SMALLHOLDER FARMER'S ADAPTATION STRATEGIES TO DROUGHT IN THE SAHELIAN ZONE OF JIGAWA STATE, NIGERIA

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Abstract

This study was conducted to understand the rural farming community's perception of drought, examine the socio-economic and environmental impacts of droughts and to identify and examine the drought coping mechanisms in place by individual households in the area. The study was based on primary and secondary data collected from 1000 farming household's survey. The data was analysed using IBM SPSS version 20. The results indicate that there was massive failure in terms of crop yield; lack of food and hence less preference or choice due to its scarcity. Loss of employment and reduction in income of the households are the economic challenges of drought and are perceived to a very high extent. The other social impacts which were also perceived to very high extent include population migration in search of employment and better living conditions, poor health condition; schooling of children and food security, malnutrition and conflicts over scarce water resources among others. The environmental impacts such as increase in average atmospheric temperature, pasture and forest degradation, deterioration of water quality, damage to fish and wild life habitat and ground water depletion were perceived by farmers to high and very high extent. The main adaptation strategies to drought which the farmers employed include: planting drought resistant variety of crops, cross- ridging, irrigation practices, delay farm clearance, application of fertilizer/manure, planting of more trees in the farm, early sowing, and changing of crop calendar among others. Despite the farmers' experience, commitments to droughts and farming as well as their familiarity with various adaptation and mitigation measures, this was not good enough to curb the menace of drought in the study area. Still, there is need to incorporate modern farming techniques especially in the aspect of irrigation and land holding size, use of machines, improved seeds as well as government intervention in terms of farming incentives and innovation diffusion among farmers.

Key words: *Sahel, Drought impacts, Drought adaptation, Smallholder Farmers, Environment.*

Introduction

Drought is ranked as the number one natural hazard with greatest negative impact on human livelihood. According to Carvajal (2007) in the human development report, the 2000-2006 periods saw that percentage of droughts have had an increasing tendency in Africa and Asia as well as Europe. Impact of drought on agriculture depends on the state of crops, the duration and amount of water storage during certain effect (Mokhtari, 2005). Drought is an insidious natural hazard which, by nature, developed slowly, and frequently occupying very vast areas and persisting for lengthy periods. It is inevitable part of climate, and it can strike any region in the world, even the humid areas (Kandji *et al*, 2007). Much of the available literature suggests that the overall impacts of climate change on agriculture especially in the tropics have been highly negative (Maddison *et al;* 2007 as cited in Rao *et al,* 2007). The United Nations Convention to Combat Desertification (Part 1, Article 1, 1994) defines drought as "a naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems". Thus, drought is a creeping phenomenon, characterized by extended periods with rainfall far below average, prolonged periods of dryness, high temperatures, high evapotranspiration demand, very low humidity, and reduced stream flow and reservoir water levels (and in some cases completely dried-up water sources) (Mortimore, 1989). Three major types of drought are generally recognized. These are meteorological drought, agricultural drought and hydrological drought (Olofin, 2014). Meteorological drought occurs when there is a prolonged absence or deficiency or poor distribution of precipitation. Agricultural drought is said to occur when moisture is not sufficiently available at the right time to meet the evapotranspiration demand of crops, vegetation, pastures and other agricultural systems. Hydrological drought occurs when groundwater recharge has declined to such an extent that the water table continues to fall. It is obvious that the three types of drought are characterized by a situation of water deficit (Abaje *et al*, 2012).

Thus, Nigeria features wide-ranging ecological zones, but drought is a phenomenon that affects the country as a whole. The degree of vulnerability however differs, with the dry sub-humid and semi-arid regions in the north, usually referred to as the Sudano-Sahelian zone (which includes the Northern Guinea Savanna), being more vulnerable to drought than the more humid regions in the south. These regions already have low levels of biological productivity, organic matter and aggregate stability. Their vegetation and plant cover are relatively sparse, and soils are relatively more susceptible to accelerated erosion by water and wind. People at risk and at loss in the Sudano-Sahelian region are more than 40 million living within about 25% of the total landmass of Nigeria, constantly under drought and soil erosion threats (Olofin, 2014). Drought and associated famine had occurred in Nigeria in 1883, 1903/1905, 1913/1915, 1923/1924, 1 942/l 944, 1954/l956, 1972/1973, 1982/l983. The major droughts, which are regional and have been established statistically to have a 30-year cycle, are known to have occurred in 1883/1885, 1913/1915, 1942/1944. These 30-year cycle droughts are usually regional and cover the entire Sahel and Sudan climatic belts. The 10-

year cycle droughts are usually localized, even in areas lying along the same latitude (Oladipo, 1993).

The underlying cause of most droughts can be related to changing weather patterns manifested through the excessive buildup of heat on the earth's surface, meteorological changes which result in a reduction of rainfall, and reduced cloud cover, all of which results in greater evaporation rates. The resultant effects of drought are exacerbated by human activities such as deforestation, overgrazing and poor cropping methods, which reduce water retention of the soil, and improper soil conservation techniques, which lead to soil degradation (Yamusa *et al*, 2011). Causes of drought in Jigawa state and its environments are related to climate variability and non-availability of surface water resources. In northern Nigeria, the Sahel Zone of Jigawa State in particular, drought can be attributed to failure of the rain- bearing monsoon winds from the Atlantic Ocean to penetrate enough into the region (Oladipo, 1993). The immediate cause of a rainfall shortage may be due to one or more factors including absence of moisture in the atmosphere or large-scale downward movement of air within the atmosphere which suppresses rainfall. Changes in such factors involve changes, regional and global weather and climate. While it may be possible to indicate the immediate cause of a drought in a particular location, it often is not possible to identify an underlying cause.

These studies are to understand the rural farming community's perception of drought, examine the socio-economic and environmental impacts of droughts and to identify and examine the drought coping mechanisms in place by individual households in the area.

Materials and Methods

The Study Area

The Sahelian zone of Jigawa State occupies almost one-third of the total land area of the state (North-East of Jigawa State). It comprises ten local government areas; Maigatari, Gumel, Gagarawa, Auyo, Kaugama, Hadejia, Guri, Kiri-kasamma, Birniwa and MallamMadori local government areas. The climate is semi-arid characterized by long dry season and short wet season with average annual rainfall of about 500 mm (Abaje *et al*, 2012a&b) which falls between May and September. The north-east parts of the study area have been drained by river Hadejia which gives opportunity for irrigation. The study area is covered by regosols and brown soils, ferruginous tropical soils which are heavily weathered and markedly laterized (Oladipo 1993a; FRN, 2000) and the vegetation is Sahel Savanna type. The study area has about 1.5 Million people, and about 80% of households derive their income from farming, including animal husbandry (Sanusi, 2013). Figure 1. Shows the Map of Jigawa State with study area in Pink Colour.

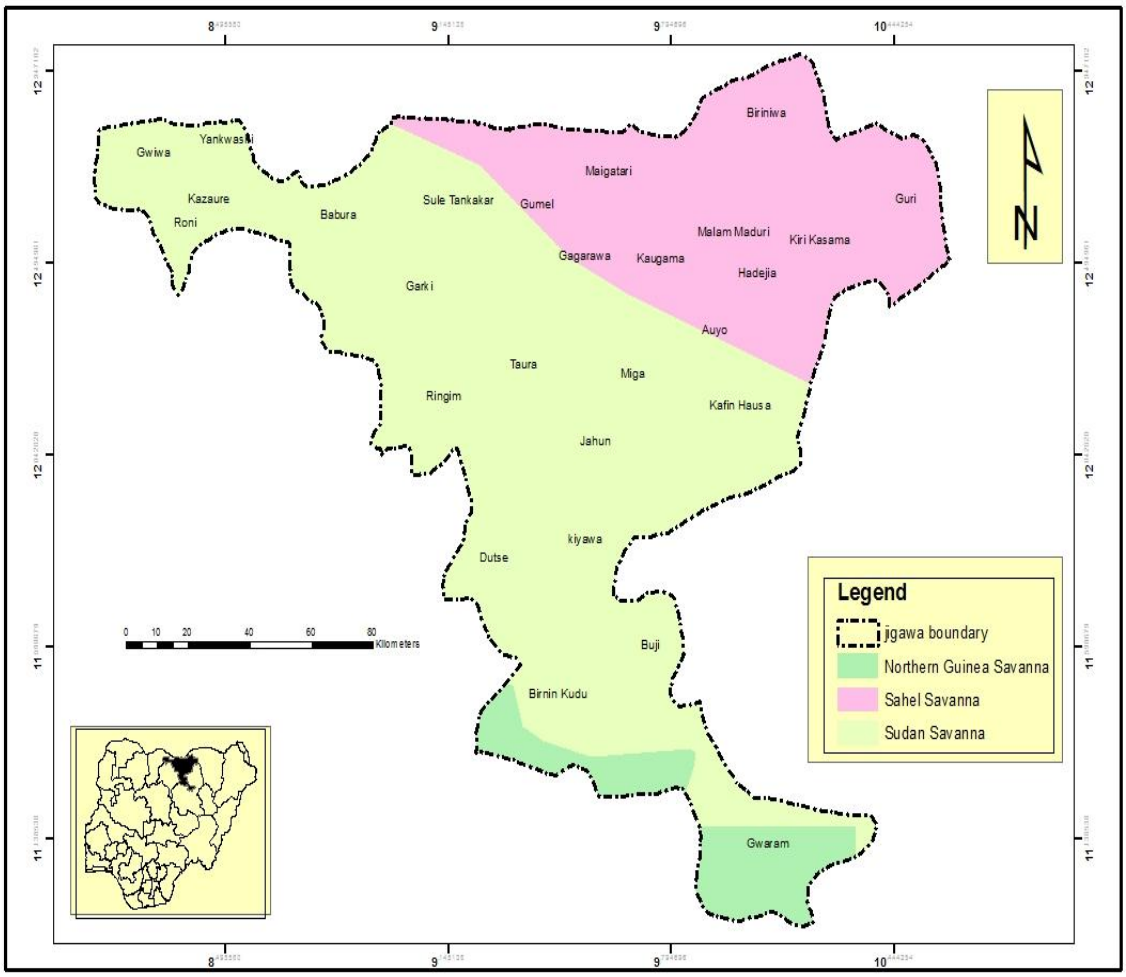


Figure: 1 Map of Jigawa State, Showing the Study Area in Pink Colour.
Source: Field Survey, 2015

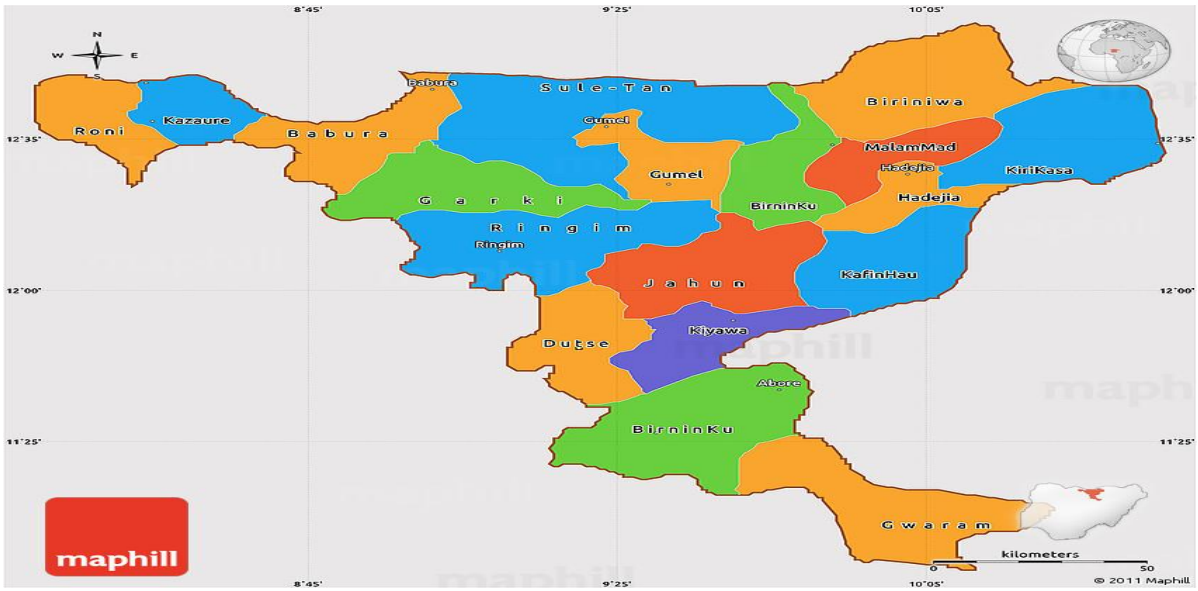


Figure 2: Map of Jigawa State Showing local governments boundary
Source: Adapted and modified from Maphill, 2011

The methods for data collection include; sampling of the respondents, questionnaire administration, interview, and reconnaissance survey and field observations.

Table 1 shows that the study area comprises ten local government areas of Jigawa state, which make up the Sahel zone. However, to take sample of the study, each local government has a number of wards, so in each local government wards under that local government are listed alphabetically and all the odd number wards are selected systematically to ensure good geographical representation across the study area. This is because the study area is quite large. Questionnaires are administered proportional to the population of each ward, but due to the non-availability of population figures for each ward from the 1991 to 2006 census results, the questionnaires were administered uniformly among the selected wards, with twenty (20) questionnaires in each ward. However, purposive sampling was adopted with help of village heads or any person in charge of that ward to identify farmers who have a lot of experience with drought incidences and traditional coping methods to administer the questionnaire. Purposive sampling, according to Bernard (2002) "is the deliberate choice of an informant due to the quality the informant possesses." Farmers above 30 years in the area, and stay for 20 years and above were the target population. The reason for this is that those within the age bracket will have the information needed about drought adaptation and indigenous coping methods. 1000 questionnaire were administered.

Table: 1 List of Wards Visited for the Study

	LGAs and Wards visited	Questionnaire Distributed	Questionnaire retrieved
1.	**AUYO**		
1	Auyakayi	20	19
2	Auyan	20	16
3	Gamafoi	20	17
4	Gatafa	20	15
5	Tsidir	20	19
2.	**BIRNIWA**		
1	Batu	20	17
2	Dangwaleri	20	18
3	Kachallari	20	17
4	Kazura	20	18
5	Nguwa	20	16
3.	**GAGARAWA**		
1	G.Chiroma	20	20
2	Gagarawa	20	18
3	Madaka	20	18
4	Maikilili	20	17
5	Yalawa	20	20
4.	**GUMEL**		
1	Baikarya	20	19
2	Dantanoma	20	18
3	G.Gambo	20	20
4	Gusau	20	19
5	K.Arewa	20	18
6	Zango	20	20
5.	**GURI**		
1	Lafiya	20	17
2	Abunabo	20	18
3	Dawa	20	16
4	Guri	20	18
5	M.Baba	20	19

	LGAs and Wards visited	Questionnaire Distributed	Questionnaire retrieved
6.	**HADEJIA**		
1	Atafi	20	19
2	Gagulmari	20	17
3	K.Kofa	20	18
4	Matsaro	20	16
5	S.Garu	20	19
6	Yayari	20	18
7.	**KAUGAMA**		
1	Arbus	20	18
2	Dabuwaran	20	18
3	Hadin	20	20
4	Jarkasa	20	20
5	U.Jibrin	20	17
6	Yalo	20	20
8.	**KIRIKA SAMMA**		
1	Baturiya	20	19
2	Doleri	20	18
3	Gayin	20	16
4	Madaci	20	17
5	Tarbus	20	19
6	Tasheguwa	20	18
9.	**MAIGATARI**		
1	Dankumbo	20	20
2	Galadi	20	20
3	Kukayasku	20	19
4	M.Arewa	20	20
5	Matoya	20	20
10.	**MALAM MADORI**		
1	Arki	20	18
2	F.Akurya	20	17
3	M.B Musa	20	20
4	M.Madori	20	19
5	Tagwaro	20	19
6	Tonikutara	20	14

Source: Field Survey, 2015

The interview and questionnaire administration has specific schedule mostly in the evening when the respondents are back from farm. The head of the ward gather the appropriate

respondents in one place, after the formal introduction we sat together have a conversation and later administer the question to them. Those that can read and understand the questionnaire they fill the questionnaire themselves and ask questions where necessary. Those that cannot read and understand the questionnaire interpret the questionnaire and administer it to them in Hausa and enter their responses on the spot.

Analysis of Data

Sorting and stacking of retrieved questionnaires according to local government areas. The questionnaires are coded with set of numbers and grouped into themes for further analysis. The codes of each questionnaire are entered into excel spread sheet one by one, later the data transferred into SPSS software version 20 to run the analysis. Chi square test and cross tabulations are used to show variation in term of responses between various local governments of the study area. Responses to open ended questions were coded under similar answers with coding 1 for "affirmative responses" and 2 for "no answer or responses" to speed up data entry into SPSS: only the affirmative responses are expressed in percent and the general household's characteristics. Chi-square tests were used to assess farmer's perceptions of various drought impacts, coping/adaptive strategies practiced to mitigate the effects of drought.

Results and Discussions

Demographic characteristics of the respondents

Table 2 shows that 67.7 percent (677 farmers) are at the age of 30-39 years; 20.3 percent (203 farmers) are within the age range of 40-49 years; 12.0 percent (120 farmers) are within the age range of 50 years and above years. Gbetibouo (2009) and Adesina *et al* (1995) observed that there is no consensus in the literature as to the exact effect of age in drought adaptation. On one hand, age may have a negative effect on the decision to adopt new farming technologies, simply because older farmers may be more risk-averse and therefore, less likely to be flexible than younger farmers. On the other hand, age may have positive effect on the decision of the farmer to adopt because older farmers may have more experience in farming and therefore, better able to assess the features of a new farming technology than the younger ones. In relation to gender, this study finding shows that 91.3% of the households were males while only about 8.7% were females. This indicates that male households dominates agricultural sector in the study area (Table 2). Asfaw *et al* (2004) noted that households headed by males have a high probability of getting information about new adaptation methods and farming technologies, and also undertake risky ventures than female households. A similar observation was made by Tange *et al* (2004) who points out that female household are less likely to adopt soil and water conservation practice measures since woman may have restricted access to information, land and other resources due to traditional societal barriers. Nonetheless, Nhemachena *et al* (2007) have contrary belief to the finding of this study. They argued that female headed households are more likely to adopt different methods of drought adaptation than male headed households. Education in general, the results shows that 91.8% of the respondents were literate, who has between 18 and above years of

formal education and remaining 8.2% had no formal education. The implication of these is that, there is high level of literacy among rural youths in the study area. This would contribute to their innovativeness and adoption of various farm adaptation techniques as well as influence the agricultural information. However, this finding was supported by Norris and Batie (1987) who argued that farmers with more education are more likely to have enhanced access to technological information than poorly educated farmers. Furthermore, Igoden et al (1990) and Lin (1991) observed a positive relationship between household education level and adaptation of new innovations. As such, farmers with better education are likely to perceive drought and adapt to it.

Table: 2. Socio-Demographic Characteristics of the Respondents.

		Frequency	Percent	Cumulative Percent
Age	30-39	677	67.7	67.7
	40-49	203	20.3	88.0
	50 and above	120	12.0	100.0
Gender	Male	913	91.3	91.3
	Female	87	8.7	100.0
Marital Status	Single	278	27.8	27.8
	Married	722	72.2	100.0
Duration in the Area	20-29 years	500	50.0	50.0
	30-39 years	282	28.2	78.2
	40-49 years	118	11.8	90.0
	50 and above years	100	10.0	100.0

Source: Field Survey, 2015

Farmers' Perceptions of Various Socio-Economic Impacts of Drought

Drought has negative impacts on the socio-economic activities of farmers or population in general, which include: mass starvation, famine and cessation of economic activities, especially where rain-fed agriculture is the main stay of the economy. It causes human migration and environmental refugees, deadly conflict over scarce resources, destruction of habitats and loss of biodiversity, poverty and climatic instability (Yamusa *et al,* 2013). In line with above facts, several farmers of various local governments in the area disclosed their perceptions on various socio-economic impacts of drought in the study area and to them in particular.

Figure 1 described the variability that exists between farmers in the various local governments in the area indicating that those local governments with access to river are less affected with drought impacts than those with no access to river. In terms of food scarcity the impacts are felt more in Gumel 60.40%, MalamMadori 60.10%, Maigatari 56.80%,

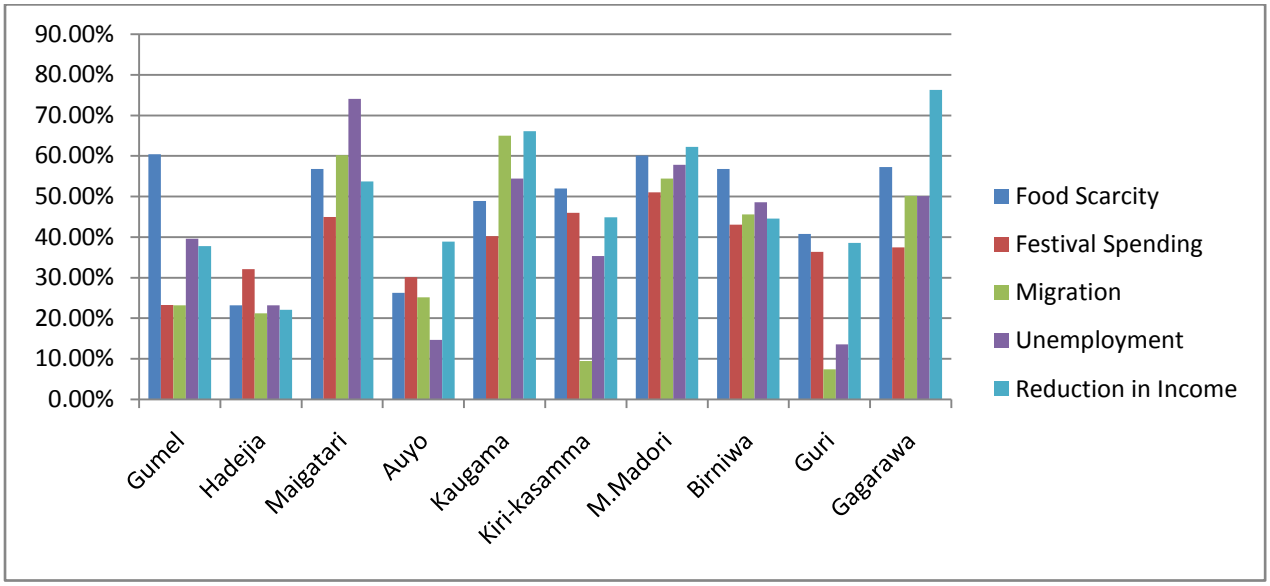
Gagarawa 57.30% and Birniwa 56.80% were the local governments that most affect by food scarcity, this is because they are rainfed farmers they only cultivate during dry season, while Auyo 26..30% and Hadejia 23.20% give lower figures in terms of food scarcity this is due to the fact that these local government are drained by river Hadejia which give them opportunity to cultivate all year round, that is why the impacts of food scarcity are felt less in Hadejia and Auyo local governments compared to other local governments with no access to river.

However, in terms of unemployment, the impact also differs between local governments. Therefore, Malam Madori 57% and Kaugama 54 % of the respondents disclosed that there is unemployment in their various areas. This is because as they disclosed they only cultivate land during dry season, a period of four to five months, after that they stay redundant. In Guri 13%, auyo 14%, and Hadejia 23.20% were disclosed by the respondents as the level of unemployment. In other words the rate of unemployment in Guri Hadejia and Auyo is negligible, this is due to the fact that people tend to cultivate all year round due to their access to the river and fishing is taking place all year round which generate employment to the farmers.

Consequently, people tend to move out in search for employment and better living conditions. The Sahelian zone of Jigawa state is not in exception in such types of temporary migration. There were differences between and among local governments in the area in terms of migration spatially. Even though temporally, the migration tends to be after harvesting period for all the towns in the study area. However, those in the wetter part of the study area migrate less compared to the local government with no access to river in the area. Therefore, as this study find out that towns of the drier part of the area such as Maigatari 60.2% and Kaugama 65.0% tend to migrate more in search of employment and better living condition and send remittances to their family. The case is also the same in Gumel, Birniwa and Gagarawa which make up the drier part of the study area. However, the case is different in the wetter part of the study area, the rate of migration is very less only in Auyo about 25.2 % and Hadejia 21.2% of the respondents attested that they went on migration for employment. The rest of the local governments give lower figures in terms of migration Guri 7.4%, Kiri-Kasamma 9.5%.

Drought has a relationship with festival directly or indirectly in the study area. Farmers sell their farm produce for wedding and other traditional festivals as such in bad years where there was low farm output people tend to reduce their spending for them to catch up. Therefore, about 56.1% of respondents from Malam Madori answered that droughts make them to reduce their spending during wedding and festivals, but the case is different in Gumel only 23.3% of respondents indicated that drought make them to reduce their spending during festivals. Maigatari 45.2%, Kiri-Kasamma 45.9% and Kaugama 40.2% of the households indicated that they reduced their spending on festival during drought years.

Figure 1: Perceived Socio-Economic Impacts of Drought based on local governments



Source: Field Survey, 2015

Furthermore, 76.0% of Gagarawa farmers answered that drought has reduced their income; while 66.1% of Kaugama local government farmers answered that drought reduced their earning, while 53.7% of Maigatari farmers attested that drought has affected their income. More so, Hadejia 22.1%, Gumel 37.8%, Auyo 38.9% and Guri 38.6% were the local governments least affected in income earning among households. This is because, these local governments were engaged in irrigation agriculture with exception of Gumel which they diversify their livelihoods to civil services and small-scale business. Therefore, spatially there are differences in terms of drought impact on income of households in various local governments of the study area, ranging from Gagarawa 76.0% and Kaugama 66.1% as the highest local governments which drought resulted in their income reduction.

This study indicates that there is variability in terms of drought impacts among various local governments in the area. In general, those with access to river felt less impact of drought because they have opportunity for irrigation and other economic activities offered by river such as fishing.

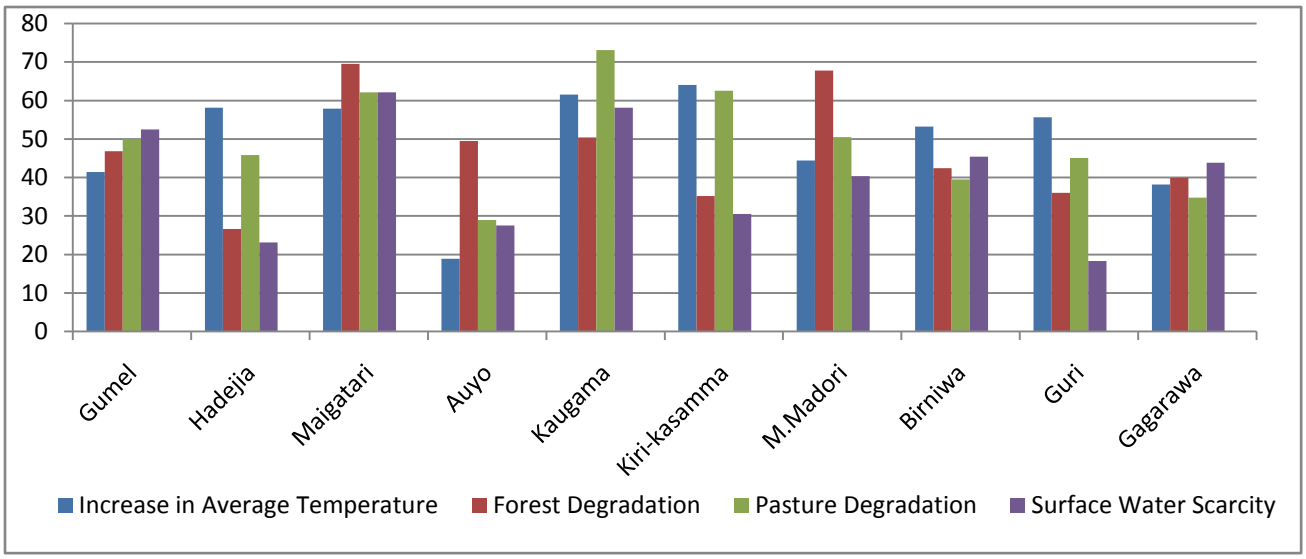
Farmers' Perceptions on Environmental Impacts of Drought

There is no variability in terms temperature increase between local governments in the area, only in Auyo that 19% of respondents disclosed that the temperature has increased due to drought. It is an established fact that drought followed by excessive heat and water scarcity has greatly affected the forests and pastures (Maddison, 2007). The study finds that there are variations among local governments in the area in terms of pasture degradation. Those in the wetter part of the study area such as Guri, Auyo, Kiri-Kasamma and Hadejia less than 40% of the respondents answered that drought has negatively impacted on pasture in these local governments. While in dry part of the area which comprises Gumel, Magatari, Kaugama, Gagarawa, Birniwa, MalamMadori more than 50% of the respondents disclosed that drought

has severely affected the pasture growth and germination. This can be depicted in the literature that moisture shortages, wildfire and excess transpiration which has consequences on growth and development vegetation and pasture. Only those plants that can withstand or adapt to the situation can survive, the less resistant ones will die and hence poor vegetation and pasture growth, diversity, composition and palatability of grasses. Grasses were only available during wet season and began to decline as rain declined, hence less feed for animals.

The variability in terms of water scarcity in the area is very significant. In other words, local governments located at wetter part of study area have more access and availability of surface water compared to those local governments in the drier part of the study area. In the wetter part less than 30% of the respondents disclosed that there is water scarcity, therefore the presence of river hadejia make them to have access to surface water. However, in the case of the drier part of the study area indicate that more than 50% of the respondents from Gumel, Magatari, Gagarawa, Kaugama and Maigatari attested that drought has impacted on surface water scarcity very high. Drought has led to scarcity of surface water through changing of river flows and water in the lakes (Kundzewicz *et al.* 2007). With higher temperature, the capacity for water-holding of the atmosphere and increasing evaporation into the atmosphere has led to more intense precipitation and more droughts (Trenberth *et al*, 2003 cited in Kundzewicz *et al,* 2007). Figure 2 below discusses the variability of environmental impacts of drought among various local governments in the area.

Figure 2: Environmental Impacts of Drought Perceived by Farmers in Various Local



Governments in the Area

Source: Field Survey, 2015

Major Agricultural Adaptation Measures on Drought by Farmers

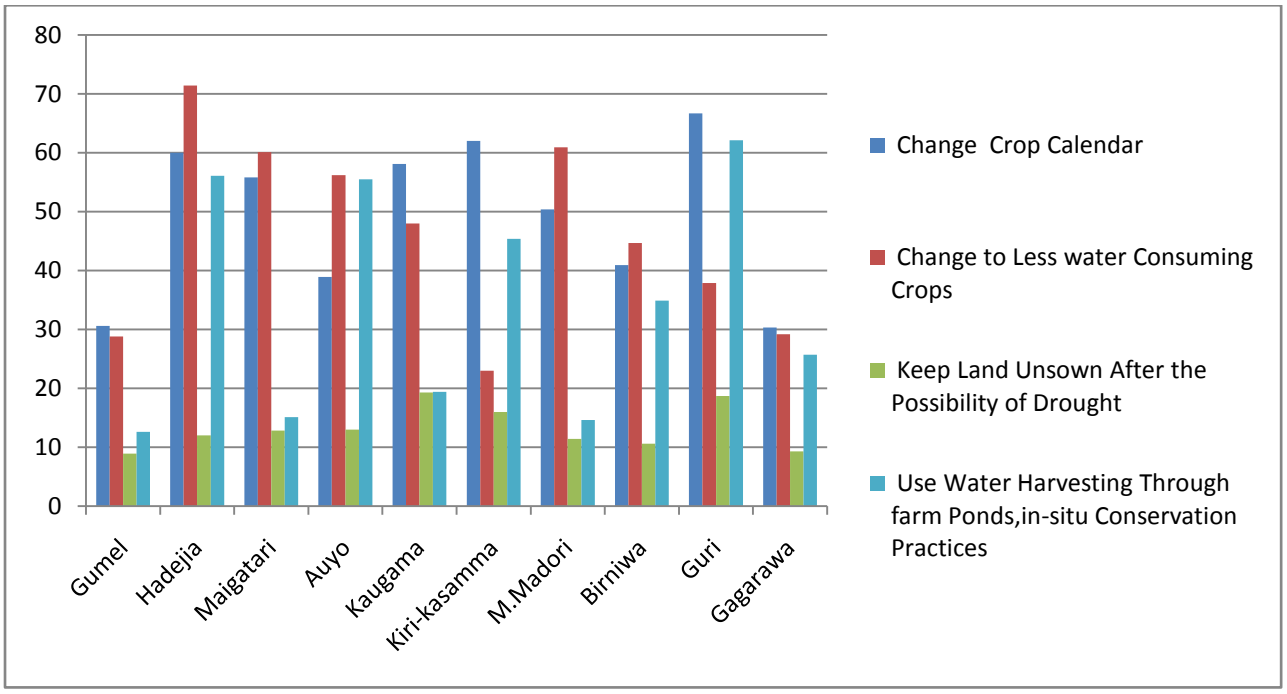
Adaptation to drought is a two steps process, which initially requires the perceptions that drought is occurring and then responding to its various impacts through adaptation and coping measures (Habiba *et al,* 2012). Based on the nature, extent loses and severity of

drought in the study area, farmers adopted several autonomous adaptation strategies to mitigate the drought impacts on agriculture.

Figure 3 explains that major agricultural adaptations measures identified such as changing the crop calendar, using less water consuming crops, using improved irrigation practices, water harvesting and reducing wastage of water during drought years. Studies by Rao *et al* (2007), Habiba, *et al* (2012), Dhaka *et al* (2010), Sahu *et al* (2013), Gandure *et al* (2004) and Gashuwa (1991) discussed similar agricultural adaptation practices in the literature. However, with regards to change of crop calendar, the study indicate that there is no significance difference between local governments in the area, only Gagarawa 30.3% and Gumel 30.6% of the respondents give lower percentages that they changed crop calendar. While the rest of the local governments irrespective of location be it wetter or drier part of the study area over 50% of the households attested that onset of rainy season determines the planting date.

The variability that exists between local governments in terms of planting less water consuming crops, indicates that irrespective of access to river or not adopting to less water consuming crops depends with individual. Therefore local governments like Maigatari 60.1%, MallamMadori 60.9% and Auyo 56.2% of the households prepared to use less water consuming crops to avoid the uncertainties of climate, while those local governments that show less preference in using less water consuming crops were Gagarawa 29.2% (households) and Gumel 28.8% (households) respectively (Figure 3).

Figure 3: Major Drought Adaptation Measures Adopted by Farmers.



Source: Field Survey, 2015

There is no significance difference between local governments in study area, with regards to leaving land uncultivated. Less than 20% of all the respondents in all the local governments of the study area leave land uncultivated. In other words few farmers leave land uncultivated in the area. This is due to the fact that the farmers are smallholder cultivating 2-3 hectares of land or less than that each and every farmer wants to take advantage of land.

The acceptance and utilization of water harvesting technology differs within and among various local government of the study area. The variability indicate that those local governments at wetter part of the study area such as Hadejia 56.1%, Auyo 55.5% and Guri 62.1% of the households in this various local governments attested that they harvest water in their farms for irrigation purposes, compared to those local governments in the drier part of the study area which less than 30% of the households attested that they harvest water to curb the menace of drought in their various locations (Figure 3).

The variability is clear between the local governments in the wetter part of the study area and those in the drier part of the study area in terms of access to and utilization of water harvesting for irrigation and other purposes.

Conclusion

The study concludes that drought affects the Sahelian Zone of Jigawa State by causing food scarcity, unemployment, income reduction of the households and migration among others. The other impacts posed by drought in the area include forest and pasture degradation, surface water scarcity and deterioration of fish and wildlife habitat among others. The importance of measures to reduce the effects of drought cannot be overemphasized. Measures such as irrigation, development of drought tolerant early maturing and high yielding crop varieties, reduction in post-harvest crop losses, efficient weather forecast, storage of excess production and development of fishery and livestock industries assist greatly in reducing the risk of drought.

Recommendations

Based on the findings, the following recommendations were made:

i. Farmers should adopt simple technique of cross-ridging to concentrate water and increase yield especially in drought conditions.
ii. Promote dry planting in which seeds are planted while waiting for the rains in order to make maximum use of moisture from the very unpredictable, but usually heavy, first rains.
iii. Delayed farm clearance until the middle of rainy season in order to reduce soil erosion of the exposed soils by the often heavy showers of the first rains should be encouraged.
iv. Farmers should adopt improved agricultural technologies. This include adoption of new technologies, planting drought resistant and early maturing varieties especially millet, sorghum and cowpea.

v. There is the need to improve information delivery and foster the use of climate information to inform decision making, using seasonal climate forecasts to inform farmers to avoid surprises, and take right decisions in case of impending drought.

vi. Adoption of irrigation farming will help to boost production especially local governments that have access to river in the area which will make production all year round.

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