



Shift in Crop Production as an Adaptation Strategy to Climate Change by Grain Farmers in Goronyo Local Government Area of Sokoto State, Nigeria

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Abstract

This study examined shifts in crop production as an adaptation strategy to climate change among grain farmers in Goronyo Local Government Area of Sokoto State. Rainfall and temperature data for 30 years were sourced from the Nigerian Metrological Services (NIMET) Oshodi, Lagos and used for this study. Farmers' perception and adaptation strategies to climate change were obtained by means of structured questionnaire administered to 385 sampled grain farmers. Purposeful sampling technique was used in the selection of the respondents. The results were summarized by means of frequencies and percentages and presented in tabular forms and pie charts. The study revealed that millet is the most cultivated crop in the study area. The farmers shifted from sorghum to millet production basically because of the late onset of the rains and frequent agricultural drought in the study area which millet can cope with. Millet yields very well compared to sorghum and maize. It requires little effort to cultivate; better adapted than sorghum and maize to dry, infertile soils, with poor water-holding capacity, high temperature, low and erratic precipitation. Farmers' perceptions of climate change issues are in line with the analysed weather records for the area. The study recommends that since the annual rainfall totals favour the cultivation of millet, the research institutes should produce better adapted varieties of millet and government should subsidize the seeds to the farmers.

Keywords: *Adaptation strategies; Climate Change; Goronyo; Grain farmers; Shift in crop production.*

1.0 INTRODUCTION

In Nigeria agriculture is the main source of food, a major source of industrial raw materials and foreign exchange, and employs about 60 percent of the population. It is dominantly rain-fed and is therefore particularly vulnerable to climate change, Federal Ministry of Environment (FME 2013). Agriculture is perhaps

the most sensitive to climate change related issues of all human economic activities. Changes in the world's climate will bring major shifts in food production. In spite of recent technological and scientific advancements, weather remains a key variable in agricultural production. Weather and climate affect agriculture and determine the

adequacy of food supplies. Climate determines whether or not rain-fed agriculture will be successfully cultivated in a given area. All stages of agricultural production from land clearing and preparation, through crop planting, growth and management to harvesting, transportation, storage, and marketing of agricultural products are subject to the influence of weather and climate. Weather and climate act both as resources and constraints to agricultural production. The resource value of weather has to be optimized while the hazards posed by weather have to be managed for optimum yield realization, Ayoade (2002). It is common knowledge that farmers in Sub-Saharan Africa, including Nigeria are struggling to cope with the current climate variability, Chakeredza *et al* (2009).

Adaptation is the adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in process, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate. It is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities, IPCC (2007). Societies have a long record of managing the impacts of weather and climate-related events. A wide array of adaptation options is available, but more extensive adaptation than is currently occurring is required to reduce vulnerability to climate change in the future.

IPCC report (2007) stated that adaptation will be necessary to address impacts resulting from the warming which is already unavoidable due to past emissions. Adaptation is necessary because setting limits on emissions will not be enough, or happen soon enough, to avoid all impacts of climate change. Adaptation is imperative because the world climate is changing and will continue to change, at rates unprecedented in recent human

history. It is expected that the climate will continue to change as a result of both natural climatic variation and human activities, Scheraga and Grammsch (1998). Therefore, while there is uncertainty about future climatic changes, failure to invest in adaptation may leave a nation poorly prepared to cope with adverse changes and increase the probability of severe consequences, Smith and Lenhart (1996).

A possible farmer adaptation to climate change is to switch varieties or crops to something better suited to the new climates they face. A farmer, currently growing maize might switch to a faster-maturing maize variety if drought becomes more common, or might choose to grow a potentially more drought-tolerant crop like sorghum. In the case of switching varieties, climate change suggests two primary adaptation alternatives, the choice of which depends on whether moisture or heat is expected to be limiting. In low-rainfall areas where moisture stress is expected to remain a primary constraint on plant growth, a promising adaptation might be to plant faster-maturing varieties that avoid drought or heat stress during sensitive stages of plant growth, such as flowering or grain filling. Developing faster-maturing varieties for areas with short and variably rainy seasons is a common goal of many breeding programs, and such a strategy would seem promising anywhere climate change is expected to shorten growing seasons, Odjugo (2010). Beyond shifting among varieties, farmers could also switch what crops they grow as the climate changes. As with choice of variety, farmers' choices about what crops to grow depend only partly on climate, and year-to-year crop choice decisions are likely dictated much more by expected prices at harvest than by climate concerns. For instance, farmers in Goronyo readily shift focus between Sorghum, millet, maize and other crops depending on the climatic variation and the market signals. It is on this premise that a paucity of shift in crop production as an adaptation strategy among grain farmers in Goronyo was carried out.

2.0 MATERIALS AND METHODS

2.10 Study Area

Goronyo is a local government area (LGA) in Sokoto state, Nigeria. It is located along Latitude $13^{\circ} 27'$ North and Longitude $05^{\circ} 40'E$ (see Fig. 1). Its headquarters is at Goronyo, on the bank of the Sokoto River. It has an area of 1, 704km². Goronyo is in the dry Sahel, surrounded by sandy savanna and isolated hills. The rainy season lasts from June to October. The annual rainfall is between 500mm in the north and 800mm to the south and an annual average temperature of 28.3°C, on the whole, it is a very hot area. However, maximum daytime temperatures are

for most of the year generally under 40°C and the dryness makes the heat bearable. The hottest months are March and April when daytime temperatures can exceed 45°C. The area's lifeline for growing crops is the floodplains of the Goronyo dam system which are covered with rich alluvial soil, Sani (2005).

Goronyo is essentially an agricultural area with traditional mode of production predominating with more than 90 percent of the population engaged in subsistence farming. The main crops produced in the local government area are millet, guinea corn, maize, rice, beans etc.

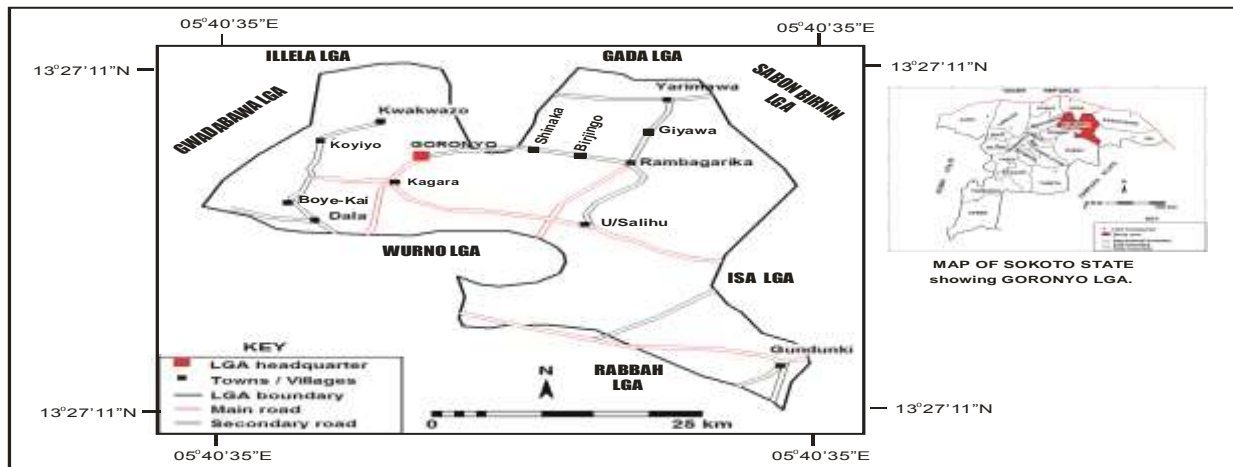


FIG. 3.1: GORONYO LGA SHOWING TOWNS / VILLAGES
Source: Modified from Administrative Map of Sokoto State, 2008

Figure 1. Map of Goronyo Local Government, Sokoto state.

2.11 METHODOLOGY

Daily rainfall and temperature records of Goronyo from 1981-2010 and Goronyo's grain farmers' perception and adaptation to climate change were used. The grain farmers' perception helped to understand the sensitivity of farmers to the changing climate and their adaptive strategies to it. The daily rainfall and temperature records for the stated period were obtained from the Sokoto Rima Basin Development Authority rainfall reading office, Goronyo and the Nigerian Meteorological Agency (NIMET), Oshodi, Lagos. Farmers' perception and adaptation strategies to climate change were obtained by means of structured questionnaire.

The respondents for the questionnaire were the grain (sorghum, millet and maize) farmers in the eleven wards in Goronyo LGA. The number of questionnaire used was based on the population of the study area. To determine the sample size for this study, the Krejcie and Morgan's (1970) method of determining sample size was adopted which states that, for an area with a population between 75, 000 - 999, 999, the sample size to be used is 382. Since the population of the study area is 182, 296 by the 2006 census, which falls between these ranges, the sample size of 382 is in order. However, 385 respondents were used to have equal representation in each ward. Purposeful sampling technique was used get the target population while simple random sampling

was used to administer the questionnaire among the eleven wards of the LGA. Purposeful sampling, according to Bernard (2002) “is the deliberate choice of an informant due to the quality the informant possesses.” The 385 questionnaires were shared equal to the population of each ward, but due to the non-availability of population figures for each ward from the 1991 and 2006 census results, the questionnaires were distributed equally among the eleven wards, with 35 questionnaires in each ward. For the purpose of administering the questionnaire, grain farmers older than 30 years of age and who must have lived for at least 20 years within the study area

were identified through the “*Sarkin Noma*” (Head of the Farmers) and the village Heads. This was done by asking the farmers of their age and how long they have lived in the area. Thereafter, the questionnaires were issued. The reason for this decision is that those within this age bracket have the information needed about climate change. The researcher was assisted by field assistants. To present the various agricultural adaptive strategies used by the farmers to cope with climate change, frequency and percentage analysis was used. The data was summarized and presented in Tables and Charts.

3.0 RESULTS AND DISCUSSIONS

3.1 Variation in grain production in Goronyo

Table 1: Ranking of Grains Produced

S/N	Popular crop	1981 – 1991 (%)	Ranking	1990 – 2012 (%)	Ranking
a)	Millet	28	2	89	1
b)	Maize	17	3	05	2
c)	Sorghum	50	1	2.5	4
d)	Others	5	4	3.5	3
Total		100		100	

Source: Field survey, August 2012.

The grain farmers ranked their favourite grains produced between 1981 - 1990 and 1991 – 2012. From 1981 – 1990, sorghum was ranked number one (50%) followed by millet (28%), while from 1991 – 2012, millet became the farmers favourite grain. Most of the farmers practiced mixed cropping. Maize is mainly cultivated as an irrigated crop along the Goronyo dam area of the study area.

3.2 Farmers’ Reasons for the shift in crops production in Goronyo

Late onset of rains and frequent agricultural drought are the main reasons among others why grain farmers shift from sorghum which use to rank number one crop in 1981 – 1990 to millet which is now ranked number one (See Table 2).

Table 2: Reasons for the Shift in Crops.

Reasons	Percentage (%)
late onset of rains	66
Early cessation of rain	23
Frequent agricultural drought	53
Introduction of short duration crops	36
Shorter growing season	23

Source: Field work 2012.

3.3 Reasons for shifting to millet production

On why the sampled farmers preferred cultivating millet to cultivating sorghum and maize in Goronyo, Fig.2 shows that a large number of the farmers 27% cultivate millet because of its high yield compared to sorghum and maize. 24%

cultivate millet because it is drought resistant, 23% cultivate millet for its economic and domestic value over sorghum and maize, 25% cultivate millet because it requires little effort and maintenance, while only 1% cultivate millet for other personal reasons.

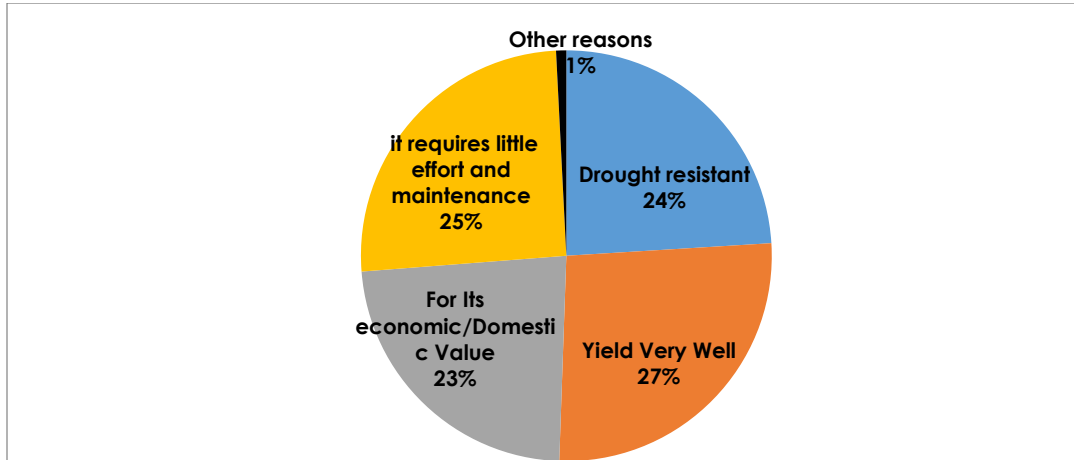


Figure 2. Farmers’ Reasons for cultivating Millet, Source: Field survey, August 2012.

3.4 Farmers’ Duration of Cultivating Millet

Farming experience increases the probability of uptake of all adaptation options because experienced farmers have better knowledge and information on changes in climatic conditions,

crop and livestock management practices Nhemachena and Hassan (2007). Table 3 presents the grain farmers’ duration of cultivating millet in Goronyo.

Table 3: Farmers’ Duration of Cultivating Millet

S/N	Duration	Number of Respondents	Percentage (%)
a)	1 -5 years	19	05
	6 – 10 years	36	9.4
b)	11 – 15 years	81	21.2
c)	16 – 20 years	88	23
d)	20 years and above	159	41.4
	Total	382	100

Source: Field survey, August 2012.

3.5 Changing Pattern of Yield

Table 4 presents the farmers’ response on the changing pattern of yield in millet production in Goronyo.

Table 4: Change in Annual Harvest

S/ N	Condition	Number of Respondents	Percentage (%)
a)	Decreasing	150	39
b)	Increasing	208	54.5
c)	Remains same	24	6.3
	Total	382	100

Source: Field survey, August 2012.

Table 4 reveals that, a good number of farmers 55% stated that their annual harvest is increasing; 39% stated that annual harvest is decreasing; while only 6.3 percent stated that their annual harvest remains the same year in, year out. The respondents were able to give reasons for the increase in the yield of grains as shown in figure

2. 69% stated that the adoption of choice adaptation strategies are responsible for the high yield of grains in Goronyo; 21% observed high rainfall amount to be responsible for the increase in yield; 7% ticked the high temperature as a reason for the high grain yield, 3% ticked other reasons as shown in Figure 3.

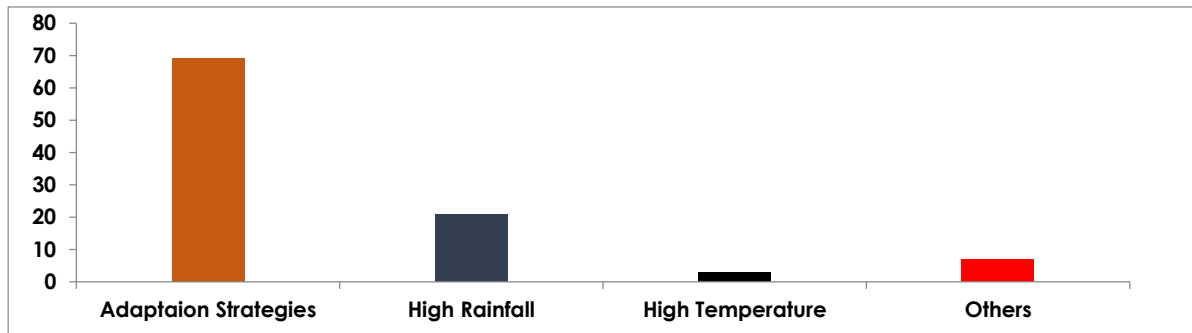


Figure 3. Farmers' Reasons for Increase in Grain Yield, Source: Field survey, August 2012.

3.6 Other Adaptation Strategies to Climate Change by grain farmers in Goronyo

It is no doubt that adaptation strategies can reduce the impacts of climate change and increase benefits. As shown in Figure 4, crop rotation,

mixed cropping, use of improved seed varieties, shifting cultivation, access to water for irrigation, use of organic and inorganic fertilizer, access to credit loan are the other adaptation strategies to climate change adopted by farmers in Goronyo.

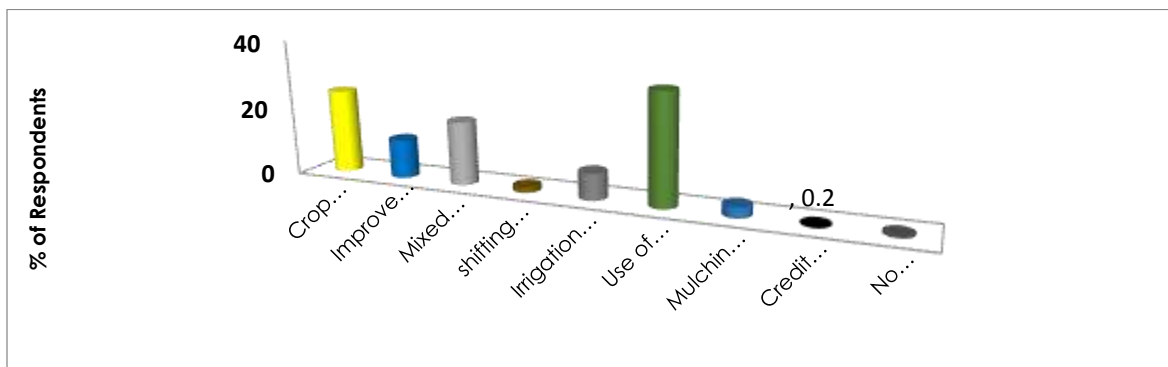


Fig. 4: Farmers' Strategies to Adapting to Climate Change in Grain Production Source: Field survey, August 2012.

3.7 Farmers' Challenges to Climate Change Adaptation

Institutional factors often considered in the literature to influence adoption of new adaptive strategies are access to information via extension services, access to improved varieties of grain seeds, access to loan credit. Agricultural extension enhances the efficiency of making adoption decisions. In the world of less than-perfect information, the introduction of new technologies creates a demand for information useful in deciding on adopting new strategies, Wozniak (1984). In this study 65% of the respondents cited lack of current knowledge on adaptation methods as the main constraint to climate change adaptation strategies. Also, in the specific case of climate change adaptation

strategies, access to climate information may increase the likelihood of uptake of adaptation techniques.

The major perceived challenges to adaptation by the grain farmers in the study area are: Lack of current knowledge on adaptation methods, lack of access to water for irrigation, inadequate information on weather incidence, lack of improved seeds varieties and lack of credit facilities. Wealth is believed to reflect past achievements of farmers and their ability to bear risks. Thus, farmers with higher income and greater assets are in better position to adopt new farming technologies, Caviglia-Harris (2002).

4.0 CONCLUSION

The study revealed that millet is the most cultivated grain crop in Goronyo. Millet is better adapted than sorghum and maize to dry, infertile soils, high temperature, low and erratic precipitation and poor water-holding capacity.

Grain farmers shifted from sorghum production to millet basically because of the late onset of rains and frequent agricultural drought. 41.4% of the grain farmers have been cultivating millet for over 20 years. It was reported that the annual yield of millet is increasing because of the adaptation measures adopted by the farmers.

Other adaptation strategies of farmers in Goronyo are; Crop rotation (e.g., from maize to millet and sorghum, a more heat-tolerant crop); mixed cropping; use of improved seed varieties, shifting cultivation, intensification of irrigation or fadama farming and use of organic and inorganic manure among others. The study also showed that a decrease in rainfall is likely to push farmers to delay their planting dates. Factors that enhances the farmers' adaptive capacity to climate change includes: the farmers' farming experience, the farmers' ability to perceive changes to weather and climate indices, access to credit loan, low rainfall for grain production and high temperature.

5.0 RECOMMENDATIONS

Following the findings made in the study within the 30 years covered, the following recommendations are made:

1. Since the annual rainfall totals favours the cultivation of millet, grain farmers should focus more on millet cultivation so as to maximize millet yield in the area.
2. Increasing farmers' access to climate change information and extension services is of great need in Goronyo. Extension services should provide useful information about weather and climate and viable adaptive strategies to climate change issues.

3. Grain farmers should adopt improved seed varieties and should practice mixed cropping, crop rotation and shifting cultivation as other adaptation measures so as to maximize the available land and the climatic condition that favours their cultivation.
4. Government policies should therefore, ensure that farmers have access to affordable credit to increase their ability and flexibility to change production strategies in response to the forecasted climate conditions. Because access to climate information, improved seed varieties, chemical fertilizer and water for irrigation increases the resilience of farmers to climate variability.

5. The Goronyo dam project should be completed by the Government and opened up for farmers' use as most of the farming activities in the study

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