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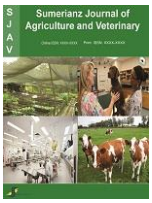

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Effect of Climate Change on Sustainability of Cassava Production in Ebonyi State, Nigeria

Osuji E. E. *
Department of Agriculture, Alex Ekwueme Federal University Ndufu-Alike Abakaliki, Nigeria
Email: osujiemeka2@yahoo.com

Tim-Ashama A. C.
Department of Agricultural Science, Alvan Ikoku Federal University of Education, Owerri, Nigeria

Nwose R. N.
Department of Agriculture, Alex Ekwueme Federal University Ndufu-Alike Abakaliki, Nigeria

Orji J. E.
Department of Agriculture, Alex Ekwueme Federal University Ndufu-Alike Abakaliki, Nigeria

Anyanwu U. G.
Department of Agricultural Economics, Federal University of Technology, Owerri, Nigeria

Nwachukwu E. U.
Department of Agricultural Economics, Federal University of Technology, Owerri, Nigeria

Anyiam K. H.
Department of Agricultural Economics, Federal University of Technology, Owerri, Nigeria

Umeh N. E.
Department of Agriculture, Alex Ekwueme Federal University Ndufu-Alike Abakaliki, Nigeria

Eze E. U.
Department of Agricultural Technology, Federal Polytechnic Nekede Owerri Imo State, Nigeria

Iwezor-Magnus D. N.
Department of Agricultural Economics, Michael Okpara University of Agriculture Umudike, Nigeria

Osang E. A.
Department of Agriculture, Alex Ekwueme Federal University Ndufu-Alike Abakaliki, Nigeria

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Abstract

Over time, climate change has negatively influenced cassava production affecting yield and output of farmers. This has also affected the economic returns from cassava farming. A total of 78 cassava farmers were drawn using purposive sampling technique. Primary data were collected using a questionnaire and were analyzed using frequency, percentage, mean and ordinary least square multiple regression model. Results shows that majority of the cassava farmers were male (67.9%), married (56.4%), experienced (70.5%) with a productive age of 55 years. Majority of the cassava farmers, (55.1%) perceived that cassava production in the area was highly sustainable as against 17.9% of the cassava farmers that differed. The identified climate change hazards on cassava production were decreased cassava yield (61.5%), reduced income (97.4%), land degradation (84.6%), increased pest and disease problems (65.4%), drought and water scarcity (88.5%), and increased production costs (97.4%). Temperature ($P<0.01$), rainfall ($P<0.01$), and number of rainy days ($P<0.05$) impacted cassava production negatively, while sunshine hours ($P<0.05$), and relative humidity ($P<0.01$) positively impacted cassava production. Insufficient planting materials (98.7%), soil fertility issues (91.0%), insufficient or irregular rainfall (89.7%), limited access to credit or financial resources (87.2%), high costs of inputs (100%), and low yields (75.6%) constrained cassava production in the area. Farmers should seek early climate change information from nearest metrological centers in their locality to mitigate adverse effects of climate change on cassava production.

Keywords: Effects of climate change; Sustainable cassava production; Farmers; Ebonyi state.

1. Introduction

Agriculture belongs to the main sector of Nigerian economy and is characterized by a multitude of small scale farmers scattered over wide expanse of land area, with small holding ranging from 0.05 to 3.0 hectares per farm land, rudimentary farm systems, low capitalization and low yield per hectare [1] The roles of agriculture remain significant in the Nigeria economy despite the strategic importance of the oil sector. Agriculture provides primary means of employment for Nigerians and accounts for more than one-third of the total gross domestic product (GDP) and labour force [2, 3]. Cassava (*manihot esculenta*) is a native of South America that is extensively cultivated as an annual crop in the tropical and subtropical regions for its edible starchy tuber [4]. Cassava has the ability to grow on marginal lands and its one of the most important staple food crops in tropical Africa with its efficient production of food energy, year round availability and tolerant of extreme environmental stress which makes it eminently suitable for farming and food system in Nigeria [2]. Cassava production plays a key role in alleviating poverty in Nigeria, as it is virtually impossible for an average household not to consume cassava product in a day [5]. In recent times, the issue of climate change through extreme temperature, frequent flooding, drought and increased salinity of water used for irrigation has become a recurrent subject of global debate [6]. The intensity of the debate is on the increase due to the enormity of the challenge posed by climate change across the world [7]. Climate change has become a big threat to agricultural production activities making the sector more vulnerable than other sectors [8]. The vulnerability of the Nigerian agricultural sector to climate change is of particular interest to policy makers because agriculture is a key sector in the economy accounting for between 60-70% of the labour force and contributing about 40% to the Nigeria GDP [9]. Climate change has disturbed cassava yields, outputs, and quality, leading to food shortages and a decline in supplies [10]. For instance, decreased cassava yield is frequently brought on by anticipated changes in harsh weather, such as temperature increase, change in precipitation pattern, change in relative humidity, windstorm, etc. [2]. High temperature causes quick deterioration of the cassava tubers resulting in low yield and poor income of the farmers [11]. Less rainfall shrivels soil-grown cassava tubers, resulting in deformation, a reduction in size, and a decline in market value [10]. Increases in rainfall give rise to a wide range of cassava pests and diseases that destroy cassava leaves in large quantities, and decreasing the photosynthetic capacity of cassava plants [12]. According to reports, as long as climate change continues, Nigeria's cassava production would continue to decline [4]. According to the 2021 Notre Dame Global Adaptation Index [3], Nigeria is the 53rd most susceptible country and the sixth least prepared to adapt to climate change. This calls for serious concern and a development of robust strategy in mitigating the adverse effects of climate change on Nigeria agriculture [13]. In recent times, cassava farmers in Ebonyi State have experienced a severe decline in cassava production resulting in decreased yields, reduced quality, and quantity as well as loss in economic value and market returns, thereby subjecting them to hunger, starvation, poverty and economic hardship. Their land productivity is seriously threatened by unprecedented changes in climate variations [14]. Currently, the growing population in Ebonyi State is driving up the demand for food production, and cassava being a significant homemade crop is struggling to keep up as crop yield decreases intensely due to adverse climatic conditions prevalent in the State. Hence it is consequent on the above scenarios that the study was conceived to examine the sustainability of cassava production under changing climate in Nigeria.

2. Materials and Methods

The study was conducted in Ebonyi State, Nigeria. The State is located in South-East zone with an estimated population of 3,242,500 persons. The State is largely into agriculture with more than 70 percent of the populace into cassava farming. The State has 13 local government areas (LGAs) (Abakaliki, Izzi, Ezza-North, Afikpo-South, Ohaukwu, Ebonyi, Oniocha, Ishielu, Ezza-South, Ikwo, Afikpo-North, Ohaozara and Ivo) with inhabitants of cassava farmers. The total land area is about 5,533 km^2 with *Latitude*: 6°10' 40.7028" and *Longitude*: 7°57' 33.4296". A purposive sampling technique was used to select the cassava farmers. In the first phase, four LGAs namely (Ikwo, Ohaozara, Ivo and Ebonyi) known for intensive cassava cultivation were picked out of the 13 LGAs. Again, from the four selected LGAs, six communities each were selected making a total of 24 communities. Consequently, from the 24 communities sampled, four cassava farmers were picked to make 96 farmers. The list of the registered cassava farmers across the LGAs formed the sample frame. Primary data were collected using

questionnaire and out of the selected 96 cassava farmers, only 78 provided useful information for data analysis. Data were analysed using descriptive statistics, and ordinary least square multiple regression technique and was stated as follows;

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6) + e$

Where

Y = Cassava yield (kg)

X_1 = Temperature (Perception; increased = 1, otherwise = 0)

X_2 = Rainfall (Perception; increased = 1, otherwise = 0)

X_3 = Number of rainy days (Perception; increased = 1, otherwise = 0)

X_4 = Evaporation rate (Perception; increased = 1, otherwise = 0)

X_5 = Sunshine hours (Perception; increased = 1, otherwise = 0)

X_6 = Relative humidity (Perception; increased = 1, otherwise = 0)

e = error term

3. Results and Discussions

3.1. Socio-economic Characteristics of Cassava Farmers

The socio-economic characteristics of cassava farmers' are shown in Table 1. The table shows that majority of the farmers were within the age bracket of 51-60 years with a mean age of 55 years. This implies that the cassava farmers were aging; though have physical strength which is utilized in cassava cultivation. Increase in age is associated with increase in farm production experiences which aid farm operations and other related activities. This corresponds to the findings of Anyaegbu, *et al.* [15]. The majority of the cassava farmers were males, (67.9%) in comparison to the females (32.1%). This implies that the cassava production was dominated by the male farmers in the area. Several studies have reported the dominance of male farmers in cassava production; this could result in their physical strength and energies exerted in cassava cultivation unlike the female farmers that are feeble and could be engaged in other domestic activities which keeps them away from farm work and this corresponds to the findings of Emenyonu, *et al.* [16]. The majority of the farmers were married (56.4%) and the singles were 12.8%, while about 10.3% were divorced and 20.5% widow/widower. This implies that the married farmers were more in cassava production than others and this could support the family labour deployed in cassava production in the area. This agrees with the findings of Osuji, *et al.* [10]. The table shows that 33.3% of the farmers had primary education, 10.3% had both tertiary education, and non-formal education. Thus the majority of the farmers (46.2%) had secondary education; this implies that the cassava farmers were relatively educated to understand the intricacies involved in cassava farm production which aid improved and increased yields in cassava production [17]. The majority of the cassava farmers (73.1%) had household sizes between 5-8 persons with a mean household size of 7 persons. This implies that the household size regarding the cassava farmers was relatively large and could support their farming strength and production activities. Household size here connotes family members and dependents utilized in cassava cultivation and other farm works. Households with large sizes are favourably disposed to farm production activities compared to smaller sizes and agree with the findings of Li, *et al.* [18]. The majority of the cassava farmers (55.1%) were involved with farming and other activities, while about 44.9% of them were engaged in farming activities only. This connotes that the cassava farmers comprised of more males were involved in other occupation which serves as support to their cassava production and source of income and livelihoods. This agrees with the findings of Osuji, *et al.* [10]. The majority of the cassava farmers (67.9%) had farm sizes within 0.1-1.0 hectares with a mean hectare of 0.8. This implies the prevalence of small farm holdings which is most common in rural agricultural areas. This is partly due to land tenure systems and land scarcity which limit large scale agricultural production. This agrees with the findings of Adjebeng-Danquah, *et al.* [19]. Again, Table 1b, table shows that about (34.6%) of the cassava farmers had extension contacts between 1-2 times, 7.7% had extension contacts between 5-6 times, while the majority of the cassava farmers (57.7%) had between 3-4 times. The mean extension contact was approximately 4 contacts, which implies that the cassava farmers had relatively physical contacts with extension agents which connote extensive passage of farm information and technical farm practices and experimentations. This agrees with the findings of Paul, *et al.* [11]. About 42.3% of the cassava farmers do not belong to cooperative society while the majority (57.7%) belonged to cassava cooperative societies. This implies that the majority of the cassava farmers had access to farm information, farming inputs, credit facilities and others. Being part of a cooperative society gives farmers the privilege of accessing farming inputs at a subsidized rate. This agrees with the findings of Osuji, *et al.* [10]. The table reveals that (32.1%) of the cassava farmers were involved in workshop/training at least 1-2 times. About 7.7% participated in workshop/training up to 5-6 times per cropping season. The majority of the cassava farmers (60.3%) participated up to 3-4 times. The mean participation in workshop/training was approximately 4 times per cropping year. This means that the cassava farmers' accessed vital information regarding cassava cultivation and production principles which translate to improved yield and bumper harvest. Participation in workshop/training assists farmers in acquiring new knowledge and updated information regarding agricultural activities and operations. This supports the findings of Emenyonu, *et al.* [16]. The majority of the cassava farmers (70.5%) had farming experience ranging between 11-20 years. The mean farming experience of the cassava farmers was 18 years, implying that the cassava farmers had experience in cassava production. Farming experience helps farmers to improve on their production capacity and overcome inherent farm problems and challenges besetting farmers. This agrees with the findings of Ayanlade, *et al.* [20]. Result shows that the cassava farmers obtained their capital from various sources. About 6.4% accessed their capital from banks, 21.8% from friends/relatives, 23.1% from co-operatives societies, while the majority, 38.5% accessed their capital from personal savings. This connotes

that majority of the cassava farmers started their cassava cultivation from their own savings which is common in rural areas and this corroborates the findings of Diallo, *et al.* [21]. The table shows that the land for cassava farming was acquired through various means. About 16.7% acquired their land via pledge, 11.5% through purchase, 10.3% through gifts, 20.5% through lease/rent and 41.0% via inheritance. This implies that the majority of cassava farmers obtained their land via inheritance as this is common with rural crop cultivation. This agrees with the findings of Diallo, *et al.* [21]. The majority of the farmers (46.2%) made use of family labour, 28.2% made use of hired labourers, while about 25.6% used both family and hired labourers. This implies that the majority of the cassava farmers used more of family labour than hired labour. This source of labour usually comes from family dependents and relations who assist in farm activities in rural areas. More so, family labour is most preferred because of its' cheap source compared to hired labourers who charge outrageous fares. This agrees with the findings of Osuji, *et al.* [10].

Table-1A. Socio-economic characteristics of cassava farmers N= 78

Variable	Frequency	Percentage
Age		
20-30	19	24.4
31-40	15	19.2
41-50	11	14.1
51-60	33	42.3
Mean	**55**	
Sex		
Male	53	67.9
Female	25	32.1
Marital status		
Single	10	12.8
Married	44	56.4
Widowed	24	30.8
Level of education		
Primary	26	33.3
Secondary	36	46.2
Tertiary	08	10.3
Non formal	08	10.3
Household size		
1-4	12	15.4
5-8	57	73.1
9-12	06	7.7
13-16	03	3.8
Mean	**07**	
Occupation		
Farming only	35	44.9
Farming and others	43	55.1

Table-1B. Socio-economic characteristics of cassava farmers N= 78

Farm Size		
0.1-1.0	53	67.9
1.1-2.0	10	12.8
2.1-3.0	06	7.7
3.1 & above	09	11.5
Mean	**0.8**	
Extension contacts		
1-2	27	34.6
3-4	45	57.7
5-6	06	7.7
7& above	--	--
Mean	**3.7**	
Cooperative membership		
Yes	45	57.7
No	33	42.3
Participation in workshop/training		
1-2	25	32.1
3-4	47	60.3
5-6	6	7.7
7 & above	-	-
Mean	**3.6**	

Farming Experience		
1-10	11	14.1
11-20	55	70.5
21-30	12	15.4
31-40	-	--
Mean	**18**	
Source of Capital		
Banks	05	6.4
Friends/relatives	17	21.8
personal savings	30	38.5
Co-operatives society	18	23.1
Other	08	10.3
Source of land		
Inheritance	32	41.0
Lease/rent	16	20.5
Gift	08	10.3
Purchase	09	11.5
Pledge	13	16.7
Source of labour used		
Family	36	46.2
Hired	22	28.2
Both	20	25.6

3.2. Sustainability of Cassava Production

The sustainability of cassava production is shown in Table 2. The table shows that about 17.9% of the cassava farmers perceived that cassava production in the area is not sustainable. This could be due to the low yield and harvest experienced by the cassava farmers. This could also result from the adverse impacts of climate change on cassava production of the farmers and their inability to mitigate climate change effects [22, 23]. About 11.5% of the farmers posited that cassava production in the area was slightly sustainable; this connotes that cassava farmers experienced a slight increase in cassava yields and harvest. This could results from improved species of cassava stems planted which connotes improved yield and cassava outputs [21]. Again, 15.4% of the cassava farmers perceived fairly sustainability of cassava production in the area. This implies that cassava production in the area fared relatively well with evidence of increased yields and outputs probably due to improved production systems deployed in the cassava cultivation. Furthermore, the majority of the cassava farmers (55.1%) perceived that cassava production in the area is highly sustainable. This implies that these group of famers experienced increased cassava yields and bumper harvest. This further shows a high level of performance in land productivity of the cassava farmers. Increased in yields could results from both internal and external factors such as (improved cassava species, farming experience, subsidized inputs, increase hectare of land, access to extension agents, access to climate change information, participation in agricultural workshops/trainings and other production supports). This agrees with the findings from Osuji, *et al.* [10]; Ukoha [24]; Adeleke, *et al.* [8].

Table-2. Sustainability of cassava production

Sustainability of cassava production	Frequency	Percentage
Highly sustainable	43	55.1
Fairly sustainable	12	15.4
Slightly sustainable	09	11.5
Not sustainable	14	17.9
Total	**78**	**100**

3.3. Identified Climate Change Hazards on Cassava Production

The identified climate change hazard on cassava production is shown in Table 3. The table shows that 61.5% of the cassava farmers perceived decreased in cassava yield. Climate change is known to impact cassava production negatively via a decrease in yield. Increase in temperature impairs cassava plants and outputs thereby causing a decrease in yield [25]. Reduced income was perceived by 97.4% of the cassava farmers. Climate change causes a drastic reduction in yield which results in reduced income. Climate change reduces the economic value and/or marketability of poor cassava yields thereby affecting farmers' livelihoods and subjecting them into abject poverty. About 84.6% of the cassava farmers indicated land degradation as climate change hazards. Climate change is known to damage agricultural lands making it infertile and unproductive thereby affecting cassava production. Land degradation is exacerbated through changes in temperature, windstorms, droughts, sand and dust storms, floods, heat waves, wild fires and other extreme weather events which affect cassava yields [26]. Changes in rainfall amount and intensity induces soil erosion and water run-off which is likely to cause land disintegration and degradation. The extent of soil erosion and water flooding wears away top vegetative soil leaving the land bare. Prolong drought leads to land denudation and desertification which degrade the land surface affecting crop cultivation. Increased pest and disease problems was perceived by 65.4% of the cassava farmers, thus increase temperature and precipitation

initiates intense pest and disease infestations which affect cassava yields and performances [27]. Warmer temperatures promote good breeding ground for pest and disease multiplication which decrease cassava outputs and yields. Conversely, higher temperatures increase pest and insect attacks on cassava fields because they reduce the strength and effectiveness of various pesticides and insecticides [28]. About 88.5% of the cassava farmers perceived drought and water scarcity. Prolong dry season leads to drought and water scarcity which affects cassava production. Decrease rainfall and/or absence of rainfall for a long time results in water shortage and unavailability leading to a drop in yield of cassava crops [29]. Climate change is known to upset rainfall patterns and systems causing serious dryness of cassava farmlands and short supply of water needed for increased cassava outputs. Increased production costs was indicated by 97.4% of the cassava farmers, this implies that farmers incurred production costs trying to enrich the already eroded soil nutrients washed off by heavy rainfall and increased flooding [30]. In order to improve and increase cassava production in the face of changing weather conditions, farmers spent a lot of money getting farming inputs such as agrochemicals (fertilizers, pesticides, insecticides, etc.) and organic manures and improved cassava varieties/species [24]. These increases their production cost and affects their economic livelihoods. Again increase in cost of available cassava products was attested by 79.5% of the cassava farmers. Increase in cost of available cassava products results from decreased cassava yields and outputs occasioned by climate change. Climate change impairs cassava yields and in the long run, available cassava products and by-products become expensive and exorbitant. Also, farmers in a bid to maximize utility in cassava sales increases cost of products [30]. About 64.1% of the cassava farmers perceived reduction in soil fertility. Heavy precipitation is predicted to occur more frequently due to climate change, which could damage cassava crops by eroding soil and depleting soil nutrients. Extreme weather conditions such as increased rainfall intensity and flooding affect cassava fields by washing away its soil nutrients, organic soil contents and other enriching soil components and additives thereby depriving the land from effective yield and performances [18]. Extended growing seasons brought on by rising temperatures and moving climatic belts have the potential to deplete soil nutrients. Increasing sea levels may cause coastal areas to flood, which will saline the soil and exacerbate soil erosion. Elevated temperatures have the potential to cause soil desiccation, which can harm the soil by lowering its nitrogen levels and fertility [31]. Furthermore, increases in temperature destroy soil texture, structure, Ph levels and soil compositions leading to soil dryness and infertility. Altered flowering and tuberization was perceived by 74.4% of the cassava farmers. This means that changes in temperature affects flowering in cassava plants causing yellow leafy colouration, moth and withering of cassava leaves. Again high temperatures slowdown flowering in cassava plants affecting growth performances and yields. Furthermore, high temperatures shrink cassava tubers underneath causing spoilage and rotten tubers. Drought also affects the tuberization of cassava plants leading to poor growth and low yields. Loss of biodiversity was experienced by 60.3% of the cassava farmers. Changes in climate and weather conditions lead to land degradation, denudation, disintegration, and desertification leading to a total loss in biodiversity of cassava fields [32].

Table-3. Identified climate change hazards on cassava production

Climate Change Hazards on Cassava Production	*Frequency	Percentage
Decreased cassava yield	48	61.5
Reduced income	76	97.4
Land degradation	66	84.6
Increased pest and disease problems	51	65.4
Drought and water scarcity	69	88.5
Increased production costs	76	97.4
Increase in cost of available cassava products	62	79.5
Reduction in soil fertility	50	64.1
Altered flowering and tuberization	58	74.4
Loss of biodiversity	47	60.3

***Multiple Responses**

3.4. Perceived Effect of Climate Change Variables on Cassava Production

The perceived effects of climate change variables on cassava production are presented in Table 4. This was ascertained using the linear functional form, which took into consideration the maximum F-value, R^2, and number of significant variables. The meteorological factors employed fully explained 88.2% of the total variations in cassava production, according to the R^2 value of 0.882. Temperature showed 1% significant level and was negative, indicating that cassava yield is decreased by rising temperatures. Warm temperature encourages the growth of soil microorganisms, producing crop insect pests and disease that affect cassava yields, income, and the long-term production of cassava. Elevated temperatures cause damage to cassava stems and growth phases, affecting cassava growth and performances. High temperatures impair cassava tubers resulting in slow growth and yield reduction [33]. Rainfall was significant at 1% and statistically negative, indicating that increased rainfall lowers cassava yields. Increasing rainfall can cause severe soil erosion, which can hinder and damage the growth of roots and shoots of cassava plants. Increased precipitation damages planted cassava crops, reducing their output and economic value. Increased rainfall causes land to flood, which reduces cassava yield and exacerbates food security issues [9] The number of wet days was significant and negative at 5%, indicating that a rise in rainy days has an impact on cassava yield through excessive land saturation and removal of vegetative top soils. Additionally, it lowers the soil's capacity to hold nutrients, which lowers land productivity of cassava fields. An increase in rainy days promotes the spread of several cassava plant diseases that affect yield and market value of cassava crops [10]. The amount of sunshine hours

was positive and statistically advantageous at 5%, indicating that more sunshine hours enhance cassava yield and productivity. For crops to grow and develop well, sunlight is necessary. It encourages cassava plants' photosynthetic activity, which guarantees sustainable yield. Its role as a medium for food plants to convert carbohydrates essential for cassava plant growth and its advancement of the microbial activities of soil organisms make it indispensable to crop production. Sunlight helps cassava plants germinate and makes it easier for the damp stems to dry before planting [34]. At 1%, relative humidity was positive and advantageous, which means that a 1% increase in relative humidity will result in 366.3% increase in cassava yield. In periods of dry seasons, relative humidity increases the moisture capacity of planted cassava resulting in increased cassava yield and land productivity. The development of plants, leaf growth, photosynthesis, pollination of cassava plants, and economic output are all enhanced by relative humidity. In addition to enhancing the texture and structure of the soil, it encourages cassava stem development and germination [2]. However, the overall finding of the study reveals that climate change had both positive and negative impacts on cassava production in the study area.

Table-4. Perceived effect of climate change variables on cassava production

Variable	Linear	Semi-log	Double-log	Exponential
Constant	20. 354 (0.753)	5.645 (0.963)	0.734 (2.644)**	5.843 (1.082)
Temperature (X_1)	-6.945 (-3.923)***	-0.884 (-1.482)*	-0.732 (-3.831)***	-0.436 (-3.023)***
Rainfall (X_2)	-10.634 (-4.841)***	-16.953 (-2.842)**	-0.679 (-1.056)	-2.891 (-0.034)
Number of rainy days (X_3)	-0.954 (-2.863)**	-1.946 (-0.743)	-3.942 (-1.033)	-0.999 (-2.522)**
Evaporation rate (X_4)	13.953 (1.023)	23.932 (2.001)**	0.731 (2.810)**	12.632 (3.630)***
Sunshine hours (X_5)	0.846 (2.738)**	1.754 (0.936)	0.762 (0.452)	19.831 (1.092)
Relative humidity (X_6)	9.933 (3.835)***	0.654 (0.032)	22.852 (3.663)***	0.453 (0.003)
R^2	0.882	0.778	0.667	0.704
F- ratio	10.902***	8.932***	9.061***	8.021***

***,**, * Significant @1%, 5%, 10% levels

3.5. Constraints Encountered by Cassava Farmers in Cassava Production

The constraints encountered by cassava farmers in cassava production are presented in Table 5. The table shows that 98.7% of the cassava farmers acceded to insufficient planting materials as a constraint affecting their cassava production. Insufficient planting materials here refer to improved cassava varieties/species which the farmers noted to be scarce and rarely unavailable [29]. According to the farmers, accessing improved cassava varieties proved difficult due to its scarcity. Soil fertility issues were attested by 91.0% of the cassava farmers, this means that the cassava farmers were constrained by soil fertility issues which compromised their cassava yield and production. No doubt, climate change impaired soil fertility in the area [10]. About 89.7% assented to insufficient or irregular rainfall, changes in climate causes irregularity in rainfall patterns and distributions which distorts cassava cultivation resulting in retarded yields and outputs. Moderate rainfall is required for optimal cassava growth and maximum yields but its absence is a nightmare to crop production [32]. Limited access to credit or financial resources was agreed by 87.2% of the cassava farmers. Credit access facilitates the purchase of improved farming inputs such as improved cassava varieties, agrochemicals, land lease/rent, etc. Lack of access to farm credits constraint farm production and subject poor farmers' to intense economic hardship and project small-scale production. High costs of inputs were perceived by all the cassava farmers, this means that the cassava farmers accessed farm inputs at higher costs and exorbitant prices. This may be probably due to the scarcity farm inputs making the available ones to be expensive [16]. Low yields in cassava production were experienced by 75.6% of the farmers. This could stem from the adverse impacts of climate change and other internal and external production factors. Low yields reduce the economic value of cassava products and impoverishes the farmers in the long run [17]. Lack of modern farming equipment or technology was indicated by 69.2% of the farmers. This means that the cassava farmers generally used un-mechanized implements which are usually associated with physical energy loss and fatigue. The use of crude farm tools retards crop cultivation of farmers resulting in poor yields and harvest in most cases [18]. All the cassava farmers, 100% acceded to limited lands, this is usually associated with rural agricultural production in that the rural lands is usually fragmented and insufficient for large scale cultivation of crops [11]. Also the land tenure systems prevalent in rural settings further limits land availability for crop production. About 85.9% of the cassava farmers opted for inadequate information concerning climate change. Climate change has come to interfere with cassava production and inability of the cassava farmers to access information concerning climate change makes it difficult for them to mitigate its adverse effects on cassava production [10]. Accessing early climate change information is very essential and important in this changing weather conditions as its helps the crop farmers to plan and re-plan their farming activities and operation to improve yields [31]. Pests and disease attacks was perceived by 89.7% of the cassava farmers. Pests and diseases exert negative influences on cassava plants such as leaf colorations, yield reduction, tuber infestations, and economic losses. Empirical studies have reported the various harm and injuries

caused by the invasion of pests and diseases on cassava fields reducing its land productivity and market value [16, 20, 22, 23].

Table-5. Constraints encountered by cassava farmers in cassava production

Constraints Encountered by Cassava Farmers	*Frequency	Percentage
Insufficient planting materials	77	98.7
Soil fertility issues	71	91.0
Insufficient or irregular rainfall	70	89.7
Limited access to credit or financial resources	68	87.2
High costs of inputs	78	100.0
Low yields	59	75.6
Lack of modern farming equipment or technology	54	69.2
Limited lands	78	100.0
Inadequate information concerning climate change	67	85.9
Pests and disease attacks	70	89.7

***Multiple Responses**

4. Conclusion and Recommendations

The findings of study reveal that climate change had a dual impact on cassava production. Climate change variables such as temperature, rainfall, and number of rainy days negatively affected cassava yields while sunshine and relative humidity had positive influence on cassava yields. Farmers should seek early climate change information to mitigate adverse effects of climate change on cassava production. Farmers should practiced more of climate smart agriculture to overcome negative effects of climate change on cassava production. Farmers should be encouraged to participate in agricultural workshops, trainings, seminars, etc. to acquire new knowledge on improved cultivation methods and improved climate change mitigation practices and methods. The government should provide agricultural incentives such as credit facilities, and subsidized inputs to assist the resource poor farmers in improving their cassava production. Adequate extension services should be made available to the cassava farmers to assist in practical trainings of improved farming methods and educate the illiterate farmers on effective climate change mitigation.

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