It has been demonstrated that early rainfall during the vegetable crop growing season improves soil water use, which is beneficial for root growth [40]. However, later in the growth cycle, late rainfall enhances soil water availability, delaying plant senescence [41]. Flooding occurs when there is more water than is needed, and its severity can be harmful to the output of vegetable crops that are susceptible to it. Due to the sluggish diffusion of gases in water and the use of oxygen by microbes and plant roots, this results in an oxygen (O_2) shortfall [42]. Excessive rainfall results in catastrophic flooding, which gets worse with heat waves, quick withering, and eventually death in vegetable crops, particularly tomatoes. Meanwhile, flooding can cause a 30-40% yield loss in onions during bulb development [43]. The response of plants to environmental stresses is dependent on the developmental stage, as well as the length and

sternness of the stresses hence; these stresses are the main cause of yield losses [44].

2.1.9 Drought and Salinity

Due to the limited water supply, drought has been found to become a major stress factor for the production of vegetables, adding to the stress on farming systems [45]. Plants need soil that is rich in both water and nutrients dissolved in water for optimum growth and development. Salinity, for example, lowers the germination rate, percentage, length of the fresh root and shoot, and weight of the fresh root and shoot in cabbage [46]. Drought inhibits bloom abscission in tomato plants, tuber sprouting in potato plants Aurora, and seed germination in vegetable crops including onion and okra [47]. Salinity leads to ion-specific stressors in plants as well as a buildup of Na+ and Cl- concentrations due to the changed K+/Na+ ratios. Wilting, leaf abscission, reduced respiration and photosynthesis, loss of cellular integrity, necrosis, and plant death are all symptoms of salt stress [48].

2.2.0 Impacts of climate change on farmers' livelihood

Heat waves are frequently accompanied by periods of stagnant air, resulting in increased air pollution and the health consequences that go with it. Climate change is expected to increase urban populations' exposure to heat-related health effects in the future [49]. Climate change impacts may affect food security and threaten human health, particularly among vulnerable communities [50] through starvation, the spread of infectious illnesses, and food poisoning. These elements affect farmers' ability to respond to environmental shocks. Farmers confront numerous challenges in dealing with the effects of climate change, including financial limits, a lack of information about climate variability, institutional constraints, sociocultural constraints, technological constraints, and infrastructure development. Uncertainties in temperature and rainfall can disrupt the normal development and growth of plants at several stages of development, from vegetative growth to fruiting [38]. This, in turn, has an impact on crop productivity and farmer profitability thus farmers are much more likely to make a loss [51]. The findings of [52] confirmed that the ability of a smallholder farmer's household to adapt to climate change is influenced by financial resources, access to information, social resources, human capital, and infrastructure. However, it has been realized that accessing credit to support adaptation is hampered by a lack of funds. Poor farming households, according to [53], have a limited amount of capital assets that could be used to implement a climate change strategy to mitigate the negative effects on their livelihoods.

III. RESEARCH METHODOLOGY

The procedure for investigating is described in this chapter. It covers the study area, the research design, the population size, the sample and sampling methods, the means of gathering data, and the tools and techniques for analyzing the data.

a. Study Area Description

The Ashaiman Municipality in the Greater Accra Region of Ghana is the subject of this research. The district was chosen for this study because of its central position in the municipality's production of food crops, specifically vegetables.

This study was conducted in Ashaiman, the capital of the Ashaiman Municipal. It is a town in the Greater Accra Region of Ghana which was formed in 2008 from the former Tema Municipality, now the Tema Metropolitan Assembly. It is one of the newly created districts under the Local Government Act of 1993 (Act 462) and LI 1889. According to the 2021 Population and Housing Census, the Ashaiman municipal assembly has a total land area of about 45 square kilometers and a population of 208,060 people. It is located 4 kilometers north of Tema and 30 kilometers north of Accra. Ashaiman is located at 5 degrees 42' north latitude and 0 degrees 01' west longitude. The annual precipitation is approximately 691 mm | 27.2 inches (Climate Data Organization).

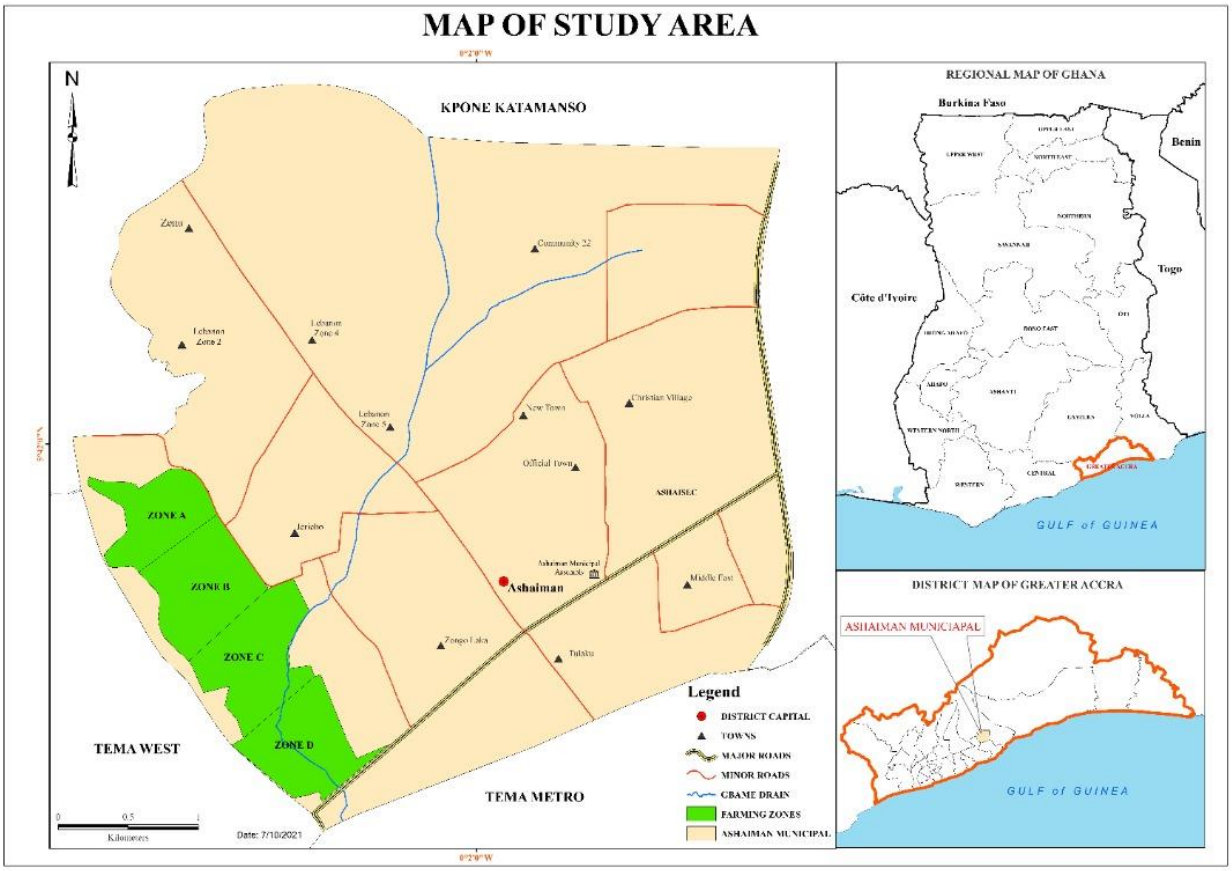

Fig 3.1: Map showing the location of the study area

3.1 Conceptual framework

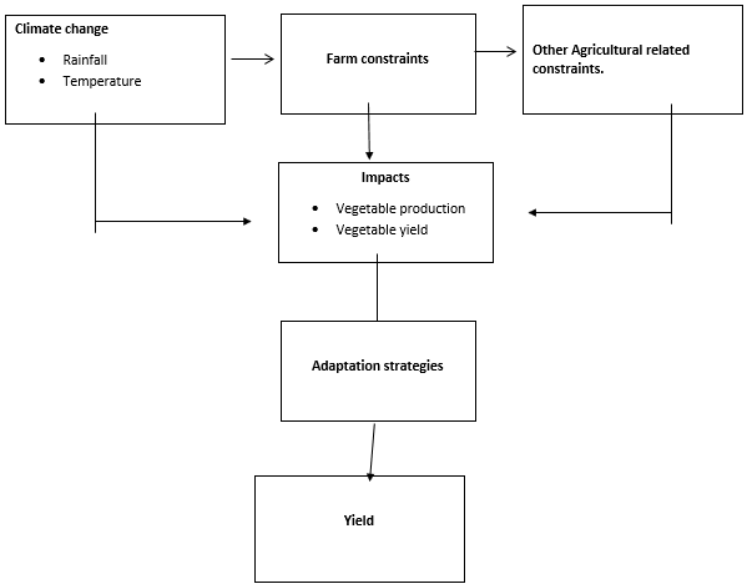

Fig 3.1: Conceptual framework

3.2 Research Design

To conduct a thorough investigation, we used a mix of qualitative and quantitative data. According to [54], combining qualitative and quantitative methods allows the researcher to conduct a thorough investigation without overlooking crucial details.

The qualitative component of the research aids in explaining and exploring people's experiences, attitudes, and life circumstances in the context of the phenomenon being studied [55]. The quantitative section employs statistical techniques to assess the quantifiable aspects of the research problem, as well as to make predictions and generalizations [56].

3.3 Data collection procedure

Both secondary and primary sources were used in the information collection. Secondary information was acquired from online research-related works as well as the Ashaiman Department of Agriculture (D.O.A), the Ministry of Agriculture (MOFA), the Ashaiman Irrigation Development Authority (I.D.A), and other sources. Through interviews and questionnaires, primary data was gathered. Farmers growing vegetable crops in the Municipality were our primary target population for this survey.

3.4 Sampling Techniques and Data Collection

The focus of data collection was on active vegetable farmers. A total of 50 people were included in our analysis, including 30 farmers, 15 market vendors, and 5 extension agents. The snowball method was used to reach out to farmers, which streamlines the process because the collection of samples will probably help us find more samples. Using a checklist and an informal interview guide, market women were chosen at random for the study; we also received input from a few extension agents.

To acquire data from respondents who cannot read or write, both closed- and open-ended questions were put to respondents (both farmers and marketers).

3.5 Data analysis

Data collected from respondents were analyzed using the Statistical Package for Social Sciences (SPSS, version 20). Microsoft Excel Sheet was used to draw tables and figures to further describe the collected data.

IV. RESULT AND DISCUSSION

4.1 Demographic characteristics of respondents

The demographic characteristics taken from respondents include sex, age, and occupation. Data was taken from 20 Agricultural extension officers, 60 farmers, and 20 market women.

4.1.1 Age distribution

The ages of respondents ranged from 20-30, 31-40, 41-50, and 51 and above. Among the respondents, those between 20 to 30 years were 40%, 31 to 40 were 40%, 41 to 50 were 17% and those within 51 and above were 3%. From the study, the highest representing age is the range between 20 to 30 and 31 to 40. The youthful age falls under these ranges. This implies that the majority of the respondents were the youth.

Table I: Age distribution of the respondents

Variable	Category	Frequency	Percentage (%)
Age	20 to 30	40	40
	31 to 40	40	40
	41 to 50	17	17
	51 above	3	3
Total		100	100

Source: Field survey, 2021

4.1.2 Sex of respondents

Out of 100 respondents, 90, representing 90% of them were males while 10, representing 10% were females. This shows that males are more into vegetable farming in the Ashaiman Municipality than females. This is in line with [57] assertion that “men dominate in open-space urban vegetable farming in Ghana, partly because of the Ghanaian tradition, where women take up marketing because they feel farming as riskier.”.

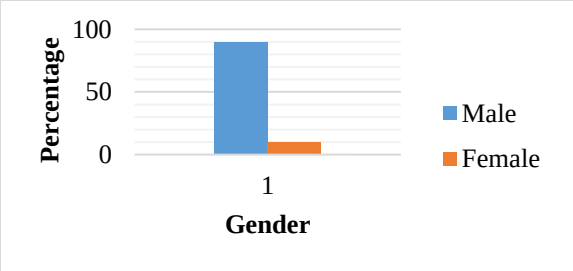

Fig 4.1: Gender of respondents

4.1.3 Educational background of respondents

The table below shows the education of respondents in the Ashaiman municipality. 73, representing 73% are educated and 27, representing 27% are uneducated. The majority of the vegetable production farmers are educated.

Table II: Response to respondents' education

Category	Frequency	Percentage%
Educated	73	73
Uneducated	27	27
	100	100

Source: Field survey, 2021

4.1.4 Level of education of respondents

Three educational levels-primary, secondary, and tertiary-were used to group respondents. Of them, 50 completed their primary education, 40 completed their secondary school, and the final 10 completed their higher education.

Table III: Response to respondents' educational level

Category	Frequency	Percentage%
Primary	50	50
Secondary	40	40
Tertiary	10	10
	100	100

Source: Field survey, 2021

4.2 Number of years of vegetable crop production

40% have been producing vegetable crops for 5 to 10 and 10 to 15 years, respectively. 18% of them have been involved for between 15 and 20 years, while 2 have been involved for over 25 years.

Table IV: Duration respondents have been into vegetable crop production

Category	Frequency	Percentage%
5 to 10 years	46	40
10 to 15 years	34	40
15 to 20 years	18	18
25years and above	2	2
Total	100	100

Source: Field survey, 2021

4.3.1 Knowledge of climate change

All 100 respondents have heard about climate change. 34% heard about it from Agricultural Extension Officers, 30% heard about it from social media and television, and the remaining 36 heard about it from associates, other sources, and by means of practicing farming.

Table V: Respondents knowledge on climate change

Category	Frequency	Percentage%
Extension Officers	30	30
Media	34	34
Others	36	36

Total	100
	100

Source: Field survey, 2021

4.3.2 Conditions that drew respondents' attention to climate change

When asked how they became aware of climate change, the respondents provided their responses. Increased temperatures drew the interest of 40% of the respondents to the climate, while unexpected rainfall drew the interest of 60%.

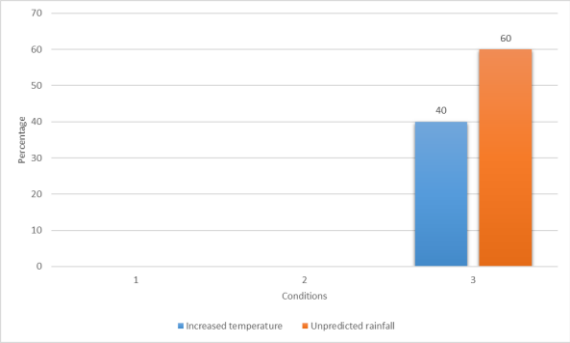

Fig 4.2: Response on how respondents' attention was drawn to climate change

4.3.3 Areas of production of vegetables affected by extreme climate change effect.

Respondents were given four options, which are Availability, storage, quality, and livelihoods, to choose which is affected by extreme climate changes. 100% chose that, extreme climate change affects all four categories of vegetable production.

4.4.1 Response to drought and flood situations in the Ashaiman Municipality

According to all the respondents, there have been instances of drought and flooding in the area. 90% say flood and drought occur annually while 10% say they occur seasonally.

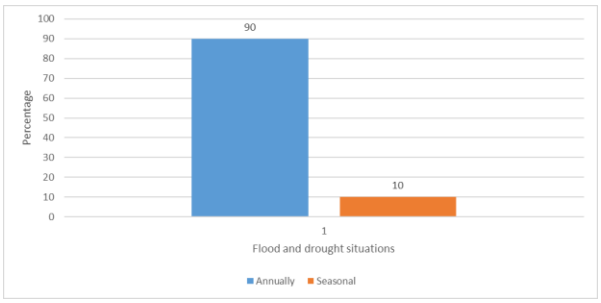

Fig 4.3: Response to drought and flood situation in the Ashaiman Municipality

4.4.2 Effects of flood on vegetable production

79% stated that, flood causes low yield in vegetable production and 21% stated that flood causes no yield at all. According to [58], most vegetables are very sensitive to flood hence, there are low yields recorded by vegetable farmers when there is flood.

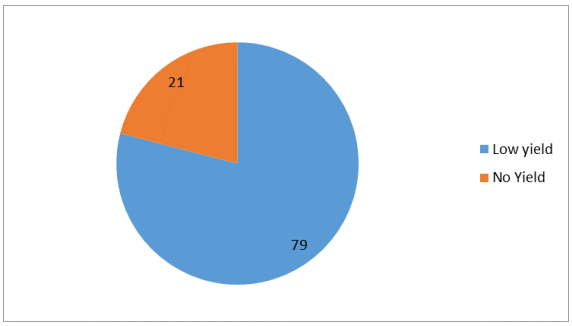

Fig 4.4: Response to the effect of flood on vegetable yields

4.4.3 How Drought Affects Vegetables

86% of the respondents stated that drought causes crops to be dehydrated while 14% stated that; drought causes crops to be stunted. [59] say drought causes an imbalance in vegetable nutrients which leads to imbalanced growth.

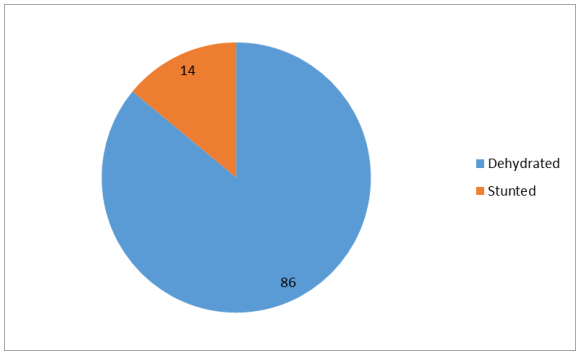

Fig 4.5: Response to the effect of drought on vegetable production

4.4.4 What farmers can do to attain high yields
Creating drainages in farms has been advised by 61% of the respondents, growing the right vegetables at the right season has been advised by 18%, 9% advised the practice of planting on time and the other 12% advised that farmers plant across to increase yields.

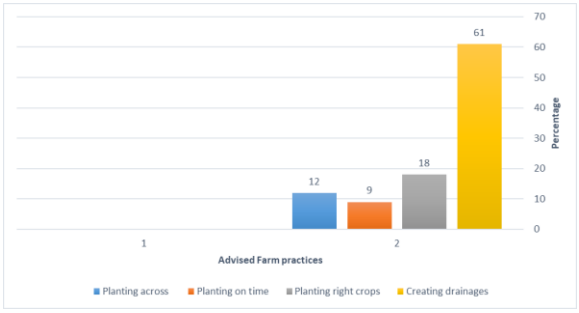

Fig 4.6: Advice from Agricultural extension officers to farmers for high yields

4.5.1 Farms practices
20% of the farmers practice irrigation and have seen it to be effective whereas 80% rely solely on rain because irrigation farming is expensive to them. This implies that irrigation is generally accepted by vegetable crop farmers in the Ashaiman Municipality as productive yet, the majority of them do not practice it due to financial constraints.

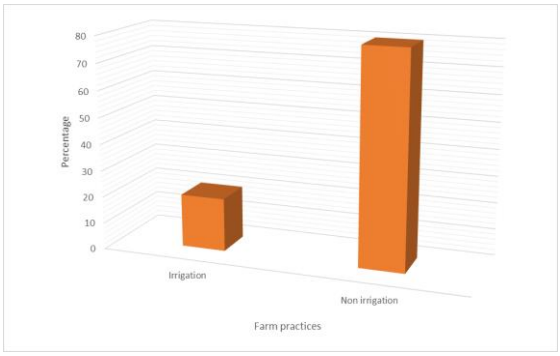

Fig 4.7: Response to irrigation and non-irrigation

4.6.1 Institutional training and intervention
According to 12 respondents, there have been training and interventions from agricultural-related institutions in the district yet, 88 of them say they do not get any training or intervention from institutions.

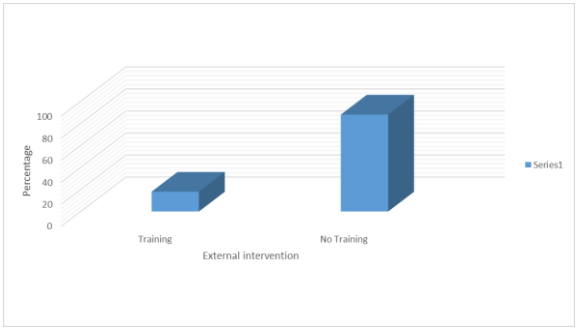

Fig 4.8: Response to institutional intervention

4.7.1 Ability of farmers to Minimize the effect of climate change on vegetable yield
Farmers were asked if they have been able to reduce the impact climate change has on the yields of their vegetables, over the years. In response, 23 of them answered yes, 26 of them said they had but partially, 51 of them answered no. The majority of farmers are resilience to the effects of climate change on yields.

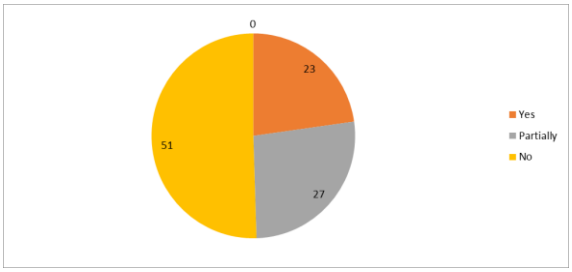

Fig 4.9: Response on the ability to reduce climate change effect on yield.

4.7.1 Causes of inability to reduce the effect of climate change on vegetable yields.

Out of the 51 respondents who are unable to reduce the effect of climate change on their vegetable yields, 18 of them mentioned that, their inability is due to lack of know-how, 22 of them say they do not have the means to and 11 of them gave no reason.

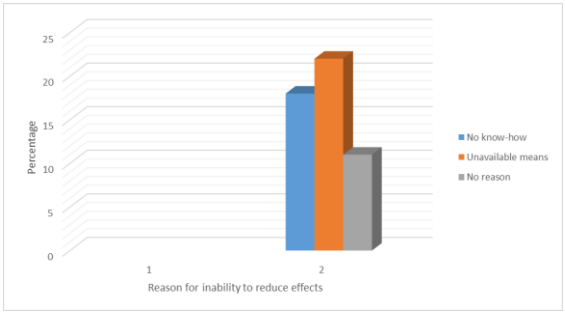

Fig 4.9.1: Causes of inability to reduce the effect of climate change on vegetable yields

4.8 How diseases caused by temperature and rainfall instability are controlled

A total of 43 respondents said they control diseases that affect vegetables as a result of temperature and rainfall instability by using fertilizer, 45 use insecticides and 12 of them do not control them.

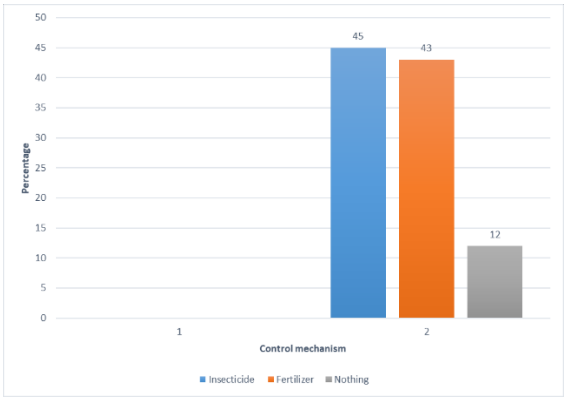

Fig 4.9.2: Response on how diseases caused by temperature and rainfall instability are controlled.

V. DISCUSSION OF RESULTS

According to Table I, which details the study's demographics, 40% of the target population is between the ages of 20 and 30 and 31 and 40. These age categories are primarily made up of young people, or "working class." In the past, farming was thought to be a career for the elderly. According to [60], "young people are increasingly pursuing non-agricultural careers rather than following in the footsteps of their parents and grandparents." Farmers are, on average, 60 years old worldwide. This investigation has established that the story has evolved through time.

Fig 4.1 indicates that out of 100 respondents, 90 of them which represent 90% are males while only 10 of them are females. This implies that the majority of female youth in the Ashaiman Municipality are not engaged in farming.

Table II and III shows that majority of respondents (73% of them) have some form of education, however 50% of them only have an elementary education.

Agricultural Extension Officers, the media, or other sources are just a few of the ways that all 100 respondents have heard of climate change. It affects their creations in various ways, as each interpret it. This seeks to address the main objective of the study. The remaining 36 learned about it from friends, other sources, and by actually farming. Agricultural extension agents informed 34% of people about it, while social media, television, and 30% of people also knew about it. Table V

Fig 4.2 indicates that, 60% of the respondents had their attention drawn to climate change by unpredicted rainfall and 40% by high temperature, indicating that, unpredicted rainfall has been rampant in the Ashaiman Municipality. This in turn significantly affects the quality of vegetables, their storage, availability, and the livelihood of farmers, which is linked to the second objective of the study. This is in line with [61] assertion that changes in climate threaten the livelihood of many people in developing countries.

Fig 4.4 and fig 4.5 indicate that 79% stated that flood causes low yield in vegetable production while 21% stated that, flood causes no yield at all. Moreover, 86% of the respondents stated that drought causes crops to be dehydrated while 14% stated that; drought causes crops to be stunted. Drought and flood in totality causes low vegetable production in the Municipality.
However, some respondents who are Agricultural Extension Officers advise that, farmers create drainages in their farms to curb flooding instances, grow the right vegetables at the right season, practice planting on time, and plant across to increase yields.
Fig 4.7 deficits that Only 20% of the target population practice irrigation farming. The remaining 80% relies fully on rainfall. This can be interpreted as no production or yield for farmers who rely on rainfall. If rains fail in a particular year, there's likely to be no production or low yield which will eventually affect their income and livelihood.

Agricultural institutions are vital in discussing crop production and yield. Fig 4.8 indicates that Twenty-two (22) of the respondents indicated that there have been training and interventions from external Agricultural agencies to aid vegetable production and yield. The largest group, which forms eighty-eight percent (88%) of the population, has had no training or intervention. This could be attributed to low knowledge of some Agricultural practices considering the percentage of respondents who have above primary education.

The findings of the study indicated that 23 farmers are unable to minimize the effect of climate change on vegetable yield, 26 of them say they have but partially, and 51 of them answered no as captured in Fig 4.9. The majority of farmers are unable to control the effects of climate change on yields due to reasons given as, lack of know-how, and unavailable means whereas some farmers do not have any reason as to why they are unable to reduce these effects as shown in fig 4.9.1

A total of 43 respondents said they control diseases that affect vegetables as a result of temperature and rainfall instability by using fertilizer, 45 use insecticides and 12 of them do not control them. This is linked to determining the strategies used by farmers to reduce the impact of climate change on vegetable yields, as captured in fig 4.9.2

Primarily, the vegetable farmers of the Ashaiman Municipality heavily rely on rainfall and a slight change in climatic situations poses a threat to their production and yield. The findings of the study indicate that climate change, specifically rainfall and temperature results in low yields and stunted growth of vegetables meanwhile, farmers have not devised ways to reduce its effect. As a result of poor production, the income, and livelihood of farmers and vendors are affected. This is in line with [62] who argue that "we rely on the latest temperature and precipitation projections of the Intergovernmental Panel on Climate Change (IPCC) to simulate the impact of climate change on agricultural revenue in Ghana".

VI. CONCLUSION AND RECOMMENDATIONS

6.1 Summary of Findings

The study's major goal was to investigate and analyze the effects of climate change, specifically on rainfall and temperature, on vegetable production yields in the Ashaiman Municipality. It sought to specifically examine the knowledge and perception of climate change among vegetable farmers, to analyze the factors influencing farmers' perceptions of climate change in the Municipality, to ascertain the impact of climate change on soil moisture, vegetable yield, and livelihoods, to ascertain the strategies farmers employed to lessen the impact of climate change on vegetable yields, and to ascertain the factors influencing farmers' adaptation decisions in the Municipality.

Using open-ended questionnaires, information was gathered from one hundred (100) respondents in the

Ashaiman Municipality. Data was examined using SPSS v.20 and both qualitative and quantitative research methodologies were used.

The initial goal was to assess the understanding and perception of climate change among vegetable farmers. According to the study, every responder is aware of climate change and has an opinion about it.

The second goal was to examine the factors that affect how farmers in the Municipality view climate change. The study found that variations in temperature and rainfall, as well as commentary from agricultural officials and the media, are some elements that influence how farmers view climate change.

The third goal was to ascertain how climate change will affect soil moisture, vegetable productivity, and livelihoods. It has been determined that climate change has a detrimental impact on soil moisture, which results in low vegetable yields, low income, and a reduction in quality of life. According to [63], variations in climatic change affect soil organisms by affecting soil moisture and vegetable composition.

The fourth goal was to identify the methods farmers employ to lessen the effect of climate change on vegetable harvests. In an effort to lessen the effects of climate change on yields, it was discovered that the majority of farmers in the Ashaiman Municipality utilize fertilizer to increase vegetable yields. According to a study, agricultural techniques like applying fertilizer and pesticides may have an impact on excellent output based on how severe a climate change is.

6.2 Conclusion

Unstable rainfall patterns and temperatures have an impact on the livelihood of many vegetable farmers and traders. Some farmers turn to the usage of fertilizer as a means of minimizing the effects of climate change on vegetable yields, but this lowers their profitability from output. The predicament of vegetable farmers in the Ashaiman Municipality has been greatly exacerbated by the lack of agricultural expertise caused by inadequate or no training from connected organizations. Financial limitations have also made it difficult for farmers to use irrigation farming during droughts and to build drainage systems to prevent floods. Low yields are the main consequence of temperature and precipitation on vegetable cultivation in the Municipality.

6.3 Recommendations

1. Incentives should be provided by the Ministry of Food and Agriculture (MOFA), specifically for women in vegetable farming, to entice more women to curb the gender deficit in farming.
2. Agricultural Agencies and stakeholders should periodically train farmers on basic and essential farm practices so as to reduce ignorance of certain practices which will in turn boost production and yield.
3. Farmers should form or be part of associations where knowledge can be shared that will financially benefit them as well.
4. Farmers should create drainage to prevent flood, practice irrigation farming to avoid drought, and, plant on time.

REFERENCES

[1] Prasad, B.V.G., Chakravorty, S., Deb, P. (2014). Food nutritional and aesthetic security for future India by horticulture. Life Science Int. J.,1(1):328-331

[2] Dhiman, (2012) A training manual on vegetable production under changing climate scenario

[3] Mensah, H., & Ibrahim, B. (2017). Alternate solutions towards sustainable irrigated agriculture in Ghana: Review of the literature. Journal of Agriculture and Sustainability, 10(1).

[4] Devendra, C. 2012 Climate change threats and effects: challenges for Agricultural and Food Security.ASM Series on Climate Change. ISBN 978-983-9445-82-4

[5] FAOSTAT (2016) FAOSTAT Statistics Database. Food and Agriculture Organization of the United. Nations, Rome, Italy

[6] Arndt C, Asante F, Thurlow J. Implications of Climate Change for Ghana's Economy. *Sustainability*. 2015; 7(6):7214-7231. https://doi.org/10.3390/su7067214

[7] Al-Hassan, R.; Poulton, C. Agriculture and Social Protection in Ghana; FAC Working Paper No. SP04; Future Agricultures Consortium: Sussex, UK, 2009.

[8] Athula, S.; Scarborough, H. Coping with climatic variability by rain-fed farmers in dry zone. In Proceedings of the 55th Conference of Sri Lanka: Towards Understanding Adaptation to Climate Change, Melbourne, Australia, 8–11 February 2011.

[9] Food and Agriculture Organization. The State of Food Insecurity in the World 2008; Food and Agriculture Organization: Rome, Italy, 2009.

[10] Brown, M., Antle, J., Backlund, P., Carr, E., Easterling, B., Walsh, M., ... & Tebaldi, C. (2015). Climate change, global food security and the US food system.

[11] Porter, J. R. et al. Food security and food production systems. In *Climate Change 2014: Impacts, Adaptation and Vulnerability. Working Group 2 Contribution to the IPCC 5th Assessment Report* (eds Field, C. B. et al.) Ch. 7 (Cambridge Univ. Press, 2014).

[12] Antwi-Agyei P, Fraser EDG, Dougill AJ, Stringer LC, Simelton E (2012) Mapping the vulnerability of crop production to drought in Ghana using rainfall, yield and socioeconomic data. Appl Geogr 32:324–334. doi:10.1016/j.apgeog.2011.06.010

[13] S. Vermeulen, B. M. Campbell, J. S. I. Ingram, Climate change and food systems. *Annu. Rev. Environ. Resour.* 37, 195–222 (2012).

[14] Agbola T, Ojeleye D (2007). Climate change and food production in Ibadan, Nigeria. Afr. Crop Sci. Confer. Proc., 8: 1423-1433.

[15] National Research Council. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas; National Academies Press: Washington, DC, USA, 2012.

[16] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

[17] Asante, F.A. and Amuakwa-Mensah, F. (2015) Climate Change and Variability in Ghana: Stocktaking. Climate, 3, 78-99. https://doi.org/10.3390/cli3010078

[18] Ghana Statistical Service (GSS). Annual Report; Ghana Statistical Service: Accra, Ghana, 2021

[19] Lorenzoni, I., & Pidgeon, N. F. (2006). Public views on climate change: European and USA perspectives. Climatic change, 77(1), 73-95.

[20] Wolf, J., & Moser, S. C. (2011). Individual understandings, perceptions, and engagement with climate change: insights from in-depth studies across the world. Wiley Interdisciplinary Reviews: Climate Change, 2(4), 547-569.Golo, B. W. K., & Yaro, J. A. (2013). Reclaiming stewardship in Ghana: religion and climate change. Nature and Culture, 8(3), 282-300.

[21] Thompson, J. E. (2017). Survey data reflecting popular opinions of the causes and mitigation of climate change. *Data in brief*, *14*, 412-439.

[22] Adger, W. N. (2007). Vulnerability of global environmental change 16 (3): 268–281. Agriculture: Ricardian approach. World Bank Policy Research Paper, (4342).

[23] Ministry of Environment, Science and Technology. Ghana National Climate Change Policy. Ministry of Environment, Science and Technology and Innovation: Accra, Ghana, 2013

[24] Agam, N., & Berliner, P. R. (2006). Dew formation and water vapor adsorption in semi-arid environments—a review. Journal of Arid Environments, 65(4), 572-590.

[25] Wang, L., Manzoni, S., Ravi, S., Riveros-Iregui, D., & Caylor, K. (2015). Dynamic interactions of ecohydrological and biogeochemical processes in water-limited systems. Ecosphere, 6(8), 1-27.

[26] Gupta, S., & Kumar, S. (2017). Simulating climate change impact on soil erosion using RUSLE model− A case study in a watershed of mid-Himalayan landscape. *Journal of Earth System Science*, *126*, 1-20.

[27] Food and Agriculture Organization of the United Nations. Climate Change and Food Security: A Framework for Action; FAO Interdepartmental Working Group on Climate Change, Food and Agriculture Organization: Rome, Italy, 2007.

[28] FAO. Climate change implications for food security and natural resources management in Africa. In Proceedings of the Twenty-Sixth Regional Conference for Africa, Food and Agriculture Organization, Rome, Italy, 3–7 May 2010.

[29] IPCC, 2001: Climate Change 2001: The Synthesis Report. A Contribution of Working Group I to the Third Assessment Report of the

Intergovernmental Panel on Climate Change [Watson, R.T. and the Core Writing Team (eds.)]. Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA, 398 pp,

[30] UNEP (2007) Fourth Global Environmental Outlook Report (GEO-4). United Nations Environment Programme. Earthprint, Nairobi.

[31] Williams PA, Crespo O, Abu M, Simpson NP (2018). A Systematic review of how vulnerability of smallholder agricultural systems to changing climate is assessed in Africa. Environmental Research letters, volume 13,10 Res. Left. 13 103004 DOI 10. 1088/1748/aae026

[32] Bhardwaj, M. L. (2012). Challenges and opportunities of vegetable cultivation under changing climate scenario. A training manual on vegetable production under changing climate scenario, 13-18.

[33] Hatfield, J. L., Gitelson, A. A., Schepers, J. S., & Walthall, C. L. (2008). Application of spectral remote sensing for agronomic decisions. *Agronomy Journal*, *100*, S-117.

[34] Hatfield, J. L., Boote, K. J., Kimball, B. A., Ziska, L. H., Izaurralde, R. C., Ort, D., ... & Wolfe, D. (2011). Climate impacts on agriculture: implications for crop production. *Agronomy journal*, *103*(2), 351-370.

[35] Sutton, M. A., Bleeker, A., Howard, C. M., Erisman, J. W., Abrol, Y. P., Bekunda, M., ... & Zhang, F. S. (2013). *Our nutrient world. The challenge to produce more food & energy with less pollution*. Centre for Ecology & Hydrology.

[36] Mattos, L. M., Moretti, C. L., Jan, S., Sargent, S. A., Lima, C. E. P., & Fontenelle, M. R. (2014). Climate changes and potential impacts on quality of fruit and vegetable crops. In *Emerging technologies and management of crop stress tolerance* (pp. 467-486). Academic Press.

[37] Ort, D. R., Merchant, S. S., Alric, J., Barkan, A., Blankenship, R. E., Bock, R., ... & Zhu, X. G. (2015). Redesigning photosynthesis to sustainably meet global food and bioenergy demand. *Proceedings of the national academy of sciences*, *112*(28), 8529-8536.

[38] Chauhan, B. S., Mahajan, G., Sardana, V., Timsina, J., & Jat, M. L. (2012). Productivity and sustainability of the rice–wheat cropping system in the Indo-Gangetic Plains of the Indian subcontinent: problems, opportunities, and strategies. *Advances in agronomy*, *117*, 315-369.

[39] Wan, Z., Zhang, Y., Zhang, Q., & Li, Z. L. (2002). Validation of the land-surface temperature products retrieved from Terra Moderate Resolution Imaging Spectroradiometer data. *Remote sensing of Environment*, *83*(1-2), 163-180.

[40] Veloz, S. D., Williams, J. W., Blois, J. L., He, F., Otto-Bliesner, B., & Liu, Z. (2012). No-analog climates and shifting realized niches during the late quaternary: implications for 21st-century predictions by species distribution models. *Global Change Biology*, *18*(5), 1698-1713.

[41] Parent, C., Capelli, N., Berger, A., Crèvecoeur, M., & Dat, J. F. (2008). An overview of plant responses to soil waterlogging. *Plant stress*, *2*(1), 20-27.

[42] Ehleringer, J. R., Field, C. B., Lin, Z. F., & Kuo, C. Y. (1986). Leaf carbon isotope and mineral composition in subtropical plants along an irradiance cline. *Oecologia*, *70*, 520-526

[43] Belavadi, V. V., Karaba, N. N., & Gangadharappa, N. R. (Eds.). (2017). *Agriculture under climate change: Threats, strategies and policies* (Vol. 1). Allied Publishers.

[44] Verchot, L. V., Van Noordwijk, M., Kandji, S., Tomich, T., Ong, C., Albrecht, A., ... & Palm, C. (2007). Climate change: linking adaptation and mitigation through agroforestry. *Mitigation and adaptation strategies for global change*, *12*, 901-918.

[45] Haskell, M. J., Jamil, K. M., Hassan, F., Peerson, J. M., Hossain, M. I., Fuchs, G. J., & Brown, K. H. (2004). Daily consumption of Indian spinach (Basella alba) or sweet potatoes has a positive effect on total-body vitamin A stores in Bangladeshi men. *The American journal of clinical nutrition*, *80*(3), 705-714.

[46] Bhatt, R. M., Rao, N. K. S., Upreti, K. K., & Lakshmi, M. J. (2009). Hormonal activity in tomato flowers in relation to their abscission under water stress. *Indian Journal of Horticulture*, *66*(4), 492-495.

[47] Gupta, B., & Huang, B. (2014). Mechanism of salinity tolerance in plants: physiological, biochemical, and molecular

characterization. *International journal of genomics*, *2014*.

[48] Carey, J. C., Tang, J., Templer, P. H., Kroeger, K. D., Crowther, T. W., Burton, A. J., ... & Tietema, A. (2016). Temperature response of soil respiration largely unaltered with experimental warming. *Proceedings of the National Academy of Sciences*, *113*(48), 13797-13802.

[49] Campbell, B. M., Vermeulen, S. J., Aggarwal, P. K., Corner-Dolloff, C., Girvetz, E., Loboguerrero, A. M., ... & Wollenberg, E. (2016). Reducing risks to food security from climate change. *Global Food Security*, *11*, 34-43.

[50] Aniah, P., Kaunza-Nu-Dem, M. K., Quacou, I. E., Abugre, J. A., & Abindaw, B. A. (2016). The effects of climate change on livelihoods of smallholder farmers in the upper east region of Ghana. *International Journal of Sciences: Basic and Applied Research*, *28*(2), 1-20.

[51] Collier, B., Skees, J., & Barnett, B. (2009). Weather index insurance and climate change: Opportunities and challenges in lower income countries. *The Geneva Papers on Risk and Insurance-Issues and Practice*, *34*, 401-424.

[52] Dasgupta, A., & Baschieri, A. (2010). Vulnerability to climate change in rural Ghana: Mainstreaming climate change in poverty-reduction strategies. *Journal of International Development*, *22*(6), 803-820.

[53] Creswell, J. W., & Tashakkori, A. (2007). Differing perspectives on mixed methods research. *Journal of mixed methods research*, *1*(4), 303-308.

[54] Bryman, A. (2006). Integrating quantitative and qualitative research: how is it done?. *Qualitative research*, *6*(1), 97-113.

[55] Teye, J. K. (2012). Benefits, challenges, and dynamism of positionalities associated with mixed methods research in developing countries: Evidence from Ghana. *Journal of Mixed Methods Research*, *6*(4), 379-391.

[56] Obuobie, E., Drechsel, P., & Danso, G. (2004). *Gender in open-space irrigated urban vegetable farming in Ghana*. IWMI.

[57] Rouphael, Y., Cardarelli, M., Schwarz, D., Franken, P., & Colla, G. (2012). Effects of drought on nutrient uptake and assimilation in vegetable crops. *Plant responses to drought stress: from morphological to molecular features*, 171-195.

[58] Badiane, O., Diao, X., & Jayne, T. (2021). Africa's unfolding agricultural transformation. *Agricultural development: New perspectives in a changing world*, 153-192.

[59] Prasad, B. V. G., and S. Chakravorty. (2015). "Effects of climate change on vegetable cultivation-a review." *Nature Environment and Pollution Technology* 14, no. 4 (2015): 923.

[60] Yamba, S., Appiah, D. O., Pokuaa-Siaw, L., & Asante, F. (2017). Smallholder farmers' livelihood security options amidst climate variability and change in rural Ghana. *Scientifica*, *2017*.

[61] Christensen, J. H., Kanikicharla, K. K., Aldrian, E., An, S. I., Cavalcanti, I. F. A., de Castro, M., ... & Zou, L. (2013). Climate phenomena and their relevance for future regional climate change. In *Climate change 2013 the physical science basis: Working group I contribution to the fifth assessment report of the intergovernmental panel on climate change* (pp. 1217-1308). Cambridge University Press.

[62] Olesen, J. E., & Bindi, M. (2002). Consequences of climate change for European agricultural productivity, land use and policy. *European journal of agronomy*, *16*(4), 239-262.

[63] Naik, P. S., Singh, M., & Ranjan, J. K. (2017). Impact of climate change on vegetable production and adaptation measures. *Abiotic stress management for resilient agriculture*, 413-428.