Variations of Indigenous Adaptation Methods to Climate Change in Gombe State, Nigeria

Yusuf Bello [iD][a], Micheal Daniel Balami [iD][b]

[a] Department of Geography, Federal University Dutsin-Ma, Katsina State, Nigeria. [b] Department of Geography, University of Maiduguri, Borno State, Nigeria.

ABSTRACT

Certain indigenous adaptation strategies were not yielding good results in some locations and others were given more priority. The study assessed the variation in the practices of indigenous adaptation strategies to climate change within the three (3) Political Zones of the state. Primary and secondary data were used for this study. Primary data were sourced from questionnaire administration, while secondary data (list of registered farmers) was source from the Gombe State Agricultural Development Program to select respondents for the study. About 384 respondents were sampled for the study. Descriptive statistics and Weighted Average Index (WAI) were used to analyse the data. The result revealed that about (64%) were within the ages of 40-49. The majority of them were married (64.3%). Most of the respondents (77.6) had one form of formal education, while (22.4%) had no formal education. The majority (83.3%) were aware of climate change, and only (29.2%) had an extension visit. Planting in between ridges (shuka a lambatu), keeping of more livestock than before, and use of indigenous seed were ranked first in Gombe South (GS), Gombe Central (GC), and Gombe North (GN), respectively. Cultivation of more plots now than before, use of indigenous weather forecasting, and practicing more irrigation than in past decades were ranked fourth in GS, GC, and GN, respectively. The study concludes that there is variation in the practices of the indigenous adaptation method by political zones. The study recommends that local adaptation strategies should be improved by the inhabitants of each zone.

1 Introduction

Climate Change is the greatest challenge that humanity faces today (Technological Ecosystems for Enhancing Multiculturality [TEEM], 2019). Climate change is a serious threat to agriculture worldwide, negatively impacting rain-fed agriculture, on which the economies of most developing nations, such as Nigeria, depend (Yakubu et al., 2020). Climate change imposes various difficulties in the lives of indigenous people through injuring their means of survival. The National Aeronautics and Space Administration [NASA] (2023) defines climate change as a significant and long-term alteration in the statistical distribution of weather patterns that spans decades to millions of years. This change is often caused by anthropogenic (human) or natural activities that increase atmospheric concentrations of greenhouse gases (GHGs) such as carbon dioxide, methane, and nitrous oxide. Fafolarin et al. (2024) define climate change as alterations in climate patterns resulting from prolonged natural processes or human activities.

Adaptation is the means by which people adjust their lives to cope and enhance their livelihood in the face of environmental challenges like climate change. Adaptations are actions taken to help communities and ecosystems cope with, moderate, or take advantage of current or future changes in climate conditions. Alternatively, practical steps to protect communities from damage and disruption associated with climate change (Intergovernmental Panel on Climate Change [IPCC], 2007). Fafolarin et al. (2024) describe adaptation as putting practical steps in place to cushion the impacts of climate risks. Most rural farmers adopt indigenous climate change adaptation strategies, which are proven effective in minimising their vulnerability to climate-related shocks. The indigenous strategies are traditional practices and knowledge mostly passed down from parents and shared among farming communities to cope with the impacts of climate variability and change.

The indigenous knowledge system is a better option for climate change adaptation at the local level. Many of the indigenous people rely on resources that are climate-sensitive, e.g. agricultural sector, as their major means of livelihood. Agriculture is vulnerable to the impact of climate change, such as floods and droughts that lead to crop failure, the outbreak of pests and diseases, which affect the economy of the indigenous population (Bello, 2015). In the context of this study, emphasis was laid on the use of local adaptation techniques. These strategies were developed based on the experience and culture of the people.

Akinnagbe and Irohibe (2014) identified African farmers' adaptation strategies to climate change as the use of drought-resistant varieties of crops, changes in cropping patterns and calendar of planting, crop diversification, conserving soil moisture through appropriate tillage methods, improving irrigation efficiency, and afforestation and agro-forestry. According to Harper and Ibrahim (2020), in Africa, a water harvesting technique known as *zai pits or tassa* helps restore degraded drylands through climate-smart agriculture. The planting pits capture erratic rainfalls, allowing infiltration of water to irrigate the seeds, which increases soil fertility and crop yields. Pastoralists and agro-pastoralists change from cattle (Bos) to sheep (Capra) and goat (Capra) husbandry during drought periods (Akinnagbe & Irohibe, 2014).

Farmers intensify crop diversification, planting ahead of rain (*torbi*), cover cropping, planting deeper than usual, and planting of tolerant or improved seed varieties as coping strategies (Yusuf & Paul, 2018). Bello and Msheliza (2019) observed that the climate change adaptation practices adopted by smallholders maize famers in Gombe state, Nigeria include: adjustment in planting date of indigenous crop varieties, adoption of high yield and early maturity crop varieties, mixed farming, intensification of Fadama cultivation, turning head of maize cop down between maturation and harvesting, ancestral spiritual invocations and planting of native grass to overcome weeds and control erosion. It is on this basis that this study seeks to investigate variation in the indigenous adaptation strategies to climate change in Gombe State.

2 Materials and Methods

2.1 Study Area

Gombe State is located between Latitude 9°30' and 12° N and Longitude 8°45' and 11°45'E. The state shares its boundaries with the following states: Bauchi State to the West, Taraba State to the South, Yobe State to the North, and Borno and Adamawa States to the East, as presented in Figure 1. There are some isolated hills in the southern region and a flat landscape in the northern region of the state. The total land area of the state is about 5705.99 km². The climate is characterized by two (2) major alternating seasons of wet and dry. The annual mean temperature is 36.3 °C, the maximum daily temperature of 38 °C is experienced during the hot dry seasons (March to April), the minimum temperature is 25°C and the mean amount of rainfall is 842.4 mm (Msheliza & Bello, 2016). The annual rainfall received in Gombe state revealed a decreasing trend, while the annual temperature indicates an increasing pattern (Bello et al., 2020).

The population of Gombe State was 2, 353879 during the 2006 census (National Population Commission [NPC], 2006), now the population is 3, 256, 962 (North East Development Commission [NEDC], 2025). The majority of the people engage in primary activities such as farming, hunting, and mining.
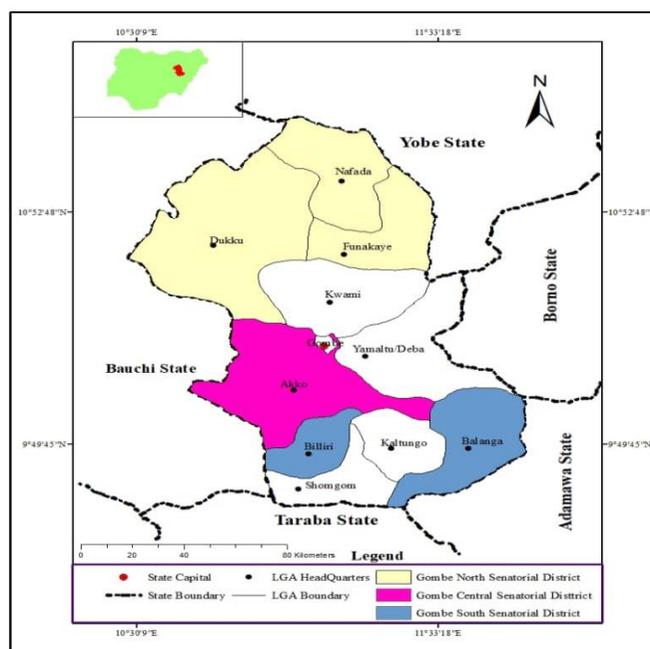

Figure 1. Gombe State showing Sampled Study Areas Source: Gombe State Ministry of Land and Survey

2.2 Data Sources

Primary and secondary sources of data were used for this study. The primary data was sourced through the administration of a questionnaire to heads of households that were registered; those household heads that were not registered were not considered for the questionnaire administration. The questionnaire was subjected to a reliability test of Cronbach (1970). The reliability estimate of the questionnaire was 0.91, which indicates that the instrument is reliable.

The secondary data (List of registered farmers) was sourced from the Gombe State Agricultural Development Project (GSADP), and the data was used to sample the respondents for the study. During the survey, only those who understood the native language were employed to serve/work as research assistants in each of the studied communities. About 18 research assistants were employed for the purpose of generating primary data.

2.3 Sampling Technique

The technique used to determine the sample size is a multistage sampling technique. This sample was determined through various stages, which include: Stage I: The first stage involved the selection of six LGAs by balloting, two from each senatorial zone Figure 1. Stage II: The second stage involved the selection of eighteen (18) political wards by a purposive sampling technique. The political wards represent North, Central, and South of every LGA. Stage III: The third stage, a random sampling technique was used to select fifty- four (54) Villages from

each of the selected political wards. Stage IV: The fourth stage, in selecting the respondent in this study, Krejcie and Morgan's (1970) table of sampling technique was used to select the sample size for the administration of interview schedules.

The sample size was determined using a formula recommended by Krejcie and Morgan (1970), given in Eqn. (1).

$$S = \frac{x^2 \, NP \, (1 - P)}{d^2 \, (N - 1) + \, x^2 \, P(1 - P)} \tag{1}$$

Where;

S = Required size

X^2 = the table of values of chi – Square for 1 degree of freedom at the desired confidence level

N = the population size

P = the population proportion

d = the degree of accuracy expressed as a proportion.

The sample size for the study was derived from Krejcie and Morgan's (1970) table of sampling techniques, which is 384. This implies that about three hundred and eighty-four respondents were selected. Cochran's (1977) formula for the determination and distribution of sample sizes was used, which is given as Eqn. (2):

$$N = \frac{Nh \times n}{P} \tag{2}$$

Where:

Nh = Population

N = Sample size

n = Total number of respondents

P = Total population of the selected communities within the study area. See Table 1.

Table 1: Sampled Frame

Senatorial District	LGAs in Gombe State	50 % of LGAS	LGA	Selected Ward	Number of Villages	Number of Registered Households	Sample Size
Gombe South	Billiri, Balanga, Shomgom and Kaltungo	2		Bare	4	603	23
			Billiri	Tanglan	2	537	20
				Todu Kwaya	3	568	22
				Talasse/Dong/Reme	3	533	20
			Balanga	Kulani/Degre/Sikkam	3	554	21
				Bambam	4	617	24
Gombe Central	Akko and Yamaltu	1	Akko	Kalshingi	3	555	21
				Kumo West	2	562	21
				Kashere	4	767	29
Gombe North	Nafada, Dukku, Funakaye, Gombe and Kwami		Nafada	Barwo Winde	4	698	27
				Jigawa	2	455	17
				Birin Bolawa	2	445	17
				Waziri North	2	457	17
		3	Dukku	Waziri South	4	502	19
				Gombe Abba	2	365	14
				Bajoga East	2	431	16
			Funakaye	Ashaka/Magaba	3	547	21
				Tongo	6	893	34
Total					54	10069	384

Source: Number of Respondents from ADP (2023)

2.4 Data Analysis Methods

Descriptive statistics were used to analyze the socio-economic status of the respondents. The Weighted Average Index (WAI) was used to analyse the indigenous adaptation strategies. The scale of 0-3 was used. The WAI was used by Ndamani and Watanabe (2016) and Fagariba et al. (2017). The WAI of the respondents' variables was computed using Eqn. (3):

$$WAI = \frac{\sum FiWi}{\sum Fi} \tag{3}$$

Where:

W = the weight of each assessed variable on the scale.

F = frequency of variables.

i = response.

3 Results

3.1 Socioeconomic Characteristics of the Respondents

The majority of the respondents (64%) fall between the age brackets of 40 – 49 years, those between ages 50-59 constitute (15.1%) while those above 60 years constitute over (20.8%). This indicates that all the respondents were old enough to understand the changes in the behaviour of climatic variables from the past to the present (Table 2). The gender distribution of the respondents, about (70.3%) of them, were male, while (29.7 %) were female (Table 2). These results coincide with the findings of Abaje and Jeje (2016) as well as Onyegbula and Oladeji (2017), who reported more male respondents than female.

Regarding the marital status of the respondents, the majority (64.3%) of them were married, and 27.3% are single, while 8.4% of them were widowed or widowers.

The majority of the respondents were married. This means that they are responsible because in an African setting, any married person is responsible (Bello, 2022). Out of the 384 respondents, 22.4% have no formal education, 35.7% attended primary school, education and 27.3% have secondary education, while 14.6% have tertiary education. The findings of Onyegbula and Oladeji (2017) are in line with the present study, where there were more respondents with formal education. This means that education was effective in the study area. About 34.1% of the respondents have less than five (5) members, which is the largest in the group, 33.6% have about 6-10 members of household, 17.4% of the respondents have sixteen (16) and above, which is the largest size in the groups, while 14.8% range from 11-15 members of household.

Table 2: Demographic Characteristics of the Respondents

Respondent Characteristics	Frequency	Percentage %
Age		
40-49	246	64
50-59	58	15.1
60-69	43	11.2
≤ 70	37	9.6
Sex		
Male	270	70.3
Female	114	29.7
Marital Status		
Married	247	64.3
Widowed	26	6.8
Single	105	27.3
Widower	6	1.6
Education		
Non-formal education	86	22.4
Primary	137	35.7
Secondary	105	27.3
Tertiary	56	14.6
Awareness of Climate Change		
Aware	320	83.3
Not Aware	64	16.7
Extension Visit		
Visited	112	29.2
Not Visited	272	70.8
Total	384	100

3.2 Extension Visit and Source of Awareness

Access to extension services goes a long way in informing people about the current changes and improvements in agricultural practices. Table 2 reveals that the majority of the respondents (272) who constitute (70.8%) had not visited any extension agents, while only about (112) of the respondents constituting (29.2%) had visited extension agents. And this study relates to the findings of Adebayo et al. (2012), where the majority of the respondents had no contact with extension agents.

About (320) respondents, who constitute (83.3%),

were aware of climate change, while about (64) respondents, constituting (16.7%), were not aware of climate change (Table 2).

3.3 Indigenous Adaptation Methods

3.3.1 Use of Indigenous Seed

The use of indigenous seed (WAI=2.45) was ranked first in the overall indigenous agricultural adaptation to climate change, followed by cultivation of more plots now than before (WAI = 2.30) as the second, while ancestral spiritual invocation (*yekku*) (WAI = 1.73) (Table 3).

Table 3: Indigenous Adaptation Strategies to Climate Change in Gombe State

Statement	Often	Rarely	Not Used	WAI	Rank
Use of indigenous seed	222	114	48	2.45	1
Use of indigenous weather forecasting	118	204	62	2.14	7
Non-clearing of the farm	127	141	116	2.02	11
Ancestral spiritual invocation (*yekku*)	89	129	166	1.79	13
Use of terracing / non-tillage	113	133	138	1.93	12
Planting before the rain (*binne*)	161	131	92	2.17	5
Replanting of the failed field (*Kofi*)	164	137	85	2.21	4
Planting in between ridges (*shuka a lambatu*)	153	124	107	2.11	8
Planting of native grass, shrub (*kafikansila*) in erosion control	149	124	111	2.09	9
Practice more irrigation than in past decades.	137	169	78	2.15	5
Keeping more livestock than before	138	194	54	2.22	3
Cultivation of fewer plots now than before	119	172	93	2.06	10
Cultivation of more plots now than before	184	132	68	2.30	2

3.4 Variation of Indigenous Adaptation Strategies

Table 4: Variation in the Indigenous Adaptation Strategies in Gombe State

Statement	Gombe South		Gombe Central		Gombe North	
	WAI	Rank	WAI	Rank	WAI	Rank
Use of indigenous seed	2.56	3	1.94	12	2.46	1
Use of indigenous weather forecasting	2.24	8	2.23	4	2.04	6
Non-clearing of the farm	2.06	12	1.87	13	1.96	10
Ancestral Spiritual invocation (*yekku*)	1.90	13	2.04	9	1.62	13
Use of terracing / non-tillage	2.22	10	2.07	8	1.68	12
Planting before the rain (*binne*)	2.36	9	2	11	2.11	3
Replanting of failed field (*kofi*)	2.59	2	2.09	7	2.00	8
Planting in between ridges (*shuka a lambatu*)	2.61	1	2.11	6	1.82	11
Planting of native grass, shrub (*kafikansila*) in erosion control	2.35	6	2.01	10	1.97	9
Practice more irrigation than in past decades.	2.33	7	2.16	5	2.07	4
Keeping more livestock than before	2.36	5	4.46	1	2.05	5
Cultivation of fewer plots now than before	2.13	11	2.30	2	2.02	7
Cultivation of more plots now than before	2.53	4	2.29	3	2.14	2

3.4.1 Variation of the First Five (5) Adaptations by Zones

Based on the ranking of the first five (5) from each zone presented in Table 5, it appears that most of the adaptation strategies in practice were similar. Still, they were ranked differently based on importance, while in some cases, two (2) zones may have the same ranking of the adaptation strategies. Planting in between ridges (*shuka a lambatu),* keeping more livestock than before, and the use of indigenous seeds were ranked first in GS, GC, and GN, respectively. *Shuka a lambatu*, a practice by the people of GS, involves harvesting rainwater from the ridges to conserve moisture. This harvested rainwater can then be used by the seed to germinate and grow without the stress of a moisture deficit. Keeping more livestock than before is an adaptation strategy that is given more priority in GC, where most families have some livestock that they use to sell when the need arises, instead of selling their food items. Due to uncertainty in the patterns of a climatic variable, the people in GN have more priority in the use of indigenous seeds.

Table 5: Variation of the First Five (5) Adaptation Strategies by Zones

Rank	Gombe South	Gombe Central	Gombe North
1	Planting in between ridges (*shuka a lambatu*)	Keeping more livestock than before	Use of indigenous seed
2	Replanting of failed field (*kofi*)	Cultivation of fewer plots now than before	Cultivation of more plots now than before
3	Use of indigenous seed	Cultivation of more plots now than before	Planting before the rain (*binne*)
4	Cultivation of more plots now than before	Use of indigenous weather forecasting	Practice more irrigation than in past decades.
5	Keeping more livestock than before	Practice more irrigation than in past decades	Keeping more livestock than before

Replanting in a failed field (*Kofi*) was ranked second in GS, while cultivation of fewer plots now than before was ranked second in GC, and Cultivation of more plots now than before was also ranked second in GN. The third ranking was the use of indigenous seeds in GS, the cultivation of more plots now than before in GC, and planting before the rain (*binne)*. The fourth ranking in adaptations are cultivation of more plots now than before in GS. This use of indigenous weather forecasting in GC and Practice more irrigation than in the past decades in GN. Keeping more livestock than before was identified in GS and GN as the fifth option. Practicing more irrigation than in the past decades was identified in GC (Table 5).

Among the major indigenous adaptation strategies concerning agriculture that were in practice in all the zones and their variations are: Keeping more livestock than before was ranked first (1) in GC and fifth (5) in GS and GN. The use of indigenous seed was ranked first (1) in GN and third in GS. Cultivation of more plots now than before was ranked second (2) in GN, third (3) in GC, and fourth (4) in GS. Practicing more irrigation than in the past decades was ranked fourth (4) in GN and third in GC. Only planting in between ridges (*shuka a lambatu)* and replanting of failed field (*kofi*) were observed in GS. The Cultivation of fewer plots now than before and the use of indigenous weather forecasting in GC and Planting before the rain (*binne)* were observed in GN (Table 5).

4 DISCUSSION

The majority of the respondents were old enough to understand the changes in the behaviour of climatic variables from the past to the present, which is also in line with the findings of Ogunseitan et al. (2021), who reported that ages 31-50 were the highest age bracket among the respondents in a related study in Imeko. Regarding the marital status of the respondents, the majority of them were married, which means that they are responsible, because in an African setting, any

married persons are responsible. Therefore, result obtain from this study are reliable. A good number of the studied population have formal education, which corresponds with the findings of Onyegbula and Oladeji (2017), where they report more respondents with formal education. This means that education was effective in the study area.

Awareness of climate change help the people to plan their lives with the current uncertainty of climatic variables, even though there are poor extension services in the study areas. The people, however, devise a means of understanding within their environment. The majority of the studied population was aware of climate change. The finding is in line with the result of Eze et al. (2019), who report that crop farmers had good knowledge of climate variability, which may likely influence them to take adaptive measures to cushion its effects. Canova et al.'s (2023) effort in educating people about climate change is ongoing through local and traditional methods.

Ekanem and Umoh (2024) indigenous strategies to climate change were based on observation, experience, and experimentation, adapted to local conditions and ecosystems. Some of the strategies include: agroecological knowledge, rainwater harvesting, agroforestry, and manual watering, among others. With the current uncertainty in the rainfall patterns, the farmers resort to using local seed that can withstand all kinds of climate conditions and produce a better yield because it has adapted to the area. The respondent believes that the local variety of crops can resist pests and diseases. Ihenacho et al. (2019) noted that many farmers prefer the use of indigenous grains because they are more drought-resistant and also produce high yields. Areas with little soil moisture: Farmers prefer drought-tolerant crops like (*Cajanus cajan*, sweet potato, cassava, millet, and sorghum).

The people prefer local seed because it saves them from the risks of total failure, unlike modernized seed. Planting of local seed varieties of crops that can withstand and

adapt to sudden changes in weather (Fafolarin, 2024). Farmers rely mainly on local varieties of crops, and they cultivate diverse crops because it minimizes the impact of climate change (Babatolu & Akinnubi, 2016). Ajani et al. (2013) noted that farmers use local seed in their cultivation, and Fafolarin et al. (2024) noted the planting of local seed varieties of crops that can withstand and adapt to sudden changes. The local varieties of seeds are rare and hardy, a quality that can withstand changing weather conditions due to the ability of these local seeds to adapt to the local climatic conditions. This practice reduces the risk of total crop failure. Praying for rain was a major strategy used by rural crop farmers to cushion the climate impacts (Famakinwa et al., 2023).

Different locations adopt various adaptation strategies based on their landscape, culture, experience, and the prevailing impact of the changing climate in the area. The people developed a unique strategy to address the existing impacts that are affecting the livelihood of the inhabitants. Some adaptation strategies were similar, but they vary in terms of priority from one location to another within Gombe state.

5 Conclusion

The study concludes that most of the respondents were between the ages of 40 and 49 years, and the male gender has the highest population. The majority of the respondents were married, and most of them have basic primary education, and they have a sizeable family size of less than five (5) family members. Most of the respondents have not visited any extension agents, and they were aware of the changing climate. The respondent identify use of indigenous seed, cultivation of more plots

now than before, and planting before the rain (*binne*) as the key indigenous adaptation strategies to climate change. Indigenous adaptation strategies vary from one zone to another, such as planting in between ridges (*shuka a lambatu)*, keeping more livestock than before, and the use of indigenous seeds, which were ranked first in Gombe South, Gombe Central, and Gombe North, respectively. Replanting in a failed field (*Kofi)* was ranked second in Gombe South, while cultivation of fewer plots now than before was ranked second in Gombe Central. Keeping more livestock than before was ranked first (1) in Gombe Central and fifth (5) in Gombe South and Gombe North.

The use of indigenous seed was ranked first (1) in GN and third in Gombe South. The study noted that different landscapes, culture and impacts lead people to adapt various practices in responding to their livelihood within the zones. Each region has a unique kind of adaptation options depending on the culture and the type of land used in operation. There is variation in the indigenous adaptation strategies in the study areas. The study recommends that the indigenous adaptation strategies identified by the people of each zone should be improved and preserved. The scientists, crop breeders, and other agricultural related institute should develop local seeds in to drought resistant and short-duration varieties to ensure food sufficiency and regional development.

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