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**Archives of Applied Science Research, 2012, 4 (1):703-713**
*(http://scholarsresearchlibrary.com/archive.html)*

**ISSN 0975-508X**
**CODEN (USA) AASRC9**

# The effect of climate change on agricultural activities in selected settlements in the Sudano-Sahelian Region of Nigeria

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## ABSTRACT

Climate change is a global crisis, latest estimate by the Inter-governmental Panel on Climate Change (IPCC, 2002) shows that a business as usual scenario will lead to an increase in global mean temperature of about $1^0$C above the present value by the year 2025 and $3^0$C before the end of the next century. The debate on climate change has been generating a lot of interest at both the national, regional and international level. Often a times, more emphasis/ focus is placed on the industrialist, the politicians, bureaucrats, and the list goes on… with little and a times passive attention given to the farmer (rural /dwellers) whose cumulative actions can either directly or indirectly make such policies to succeed or fail. The Sudano-Sahelian region of Nigeria is roughly located on longitude $3^0$ and $15^0$ East and latitude $10^0$ and $14^0$ North. The zone is characterized by persistent drought, wet and dry spells (Sawa, 2002), declining rainfall intensities and increasing the dry season (Ojonigu, 1990). Olaniran, (2002) summarized all these anomalies and confirm that there has been climate change in rainfall regions in the area. The anticipated effects of climate changes on agriculture is what this study attempts to understand. The paper examined the effects of climate change on agriculture (crop production), the coping strategy been adopted and the level of its intensity. This in turn would aid the policy makers and Non-governmental Organization to articulate the plight of the local/rural dwellers in the Sudano-Sahelian region and perhaps bring succor to them. The Settlements that were chosen are Kalalawa village (Long $5.024^1$ and lat $13.210^1$) in Kware Local Government Area (LGA) of Sokoto state; Zangon Buhari (long $8.550^1$ and lat $11.663^1$) in Bunkure LGA of Kano state; and Chingowa (long $12.888^1$ and lat $12.537^1$) in Magumeri LGA of Borno state. Tools used for the generation of field data were questionnaire and focus group discussion (FGD), descriptive and inferential statistical technique were employed in the analysis of the data. The findings reveal that millet, sorghum, and beans appear to be the staple food crop, which significantly vary within the region. Most of the farm plots are owned by the farmers. Rainfall both in terms of intensity and duration has been on a decline, while temperature conditions have been on the increased. Among some the effects are decline in crop yield which has attracted the application of fertilizer, drying of water sources, abandoning of farmlands, and migration. The recommendations are improve farming systems/practices, planting of trees, sinking of boreholes/ water facilities, Government assistance, and prayers to God are the only way forward.

**Key WordS:** Variability, Vulnerability, Productivity, Rainfed, and Irrigation

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## INTRODUCTION

There is a pervasive lack of clear conceptualization on the effect of climate change on the rural dwellers. Most often their views are not sorted before decisions that affects them are made. A significant drawback in combating the effects of climate variability is the failure of African governments to devolve power to who are affected and link environmental degradation to economic policies. In view of these, many programmes and policies lack support or are under-mined by the people. Climate change is a global crisis, latest estimate by the Inter-governmental Panel on Climate Change (IPCC, 2002) shows that a business as usual scenario will lead to an increase in global mean temperature of about $1^0$C above the present value by the year 2025 and $3^0$C before the end of the next century.

The problem is not whether there is a crisis in rural Africa, but what its nature really is. Food shortages are occurring yearly in different parts of the continent. Since the Sahelian Drought of the 1970s, they have captured the able and compassionate attention of film-makers and provoked unprecedented international awareness, charitable giving and voluntary agency activity (Mortimore, 1989). Diagnostic and prescriptive fashions succeed one another almost as rapidly as the ups and downs of the Africa rainfall. For the farming sector alone, a plethora of constraints has been identified. Atypical list might include the following: low productivity caused by infertile soils, erosion, drought, flood, pest and diseases (ecological constraints); labour shortage, caused by rural-urban migration; technical backwardness, caused by scarcity of inputs; conservative farm management, caused by an ageing farm population, and by the low status given to agriculture in educating the young; high marketing costs, caused by inadequate rural infrastructure, and by restrictive trade practices; under-investment, caused by scarcity of credit, low farm prices, unfavourable or vacillating price policies, and unfavourable terms of trade between the rural and urban sectors.

The Sudano-Sahelian zones of Nigeria is characterized by persistent drought, wet and dry spells (Sawa, 2002), declining rainfall intensities and increasing the dry season (Ojonigu, 1990). Olaniran, (2002) summarized all these anomalies and confirm that there has been climate change in rainfall regions in the area. The combined effects of drought and increasing potential evaporation as recorded by Ayoade and Oyebande (1983), World Book (2001), Salama and Okafor (2003) put the water balance or budget on the deficit, which signifies scarcity. The per-capita domestic water consumption when computed on the increasing population of the region which has risen to about 33,039,886 (NPC, 2007) persons has already define an increasing domestic water demand in an established low water supply (Ndabula and Jidauna, 2010). The anticipated effects of climate changes on agriculture is what this study attempts to understand. The issue of climate change has come to stay. The IPCC report (2002) reveals that climatic variations have been the persistent decline in the rainfall in the Sudano-Sahelian region since 1960s. Moreover, drought and desertification has been on the increase. Suffice to say that the paper examined the effects of climate change with regard to the adaptive/ coping strategy of the farmers to the declining rainfall pattern which has in turn affected agriculture/ crop productivity. This trend has resulted to a perennial water scarcity in the region. The paper examined the effects of climate change, the coping strategy been adopted and the level of its intensity. This in turn

would aid the policy makers and Non-governmental Organization to articulate the plight of the local/rural dwellers in the Sudano-Sahelian region and perhaps bring succor to them.

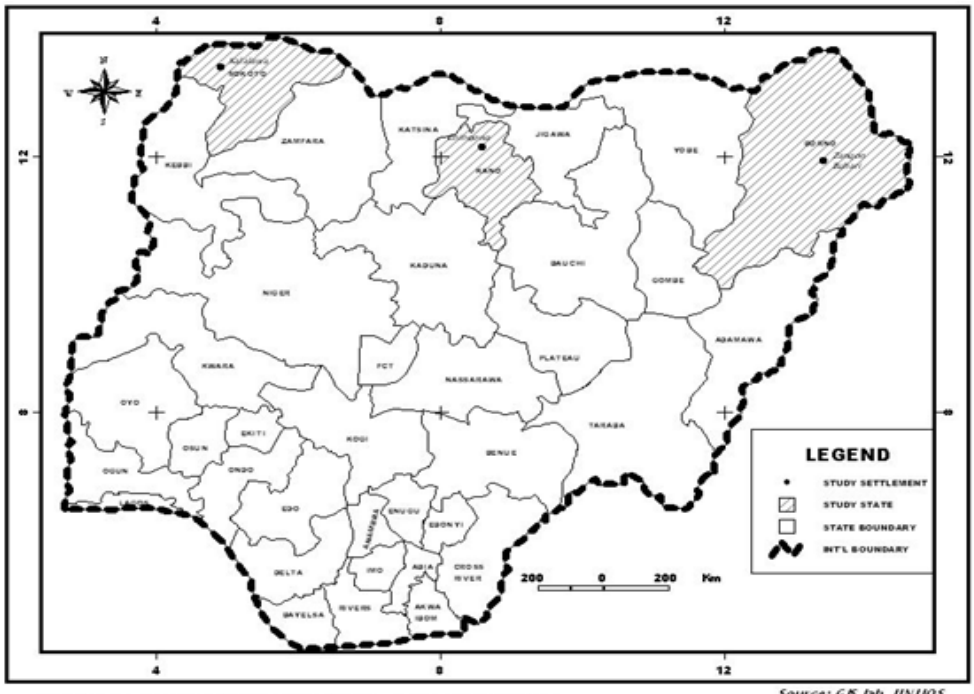


Fig.1: Nigeria Showing The Studied Locations Sampled

## MATERIALS AND METHODS

The Sudano-Sahelian region of Nigeria is roughly located on longitude $3^0$ and $15^0$ East and latitude $10^0$ and $14^0$ North. The temperature is high, except during the cold harmattan and rainy season. The average temperature in the hot season is about $40.6^0$C, while the annual rainfall is less than 75 cm. The rainy seasons are usually short, which is often within the ranges of four to five months. Owing to seasonal fluctuations, it could even drop to less than four months. Hence, evaportranspiration is usually high most especially in the hot season (Areola et-al 1992; Ayoade, 1988; and Desanker & Magardza, 2001). The Sudano-sahelian region spand roughly through Sokoto, Zamfara, Katsina, Kano, Jigawa, Yobe, and Borno States respectively (Fig. 1 & 2). The study adopted a survey design, which used a systematic sampling technique in choosing the settlement for the research. The reason is to cater for spatial representation for the region that lies within this belt. Hence, longitude and latitude were used in the selection of the three sample locations. The Settlements that were chosen are Kalalawa village (Long $5.024^1$ and lat $13.210^1$) in Kware Local Government Area (LGA) of Sokoto state; Zangon Buhari (long $8.550^1$ and lat $11.663^1$) in Bunkure LGA of Kano state; and Chingowa (long $12.888^1$ and lat $12.537^1$) in Magumeri LGA of Borno state. A well structured questionnaire was designed and administered along with Focus Group Discussion (FGD) in each of the selected sample location. In administering the questionnaire, in each of the villages /location, the area was grouped into five zones to cater for spatial representation and it was in the ratio of 10:1 each of the sub-zones

within the village to make it a total of 50 in each of the sample settlement. Moreover, three different sessions of FGD were held for the young, adults/household head and married women, and the aged in each of the sample locations. The descriptive and inferential statistical techniques were used in the analysis. The descriptive statistics included data summaries in the form of frequencies and percentages presented in tables, and graphs. The inferential statistics were used to examine whether there is a significant variation in the agricultural products (crops) in the region using Kruskal-Wallis ANOVA, and equally the quantity of fertilizer requirements and quantity of irrigated crops harvested using the Pearson Product Moment Correlation Co-efficient.

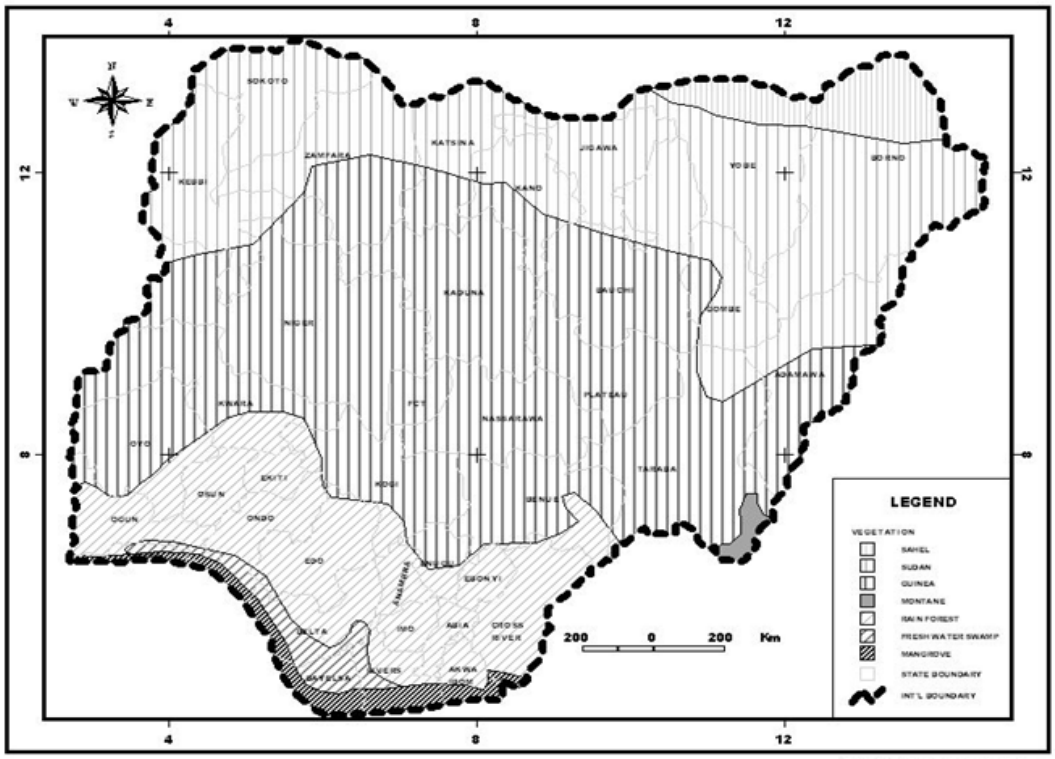


Fig.2: Vegetation Zones of Nigeria

## DISCUSSION

The first paragraph of the Copenhagen Accord declares a “strong political will to combat climate change in accordance with the principle of common but differentiated responsibilities and respective capabilities”. This statement reveals the inherent contradiction between what can be done in common at the top global level and the different realities at the bottom local level. (Hasan and Dwyer, 2010). Crop production like other form of agricultural practices in the region, is to a larger extent the most dominant form of agricultural productivity in Sub-Saharan Africa. Thus, crop production is predominantly dependent on rainfed, with exceptional condition/cases where Ponds, Rivers and Dams are available, irrigation practices often occur closer to these surface sources of water.

## Crop production

The region is favoured for the growing of the following agricultural produce as presented in table 1.

**Table 1. Agricultural produce per Fifty Household**

| Crops | Chingowa (%) | ZangonBuliani (%) | Kalalanwa (%) |
|---|---|---|---|
| Millet | 45 (32.4) | 47 (34.6) | 50 (32.5) |
| Sorghums | 9 (6.5) | 39 (28.7) | 50 (32.5) |
| Groundnuts | 24 (17.3) | 5 (3.7) | 6 (3.9) |
| Beans | 44 (31,7) | 15 (11.0) | 44 (28.6) |
| Rice | 0 (0) | 17 (12.5) | 1 (0.6) |
| Maize | 14 (10.1) | 13 (9-6) | 0 (0) |
| Vegetable | 3 (2.2) | 0 (0) | 3. 1.9) |
| **TOTAL** | **139 (100)** | **136 (100)** | **154 (100)** |

*Source: AMMA, 2008; & Jidauna, 2008.*

It is obviously clear that in the Sudano-Sahelian region of the Nigeria, millet appears to be the most stable crop grown (2.4%, 34.6% and 32.5%). While sorghum ranks highest in Zangun-Buliari and Kalalawa (28.7% & 32.5%), beans appears to dominate after millet in Chingowa (31.7%). Others like groundnuts, rice, maize and vegetable occur in variant proportion. Thus, there is a significant variation in the quantity of crops produced within the Sudano-Sahelian region of Nigeria ($\alpha$ 0.05 level of significance).

Land holding is usually small and equally fragments within and between the families. However, majority of the farmers (52%) owned the farms while a good number (35%) of them rent (fig 3). Most of the farmers that rent the farms land for cultivation either pays in cash or with the agricultural produce harvested from the farm land.

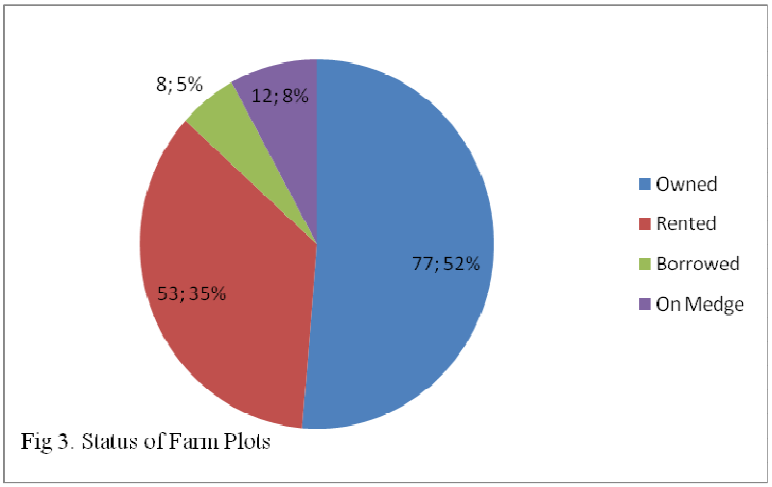


Fig 3. Status of Farm Plots

Moreover, other farms are either borrowed from families or individuals, while some are on pledge in which among some of the terms are stipulated by the parties involve. Most often, the owner of the farm can partner with either second or third-party in cultivating the farm (pledge).

**Evidences of climate change:**

The threats to the sustainability of the planet are the concern of every-one and meeting these threats is more than just doing the science, reducing waste and creating alternative sources of energies. Much of the progress may come from understanding the diverse needs, opinions and attitudes of people everywhere and having the leadership, political and public support to coordinate multiple solutions at global, national and local levels (Hassan and Dioyer, 2010). To this effect, most the farmers opined that there have been consistent changes in climatic elements over the past twenty years. There has in turn made it difficult for them to predict the rains and the commencement of the planting season. The rainfall patterns are summarized in table 2.

**Table 2. Local Perception on Rainfall pattern in the Sudano-Sahelian Region of Nigeria**

| Rainfall | Quantity | % | Duration | % | Mango | % | Intensity | % | Flood | % |
|---|---|---|---|---|---|---|---|---|---|---|
| Increase | 17 | 11.0 | 8 | 6.1 | 22 | 15.1 | 8 | 6.7 | 14 | 12.0 |
| Stable | 15 | 9.7 | 7 | 5.3 | 26 | 17.8 | 10 | 8.4 | 12 | 10.3 |
| Decrease | 121 | 28.6 | 111 | 84.7 | 74 | 50.7 | 92 | 77.3 | 86 | 73.5 |
| Don't know | 1 | 0.6 | 5 | 4.5 | 24 | 17.4 | 9 | 7.6 | 5 | 4.3 |
| **TOTAL** | **154** | **100** | **131** | **100** | **146** | **100** | **119** | **100** | **117** | **100** |

*Source: Field work, 2008.*

The quantity and duration of rainfall pattern experienced in the region has remarkably decreased (78.6% & 84.7%). The mango rains, which marks the early period of the rainy season has equally decreased (50.7%), while the intensity of the rains experienced in the rainy season has decrease too (77.3%). The rate of flood has decrease (75.5%), though there have been exceptions cases of occasional floods been witness after heavy down pour. It's part of the flooded water that produce stream flood.

The stream flow data are thus: Decrease (76.8%), increase (15.8%) and indifferent (7.4%). The stream flow augment as a source of water (surface) that is use for agricultural activities (irrigation), which has been decreasing (76.8%) in the past twenty years. To this effect the level of stream flow, time of annual recharge, time of cessation, and frequency of floods is affected.

The temperature condition has taken a different turn over the past twenty years as presented in table 3.

**Table 3. Local Perception on the Temperature Condition in the Sudano- Sahelian Region**

| Temperature | Dry Season | % | Rainy Season | % | Cold Season | % | Hot Season | % |
|---|---|---|---|---|---|---|---|---|
| Increase | 86 | 63.7 | 50 | 43.1 | 57 | 40.1 | 97 | 74.0 |
| Stable | 10 | 7.4 | 19 | 16.4 | 15 | 10.6 | 12 | 9.2 |
| Decrease | 34 | 25.2 | 41 | 35.3 | 69 | 48.6 | 19 | 14.5 |
| Don't know | 5 | 3.7 | 6 | 5.2 | 1 | 0.7 | 3 | 2.3 |
| **TOTAL** | **135** | **100** | **116** | **100** | **142** | **100** | **131** | **100** |

*Source: Field work, 2008.*

The temperature condition in the dry season has been on the increase (86%) over the years. Though, most of the farmers believe that the temperature condition in the rainy season has equally increased (43.1%), and others believe that it has decreased (35.3%). While the temperature condition in the cold season has decreased (48.6%) that of the hot season has been

on the increase (74.0%) in the past twenty years. Conway as cited in the Proceedings of the Governing Council High-Level Panel and Side Events (2010) explained two scenarios as a result of climate change. In one scenario, trends will begin to occur in certain parts of the world: it will become hotter, dryer, or wetter. These kinds of trends can be modeled mathematically, and the information can be passed on to farmers. This is currently being done in Burkina Faso, where farmers are being notified as to whether the first rains are going to be long or short, which enables the farmers to know if and when to plant their seed.

The changing pattern in both rainfall (rainy season) and temperature has directly affected the level and rate of agricultural activities vis-à-vis crop productivity in the Sudano-Sahelian region of Nigeria.

**The Effect of Climate Change on Crop Production.**

Owing to the changing pattern in rainfall and temperature condition in the region, local level of prediction by the farmers has been obscured by climate change. Thus, the period of inception/ commencement of the rainy season to the time of cessation are very obscure.

To these effect, most farmers in the region now depended on fertilizer to boost their crop production (table 4).

**Table 4. The Estimated Quantity Fertilizer Requirements for Crop Grown Per Fifty Household Head in the Sudano-Sahelian Region**

| Crops | Fertilizer (kg) | Quantity (kg) |
|---|---|---|
| Tomatoes | 40,250 | 277,225 |
| Onions | 1,400 | 101,640 |
| Maize | 650 | 67,500 |
| Sugar | 1,700 | 16,881 |
| Pepper | 250 | 1,368 |
| Groundnuts | 50 | 500 |
| Water melon | 100 | 50 |
| Rice | 350 | 100,000 |

*Field Work, 2008*

Most of the farmers produce different varieties of crops. Though, most of the crops: sugar cane, maize, groundnuts, water melon, and rice are produced largely through rainfed. Tomatoes, onions, peppers and atimes maize are produced through irrigation. As a measure in coping with climate variability, fertilizers are often used to supplement; that's both crop growth and maximum productivity.

Irrigation crop estimate (out-put) of tomatoes (ranks highest) which is about 277,225 kg is grown or will require about 40,250 kg of fertilizer while 101,640kg of onions will require about 1,400kg of fertilizer, and 67,500kg.

Other food crops have little requirements for fertilizer amongst which are groundnuts, water melons and rice respectively. Thus, the level of harvest is a function of the quantity of fertilizer applied in the irrigated farms by the farmers. There is a significant relationship between quantity

of crop harvested and the quantity of fertilizer used (α 0.01 level of significance using a two tailed test), with a co-efficient of determination at 99.9% which is a very strong relationship.

The consistent decline in the rains has impacted negatively to the farmers (Especially those in Zangon Buhari and Kalalawa) where most of the surface water sources no longer hold up water through the dry seasons to augment for irrigation farming. Most of the farmers make use of Rivers and Boreholes (40.3% & 23.1%) as their major source of water for irrigation, while those close to Dams (21.6%) utilize it too for the same purpose (Fig 4).

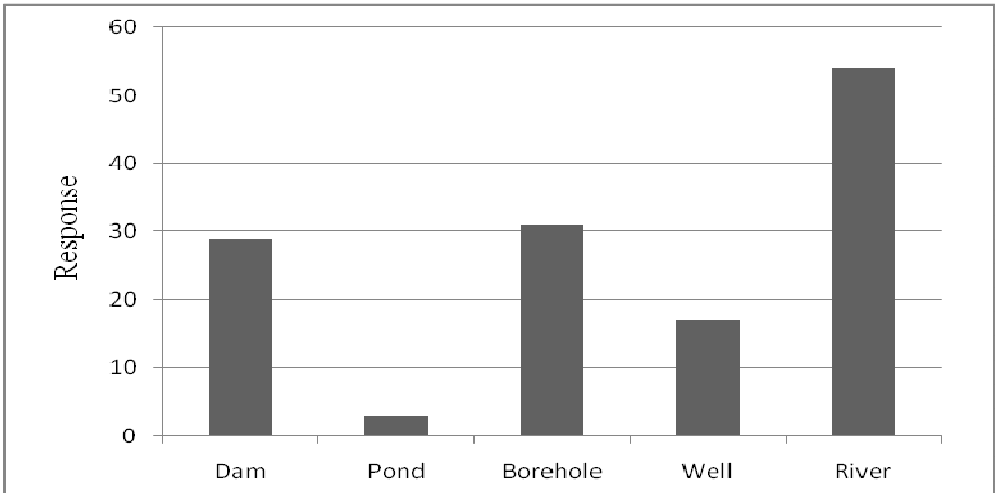


**Fig 4. Irrigation water Sources**

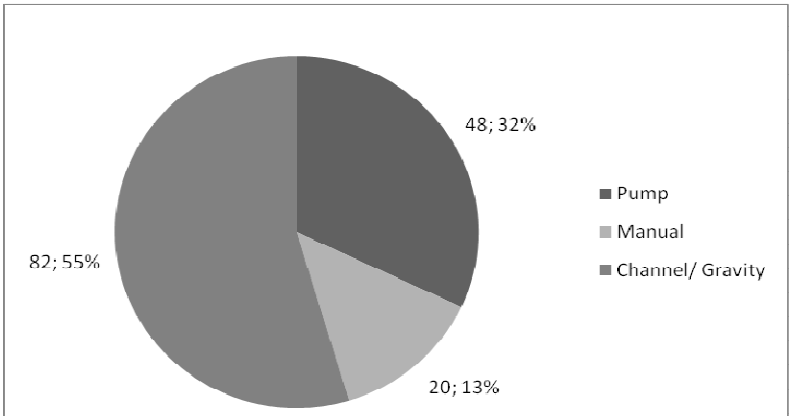


Fig 5. Irrigation Technique

Others sources of water like that of ponds and wells are equally access for irrigation purpose by the farmers. Water scarcity is the main source of vulnerability in most dry areas. Water availability is typically measured in terms of actual renewable water resources (ARWR) per capita, which is declining in most dry regions. The Middle East and North Africa (MENA)

region is the world's most water-scarce region with ARWR of 1,100 m3 per capita, compared with 8,000 m3 in sub-Saharan Africa and 2,700 m3 in South Asia. As populations grow, ARWR in the region is projected to fall to 550 m3 per capita in 2050 (Governing Council High-Level Panel and Side Events, 2010).

The farmers adopts the channeling and gravity method (54%) as a technique for irrigating their farm lands, while others make use of pumps and manual system (sprinkler) respectively (fig 5)

Most farmers admitted that despite improvement in their farming method/techniques, there have been consistent decline in quantity of crop harvest which they attributed to weeds, pest, water shortage, fertilizer shortages and heat. For instance, in Kalalawa, the aged group in one of the sessions held for FGD admitted that nomad in time past from Niger crossed to their communities to graze their flocks, such can neither be seen or said in present times. Moreover, that at some twenty years ago, most of their ponds, river, and wells use to hold water almost to the next rainy season. However, such is not the case as it was a common resolve by most farmers. This is because, there have been consistent drop/ decline in the size (acre) of farm land been cultivated by farmers. In some instances like in Chingowa, and Kalalawa, some of the farmers abandoned their farmlands and resort to other profession amongst which are trading, crafts, commercial motor cycling, shoe mending and tailoring. For instance, most of the youths migrates South-ward in search of better fortune in the cities.

In severe instances like in Kalalawa, they admitted that in worst cases, some families often migrates south-ward in search of better lands or to places/ locations that hold up better opportunities.

Considering that the food produce hardly sustained the family to the next harvest and coupled with decline in crop yield, most families have to cut down the ratio of their daily meals. A mist this that people are forced to sale-off their animals, trade-off their belongings, and eventually migrate (in extreme conditions).

## CONCLUSION

In this paper, I articulate through examples why I believe that high-level global meetings and accords will inevitably fall short of expectations because of the inherent contradictions. This is because the global climate change debate tends to adopt a top-button approach rather than a button-top approach. The worst heat and most vulnerable are the rural dwellers/ farmers in the least developed and developing countries of the world (Sub-Saharan Africa: Saheliian region). To this effect, Farmers are investing in sustainable land management. They need to be listened to, and sound policies need to be provided. Also, the challenge is complex and it is essential that we build up and strengthen our institutional governance systems. Farmers' education is the key to managing natural resources and achieving food security a-mist global climate change. Owing to these, their views should not be discarded, and their plight properly articulated into the global climate debate. While I believe that spatial variation exist in perception of the severity impact at a local level, however, when collated and harmonize, a pro-active and a way forward will be achieve at a global level.

This paper discovered that the farmers and the rural dwellers in the Sudano-Sahelian region of Nigeria are aware of the problems posed by climate change to agriculture, and even to a greater extent pointed out the areas of manifestation (evidences) and the general effect posed to their survival. Thus, they believe that improve farming systems/ practices, planting of trees, sinking of boreholes/ water facilities, Government assistance, and prayers to God are the only way forward. While it is believe that coping strategies employed by households vary spatially and temporally (Cogel, 1995), the severity of the impact of climate change on agricultures is real and the issues should not be reduced to either biannual or annual colloquium that produces volume of reports that end-up on book shelves.

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