Discovery Agriculture

To Cite:
Ojeh VN, Mogborukor JOA, Sambo I, Chukudi MG. The use of indigenous Knowledge Forecasting in Climate Adaptation by farmers and pastoralists in the Northern Taraba state, Nigeria. *Discovery Agriculture* 2024; 10: e7da1555
doi: https://doi.org/10.54905/disssi.v10i21.e7da1555

Author Affiliation:
[1]Department of Geography, Taraba State University, Jalingo, Nigeria
[2]Department of Agronomy, Taraba State University, Jalingo, Nigeria

[*]**Corresponding Author**
Department of Geography, Taraba State University, Jalingo, Nigeria
Email: vinceojehnetwork@gmail.com

Peer-Review History
Received: 04 January 2024
Reviewed & Revised: 08/January/2024 to 11/March/2024
Accepted: 15 March 2024
Published: 19 March 2024

Peer-Review Model
External peer-review was done through double-blind method.

Discovery Agriculture
pISSN 2347-3819; eISSN 2347-386X

DISCOVERY SCIENTIFIC SOCIETY

The use of indigenous Knowledge Forecasting in Climate Adaptation by farmers and pastoralists in the Northern Taraba state, Nigeria

Ojeh VN[1*], Mogborukor JOA[1], Sambo I[1], Chukudi MG[2]

ABSTRACT

This study examined the use of indigenous Knowledge Forecasting in climate Adaptation by arable farmers and pastoralists in Northern Taraba, Nigeria. Based on a survey design, data was collected from both arable farmers and pastoralists. The 2006 Taraba state population census report put the number of farming households in the state at 288,000. Using the Rao soft sample size calculator, a statistically acceptable sample size for this population of households at a 98.4% confidence level and margin of error of 1.6% (~ 0.01% level of significance) was 580. The figure, 580, was then divided into the 3 senatorial zones that make up Taraba state, it became 193.3 per zone but 194 was used in the study. On the other hand, the total population of the pastoralists in Northern Taraba was given as 20,541. Also, showed that a statistically acceptable sample size for this population of households at a 95% confidence level and a margin of error of 5% (0.05% level of significance) was 378. However, after a series of attempts to get the attention of the pastoralists to fill out the questionnaire proved abortive, the attention of the state Miyetti Allah office was sought. Therefore, the sample size for the pastoralist was recomputed using a 66% confidence level on which gave a new sample size of 91. After the post-field data cleaning, the researchers found only 79 of the copies of the returned research instrument usable for analysis. Therefore, in all, 285 copies of the questionnaire were taken to the field for administration to both the arable farmers and pastoralists. At the end of the fieldwork which took place between June - October 2022 and data cleaning, 259 (Arable farmers 180, Pastoralist 79) copies of the research questionnaire were used for the analysis. The study shows that 76.9% and 23.2% were male and female, respectively. The high percentage of the male gender proved that men are more into farming and pastoralism than women in studying the area. The result revealed that the majority of the respondents 219 (84.6%) are married against 26 (10%) of the singles in the study area. Furthermore, the sources of the knowledge of these indicators, which was translated or handed over to the farmers by learning and observation from their elders (83.1%) and ancestors (16.9%). The study found that IEI is widely used by farmers and pastoralists to predict the onset and cessation of rainfall. The most common IEI used include plant phenology, animal behavior, and

astronomical signs. The study also found that farmers and pastoralists believe that IEI is very.

Keywords: Indigenous Knowledge, Forecasting, Climate Adaptation, Farmers

1. INTRODUCTION

The adverse effects and impacts of climate change and variability are major challenges to socioeconomic activities and development globally. Climate variability and change have had a significant impact on crop production for arable subsistence farmers and pastoralists. Climate change has changed a well-known circle of production that has existed for decades. Climate variability show itself in various forms including unpredictable onset and cessation of rains (Gumucio et al., 2020). The African continent and indeed countries in the sub-Saharan region of Africa are particularly vulnerable to the vagaries of climate change; including food insecurity, water stress and scarcity, loss of biodiversity, ecosystem degradation, livestock and crop yield decline, and loss, to mention but few, as a result of droughts, hot days, heat waves due to high temperatures, extreme rainfall events resulting in erratic rainfall patterns, heavy long periods of rainfall, long periods of dry season, unusual heavy winds, occurrence of floods, loss of forest resources, soil erosion occurrences, drying up of streams/rivers (Kolawole et al., 2016; Adebayo and Oruonye, 2013).

Ajani et al., (2013), affirmed the above facts when he stated that "climate variability and change in sub-Saharan Africa will have overwhelming impacts on agriculture and land use, ecosystem and biodiversity, human settlements, diseases, health and water resources". This is already very clear to farmers and pastoralists even in Northern Taraba. The unpredictability of weather events and seasonal climate influences the precision of farm-level decisions that need to be taken daily to months ahead of a season (Asante and Amuakwa-Mensah, 2015). For example, farmers have to re-sow seeds several times due to delays in rainfall which affect germination, increasing the cost of production, and straining their livelihood (Ndamani and Watanabe, 2016). What Ndamani and Watanabe, (2016) said was a reality as some farmers shared their experiences during the fieldwork. According to one of them "In the year 2020, the farmer had to plant maize in a particular field up to three times because there was a dry spell for about three weeks after the onset of rains".

Furthermore, one of the climate change events that have affected the socio-economic life of the populace is the occurrence of flash floods from torrential rains that always wash away thousands of hectares of farmland. For instance, the 2012 rainy season in Nigeria has been worse than those of the earlier years as heavy rains at the end of August and the beginning of September led to serious floods in most parts of the country. By 29th September of 2012, the floods had affected 134,371 people, displaced 64,473, injured 202, and killed 148. This flood disaster destroyed large agricultural tracts of land most still with crops on the field. The losses and damages also included swept away fish ponds bothering the rivers, destroyed rice farms, loss of livestock (cattle, sheep, goats, pigs, and poultry), destroyed irrigation infrastructure and equipment, lost fish from the ponds, inputs washed away (feeds and seeds). Also reported that there were losses of purchasing power for those whose source of livelihood is in poultry, livestock, and crop farming in the affected areas. This led to increased poverty, hunger and even death.

To minimize the impact of climate change and variability, a need to encourage the use of indigenous Knowledge (IK) the prediction of weather events. Long before the initiation of modern scientific methods for weather forecasting and climate prediction, farming continued successfully, with the exception of regular disasters (Zuma-Netshiukhwi et al., 2013). Farmers use traditional knowledge and indicators of rainfall forecasting/prediction. Compared to the dominant industrialized societies, in which activities in the last 200 years or so have caused most of the climate impacts currently observed, indigenous people living on their traditional lands bear little responsibility for current and future projected consequences of a changing climate (Zuma-Netshiukhwi et al., 2013). Many communities in Africa depend on local or Traditional knowledge for weather forecasts for crops cultivation. Each of the local communities has its own IK indicators for weather forecasts. The rural communities of Ilocos Norte Province of the Philippines rely heavily on Indigenous weather forecasts to plan and prepare agro forestry activities as well as in disaster prevention cited in.

The literature reviewed specifically revealed that these farmers derive their weather forecasts from observations of the atmosphere and astronomical conditions, plants, and the behavior of organisms such as animals, birds, and mammals. An intensive study carried out in Zimbabwe indicates that, Indigenous rainfall prediction indicators that farmers in Zaka district use include the density of spider webs in their locality, with a lot of spider webs indicating a very wet season (spiders don't want damp or wet conditions). Also, when

spiders close their nests, an early onset of rain is expected because spiders do not like any moisture in their nests. This indicator has been observed over some years which made them to draw conclusions be an effective way of predicting rainfall. Elia et al., (2015), on Indigenous Knowledge use in seasonal weather forecasting in Tanzania: The case of semi-arid central Tanzania, also shows that farmers use the emergence of fresh tree leaves, flowers and fruits to predict the onset of rain.

When rainfall is about to commence, trees produce leaves and flowers, and farmers use these local indicators to prepare for the new season's farming activities. Elia et al., (2015), also found out that a white-browed coucal (*Centropus superciliosus)* bird species' appearance symbolizes the onset of the rainy season. More Chibelela and Maluga villages in Tanzania use wind and dust direction to predict the onset of rainfall, the amount of rainfall, and the continuity of rainfall in a season. In Zambia Mbewe et al., (2019), in conformation to Elia et al., (2015) drew a conclusion that Plant species were said to be handy in weather predictions in a variety of ways; Some plants changed their morphology with the season, plant species such as *Brachystegia and Julbernardia* bloom into green and release tender leaves marking the onset of the rain season. These trees start to bloom in September and shed off their leaves during the dry season. Indigenous knowledge forecast has positively influenced arable climate-change adaptation in Uganda.

Nkuba et al., (2020), asserts that the use of both SF and IF increased the likelihood of livestock diversification. Indigenous or local knowledge method of adaptation used in the prediction of weather and climate has come a long way to help farmers reduce and mitigate disasters that occur in seasons that always result in several losses. The question now is why is it that farmers are still very vulnerable to climate change and variability? Literature revealed that arable farmers and pastoralists have not made good use of forecasts for onset and cessation rains which has contributed to their vulnerability to the effects of rainfall seasonality change that include loss of crop harvests (Nkuba et al., 2020). The low use of SCFs has negative implications on the choice of crop enterprises that match the length of the rain season for arable farmers engaged in annual crop production. Furthermore, low use of SCFs may result into poor livestock breeding outcomes for pastoralists (such as reduced milk yields, livestock mortality and reduction in herd size) which would adversely affect their livelihoods (Nkuba et al., 2020).

2. MATERIALS AND METHODS

The Study Area

Northern Taraba (the study area) consists of six LGAs, Ardo Kola, KarimaLamido, Lau, Jalingo, Yorro and Zing (Figure 1). The area has a tropical continental-type of climate with wet summers and dry winters. Rainfall usually starts around May/June and ends at about September/October. The area receives an average rainfall of about 900mm per annum. The mean maximum temperature of the area is about 30OC. The highest air temperature is normally experienced in March and April. Maximum temperature ranges between 26oC to 39oC, while minimum temperature ranges between 15oC to 18oC the vegetation of the study area is the Sudan savanna woodland. Agriculture is the mainstay of the economy. Over 75% of the land is arable. Many foods and cash crops are grown, such as; maize, guinea corn, rice, yam, millet, sesame, cassava, sorghum, and beans among others.

About 90% of the entire population engages in crop cultivation. Both civil servants and businessmen are into farming activities. This forms the main source of their livelihood. Many suffered great losses from farming due to drought and flooding as a result of climate change and variability. This may not be far from the lack of usage of the two-climate information we are concerned with in this study. Taraba State has the potential to feed the entire country of Nigeria looking at the vast expanse of fertile land. Another economic activity of recent that generated much money for the people was the harvest of Rosewood popularly known as Madrid (*Erinaceous Pterocarpus*) and the mining of mineral deposits. The exportation of this wood has generated more revenue and has improved economic activities in the state. The rearing of livestock plays a central role in the economy of the State.

Northern Taraba has the highest concentration of livestock in Nigeria, especially cattle. This is attributable to the climatic conditions found in most parts of the State. It is estimated that 4.5 million cattle, 2.5 million sheep, 3.0 million goats, 6.0 million poultry, and 2.8 million pigs are reared in the State (Oruonye, 2014). Over 30% of agricultural products of the state are from the livestock business, which creates employment for the rural dwellers. It is possible that the socio-economic life of the State can grossly improve if the farmers and the pastoralists have access and graciously utilize the indigenous and scientific forecast as an adaptation strategy to climate change and variability.

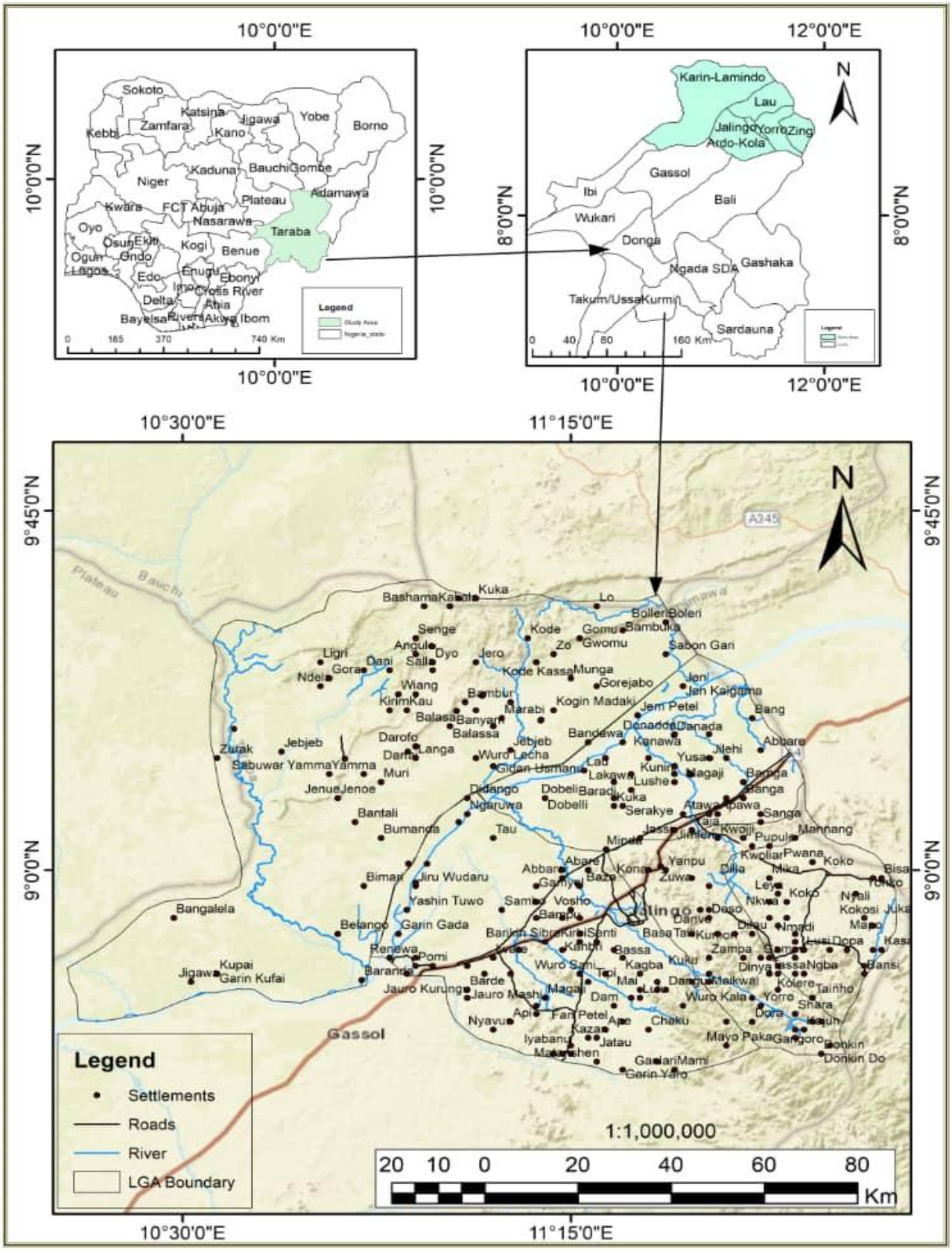

Figure 1 Map of the study area

Sampling Size and Techniques

The sample sizes were drawn from the population of the study using the Rao soft sample size calculator. The 2006 national population census put Taraba state's number of farming households at 288,000. Using the Rao soft calculator, a statistically acceptable sample size for this population of households at 98.4% confidence level and a margin of error of 1.6% (~ 0.01% level of significance) was 580. The figure, 580, was then divided into the 3 senatorial zones that make up Taraba state, it became 193.3 per zone but 194 was used in the study. On the other hand, the total population of the pastoralists in Northern Taraba was given as 20,541. Using it showed that a statistically acceptable sample size for this population of households at 95% confidence level and a margin of error of 5% (0.05% level of significance) was 378. However, after a series of attempts to get the attention of the pastoralists to fill l the questionnaire proved abortive, the attention of the state Miyetti Allah office was sought.

The intervention of the state office assisted greatly and boosted the researcher's confidence of getting access to the pastoralist. On the advice of the Miyetti Allah on the security situation in Northern Taraba because of the numerous crises involving the herders and the farmers that were ongoing at the time of the fieldwork and there was a lack of trust for interviewers. Therefore, the sample size for the pastoralist was recomputed using a 66% confidence level on which gave a new sample size of 91. After the post-field data cleaning, the researchers found only 79 of the copies of the returned research instrument usable for analysis. Therefore, in all, 285 copies of the questionnaire were taken to the field for administration to both the arable farmers and pastoralists. At the end of the fieldwork which took place between June - October 2022 and data cleaning, 259 (Arable farmers 180, Pastoralist 79) copies of the research questionnaire were used for the analysis.

A multi-stage sampling process was used to select two hundred and seventy farmers and 91 pastoralists in the Northern Senatorial Zone of Taraba State for the study area. The first stage of the multi-stage sampling process was the selection of three Local Government areas out of six local government areas in the Northern senatorial zone (study area) of the state through a simple random sampling process. Northern Taraba (the study area) consists of six LGAs, Ardo Kola, Karima Lamido, Lau, Jalingo, Yorro and Zing. Out of the six local governments, three local governments were purposively selected to undergo the study. These include, Ardo Kola, Lau and Zing Local Government Areas. The choice of Lau was due to its renowned activities of crop cultivation and the rearing of cattle. Been that it was close to River Benue where Arable crops such as rice, maize, and host of others are cultivated and many herdsmen seems to live in the area to graze at the Benue valley. Zing and Ardo Kola are known for farming activities especially food crops in large quantities. For instance, Zing yams have made name in Nigeria.

That is to say, all over the country celebrate yams produced in Zing, Taraba State. Therefore, we felt it would be good to interact with the farmers to see and hear how they are coping with the challenge of climate change in crop production. Similarly, Ardo Kola is known for its massive cultivation of maize, yam, beans etc. And the rearing of animals such as cows, goat etc. This informed the choice of the three Local Government areas. The second stage involves the selection of three political wards from each of the Local Government Areas. For instance, in Ardokola Local Government Sunkanni "A" ward, Iware ward and Barkin dutse ward were picked. The reasons behind these wards' selection were simply the involvement of the populace in both the cultivation of arable crops and the rearing of animals. In Lau, Jimlari ward, Sayonti (Mayo Lope) GarinMagaji Wards were purposively selected due to the same reason stated in the case of Ardokola LGA.

In Zing Local Government area, though they had less population or activities of the Pastoralist compared to Lau and Ardo Kola, nevertheless there is sizeable number of Pastoralist in the area and a large percentage of arable farmers in the local Government hence, the choice of the local government. Thirdly, a stratified random sampling process was used to select arable farmers and Pastoralists who are between the ages 20 and above years and have not less than 5 years of experience in farming and keeping of livestock from each of the wards. This age range and years of farming experience were used to ensure that the people we are dealing with have the indigenous knowledge experience. The data used for this study were obtained from a survey of farmers and herders (pastoralists) in three LGAs of the Northern senatorial zone of Taraba state, Nigeria.

The data were obtained during the 2022 cropping season. Data were collected using a semi-structured questionnaire on the socio-economic characteristics of the respondents, indigenous Knowledge and Scientific climate forecast as a method of adaptation and factors influencing choice of adaptation techniques. A total of 285 arable farmers and pastoralists were selected from 9 political wards in northern Taraba State. Thirty-one questionnaires were distributed in 6 wards in Ardo-kola and Lau while thirty-three research instruments were distributed in three wards in Zing LGA. Twenty-one was administered to the farmers while ten distributed to the pastoralists in Ardo-kola and Lau while twenty-three were distributed to the farmers and ten were given to pastoralists in each of the

selected three wards in Zing. It was quite unfortunate that 26 of the questionnaires were not retrieved. We finally used 259 for the analysis instead of 285.

3. RESULT AND DISCUSSION OF FINDINGS

Descriptive Overview of the Respondents

The study shows that 76.9% and 23.2% were male and female, respectively. The high percentage of the male gender proved that men are more into farming and pastoralism than women in the study the area (Table 1). All the female gender in the study were into farming. None of the women in the study area were pastoralists. There are some that do assist in the event that the men are occupied with some certain engagement but not that it was their occupation.

Table 1 Demographic Data of Respondents

		Frequency	Percent	Valid Percent
Gender	Male	199	76.9	76.9
	Female	60	23.2	23.2
	Total	259	100.0	100.0
Marital Status	NR	12	4.6	4.6
	Single	26	10.0	10.0
	Married	219	84.6	84.6
	Divorced	2	0.8	0.8
	Total	259	100.0	100.0
Age	1-20 years	5	1.9	2.0
	21-40 years	116	44.8	46.0
	41-60 years	108	41.7	42.9
	61-80 years	21	8.1	8.3
	80 years +	2	0.8	0.8
	Total	252	97.3	100.0
	Total	259	100.0	
House head	NR	8	3.1	3.1
	Yes	224	86.5	86.5
	No	27	10.4	10.4
	Total	259	100.0	100.0
Edu. Qual.	NR	10	3.9	3.9
	No Schooling	67	25.9	25.9
	Primary Sch	30	11.6	11.6
	JSS	56	21.6	21.6
	SSS	9	3.5	3.5
	Diplom Level	55	21.2	21.2
	University	22	8.5	8.5
	Prof. cert.	8	3.1	3.1
	Any other	12	4.6	4.6
	Total	259	100.0	100.0

Source: Fieldwork analysis 2023

The study revealed that most of the singles, may likely have gone to the city to pursue education or engaged in skilled, semi or unskilled labour in the city as majority of the respondents 219 (84.6%) are married against 26 (10%) of the singles counterpart in the

study area. This shows that the respondents had adequate information on the subject matter as most of them are married and are practitioners. Similarly, the age characteristics, show that 44.8%, 41.7%, and 8.1% were between 21-40, 41-60, and 61-80 and 0.8% 80 above, respectively. The high composition of the age group 21-40 (44.8%) and 41-60 (41.7%) distribution indicate that most of the active young people are engaged in farming and pastoralism.

The older men are beginning to retire from farming and rearing of animals in the study area. This is congruent with the study of Adeoti et al., (2016), which confirm that majority of the sampled farmers were in their productive age. Age plays a significant role in economic activities in any population just as can be seen in the study area. Table 1 also show the statistics of the households' head. The data collected shows that majority of the respondents were the household heads. Out of 259 respondents, 224 (86.4%) were men, the head of the household against the 24.6% that are women and grown-up children.

The use of indigenous knowledge (IK) forecasting by farmers and pastoralists in Northern senatorial zone of Taraba State

The findings from the study shows that 85.3% of the total respondents had access to IK and 81.1% used Indigenous Knowledge as climate source of information for decision-making as shown in (Table 2). The high composition of the use of indigenous forecasting in the study area shows that the people believed so much in IK as they have tested and have proved to be very effective. On the other side it was discovered that accessibility to Scientific forecast was a very difficult issue. The findings show that one of the major sources of the IK was the elders. Table 2 revealed that, sources of indigenous knowledge are derived from the elders in the villages. The number of respondents established that 80.1% received or learn the act of interpreting weather phenomenon or information through the elders, other sources in this context may refer to their farmer groups, friends and mothers.

The high composition of the elders in the study confirmed the positions of Nkuba et al., (2020), Makwara, (2013), Nyadzi et al., (2022) who maintained that sources of IK are from the elders. The reason for the preference of the IK over the SF by some farmers and pastoralists was examine in the study. The research shows that, some people preferred IK because of its availability and the less cost as Table 2 revealed 80.3% of the respondents who bore their mind to affirm its availability against 1.5% that said it was cheap. According to them, "it is not something to buy or that demands for conventional training in one college or university". The responses of the farmers here are consistent with the work of Nkuba et al., (2020), in Uganda.

The Use of IK in Predicting Onset and Cessation of rainfall

The study shows that the majority of the farmers and pastoralists (85.33%) use indigenous knowledge to predict or forecast the onset of rain. Knowing the exact time rain is likely to fall after a long period of dry season is of uttermost important to farmers. This is to enable them to decide the type and a variety of crops to plant in a certain period. When farmers have predicted that the rainy season will not last long, they choose crops that will be harvested within a short period. For instance, the use of 40 days' maize and 40 days' bean is frequently used in the event of early cessation of rainfall. Similarly, early planting of crops that will take quite a longer time is also encouraged as a step to reduce or mitigate the consequences of climate change. This is the most common reason farmers and pastoralists employed the use of IK in the prediction of the Onset of rains. In the note shell the use of IK in the prediction of onset and cessation of rainfall encourages diversification of crops and enable farmers to maximize crop yield in harvest.

The Table 2 shows that the use of IK in predicting the onset of rains is of uttermost importance to the farmers because of reliability assessment they have done over the years. According to the assessment of the farmers and pastoralists, (37.1 % and 50.2 %), affirmed that IK is extremely effective and effective, while only insignificant percent (3.1% and 1.9%) had a contrary opinion. This reliability assessment has proved beyond any reasonable doubts that IK is an important tool in adaption strategy for climate. This reliability is consistent with Nkuba et al., (2020), who affirmed that farmers in Uganda trust in their IK forecast because of its reliability. The outcome of the study shows that 89.96% used IK to predict or forecast the cessation of rain just as they did in the onset of rain. Table 2 the study shows the reliability of farmers' prediction of cessation of rains using IK. The result shows that 29.7% and 37.5% of the respondents' experience is very effective and effective respectively, only 3.5% and 1.9 % seems to disagreed with the effectiveness of prediction of cessation using IK.

Table 2 The Reliability IK forecasts in predicting the onset and the cessation of rainfall

		Frequency	Percent	Valid Percent
Access to IK		221	85.3	85.3
The use of IK		210	81.1	81.1
Source of IK	NR	47	18.1	18.1
	Elders	208	80.3	80.3
	Others	4	1.5	1.5
	Total	259	100.0	100.0
Reason for the use of IK	NR	34	13.1	13.1
	Available readily	207	79.9	79.9
	Cheap	18	6.9	6.9
	Total	259	100.0	100.0
Reliability of IK in the Prediction Onset	NR	20	7.7	7.7
	Extremely effective	96	37.1	37.1
	Effective	130	50.2	50.2
	Ineffective	8	3.1	3.1
	Extremely ineffective	5	1.9	1.9
	Total	259	100.0	100.0
Reliability of IK in the Prediction cessation	NR	71	27.4	27.4
	Extremely effective	77	29.7	29.7
	Effective	97	37.5	37.5
	Ineffective	9	3.5	3.5
	Extremely ineffective	5	1.9	1.9
	Total	259	100.0	100.0
The IK prediction above is based on Farmers	NR	33	12.7	12.7
	Past Experience	155	59.8	59.8
	Past and Present Experience	47	18.1	18.1
	Present Experience	24	9.3	9.3
	Total	259	100.0	100.0

4. CONCLUSION AND RECOMMENDATION

The study found out that, a good percentage of the farmers in the study area employed the use of the Indigenous knowledge IK in the course of carrying out their business. The use of IK prediction significantly influenced arable farmers and pastoralists' adaptation to climate variability and change as about (81.1%) of the respondents attested. The study discovered that just like other parts of the world, the Northern Taraba also uses the behavior of flora and fauna in its environment to predict the weather. The prediction was mainly done to ascertain the exact time of the commencement of the rainy season (Onset) and the time the dry season would set in (Cessation). The result of the research further revealed that, farmers use and utilized the prediction of the onset and the cessation of rains to know the time to clear their farm, time to plant their crops, the type or variety of the crops to plant.

The use of IK has helped to increase the likelihood of the adaptation of crop diversification. This over the years has helped many to avert disasters like flooding, drought, early cessation of rains, late-onset and fake onset of rain. The pastoralists likewise, use the IK forecasts to plan livestock mobility and sharing among relatives and friends to minimize drought losses. Recall that the pastoralist migrates with their cattle from one location to another in search of greener pasture for their livestock. Prediction of the onset and cessation of rain has helped them to successfully carry out their business in the past.

The challenges facing IK weather forecasting include a poor knowledge transfer system, insufficient documentation, and the death of forecast experts, Therefore, it is recommended that a systematic documentation of IK is essential, including developing curricula on traditional weather forecasting at appropriate levels.

The importance of climate information from indigenous knowledge (IK) systems and SF in adaptation to extreme weather events in rural livelihoods cannot be over-emphasized. From the study, we discovered that IK and SF work hand in and are complementary in nature. Therefore, we recommend that the government and the development partners should approve the integration of indigenous knowledge forecasts into the national meteorological services.

Informed consent

Written & Oral informed consent was obtained from individual participants included in the study.

Conflicts of interests

The authors declare that there are no conflicts of interests.

Ethical approval

The ethical guidelines for Human Subjects are followed in the study.

Funding

The study has not received any external funding.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES

1. Adebayo AA, Orunoye ED. An Assessment of Climate Change in Taraba State, Nigeria. Nigerian J Trop Geogr 2013; 4(2):1-14.
2. Adeoti A, Coster AS, Akanni TA. Analysis of Farmers' Vulnerability, Perception and Adaptation to Climate Change in Kwara State, Nigeria. Int J Clim Res 2016; 1(1):1-16. doi: 10.18488/journal.112/2016.1.1/112.1.1.16
3. Ajani EN, Mgbenka RN, Okeke M. Use of Indigenous Knowledge as a Strategy for Change Adaptation among Farmers in Sub-Saharan Africa: Implications for Policy. Asian J Agric Ext Econ Soc 2013; 2:23-40. doi: 10.9734/AJAEES/2013/1856
4. Asante FA, Amuakwa-Mensah F. Climate Change and Variability in Ghana: Stocktaking. Clim 2015; 3(1):78-99. doi: 10.3390/cli3010078
5. Elia EF, Mutula S, Stilwell C. Indigenous Knowledge use in seasonal weather forecasting in Tanzania: the case of semi-arid central Tanzania. SAJLIS 2015; 80(1):18-27.
6. Gumucio T, Hansen T, Huyer S, Huysen TV. Gender-responsive rural climate services: a review of the literature. Clim Dev 2020; 12(3):241-254. doi: 10.1080/17565529.2019.1613216
7. Kolawole O, Motsholapheko M, Ngwenya B, Thakadu O, Mmopelwa G, Kgathi D. Climate variability and rural livelihoods: how farming households perceive and adapt to climatic shocks in the Okavango Delta, Botswana. Weather Clim Soc 2016; 8(2):131-145. doi: 10.1175/WCAS-D-15-0019.1
8. Makwara EC. Indigenous Knowledge Systems and Modern Weather Forecasting: Exploring the Linkages. J Agric Sustain 2013; 2(1):98-141.
9. Mbewe M, Phiri A, Siyambango N. Indigenous Knowledge Systems for Local Weather Predictions: A Case of Mukonchi Chiefdom in Zambia. Environ Nat Resour Res 2019; 9(2).
10. Ndamani F, Watanabe T. Determinants of farmers' adaptation to climate change: A micro-level analysis in Ghana. Sci Agric 73(3):201-208. doi: 10.1590/0103-9016-2015-0163.
11. Nkuba MR, Chanda R, Mmopelwa G, Kato E, Mangheni MN, Lesolle D. Influence of Indigenous Knowledge and Scientific Climate Forecasts on Arable Farmers' Climate Adaptation Methods in the Rwenzori region, Western Uganda. Environ Manage 2020; 65(4):500-516. doi: 10.1007/s00267-020-01264-x
12. Nyadzi E, Werners ES, Biesbroek R, Ludwig F. Towards weather and climate services that integrate indigenous and scientific forecasts to improve forecast reliability and

acceptability in Ghana. Environ Dev 2022; 42:100698. doi: 10.1016/j.envdev.2021.100698

13. Oruonye ED. An assessment of the Level of Awareness of Climate Change and Variability among Rural Farmers in Taraba State, Nigeria. Int J Sustain Agric Res 2014; 1(3):70-84.
14. Zuma-Netshiukhwi G, Stigter K, Walker S. Use of Traditional Weather/Climate Knowledge by Farmers in the South-Western Free State of South Africa: Agrometeorological Learning by Scientists. Atmos 2013; 4:383-410. doi: 10.3390/atmos4040383