

Review Paper

Climate Change, Population Pressure and Agricultural Livelihoods in the West African Sahel (Special Reference to Northern Nigeria): A Review

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Abstract

Climate change is recognized presently as one of the most potential threats to man and his environment. This is particularly the case in developing countries because they are least equipped to adapt to the phenomenon and the risks associated with it. It has adversely affected agricultural productivity in Africa. The West African Sahel which includes the extremes of northern Nigeria has proven vulnerable to the impacts of climate change due to its already known history of climatic vagaries and variability's. This paper did a desk discussion through a review of literature appraising the impact of current climatic variability and change on agricultural livelihoods in West African Sahel zeroing in on northern Nigeria. The paper recognized climate change as attributable to natural climate cycle and human activities. It observed that the West African Sahel has shown various changes especially in terms of rainfall, of which inter-annual variability is very high. It has witnessed increases in temperature and increased dry spells. These have had significant negative consequences for the poor resource farmers whose incomes and livelihood depend on rain-fed agriculture; thus jeopardizing their livelihood. Adding to this scenario is the high rate of population increases which exacerbates pressure on the already stressed land-resource environment. It is therefore recommended and advocated among others that besides the need for the intensification of efforts by development players in the region to diversify livelihood portfolios of poor rural farmers, that quality and lively efforts be made towards integrating indigenous knowledge and practices into formal climate change mitigation and adaptation strategies.

Keywords: Climate change, Agricultural livelihoods, West African Sahel.

INTRODUCTION

Climate change is recognized presently as one of the most serious environmental threats to man on the earth. It is seen as instigated by natural climate cycle and human activities (anthropogenic factors). Climate change is generally referred to as global warming which its major causes are anthropogenic, that is, the emission and increasing concentration of greenhouse gases (GHGs) in the atmosphere caused by human activities. Oxfam

(2011) stresses the need for recognition that climate change impacts will vary across different locations and at different times into the future, as soil types, topography and other factors vary across the region. It is recognized that the people who will bear the brunt of climate change are the poor from global South (including Africa) because they are least equipped to adapt to the phenomenon and the risks associated with it (Bunce, Rosendo, and Bronw,

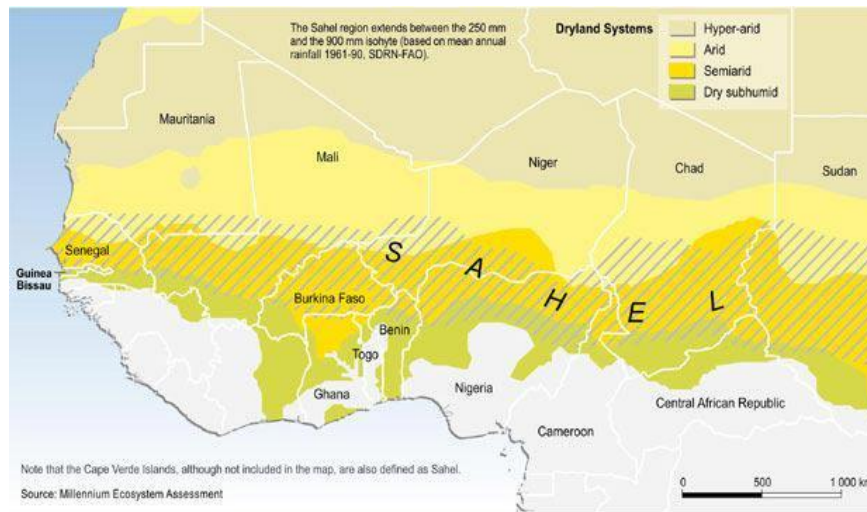


Fig 1. Map of West Africa, showing the 'Sahel', a semi-Arid region on the 'shores' of the Sahara

2010). Africa is acclaimed to be the most vulnerable continent to climate change because of its tropical location (3/4 of Africa is Tropical); dependence on climate change-sensitive Agriculture and finally socio-economic gaps in governance, government financing, high rates of poverty and growing population which all expose the region to high vulnerability to climate change (Garcia, 2008). Worse still the African Sahel (the West African Sahel), owing to its fragile ecosystem and climate vagaries still stands at a higher risk of climate change impact.

According to Dube *et al.*, while some studies have been conducted at individual country levels about the projected and recorded impact of climate change, they have tended to examine commercial farmers and to neglect small holder farmers, yet Pricope *et al.*, has shown that the bulk of climate change impact is likely to be felt by smallholder farmers who lack the requisite means for adaptation. It is equally argued that much debate on climate changes places more emphasis on the industrialists, the politicians, bureaucrats, with little attention to small holder rural farmer whose cumulative actions can either directly or indirectly make such policies to succeed or to fail. In the West African Sahel, more than 50% of the population constitute smallholder farmers and agriculture contributes in the range of between 35% and 60% of the national economic output measured in terms of the Gross Domestic Product.

The region has been identified as one of the most vulnerable regions to climate change due to its proximity to equator, its already high temperatures and low rainfall, the high reliance of local population on rain fed agriculture, high population density and low adaptive capacity (Mohammed, 2011). Agriculture in the region has suffered from a variety of factors which include the pressure of growing population on available land

resources and diminishing soil fertility (Dube *et al.*, 2016). These factors in combination with climate change are projected to have dire consequences on agricultural production and livelihoods in general. This paper therefore appraises the impact of climate variability and change on agricultural livelihoods in West African Sahel (which includes part of Northern Nigeria) as part of an intellectual discourse and as part of an awareness campaign among various stakeholders to forestall any sort of lackadaisical attitude to this all important and vexed issue of climate change and so retreat its negative impacts on agricultural livelihoods of our most vulnerable population, the small holder farming population of the Sahel. The rest of this discourse is broken for convenience along the following lines;

- 1). Composition and climatic characterization of West African Sahel.
- 2). Climate variability and change.
- 3). Climate change impacts on Agricultural livelihoods.
- 4). General perspectives on Adaptation and Mitigation strategies.

COMPOSITION AND CLIMATIC CHARACTERIZATION OF WEST AFRICAN OF SAHEL

The name "Sahel" is derived from the Arabic word Sahil and means "border of the desert". The Sahel covers nine countries close to the Sahara desert. These include Burkina Faso, Mali, Guinea Bissau, Mauritania, Niger, Chad, Cape Verde, Senegal and the Gambia. (Fig.1) The region borders the Sahara desert to the north. The West African Sahel region is a semi-arid area that runs from the Atlantic Ocean eastward to Chad, separating the Sahara Desert to the north and Sudanian Savannah to

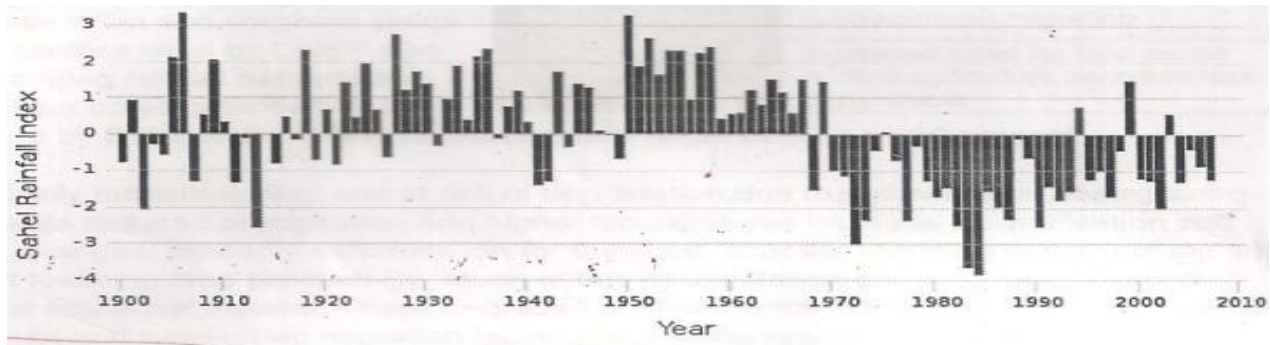


Figure 2. Sahel precipitation anomalies, 1900-2010

the south. It has a total area of 5.4 million km² and a population of almost 60 million. Its vegetation is primarily composed of savannah typical bushes, grasses and trees with increasing density from north to south, representing the change from semi-arid grasslands to thorny Savannah (Sissoko *et al.*, 2011, Dube *et al.*, 2016, USAID, 2017). The region is one of the poorest and most environmentally degraded in the world, and is considered one of the world's most vulnerable regions to climate change (USAID, 2017).

The Sahel has a hot, semi-arid climate characterized by very high temperature year-round; long, intense dry season from Oct–May; and a brief, irregular rainy season linked to the West African Monsoon. Mean temperature range 21.9 – 36.4°C, with substantially cooler temperatures in the mountainous regions on northern Chad, Niger and Mali and coastal zone of Mauritania. Mean annual rain varies from year to year and decade to decade, but generally is lower in the north (100 – 200mm) than in the south (500 – 600mm) and is limited to the summer months of June – September. The length of the rainy season ranges from one to two months in the north and four to five months in the south. In the winter (November – March), the dry dust-Laden Harmatan trade winds blow from the northeast to the southwest, these induce desert-like weather condition (ie low or very little cloud cover, no rainfall) and can produce severe dust/sandstorms (USAID 2017). Prolonged dry season (up to 10 months annually) with high evaporation rates rotate with short rainy seasons, but regularity is not assured (Sissoko *et al.*, 2011).

CLIMATE VARIABILITY AND CHANGE

The climate trends in the Sahel region are in line with the rest of West Africa where rainfall data shows a marked decline of precipitation from 1960s (Dube *et al.*, 2016). This implies that the region has encountered more droughts since the 1960s and 1990s. Sissoko *et al.*, (2011) estimate that between that 1960s and 1990, there was a decline of between 20% and 40% in precipitation in the region. This led to a re-classification of some regions

in the area from semi-arid to arid from sub-humid to semi-arid. This can be considered as the most dramatic example of worldwide multi-decadal climate variability (Diallo, 2000; Hume 2001). According to USAID, (2017) in the 1970s and 1980s, the region experienced the most dramatic drought observed in the 20th century, with a 30% decrease in rainfall, initially attributed to human mismanagement of land resources but present studies strongly show that ocean warming and air pollution from human activities played a major role in the drying of the Sahel. Although the Sahel has seen a recovery in rainfall since the 1980s, cumulative precipitation has not returned to the pre 1960s levels and certain characteristics have changed: rainfall events appears to be less frequent and have a shorter duration with greater intensity (Held, 2016, Nickolson 2013, FAO 2008). Fig 2 above shows Sahel precipitation anomalies from 1900 – 2010 as adapted from USAID 2017.

Sahel precipitation was above the long-term mean from 1915 through the late 1930s and during the 1950s – 1960s, after which it was persistently below the long-term mean, with the largest negative anomalies in the early 1980s. Equally USAID (2017) made a summary of historic climate trends and projected climate changes in West African Sahel as presented below.

HISTORICAL CLIMATE

Historic climate trends include:

- 1). Average temperature increases of 0.6°–0.8°C between 1970 and 2010 – slightly higher than the global average.
- 2). Increase in number of warm days/nights and decreased number of cold days/nights.
- 3). Overall reduction in cumulative rainfall. From 2000–2009, average rainfall was below average in Burkina Faso by 15%, in Chad by 13%, in Mali by 12%, and in Niger by 8%.
- 4). Lengthening of the dry season.
- 5). Growing climate divide between Eastern (Niger, Chad) and Western Sahel (Burkina Faso, Mali, Mauritania)

with less rainfall in the west.

6). Increase in frequency and severity of extreme rainfall events and flooding.

FUTURE CLIMATE

Projected climate changes include:

- 1). 3° to 6°C rise in average temperatures by 2100, with +3°C in the coastal areas (Mauritania) and +4°C in Continental Sahel (Mali, Chad, Burkina Faso, Niger).
- 2). Maximum warming affects summer months (June–September) and min. Temperatures
- 3). Uncertain precipitation projections due to high inter-annual variation, but inter-annual and spatial variability are expected to increase.
- 4). Reduced duration of rainy season, with increased extreme rainfall events in the south.
- 5). Decrease in frequency of days and nights that are considered 'cold'; in much of the region 'cold' nights will not occur at all by the 2090s.
- 6). Sea level rise in Mauritania of up to 14.4cm by 2050 and 40cm by 2100".

The sum is that there has been visible changes in climate as evidenced by increases in temperature over the years, decreasing cumulative rainfall, lengthening of dry season with more sustained changes in the future as projections show which will of course have far reaching implications on agricultural land resources in the region and the corollary of ethnic conflicts over the remaining scarce agricultural resources.

CLIMATE CHANGE IMPACT ON AGRICULTURAL LIVELIHOODS

In this paper, we shall be limiting our discussion of impacts on agricultural livelihoods on crop and livestock production.

Crop Production: Agriculture in the Sahel is extensive, poorly mechanized and almost entirely reliant on the limited three to four months of variable summer rainfall (June – September), making it highly vulnerable to climate variability and change. Annual rainfall levels and their regional and temporal distribution have far-reaching impacts on water availability and quality, on crop yield and production and thus on food security at household and national level. Changes in precipitation directly influence the risk of drought-related crop failure (Sissoko *et al.*, 2011). In dry years, the region faces serious challenges related to food security and must rely on grain purchases and food aid to meet requirements. Agriculture contributes 40% of the combined regional GDP and employs more than 70% of the labour force in Niger, Burkina, Mali and Chad and 52% in Mauritania. Farming

is practiced down to the 350mm rain belt, while pastoralism provides the principal livelihood below this threshold. Landlocked countries (Burkina Faso, Chad, Mali and Niger) are major cereal producers that export to neighbouring countries, Staple dry land crops include millet, sorghum, and cowpea, while cotton and groundnut are major cash crops (Del Rio, 2014, FAO, 2005, FAO,, 2013, USAID, 2017)

Soils in the region are generally nutrient-limited, Overuse of land for agricultural purposes-Overgrazing, and continuous cropping have left the soils fragile and infertile with very low levels of organic matter. For Hilhorst and Muchena (2000) and Gachimbi *et al.*, (2005), the main cause of soil degradation is soil mining ie removal of soil nutrients without replenishment. Land cover changes, primarily deforestation for firewood, alter the water content of the soil, increasing water stress and lowering crop productivity while reduced precipitation and higher temperatures increase desertification and sand intrusion. Added to all these is rapid population growth (average 3% per year) which further increases the need for food production thereby imposing additional stress on limited available land. Temperature increases higher than 2oc are projected to decrease millet and sorghum yields by 15 – 25 percent by 2080. It is also shown that because of changing rainfall patterns and degraded land, Chad and Niger could potentially lose their entire rain fed agriculture and more variable rainfall patterns will likely alter the distribution and timing of crop diseases and pests. For example, a hotter, wetter environment increases the risk of diseases from mildew, leaf spot, bacterial stem and root rot, while aphids, borers, bollworm, beetles and white fly thrive in a hotter, drier environment (FAO 2013, UNEP, 2011).

Many parts of northern Nigeria especially the border towns in Sokoto, Zamfara, Katsina, Kano and Borno fall within the dry Sahel zone of West Africa and so equally experiences all the climate variability's and change already enunciated for the rest of the West African Sahel. Evidence of climate change has been reported in Nigeria by diverse authors and researchers. Odegogo (2009) observed that the areas experiencing double rainfall Maxima (Savanna) is shifting Southward while the short dry season (August Break) is being experienced more in July as against normal occurrence in the month of August prior to the 1970s; also in the North-east Nigeria, the number of rain days had dropped by 53% while erratic rainfall pattern and increasing temperature has been reported in Katsina, Maiduguri, Kano, Sokoto and Nguru. In fact Nigeria Television Authority (NTA, 2010) weather forecast reported that for the first time in the history of Nigeria, Maiduguri, the capital city of Borno State had a temperature of 47oc. All these have resulted to increase in drought evapotranspiration and to decline in water tables or total dry up of some rivers and lakes especially lake Chad with continuous extinction of forest and biodiversity (Adefolalu, 2007). It is reported that the

surface area of Lake Chad had shrunk from 25,000 square kilometres in the 1960s to 4,800 square kilometres in 2014. The effects of these strange climate events are drastic reduction in agricultural productivity of the small holder farm households resulting in livelihood degradation and associated consequences of poverty, hunger and conflict arising from competition for depreciated land resources.

It is reported low farming yields, of food and cash crops such as millets, guinea corn cowpea and sorghum. This invariably translates to low income capacity in the sale of crops and the economic power in these areas. Local inhabitants and farmers are quite aware and conscious of climatic change effects on their communities as desertification/encroachment, dryness of streams, wind erosion, extreme climate conditions, low yield of crops and migration of youths to cities and border towns (Okunola and Ikuomola, 2010). Climate change has also caused reduction of arable lands cultivation as desert encroachment with its associated sand dunes is depriving farmers of their agricultural farmlands and grazing rangelands. Moreover the frequent droughts and lesser rains have started shortening the growing season thereby causing crop failure and food shortages.

It has been noted that drought and desert encroachment due to climate change have led to ecological destabilization in the semi-arid region of northern Nigeria. It is reported by UNEP (2005b) that satellite images show that the lake Chad which is a continuation of boundaries of many countries including Nigeria has shrunk considerably over the past 30 years and is now 5% of its former size due to persistent low rainfall in the region. The reducing of Lake Chad is also blamed on the increasing use of the inland rivers flowing into it by farmers for irrigation and domestic purposes. In this part of the region as already mentioned, streams, surface water, borehole and wells go dry. The consequences of all this on agricultural livelihood is drastic and has violently exacerbated the incidence of poverty as a result of poor agriculture yield and consequent dramatic rise in staple food prices.

In a food affordability survey in Nigeria carried out by FAO (2005), it was observed that the northern states which fell in the Sahelian environment as Zamfara, Sokoto, Borno, and Kano among others were worst hit and the proportion of those who had been unable to afford food 'almost every month' between January and December 2005 was on the increase (Okunola and Ikuomola, 2010). Corroborating further, Sissoko *et al.*, (2011) maintain that for a large part of the population in sub-Saharan West Africa, subsistence farming is the main activity on which its livelihood depends. The arid and semi-arid regions are among the harshest and most vulnerable production environment in the world, less and/or more variable precipitation, high temperatures would threaten crop production and yield and lead to decrease in food availability as it is today.

Livestock Production

Livestock production is a major contributor to the rural livelihoods in West African Sahel. It accounts for about 35% of gross domestic product (GDP) and supplies about 30% of the revenue in the agriculture sector. It provides the major source of employment for the majority of the people and by far the most important source of revenue (Sissoko *et al.*, 2011). Goat, camel, sheep and cattle herding is an integral part of Sahelian livelihoods (e.g. for employment, meat and milk production, a source of credit, savings and dowry payments). Livestock herding contributes up to 10 – 15 percent of GDP in Burkina Faso, Chad, Mali and Niger and an even larger share in Mauritania where 50 percent of the population is pastoralist.

Drought is a major constraint to livestock production in the West African Sahel affecting it through reduced herbage production and water scarcity which often leads to high herd mortality (Hiernous *et al.*, 2009, Sissoko *et al.*, 2011, USAID 2017). Furthermore USAID (2017), maintain that changes in temperature, rainfall and the occurrence of droughts and floods all negatively affect forage and fodder production, water availability and livestock productivity. For example, higher temperatures reduce feed intake and lead to energy deficits and decreased milk production, fertility, fitness and longevity while drought can reduce calving rates from the normal 60 – 70 percent to 25 – 30 percent.

Historically, pastoralist maximized productivity by migrating herds south during the dry season (October to June) and north during the wet season, thereby exploiting grazing and water imbalances. However, erratic rainfall and ongoing drought have forced pastoralists to alter traditional migratory corridors in search of new seasonal watering holes and rangelands leading to conflicts. While farmer and pastoralists historically worked together effectively (with pastoralists benefiting from grazing of crop residue and farmers benefiting from manure droppings), increased competition and conflicts is now an issue of concern between the Sahel's farming and pastoralist communities as land degradation and competition over water and land resources (grazing versus crop cultivation) increases (IUCN 2011, USAID, 2014).

The IPCC fifth assessment report, reports that the vulnerability of livestock keeping communities may be amplified as climate change interacts with other stressors of the livestock sector such as rangeland degradation, increased variability in access to water, fragmentation of grazing areas, in-migration of non-pastoralists into grazing areas among others (Niang, *et al.*, 2014).

GENERAL PERSPECTIVES ON ADAPTATION AND MITIGATION STRATEGIES

Adaptation strategies that are already in use by farmers refer to measures that mitigate negative impacts, such as adoption of specific varieties of crops to cope with Sahelian conditions, and/or diversification of agricultural production to reduce the risk of losses. The Sahelian population is known to be highly resilient. This is because changes and variations in climate and other environmental factors have always been part of their lives, forcing farmers to adopt specific production strategies e.g. the choice of specific crops/crop varieties and/or variety of mixture adapted to the erratic Sahelian condition and/or diversification of cropping systems to reduce and spread risks (de ridder *et al.*, 2003). Irrespective of this high resilience of the Sahelian population adaptive capacity is low and investment will have to be made to reduce the negative impacts of climate change. A community's capacity to adapt to climate change and the associated risks depends on its economic resources, geographic location, available technologies and information, infrastructures, institutions and networks (FAO 2007).

Generally, poor infrastructures and weak institutions inhibit adaptive capacity and planning of a community. The locals in northern Nigeria especially the Sahel region have exhibited various behaviours to cope with climate change realities. Livelihood has been diversified to embrace more trading activities, artisanry, okada riding, and migration to towns. Education is equally more emphasized and embraced by the youths so as to have opportunity for employment in the civil service and politics as farming because of its continuous nose-diving in yields is no longer viewed as a viable sustainable livelihood strategy.

Deviant survival strategies as smuggling, stealing and prostitution have also been on the increase. Farmers have equally increasingly embraced the use of fertilizers, insecticides and irrigation practice and Fulani herdsmen are now on continuous migration throughout the year in search of water holes and rangeland unlike before when they migrated in the middle of the dry season and after harvest (Okunola and Ikuomola 2010). Odugbo (2009) equally noted that climate change has led the farmers to a shift in crops cultivated in northern Nigeria. The preferred crops grown are guinea corn followed by groundnut and maize, but due to increasing temperature and decreasing rainfall amount and duration occasioned by climate change, the farmers as a means of adaptation have shifted to the production of millet followed by maize and beans. It is equally reported that government's response to the issue of climate change in this region has not been strong comprehensive and determined enough to create a sustainable impact in reversing its negative effects yet according to Bello *et al.*, (2012) holistic approaches on climate change are required to stem its tide.

Adaptation strategies are fundamental to reduce the risk of primary production failure, to diversify the sources

of food and livelihoods and to create a buffer against future food and livelihood stress. In order to stabilize and improve livelihoods, as well as responding to the critical impacts of climate change, a number of measures can be initiated and/or developed. Among the possible adaptation measures are identification of drought tolerant crop varieties, irrigation and water management. An operational agro-meteorological information system can provide farmers with advice and warning during the planning phase and the growing season (Roncoli *et al.*, 2003; Konate, 2004). At regional and national level, policies need to concentrate on food security and economic growth. National decision-makers have to develop food aid policies to support vulnerable population, including programs for food crisis prevention and management (Sissoko 2011). In terms of economic development, priority needs to be given to adaptation and implementation of comprehensive programs on mainly water management and irrigation, desertification control, development of alternative sources of energy and the promotion of sustainable agricultural practices by farmers (Toulmin 2005, Brooks *et al.*, 2005). Policies at the national level should contribute to achieving food security for the majority of the population, regulate and manage water resources and address the issue of energy security and increase the contributions of agriculture to national GDP.

CONCLUSION AND RECOMMENDATIONS

This paper did a synthesis from literature on the impact of climate change on agricultural livelihoods in the West African Sahel. It finds out that the West African Sahel is one of the most vulnerable regions to the negative effects of climate change in the world. This is due to its already known harsh environment, extreme climate vagaries and variability's, stressed by a fast-growing population and consequently increasing pressure on the scarce natural resources.

It has witnessed increases in temperature, increased dry spells, and variations in rainfall quantities and distribution which if allowed to continue will further exacerbate environment degradation, thereby degrading agricultural livelihoods more and so accelerating poverty and underdevelopment. This calls for an urgent implementation of mitigation and Adaptation strategies in the region. It is recommended that development players in the region should intensify efforts to diversify the livelihood portfolios of poor rural farmers who suffer and will suffer the most from climatic changes (Dube *et al.*, 2016).

Concerning the Sahelian region of Nigeria it is specifically stressed among others that the private sectors and Nigeria government should drive the agricultural sector through consistent policies, holistic national adaptation strategy, proper funding and

infrastructure development in order to survive the effects of climate change.

Better-equipped weather stations to prevent weather-related disasters through early warning and effective response/adaptation system should be established; drought resistant and short duration high yielding crops should be developed and made available to farmers and also improved animal husbandry including improved brood stock traits, health and feeds should be provided to farmers. Equally, education, information and training of farmers to adapt to climate change by changing their farm practices to avoid the negative effects of climate change should be encouraged while equally there should be integration of indigenous knowledge and practices into formal climate change mitigation and adaptation strategies (Bello et al 2012). Confronting the challenges posed by climate change is imperative to avoid falling victim to its present and projected effects on the agricultural livelihoods in the West African Sahel.

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