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THE USE OF INDIGENOUS METHODS IN SEASONAL CLIMATE PREDICTION AND ADAPTATION AMONG FARMERS IN ATISBO LOCAL GOVERNMENT AREA OF OYO STATE, NIGERIA

Richard Adeleke[1]

[1]*Department of Geography, University of Ibadan, 200284, Ibadan, Nigeria.*
Email: richardadeleke08@gmail.com

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ABSTRACT

In recent times, agricultural productivity has been on the decline in ATISBO Local Government of Oyo State due to neglect by the government and more recently, severity of climate change. More worrisome is the fact that farmers do not have access to modern technologies for climate prediction and adaptation which has made them to rely heavily on their indigenous methods. Consequently, the focus of this study is to investigate the indigenous methods used by farmers in climate prediction and adaptation as well as the effects of climate change on crop yield. Data for the study were obtained via a structured questionnaire and focus group discussion involving 260 farmers. It was found that farmers' age (R^2=19.7%; B=0.444), duration of stay in locality (R^2=35.7%; B=0.598) and education (R^2=38.9%; B=-0.623) were the major determinants of the use of indigenous methods in climate prediction and adaptation. Animal behaviour, plant phenology, atmospheric changes, astronomical changes and water bodies were the major indigenous methods of climate prediction while multi cropping and contour ploughing were some adaptive measures. Crop yields of the farmers declined drastically while it is glaring that climate change is taking its toll on the indigenous methods of farmers. The paper recommends easy access of farmers to modern technologies for climate prediction and adaptation, as well as the integration of indigenous methods with scientific method.

Contribution/Originality: This study is one of the very few studies to investigate the use of indigenous methods in seasonal climate prediction and adaptation among farmers in Nigeria. Although different indigenous methods were reported, the severity of climate change is beginning to take its toll on the indigenous methods of farmers.

1. INTRODUCTION

In Oyo State, like in many other parts of Nigeria, the majority of the people live in rural areas where poverty and deprivation are the most severe. The dependence of rural dwellers on agriculture and its overall contribution to the economy makes agriculture a key industry in Oyo State. It is the single largest employer of labour, a source of raw materials to industries and a major source of revenue to the state. The rapid population growth rate experienced in the state suggests that agriculture now has more mouths to feed than ever before. With a population of over 5,000,000 people (National Population Commission, 2006) agriculture has not been able to meet the increasing and more diversified food requirements of the population. Thus, from being self-sufficient in food production, the state is now experiencing a serious food crisis due to uncertainty in seasonal prediction for crop cultivation (Olutegbe and Fadairo, 2014). In Nigeria, the rainy and dry seasons are crucial as they guide agricultural activities. Besides, crops react differently to different seasons which in turn determine their productivity. The uncertainty in seasonal forecasting has been largely due to the severity in climate change experienced globally. Climate change is the alteration in the basic elements of climate which takes place over a long period of time. Although these changes have been attributed to both human and natural factors, the influence of human activities have been significant such as the emission of greenhouse gases and changing land uses (Dusky *et al.*, 2009). Natural internal processes or external forces such as modulations of the solar cycles and volcanic eruptions have also resulted in climate change. For instance, large volcanic eruption can lead to the release of sulphate particles which spreads through the atmosphere with a detrimental effect (POST, 2012 cited in Adeleke (2018). While governments throughout the world are seriously analysing the threats posed by climate change, the impacts on agriculture have been identified as the most serious because of the number of people likely to be affected and the severity of impacts on those least able to cope (Wreford *et al.*, 2010).

In recent times, modern agriculture has devised means of seasonal forecasting and minimising the impacts of climate and weather uncertainty through technology (Wreford *et al.*, 2010). For instance, farmers in Kazan District of the Turkish capital who owned tablet phones had access to agricultural data through free Internet provided by the government (Jena, 2015). With less stress, farmers had information on seasonal changes which helped them plan their planting activities. In India, climatic information was disseminated to farming communities through short message service (SMS) and interactive voice response technology (Balaji and Craufurd, 2011). Some farmers in Ottawa, Canada, also had weather stations on their farmlands to monitor temperature level, amount of rainfall and wind direction (Bickis, 2017). Most crops in Arizona are grown using powered irrigation (Berardy and Chester, 2017). In Peoples Republic of China and Thailand, scientific crop breeding has been used to amplify the potential of existing traits or transfer traits to other plants to raise thresholds of tolerance to an increase in average minimum and maximum temperatures (Asian Development Bank, 2014). Also, laser technology has been used to bring agricultural fields to near flatness thereby reducing run off in time of excessive rainfall. There has also been an improvement in crop yields on laser level fields in India (ADB, 2014).

However, farmers in Oyo State of Nigeria, especially in ATISBO Local Government Area, do not have access to these modern agricultural technologies for seasonal climate prediction and adaptation due to poor technology, low support from the government, lack of adequate research on farmer's needs, lack of information and low level of education of the farmers. The research institutes in the state have not been able to come up with any meaningful innovation to aid seasonal forecasting and to adapt to the effects of climate change owing to lack of funding and support from the government (Olukunle, 2013). In very few occasions where there are agricultural innovation breakthroughs, there has not been any follow up as most of the works end up being abandoned. Furthermore, farmers lack agricultural information and this brings about ignorance in the use of modern agricultural technologies. The lack of information means that farmers hardly feel the impact of such innovation (Mgbenka and Mba, 2016). Even if these technologies are made available, majority of the farmers may not be able to use them due to their low level of education. This is because with better education, farmers appreciate and can comprehend the use of modern farm technologies in forecasting and adapting to climate change (Julius, 2013).

Despite the above stated challenges, farmers in ATISBO Local Government Area have been able to use their indigenous methods in seasonal climate prediction and adaptation. This indigenous method is holistic, not necessarily written down, passed down orally and grasped only through long experience (Agrawal, 1995). People who use indigenous methods have a long association with nature and have deeper understanding of it. It is unique to a given culture and society and it is also a reflection of their geographical location (Risisro *et al.*, 2013). Over the years, farmers in ATISBO Local Government Area of Oyo State, Nigeria have learnt how to grow their food, how to preserve them and also how to survive in difficult environment. They know what varieties of crops to plant, when to sow and weed and how to carry out seasonal forecasting. Consequently, the local government has been referred to as the food basket of the state while also contributing significantly to the revenue of the state. Although in recent times, this status has been faced with serious threat with the recent food crisis experienced in the state (Olutegbe and Fadairo, 2014) which is indicative of the fact that climate change is taking its toll on the farmers and their indigenous methodologies of seasonal climate prediction and adaptation. This is worrisome as over 90% of the people in ATISBO Local Government Area depend on agriculture for their livelihood. This will result in untold hardship and an increase in poverty level as it is already insinuated that the area is one of the most marginalised in the state with little or no presence of government felt. It is against this backdrop that this study intends to examine indigenous methodologies used by farmers in seasonal climate prediction and adaptation and the socio-economic factors that explain the use of indigenous methods. Besides, it also examined the effectiveness and challenges facing indigenous methods. It also seeks to analyse the effects of climate change on crop yield. It is believed that this research will give an insight into the indigenous methodologies used by famers. Moreover, it will serve as an input for the design of agricultural technologies based on indigenous methodologies of farmers in seasonal climate prediction and adaptation.

2. MATERIALS AND METHODS

2.1. Study Area

This study was carried out in ATISBO Local Government Area of Oyo State, Nigeria, as shown in Figure 1. ATISBO is an acronym for the major communities in the local government. Thus, ATISBO stands for Ago-Are, Tede, Irawo, Sabe, Baasi, Ofiki and Owo. It is a rural local government located in North-West of Oyo State between latitude 8^0 10'N to 8^0 30'N of the Equator and longitude 2^0 50'E to 3^0 40'E of the Greenwich. It has a land mass of 2056 sqkm and it is bounded by the Republic of Benin on the East, Saki West Local Government on the North, in the West by Orire Local Government and in the East by Iwajowa and Itesiwaju Local Government Areas (Umunna *et al.*, 2012). It is made up of twenty districts and ten wards (Umunna *et al.*, 2012). It is also one of the 33 local government areas in Oyo State with its headquarters in Tede. The topography is predominantly agrarian with some mining lands where precious stones such as tourmaline and tantalite can be found. With a population of 110,792 (NPC, 2006) the people are predominantly farmers and they account for 90% of the population. However, traders, artisans, miners and civil servants are also found there. Crops grown include cassava, maize, yam, Shea butter, cocoa, vegetables, mango and cashew, among others. The major residents are the Yoruba who are the indigenous dwellers. Aside from the presence of a mini branch of British America Tobacco in the local government, there is dearth of modern industries in the local government largely due to the shortage of infrastructural facilities. As a result, there has not been any meaningful development in the area. The area falls within the tropical wet and dry climate. The wet season extends from March to October with a double maxima rainfall in June and September while the dry season runs through November to February. The monthly temperature varies between 24.6°C and 29.9°C with a mean monthly temperature of 27°C. It lies within the tropical rainforest vegetation belt with the presence of trees such as iroko, obeche, and mahogany, among others.

2.2. Data Sources and Sampling Technique

Both primary and secondary data were collected and used for this study. Questionnaire and focus group discussion were used to obtain the primary data. The questionnaire was divided into two sections. Section 'A' focused on the socio-economic characteristics of the farmers such as their age, gender, occupation, farming experience, ethnicity and duration of stay in locality while section 'B' focused on the effects of climate change on crop yield. On the other hand, the focus group discussion was used to elicit information on indigenous methods used in seasonal climate prediction and adaptation, as well as the effectiveness and challenges confronting the use of indigenous methodologies. Secondary data on temperature and rainfall distribution in Oyo State was obtained from the records of Nigerian Meteorological Agency. Farmers formed the study population and 260 of them were sampled from 10 political wards in ATISBO Local Government Area. The wards are Ago-Are I, Ago-Are II, Alaga, Basi, Irawo-Ile, Irawo-Owode, Ofiki, Owo/Agunrege/Sabe, Tede I and Tede II. ATISBO Local Government Area was purposively selected because it is largely agrarian producing both cash and food crops, and due to the expertise of the farmers in the use of indigenous methods.

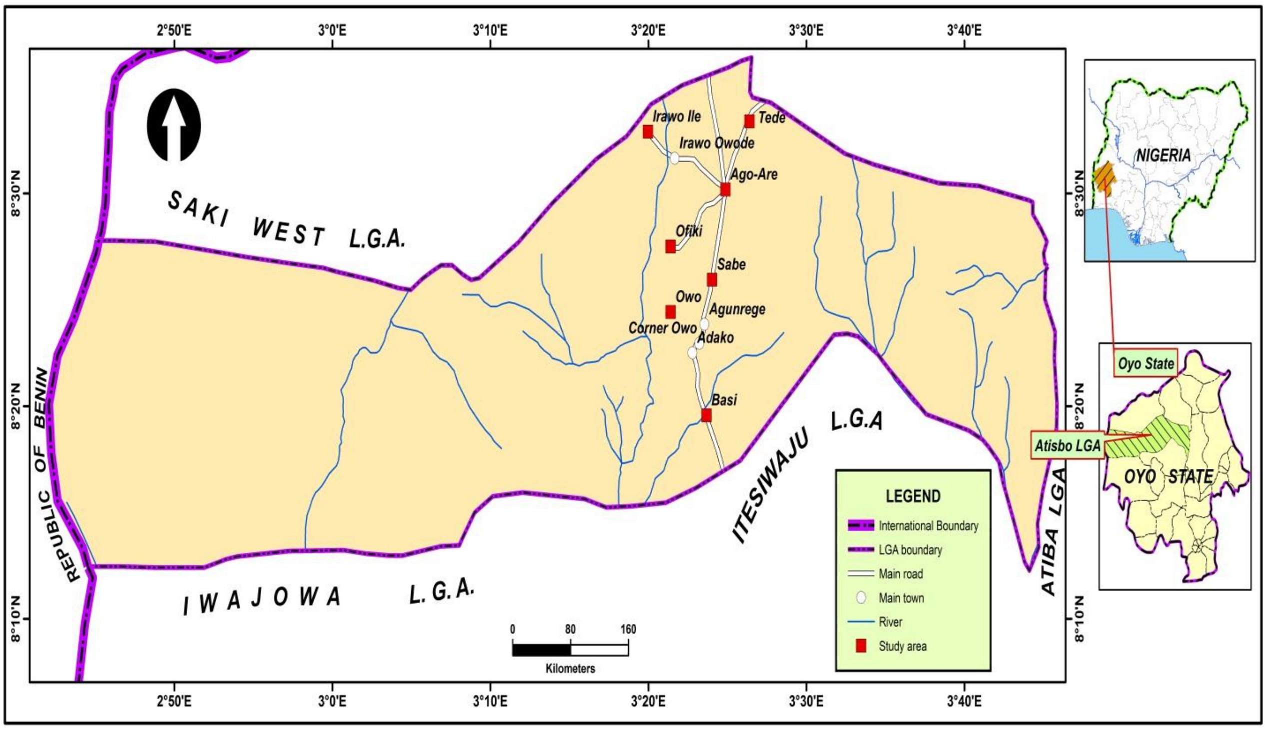

Figure-1. Location of study area

Source: Author.

Multi stage sampling was used in administering the questionnaire. Each of the ten wards consist of an average of ten neighbourhoods and 20% of the neighbourhoods were selected which gives a total of two neighbourhoods per ward. Thus, 13 copies of the questionnaire forms were administered in each neighbourhood to households at a regular interval of three. In each house, the questionnaire was administered to farmers and they also formed the participants for the focus group discussion based on their consent. The focus group discussion consisted of 26 groups of 10 persons and all the indigenous methods used in seasonal forecasting and climate change adaptation were explored.

2.3. Study Variables and Data Analysis

Six socio-economic variables were selected based on their identification in the reviewed literature as possible determinants of the use of indigenous methods. These variables are age of the farmer, education, duration of stay in locality, farming experience, gender and ethnicity.

Age of the farmer: In a study carried out by Usman *et al.* (2015) they found that age was positive and significantly related to the use of indigenous methods by farmers in Adamawa State, Nigeria. This is because as farmers get older, they become efficient in the use of indigenous methods (Epu, 2010).

Duration of stay in locality: Indigenous method base is local because it is produced from its surroundings, the economic and social activities and a unique environment. In other words, indigenous knowledge can better be grasped through a prolonged stay in an environment (Kloppenburg Jr, 1991; Senanayake, 2006; Zambrana *et al.*, 2014).

Farming experience: Indigenous method is a function of practical engagement in everyday life which is reinforced through experience (Senanayake, 2006). Thus, long exposure to farming brings about familiarization, perfection and specialization with the use of indigenous methods (Usman *et al*., 2015).

Gender: The division of responsibilities along gender lines expose male and female to different economic activities. Consequently, in most sub-regions of north-western South America, it was found that the men engaged in activities that frequently bring them in contact with nature such as hunting, clearing fields and farming resulting in a better understanding and use of indigenous methods (Zambrana *et al*., 2014).

Ethnicity: It has been made known that being an ethnic member of a locality connects the individual more to that locality. This was the case in some regions of north-western South America where the indigenous population had more knowledge about the use of their indigenous methods (Zambrana *et al*., 2014).

Education: The acquisition of values and skills relating to indigenous methods are orally transmitted or acquired through imitation and demonstration with less formal education (Senanayake (2006)). The findings of Usman *et al.* (2015) suggested that formal education is a threat to indigenous methods as farmers may be influenced to use scientific methods in carrying out their farming activities.

In order to determine the socio-economic characteristics that significantly influence the use of indigenous methods in seasonal climate prediction and adaptation among farmers in ATISBO Local Government Area of Oyo State, the identified socio-economic variables were subjected to a stepwise regression analysis. Stepwise regression analysis not only identifies the key variables out of so many variables that explain a phenomenon or dependent variable, but it also has the power to indicate the contribution of each independent variable to the dependent variable (Osayomi, 2012). Having subjected the variables to a stepwise regression analysis, it was then finally hypothesised that the use of indigenous methods in seasonal climate prediction and adaptation among farmers in the study area is significantly influenced by age, duration of stay in locality and education of the farmers.

The stepwise regression models are stated below:

$$Y= a+ b_1X_1+ bX_2+\ldots+b_nX_n+ e$$

Where 'Y' is the dependent variable represented by 'the use of indigenous methods in seasonal climate prediction and adaptation', 'a' intercept or constant while 'X'_1 to 'X'_3 represents farmers' age, level of education and duration of stay in locality respectively and 'e' stands for error term.

The effect of climate change on crop yield was also assessed. Crop yield was limited to the cassava crop because it is the major cash crop cultivated in ATISBO Local Government Area which contributes significantly to the income of the farmers and the revenue of the state. A 32 year period (1980-2017) was covered in order to have a better understanding of the effect of climate change on crop yields. This was categorised into 1980-1989, 1990-1999, 2000-2009 and 2010- 2017. Graphs and tables were also used in presenting the findings of this study

3. RESULTS AND DISCUSSION

3.1. The Influence of Farmers' Socio-Economic Characteristics on the Use of Indigenous Methods in Seasonal Climate Prediction and Adaptation

As presented in Table 1, the study revealed that the majority of the farmers were 60 years and above (45.2%) and had lived in the study area for more than 51 years (43.9%). In addition, the majority of the farmers had no formal education (53.8%). It was found that age of the farmers (R^2=19.7%; B=0.444) and duration of stay in locality (R^2=35.7%; B=0.598) were positive and significantly related to the use of indigenous methods in seasonal climate forecasting and adaptation Table 1. This is consistent with the findings of Warren (1991) that indigenous methods are acquired through a long association with nature. Epu (2010) also argued that as farmers get older, they become vast and efficient in the use of indigenous methods as age is vital in the accumulation of knowledge. In contrast, a negative but significant relationship (R^2=38.9%; B=-0.623) was found between farmers' education and the use of indigenous methods in seasonal climate prediction and adaptation. In a related finding, Agrawal *et al.* (2011) argued that indigenous methods are passed down orally and grasped only through long experience requiring little or no formal education. Also, the quest for formal education outside one's geographical location limits the opportunity to learn about and participate in activities relating to indigenous methods (Zambrana *et al.*, 2014). These predictors explained a significant proportion (94.3%) of the use of indigenous methods in forecasting and adapting to climate change in ATISBO Local Government Area.

Table-1. Respondents' characteristics.

Variable	Frequency	Percentage
Age		
60 years and above	123	47.3
50-59 years	44	16.9
40-49 years	42	16.2
30-39 years	41	15.8
Less than 30 years	10	3.8
Educational status		
Tertiary	18	6.9
Secondary	42	16.2
Primary	60	23.1
No formal education	140	53.8
Duration of stay in locality		
Above 51 years	114	43.9
41-50 years	72	27.7
31-40 years	36	13.8
21-30 years	20	7.7
10-20 years	14	5.4
Less than 10 years	4	1.5
Results of stepwise regression analysis on the influence of farmers' socio-economic characteristics in the use of indigenous methods in seasonal climate prediction and adaptation		
Variable	**R^2**	**Beta**
Age	19.7%	0.444
Duration of stay in locality	35.7%	0.598
Educational status	38.9%	-0.623

Source: Field survey, (2017).

3.2. Farmers' Perception of Climate Change

Interestingly, all the respondents (100%) were aware of climate change and their perceptions of climate change are presented in Table 2. It was found that the farmers observed climate change through their inability to plant twice a year. Based on the reports of the farmers, before climate change, early planting started in February while late planting started in June, however, this is no longer the case as farmers can only plant their crops once in a year due to the drastic decline in rainfall levels over the years. The disappearance of early January rain called '*Ipebu*' among the indigenes was also an indicator of changing climate. Moreover, the farmers observed the non-appearance of rainbow during the rainy season as another key determinant of changing climate. They claimed that between 5 to 10 years ago, the rainbow would always appear as an indicator of the stoppage of rain for that day, which is no longer the case in recent times.

Going forward, farmers determined changing climate through fluctuation in the onset of the wet and dry seasons. The farmers were of the opinion that the rainy season now starts in April while the dry season starts in October as against the initial period of February for the rainy season and November for the dry season. Besides, a longer spell of dry season has been observed with a shorter period of rainy season. Nevertheless, the volume of rainfall has increased. It was also reported that the intensity of soil erosion has been on the rise due to the high volume of rainfall experienced. Closely linked with this is the surge in the occurrence of flooding reported by the farmers. Fog concentration on mountains such as *Oke Iya Nla, Ijomu and Igbadi* has been observed to be on the decline, whereas in time past, the mountains were usually covered with fog which makes the mountains invisible during the early hours of the day. Although mountains have the tendency of lowering the temperature of surrounding areas, the respondents reported a steady increase in temperature over time; especially farmers living close to mountains such as *Oke Iya Nla, Ijomu and Igbadi* who observed a sudden rise in heat level in their localities. Some respondents also reported having more concentration of dust in the atmosphere unlike in times past.

Table-2. Farmers' perception of climate change.

S/N	Farmers' perception of climate change
1	Inability to plant twice a year
2	Disappearance of early January rain
3	Non-appearance of the rainbow
4	Fluctuation in the onset of the wet and dry seasons
5	Intensity of soil erosion
6	Occurrence of flooding
7	Fog disappearance on mountains
8	Increase in temperature of houses close to mountains
9	High concentration of dust in the atmosphere

Source: Field survey, (2017).

3.3. The Use of Indigenous Methods in Seasonal Climate Prediction and Adaption

Farming in ATISBO Local Government is dependent on rain fall. Despite the increasing variability in rainfall over the years, this study shows that farmers in ATISBO Local Government adopted diverse indigenous methods in forecasting the onset of the wet season which has helped in guiding their planting activities Table 3. The study revealed that the farmers used the disappearance of hawks to signal the commencement of the rainy season as hawks by their nature abhor rainfall. The change in cloud colour was also vital in forecasting the onset of the wet season, as the farmers explained that the imminent arrival of the wet season was usually accompanied by a cloudy sky. Furthermore, the farmers monitored rainfall onset through the flowering of orchid and epiphyte. Although one may want to argue that this method should have been the most important going by the large expanse of vegetation cover in the location, the farmers claimed that the method is not always reliable as plant such as *Bauhinia reticulata* called *'abafin'* among the indigenes produces its flowers during the dry season. In such a situation, it then becomes misleading relying on such a method in forecasting the onset of the rainy season. According to the farmers, the emergence of rainy season is also accompanied by intense sunlight resulting in heat at night. For some farmers, hot wind is another key indicator. In some cases, the farmers used their feet to gauge the intensity of sunlight with the inability to walk bare footed being a sign that the rainy season is fast approaching. The flowering of some trees such as mango tree, Shea butter and cashew tree were also vital determinants. The chattering of the *Senegal lark heeled* bird called *'Elulu'* among the indigenes was also important in forecasting the onset of the wet season.

The emergence of the dry season is another important factor that determines farming activities besides rainfall, and the different indigenous methods used in forecasting the onset of the dry season are presented in Table 3. The farmers observed the onset of the dry season through leaf fall as they claimed the leaves of most trees wither during the dry season. Some of the farmers also anticipated the dry season through intermittent thunderous sound produced in the sky in October which leads to the flowering of guinea corn. In some cases, the frequent laying of eggs by bush fowls on farmlands has also been identified. The farmers forecast dry season through the chirping of male crickets which usually infested their farmlands. In addition, the drastic declines in the amount of water in wells and streams due to intense sunlight have also been used by the farmers. Also, it was made known by the farmers that the moon and stars become more visible in the sky due to less cloud cover when the dry season is fast approaching. The farmers also took into cognizance the early rising of the sun, asserting that the sun appears in the sky earlier than usual at about 9am. In some cases, farmers made use of the gradual change in the colour of grasses from green to brown as it was revealed that grasses become less luxuriant when the dry season is approaching. To some farmers, the sudden appearance of hawks signal the arrival of dry season with the majority of them residing on trees. It was also reported that land becomes brownish and harder for cultivation as a result of little moisture left in the soil. The domination of the environment by grasshoppers also signals the commencement of the dry season.

The indigenous methods, especially plant phenology used by farmers in seasonal climate prediction as identified by this study, was in stark contrast with those used in Northern part of the country and some arid regions of Africa with similar climatic condition. This buttresses that fact that indigenous methods used in forecasting climate change are largely dependent on geographical location. In the Northern part of Nigeria, *Adansona digitata*, *Tamarindus indica*, *Vitex*, *doniana*, *Zimenia americana* were local methods of seasonal forecasting (Abdulrashid, 2013). The flowerings of *Parkia biglobosa*, defoliation of *Fadherbia albida*, sprouting of *Dactyocteium aegytium* are some local indicators of weather forecast in Kano, Kaduna and Bauchi States (Adunni *et al*., 2012). Similarly, in arid regions of Africa such as Chimanimani in the eastern part of Zimbabwe, the shedding of leaves by baobab and mopani trees were the key indicators of the onset of the dry season (Risisro *et al*., 2012). In semi-arid central Tanzania, plant phenology such as *Vitex ferruginea*, *Pterocarpus angolensis*, baobab and acacia trees produce leaves and flowers to indicate the beginning of the rainy season (Elia *et al*., 2014).

Climate change has made the farmers to devise ways of coping with its negative effects as presented in Table 4. The study revealed that the farmers adopted the use of multi-cropping, that is, planting different types of crops as an insurance against certain crops that may not produce well due to the adverse effects of the changing climate. It was found that cereals and legumes were planted together. The advantages of mixing crops with varying attributes are in terms of maturity period (maize and beans) and drought tolerance (maize and sorghum). This finding is in congruent with that of Akinnagbe and Irohibe (2014) that multi cropping was the commonest adaptive strategy used in all African countries except Cameroun and South Africa. The study further shows that farmers engaged in the digging of pits during the wet season to store water for use during the lengthy dry season. Even though this method is very tedious, the farmers explained that the stored water could last for about 3 months depending on the depth of the dug pit and the numbers of pits dug. In other words, through the digging of pits, the farmers in the study area have resorted to an irrigation method of farming in order to keep their crops wet during the dry season. In like manner, this method was adopted by farmers in Egypt, Kenya, South Africa, Gambia and Sudan in order to cushion the effects of rainfall variability (Akinnagbe and Irohibe, 2014).

In an attempt to cope with the negative effects of climate change, the farmers have also resorted to cultivating more farmlands in order to increase their productivity level. The farmers, however, explained that due to the increasing population, having access to lands for planting has become very difficult. Aside from this, the few farmlands available are usually jointly owned by the members of a household known as '*Agbo-ile*' among the indigenes. Conversely, it was found that some farmers shifted their planting period to a more suitable time or month. Similarly, Akinnagbe and Irohibe (2014) argued that climate change adversely affects crop production through long term alterations in rainfall leading to changes in cropping pattern. Similar adaptive measure was adopted by farmers in Cameroun, Equatorial Guinea and Central African Republic (Urama and Ozor, 2011). In order to reduce soil erosion, the farmers have resorted to contour ploughing. An akin strategy was adopted in Tanzania to minimize soil erosion and to improve root penetration as well as moisture conservation (Lema and Majule, 2009). In pursuance of improving soil nutrient, farmers have engaged in the burning of bushes and burying of crop residues. In a related finding, Lema and Majule (2009) reported that farmers in Tanzania were involved in the burying and burning of crop residues to replenish soil fertility and to improve soil organic matter.

Table-3. Indigenous methods of seasonal climate prediction among farmers.

Indicator	Description and implication
	Animal behavior
Hawk	The appearance of hawk was used to forecast the onset of the dry season while its disappearance marks the onset of rainy season
Bird	The chattering of the Senegal lark heeled bird signals the onset of rainy season
Cricket	Chirping of male crickets was used to forecast the onset of dry season
Bush fowl	Frequent laying of eggs by bush fowl indicates the commencement of the dry season
	Astronomical changes
Sunlight	Early rising of the sun, intense sunlight resulting in heat and its burning effect while walking barefooted mark the onset of the wet season
Stars and moon	Stars and moon becoming more visible in the sky are determinants of the beginning of dry season
	Atmospheric changes
Cloud	Cloudy sky marks the onset of rainy season
Thunder	Intermittent thunderous sound in October marks the onset of dry season
Wind	The blowing of hot wind indicates the commencement of rainy season
Water bodies	
Wells and streams	Decline in water level of wells and streams mark the onset of dry season
Plant phenology	
Orchid and epiphyte	Flowering of orchid and epiphyte mark the commencement of the wet season
Bauhinia reticulate	The flowering of *Bauhinia reticulata* signals the onset of the dry season

Source: Field survey, (2017).

Table-4. Indigenous methods of coping with climate change.

S/N	Coping strategies
1	Multi cropping
2	Digging of pits
3	Cultivating more farmlands
4	Change in cropping pattern
5	Contour ploughing
6	Burning of bushes and burying of crop residues

Source: Field survey, (2017).

3.4. Effectiveness and Challenges of Indigenous Methodologies in Seasonal Climate Prediction and Adaptation

From the study, a slim margin of 4% was observed between those who were of the opinion that the methods are very effective (52%) and those who expressed a contrary view (48%). Farmers who said the methods are effective argued that the possibility of the method failing is minimal and easy to understand. This was in tandem with the findings of Kolawole *et al.* (2014) that farmers in Malawi and Botswana were of the opinion that indigenous forecast tends to be more accurate and easy to understand unlike the complex scientific forecasts which requires expensive equipment, formal education and special training. In addition, it was revealed that indigenous methods can easily be shared unlike scientific methods. Orlove *et al.* (2010) in giving credence to the findings of this study stated that farmers find it easier to share knowledge on forecasts with other farmers on a wider scale which helped them to monitor the changes in seasons.

Even though the majority of the farmers claimed these methods are effective, 48% of the farmers expressed an opposite view. These farmers reported that the severity of climate change made it very difficult to predict seasonal changes. In reinforcing the findings of this study, Joshua *et al.* (2011) reported that the recent severity in climate change has reduced farmers confidence in indigenous knowledge. Furthermore, the farmers affirmed the negative perception from people that the use of indigenous methods discourages external funding from government. This was corroborated by Saitabau (2014) that there is the tendency of viewing indigenous methods as a barrier to the success of externally funded projects in connection with agricultural technology. Moreover, it was made known by the farmers that the users of indigenous methods are seen as inferior and indigenous methods are becoming disrupted by modernization. This is because the scientific method of seasonal forecasting is regarded to be superior as against indigenous methods of the farmers which are regarded as backward (Jiri *et al.*, 2016).

3.5. Effect of Climate Change on Crop Yield

In ATISBO Local Government, rainfall and temperature are important physical environmental factors affecting agricultural activities. In recent years, however, there has been a drastic decline in the amount of rainfall and rapid rise in temperature level. It was found that 75% of the farmers opined that between 1980 and 1989, the amount of rainfall was moderate while it became higher between 1990 and 1999 according to 82% of the farmers. The rainfall amount was reported to be low between 2000 and 2009 by 60.4% of the respondents while there was a drastic decline between 2010 and 2017 based on the perception of 82.2% of the respondents. On the other hand, temperature level was considered to be moderate between 1980 and 1989 in the view of 68% of the respondents. According to 73% of the respondents, the temperature was regarded to be high between 1990 and 1999, while it was interpreted to be higher between 2000 and 2009 by 81.2% of the respondents. Conversely, it became extremely higher between 2010 and 2017 according to 76% of the respondents. A comparison of the rainfall and temperature report of the farmers with empirical data on rainfall and temperature in Oyo State from 1980 to 2017 show that, truly, temperature had increased at a steady rate over the years while the amount of rainfall had also declined Figure 2.

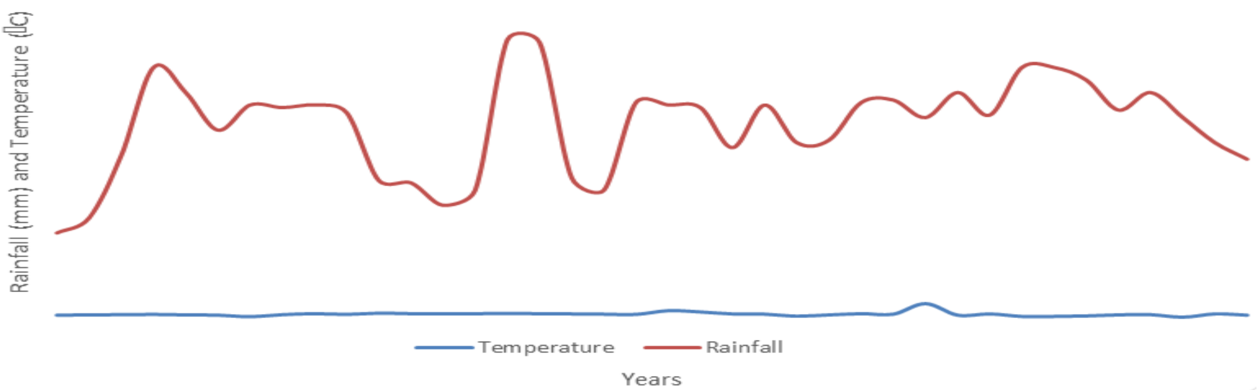

Figure-2. Annual mean maximum rainfall and temperature in Oyo State, (1980-2017).
Source: Nigerian Meteorological Agency (2017).

The fluctuation in rainfall amount and temperature level affected the crop yields of the majority (95.6%) of farmers when compared from 1980 to 2017. As presented in Table 5, between 1980 and 1989, the average kilogram of cassava harvested for a planting season was 750 when the amount of rainfall was moderate with a slight jump to 752kg between 1990 and 1999. However, between 2000 and 2009, there was a decline to 500 kilograms and a further decline to 200 kilograms between 2010 and 2017 due to severity of climate change. The percentage decline in cassava was also compared from 1980 to 2017. The average kilogram of cassava increased marginally to 34.1% between 1990 and 1999 from 34% between 1980 and 1990. It however, declined to 22.7% between 2000 with a further decline to 9.1% between 2010 and 2017. These declines show the adverse effects climate change is having on food crop production in the study area.

Table-5. Effect of climate change on crop yield.

Year	Crop yield (Cassava) in Kg	Percentage
1980-1989	750	34
1990-1999	752	34.1
2000-2009	500	22.7
2010-2017	200	9.1

Source: Field survey, (2017).

4. CONCLUSION

This study has been able to give a better insight into the indigenous methodologies used by farmers in ATISBO local government area in seasonal climate prediction and adaptation, its effectiveness and challenges. Besides, it also explored the effects of climate change on crop yield. A whole lot of indigenous methods were used by the farmers in seasonal climate prediction such as animal behaviour, plant phenology, atmospheric changes, astronomical changes and water bodies. The farmers also had in place indigenous tools for adapting with the negative consequences of climate change. Although the farmers were confident of their indigenous methods, there was no significant difference with those who have begun to doubt the efficacy of the method. This was reflected in the drastic decline of crop yields of the farmers. This shows that the severity of climate change is beginning to take its toll on the indigenous methodologies of the farmers which calls for serious concern and attention as the severity of climate change remains unabated globally. If the State is to avoid future possible famine, unemployment explosion and decline in her revenue from the sale of agricultural produce, an urgent attention should be given to the challenges faced by farmers in ATISBO local government dubbed the food basket of Oyo State. The government should ensure that farmers have access to scientific climatic information to plan their planting activities. Also, it would be expedient to have an agricultural research institute located in the local government area to carryout research relating to agriculture and to enlighten the farmers on modern agricultural practices. Despite the challenges facing the indigenous methodologies used by farmers, its importance cannot be underestimated. For a developing country like Nigeria where majority of the farmers do not have access to scientific climatic information, the preservation and integration of indigenous methods with scientific methods of seasonal climate prediction will be of great benefit.

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REFERENCES

Abdulrashid, L., 2013. In sustainability of indigenous knowledge in seasonal rainfall forecast and farming decision in semi-arid areas of Katsina State. Nigeria International Journal of Arts and Commerce, 2(4): 35-46

Adeleke, R., 2018. Climate variability and is effects on school attendance in selected public senior secondary schools in urban areas of Ibadan, Nigeria. Asian Journal of Geographical Research, 1(2): 1-10.

Adunni, S.S., K.O. Oluwasemire and N.O. Nnoli, 2012. Traditional capacity for weather prediction, variability and coping strategies in the front line states of Nigeria. Agricultural Sciences, 3(04): 625-630.Available at: https://doi.org/10.4236/as.2012.34075.

Agrawal, A., 1995. Indigenous and scientific knowledge: Some critical comments. Indigenous Knowledge and Development Monitor, 3 (1): 33-41.

Agrawal, B., S. Das and A. Pandey, 2011. Boerhaavia diffusa Linn: A review on its phytochemical and pharmacological profile. Asian Journal of Applied Sciences, 4(7): 663-684.

Akinnagbe, O. and I. Irohibe, 2014. Agricultural adaptation strategies to climate change impacts in Africa: A review. Bangladesh Journal of Agricultural Research, 39(3): 407-418.Available at: https://doi.org/10.3329/bjar.v39i3.21984.

Asian Development Bank, 2014. Technologies to support climate change adaptation in developing Asia. Philippines: Philippines press; pp 1-206. Retrieved December 20, 2018 from https://www.adb.org/sites/default/files/publication/149400

Balaji, V. and P. Craufurd, 2011. Using information and communication technologies to disseminate and exchange agriculture-related climate information in the Indo Gangetic Plains. © 2011 CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) 2011.

Berardy, A. and M.V. Chester, 2017. Climate change vulnerability in the food, energy, and water nexus: Concerns for agricultural production in Arizona and its urban export supply. Environmental Research Letters, 12(3): 035004.Available at: https://doi.org/10.1088/1748-9326/aa5e6d.

Bickis, I., 2017. Farmers turn to specialized forecasting in face of rising extreme weather threat. Canada: The Canadian Press. Retrieved from https://www.citynews1130.com/2017/08/11/farmers-turn-to-specialized-forecasting-in-face-of-rising-extreme-weather-threat/

Dusky, J., M. Spranger and C. Fraisse, 2009. Extension and the climate change challenge: Providing climate services to citizens and communities. Southern Climate.

Elia, E.F., S. Mutula and C. Stilwell, 2014. Indigenous knowledge use in seasonal weather forecasting in Tanzania: The case of semi-arid central Tanzania. South African Journal of Libraries and Information Science, 80(1): 18-27.Available at: https://doi.org/10.7553/80-1-1395.

Epu, P., 2010. Facilitating innovation for development. Journal of Research and Applied Sciences, 6(3): 129-132.

Jena, M., 2015. How technology is helping farmers to adapt to climate change. Toronto: World Economic Forum. Retrieved from https://www.weforum.org/agenda/2015/10/how-technology-is-helping-farmers-adapt-to-climate-change

Jiri, O., P.L. Mafongoya, C. Mubaya and O. Mafongoya, 2016. Seasonal climate prediction and adaptation using indigenous knowledge systems in agriculture systems in Southern Africa: A review. Journal of Agricultural Science, 8(5): 156.Available at: https://doi.org/10.5539/jas.v8n5p156.

Joshua, K.-M., C. Ngongondo, L. Chipeta and F. Mpembeka, 2011. Integrating indigenous knowledge with conventional science: Enhancing localised climate and weather forecasts in Nessa, Mulanje, Malawi. Physics and Chemistry of the Earth, Parts A/B/C, 36(14-15): 996-1003.Available at: https://doi.org/10.1016/j.pce.2011.08.001.

Julius, A., 2013. Impacts of gender and farmers' level of education on access to agricultural extension services in Abuja, Nigeria. International Journal of Agricultural Economics and Extension, 1(7): 055-060.

Kloppenburg Jr, J., 1991. Social theory and the de/reconstruction of agricultural science: Local knowledge for an alternative agriculture 1. Rural Sociology, 56(4): 519-548.Available at: https://doi.org/10.1111/j.1549-0831.1991.tb00445.x.

Kolawole, O.D., P. Wolski, B. Ngwenya and G. Mmopelwa, 2014. Ethno-meteorology and scientific weather forecasting: Small farmers and scientists' perspectives on climate variability in the Okavango Delta, Botswana. Climate Risk Management, 4: 43-58.Available at: https://doi.org/10.1016/j.crm.2014.08.002.

Lema, M. and A.E. Majule, 2009. Impacts of climate change, variability and adaptation strategies on agriculture in semi arid areas of Tanzania: The case of Manyoni District in Singida Region, Tanzania. African Journal of Environmental Science and Technology, 3(8): 206-218.

Mgbenka, R. and E. Mba, 2016. A review of small holder farming in Nigeria: Need for transformation. International Journal of Agricultural Extension and Rural Development Studies, 3(2): 43-54.

National Population Commission, 2006. Population and housing census of federal republic. Housing characteristics and amenities table. Nigeria; NPC. Priority Table, 2: 372. Retrieved from https://nigeriacrvs.gov.ng/

Nigerian Meteorological Agency, 2017. Temperature and rainfall distribution in Oyo State. Available from http://www.nimet.gov.ng/.

Olukunle, O.T., 2013. Challenges and prospects of agriculture in Nigeria: The way forward. Journal of Economics and Sustainable Development, 4(16): 37-45.

Olutegbe, N. and O. Fadairo, 2014. Correlates and determinants of climate change adaptation strategies of food crop farmers in Oke-Ogun area of South-Western Nigeria. Journal of Agricultural Extension and Rural Development 8(7), pp. 122-129, July, 2016.

Orlove, B., C. Roncoli, M. Kabugo and A. Majugu, 2010. Indigenous climate knowledge in Southern Uganda: The multiple components of a dynamic regional system. Climatic Change, 100(2): 243-265.Available at: https://doi.org/10.1007/s10584-009-9586-2.

Osayomi, T., 2012. Regional determinants of road traffic accidents in Nigeria: Identifying risk areas in need of intervention. African Geographical Review, 32(1): 88-99.Available at: http://dx.doi.org/10.1080/19376812.2012.750224.

Risisro, J., D. Mashoko, E. Rurinda and D. Tshuma, 2012. Weather forecasting and indigenous knowledge systems in Chimanimani District of Manicaland, Zimbabwe. Journal of Emerging Trends in Educational Research and Policy Studies, 3(4): 561-566.

Risisro, J., D. Tshuma and A. Basikiti, 2013. Indigenous knowledge systems and environmental management: A case study of Zaka District, Masvingo Province, Zimbabwe. International Journal of Academic Research in Progressive Education and Development, 2(1): 19-39.

Saitabau, H., 2014. Impacts of climate change on the livelihoods of loitamaasai pastoral community and related indigenous knowledge on adaptation and mitigation. Retrieved from http://www.ethnobiology.net/wp-content/uploads/From-the-Field_Henry_ISE-Paper-2014

Senanayake, S., 2006. Indigenous knowledge as a key to sustainable development. Journal of Agricultural Sciences–Sri Lanka, 2(1): 87.Available at: https://doi.org/10.4038/jas.v2i1.8117.

Umunna, M., A. Adeeko, O. Onifade, O. Adigun and A. Apapa, 2012. Poultry farmers' access to extension services in Atisbo aocal government area of Oyo State, Nigeria. African Journal of Basic & Applied Sciences, 4(6): 221-225.

Urama, K. and N. Ozor, 2011. Agricultural innovations for climate change adaptation and food security in Western and Central Africa. Agro-Science, 10(1): 1-16.Available at: https://doi.org/10.4314/as.v10i1.68717.

Usman, I., A. Girei and A. Salihu, 2015. Assessments of the relationship between socio-economic characteristics of Nomadic Cattle Fulani's and the use of indigenous control methods of Helminthosis in cattle in Adamawa State, Nigeria. Scholars Journal of Agriculture and Veterinary Sciences, 2(3A): 195-200.

Warren, D., 1991. Using indigenous knowledge in agricultural development. World bank discussion papers; no WDP 127. Washington DC: The World Bank. Available from http://documents.worldbank.org/curated/en/408731468740976906/Using-indigenous-knowledge-in-agricultural-development.

Wreford, A., D. Moran and N. Adger, 2010. Climate change and agriculture; impacts, adaptation and mitigation. Paris: OECD Press. Retrieved from https://www.cabdirect.org/cabdirect/abstract/20103233880

Zambrana, P.-N., R. Camara-Lerét, R. Bussmann and M. Macía, 2014. The influence of socioeconomic factors on traditional knowledge: A cross scale comparison of palm use in Northwestern South America. Ecology and Society, 19(4): 9.Available at: https://doi.org/10.5751/es-06934-190409.