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Accuracy of Indigenous Knowledge for Predicting Farming Seasons among Crop Farmers in Ogun State, Nigeria

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Abstract
This study assessed the accuracy of indigenous knowledge for predicting farming seasons among crop farmers in Ogun State by employing a cross-sectional survey research design. A multistage sampling procedure was used to select 250 crop farmers from the four extension zones in Ogun State. Additionally, two key informant interviews (KII) and one focus group discussion (FGD) were held in each farming community. Quantitative data were obtained using an interview schedule, while qualitative data were obtained using checklists for KII and FGD. Quantitative data were subjected to frequency counts, percentages, means, standard deviations, and thematic analysis. Results revealed that 55.6% and 51.2% of the farmers cultivated annual crops and were not involved in livestock rearing, respectively. The incidence of the dry season was predicted mostly by the dropping of leaves from the fig tree (73.2%), almond leaves (70.4%) and sprouting of the Lantana plant (61.6%). Heavy budding of the acacia tree (70.0%), sprouting of *Aloe ferax* in the mountain (70.8%), and development of young leaves and grasses in the field (76.0%) were some of the indicators used in predicting the rainy season. Some translational meanings derived from the qualitative data are that the appearance of rainbirds and chameleons predicts the onset of the rainy season. At the same time, the defoliation of almond trees and African teaks indicates the start of the dry season. Furthermore, farmers' predictions of farming seasons were relatively consistent with science-based climate information. The study concluded that indigenous knowledge indicators are relatively accurate in predicting farming seasons compared to science-based climate information.
Keywords: Agricultural practices, Chameleon, Climate information, Fig tree, Local knowledge, Predictive indicators, and Seasonal forecasting

Introduction

By 2050, there will be 9.1 billion people on the planet, a 34% increase in population (Food and Agriculture Organisation - FAO, 2019). The majority of this expansion will take place in underdeveloped nations like Nigeria. Specifically, Nigeria has been projected to be the third most populous country by 2050 (Worldometer, 2024). A 70 percent increase in food production is necessary to feed a population that is growing, urbanizing, and becoming wealthier (FAO, 2019). In contrast to the previous 2.1 billion tonnes, an estimated 2009 report by FAO predicted that annual cereal production would need to increase to roughly 3 billion tonnes, while annual meat production is anticipated to rise to more than 200 million tonnes to reach 470 million tonnes (FAO, 2009a). Due to population trends, there would be tremendous pressure on all agricultural subsectors, including forestry and fisheries, to produce enough food, feed, and fibre in addition to earning a living and providing jobs and ecosystem services, all while meeting the demands of combating climate change (FAO, 2019). The challenge is to sharply boost agricultural output to ensure food security for all while preserving the foundation of natural resources and adapting and mitigating the effects of climate change (FAO, 2009b). Farming remains the dominant economy of rural farmers in different parts of Nigeria, with farmers engaging in varying enterprises (ActionAid, 2016). Among the varying farm enterprises managed by rural farmers, crop cultivation remains outstanding, arising from the heavy dependence of the generality of the Nigerian populace on crop-based food consumption. Crop cultivation in the country depends on rainfall distribution, with varying patterns across the country. According to Nnadi *et al*. (2019), rainfall distribution, particularly in the southern tropical part of the country, runs between April and October with a temporary cessation in August, thereby determining not only the farming season in the country but also the growing periods for specific crops. Amelioration of the farming activities to fit into the rainy pattern thus engendered the need for the farmers to be timely informed about the agro-climatic situation of their farming environment.

In conjunction with the Nigerian Meteorological Agency, the extension advisory services are responsible for providing farmers with relevant and up-to-date climatic information. The farmers relied on their local knowledge of agro-climate to forecast the weather situation and guide their crop production decisions (Naswen and Ejembi, 2017; Feed The Future, 2019). Although it has been widely established that the local knowledge had long worked for the farmers using various biotic and abiotic indicators to predict and determine their farming activities, the evolution of climate change at the turn of the century has, however, challenged the farmers' efficient farm and environmental management for sustainable production and quality living. It is commonly recognized that the threat of climate change has worsened poverty and caused people to face more difficulties, particularly in underdeveloped nations with inadequate infrastructure and economic stability (Intergovernmental Panel on Climate Change – IPCC, 2014; Hallegatte *et al*., 2016). Meteorological specialists are making extra efforts and using cutting-edge technologies to monitor the climate and lessen its associated issues (World Bank, 2019; World Meteorological Organization – WMO, 2020). This is frequently accomplished by efficient weather monitoring, precise forecasting, and the dissemination of early warning signals or information to farmers so they can prepare for any potential effects of this change (Ceola *et al*., 2014; Kogan *et al*., 2019). Despite efforts to spread fact-based climate information, rural farmers find it difficult to obtain it. Therefore, they must rely on traditional wisdom to monitor the weather (Hansen *et al*., 2011; Tall *et al*., 2014).

With the heavy dependence of the local farmers on the use of indigenous knowledge of weather monitoring and prediction, it becomes essential to look at the local knowledge of weather monitoring in the face of the pervasive and farm-threatening climate change in Ogun State. The effectiveness of the indigenous knowledge used by rural farmers across the State needs to be ascertained for conformity with global technological advances and for precision and reliability in mitigating climate change for sustainable crop enterprise production. Specifically, the objectives of the study are to assess farm enterprise production practices, identify the Indigenous knowledge indicators for predicting rainy and dry seasons, assess the translational meanings of the indicators, and assess the accuracy of the Indigenous knowledge system in comparison with science-based weather monitoring.

Methodology

Study area

This study was conducted in Ogun State which is one of the six Southwestern States in Nigeria. The agroclimate of the State is characterized by a bimodal rainfall pattern of about seven months, which occurs from April to October, with temporary cessation in August and a Peak in July—the dry season of about 4 to 5 months which often sets in in November and runs through March. Seventy percent of the State's land area is suitable for arable crop production. Rice, corn, cassava, yam and bananas are the principal food crops. The principal cash crops are rubber, palm oil, cocoa, kola nuts, and palm kernels. The farming system is, however, largely rain-fed agriculture, with farmers depending on rainfall for farming activities. With this, the farming system and the farming activities of the farmers are greatly influenced or affected by the trending climatic change.

Sampling techniques and sample size

A multistage sampling procedure was adopted in this study. Stage one involved randomly selecting one-third of the local government areas in the four Extension zones. This resulted in selecting six extension blocks (Ilugun, Opeji, Sawonjo, Ala, Ibiade, and Obafemi). Stage two involved randomizing half of the circles/communities in the selected blocks, selecting 21 communities through a cluster sampling technique. Stage three involved the convenient sampling of 250 farmers from the selected communities based on availability and readiness to participate in the research.

Measurement of key variables

Farmer enterprise production practices: This was measured as the kinds of crops (annual or perennial crops) cultivated and livestock animals (poultry, fishery, pig, sheep and goat) reared by the respondents.

Indigenous knowledge systems for weather monitoring: This was measured at the nominal level by asking respondents to indicate which indicators predict rainy and dry seasons.

Translational meaning of the IKS indicators: This was measured qualitatively through in-depth interviews and focus group discussions to get deeper insights into the meaning of the different IKS indicators.

Accuracy of indigenous weather monitoring system: This was determined by matching the local knowledge indicators with the science-based weather forecasting indicators.

Methods of data analysis

Collected data were cleaned, coded and entered into the Statistical Package for Social Sciences – SPSS version 21.0. This study was subjected to frequency counts, percentage, mean, standard deviation and thematic analysis.

Results and Discussion

Farm enterprise production practices

Types of crops cultivated by surveyed farmers are presented in Figure 1. It demonstrates that 55.6 percent of the farmers farmed annual crops, compared to 5.6% who only farmed perennials. Both annual and perennial crops were cultivated by 38.8 percent of the farmers. This high proportion of arable crop production is attributed to the regular demand for food crops by households in general and satisfying the farmers' immediate food needs. In addition, the annual crops take a relatively shorter production cycle than the perennial crops and form the basis for regular cash flow required by the farmers to satisfy their economic and other basic essential household needs. Figure 2 reveals that 34.4%, 5.6%, 9.6% and 13.2% kept poultry, fishery, pig and sheep/goats, respectively, while 51.2% of the farmers kept no animals. The observed low proportion of farmers in animal production could be attributed to the high cost of livestock production in terms of feeds and other inputs. The rural farmers are generally poorly resourced and, as such, find it difficult to raise farm animals on a commercial scale. Respondents were mostly involved in poultry production. This is underscored by the fact that the birds reproduced faster than any other animal and, are largely local breeds, are reared in an extensive system, which is less expensive as the system hardly requires that the farmers provide regular feed and medication or even housing units for the birds. The birds fend for themselves and reproduce with little or no farmer input. Consequently, the farmers largely consume the birds and sometimes sell them to raise or make some income. The same extensive management system was adopted for rearing sheep, goats, and pigs.

Indicators for predicting dry and rainy seasons

Table 1 shows the indicators of indigenous knowledge that predict the incidence of dry season. The result reveals that the majority of the farmers used the dropping of leaves of fig trees (73.2%) and dropping of Almond leaves (70.4%) as biological indicators to predict the incidence of the dry season, and 61.6% of them used sprouting of Lantana plant (*Lantana spp*) as biological indicators. More than half (52.8%) of the farmers used the appearance of rainbows as an astronomical indicator for predicting the dry season, while close to half (47.6%) used the appearance of red clouds to indicate the incidence of the dry season. Increased intensity of temperature and hotness of the wind were used by 50.4% and 50.0% of the farmers as atmospheric indicators for predicting the dry season, respectively. This implies that the farmers had a substantial indigenous knowledge base for predicting dry season, especially with regard to the biological, astrological and atmospheric indicators. Though there are some variations, Chikaire *et al*. (2018) documented that farmers in Imo State made use of drying of fruits on trees, dropping of immature fruits, increased occurrence of termites, shedding of the leaves, morning star appearing in the east, red clouds appearance on sky and appearance of rainbows as important indicators for predicting dry season. This Indigenous knowledge was used by Mr. Babalola, a 67-year-old participant in a focus group discussion, who related the peak of the dry season between December and January. Madam Adunni at Oja-Odan, during an in-depth interview, posited that the dry season has been between October and February. She also observed that the dry season peaks between November and December. These findings align with Williams *et al.* (2018) submission that local knowledge ideas comprising sightings and sounds of uncommon birds, leaf droppings and warmer soil than normal temperature on barefoot are valuable indicators for climatic prediction by rural farmers for sustainable agriculture and food production. For the indicators of the onset of the rainy season, Table 2 shows that higher proportions of the farmers relied on biological elements such as heavy budding of the acacia tree (70.0%), sprouting of *Aloe ferax* in the mountain (70.8%), development of young leaves and grasses in the field (76.0%), heavy fruiting of wild mango (75.2%), the appearance of a large number of ants (74.0%), frequent sounds of frogs in the bush (76.8%), high occurrence of bees in gardens (60.0%), the appearance of millipedes (62.0%), appearance of migratory birds (60.4%), nestling of birds (64.8%), appearance of army worms on trees (66.4%), and appearance of butterflies (52.0%). Results in Table 2 further reveal that some farmers used astronomical indicators, including moisture surrounding the moon, moon crescent facing downward, and red rainbow colour dominating the sky to predict the onset of the rainy season. More than half of the farmers also used moistened soil when felt by hand (58.0%) as an atmospheric indicator. Some of these indicators have been reported to have been used by rural farmers across agrarian communities in Imo (Chikaire *et al.*, 2018) and Akwa Ibom (Williams *et al*., 2018) States for predicting the onset and cessation of the rainy season. It generally implies that rural farmers are making use of locally available nature-based resources, such as trees, plants, insects and other biotic organisms, as well as astronomical and atmospheric resources for prediction of local weather conditions and use as adaptation measures in the face of climate change (Building Nigeria's Response to Climate Change – BNRCC, 2011; Zongo *et al*., 2022).

Translational meanings of IKS

The results of in-depth interviews across the study locations on the indigenous indicators used by farmers to predict seasons and determine what and when to plant are summarized in Table 3. The onset of the rainy season was depicted by the appearance of rain birds (*Elulu*) and Chameleon (*Oga*), as well as fig (*Opoto*) tree blossoms and the swarming of white flies. The cessation of rainfall or the start of the dry season was described to occur when there is defoliation of the Almond tree and African teak, cricket crows, and when the Oak tree and the Flamboyant plant shed leaves. Clear moons and stars also appear during the dry season. The cloud covering the moon was used to depict the peak of raining season, while dark clouds show that rain is coming. When soldier ants become rampant and the African tulip tree sheds leaves in August, it begins the late rainy season. Termites building hills is an indication of drought. The Pied Crow bird's appearance was considered an omen for the farmers as drought was imminent. The use of birds, vegetation, animals and creatures for weather forecasting has also been documented in other African countries, such as Zimbabwe (Shoko, 2012), with varying translational meanings.

Accuracy of Indigenous knowledge system

Predictions of farming season using the indigenous knowledge system vis-à-vis historical science-based climate data are presented in Table 4. It also includes the farming activities carried out by crop farmers in Ogun State. Occurrences of rainfall for farming season using the science-based data are also presented in Figure 3 for comparison. Findings reveal that the local people, using the Indigenous knowledge systems, predicted that the first rain was in mid-February; also, science-based climate data indicated that the change occurred between February and March. Also, the local people predicted the onset of rainfall in March, while the climate data observed the same between March and April. Rainfall establishment, humid period and cessation of rainfall were accurately predicted in April – May, May – October, and October – November, respectively. However, using the Indigenous indicators, the local farmers indicated that the dry season was from December to February, while the science-based climate data specified December to March. This means that there is a high correlation between the farmers' predictions and science-based climate information on weather forecasts for determining farming seasons. The implication is that where the farmers have no access to science-based weather forecasts, they can still reliably utilize the indigenous knowledge system to prepare for farming activities. Farmers' predictions of the onset, establishment, and cessation of rainfall and the humid and dry periods were relatively accurate compared to formal meteorological data. This high correlation suggests that indigenous knowledge can complement science-based climate information, offering a more holistic approach to weather forecasting and agricultural planning. This research supports blending scientific techniques and indigenous wisdom to improve agricultural resilience. For example, Nyong *et al.* (2007) stressed how crucial it is to include traditional ecological knowledge in measures for adapting to climate change. Likewise, Orlove *et al*. (2010) emphasized that local knowledge systems can increase the precision of weather forecasts and offer insightful information about environmental changes.

Conclusion

Based on the findings from this study, it was deduced that local farmers are highly rich in the use of indigenous knowledge systems, which are mainly based on the behaviours of plants, trees, animals and astronomical indicators. The study concluded that indigenous knowledge indicators accurately predict farming seasons, supporting farmers' agricultural activities. Hence, the study recommended that extension agencies help document indigenous knowledge systems in all Ogun State farming communities. This can be in documentaries and books and archived in libraries. An Indigenous Knowledge Hub or Institute should be established for further scientific research, and IKS should be integrated with science-based resources for weather forecasting.

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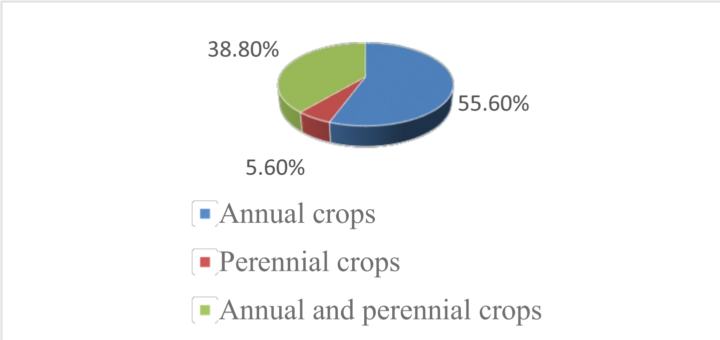


Figure 1: Distribution of farmers by types of crops cultivated

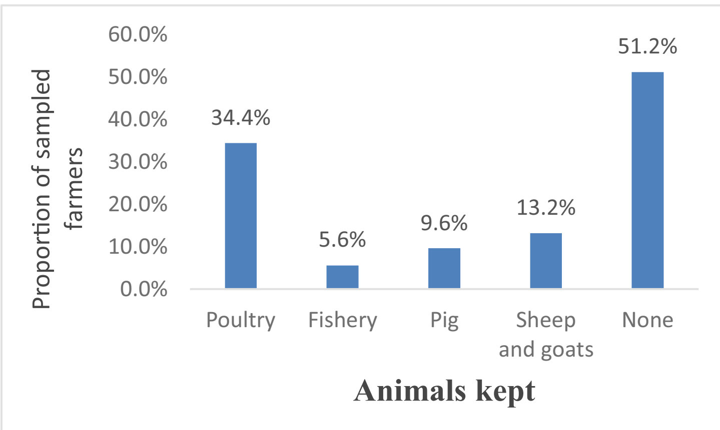


Figure 2: Distribution of farmers by animals kept

Table 1: Indigenous knowledge indicators for predicting dry season (n = 250)

Indicators	Frequency	Percentage
Biological indicators*		
Dropping of fig tree (*Ficus carica*) leaves	183	73.2
Fruits dropping before maturity	176	70.4
Increased appearance of termites	106	42.4
Sprouting of *Lantana spp*	154	61.6
Astronomical indicators*		
Morning stars appearing in the east	84	33.6
The appearance of red clouds	119	47.6
Appearance of rainbows	132	52.8
Atmospheric indicators*		
Increased intensity of temperature	126	50.4
Frequent occurrence of strong winds	106	42.4
Hotness of the wind	125	50.0

*** Multiple responses**

Table 2: Indigenous knowledge indicators for predicting rainy season (n=250)

Indicators	Frequency	Percentage
Biological indicators*		
Heavy budding of the acacia tree	175	70.0
Sprouting of *Aloe ferax* in the mountain	177	70.8
Development of young leaves and grasses in the field	190	76.0
Heavy fruiting of wild mango	188	75.2
Appearance of a large number of ants	185	74.0
Frequent sounds of frogs in the bush	192	76.8
High occurrence of bees in gardens	150	60.0
Appearance of millipedes	155	62.0
Appearance of migratory birds	151	60.4
Nestling of birds	162	64.8
Appearance of army worms on trees	166	66.4
Appearance of butterflies	130	52.0
Astronomical indicators*		
Moisture surrounding the moon	117	46.8
Moon crescent facing downward	121	48.4
Red rainbow colour dominates the sky	119	47.6
Atmospheric indicators*		
The eastward direction of the wind	113	45.2
High night temperature	115	46.0
Moistened soil when felt with hand	145	58.0

*** Multiple responses**

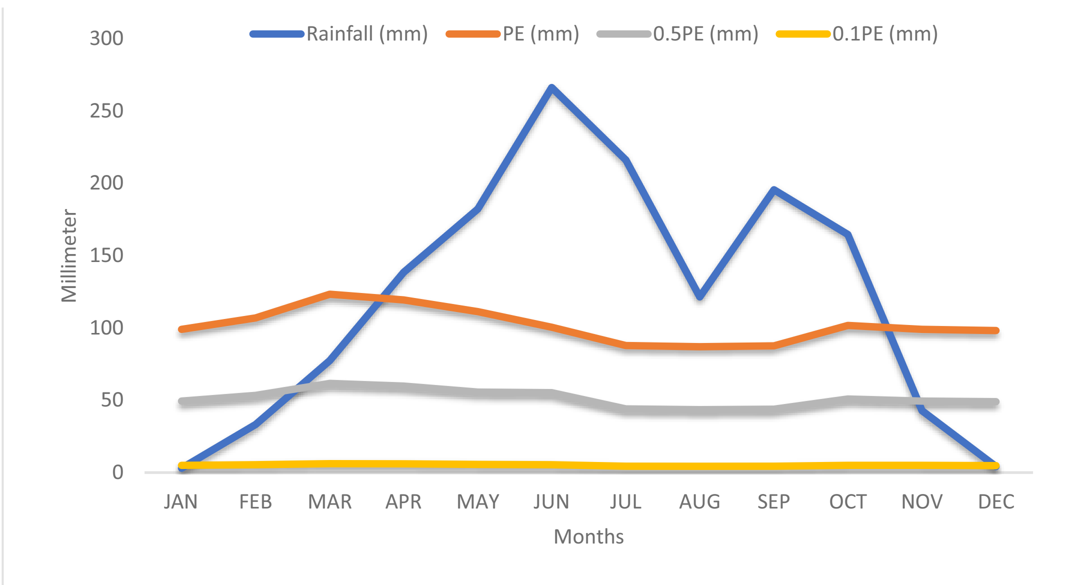
Table 3: Meanings given to some Indigenous indicators by farmers

Indicator	Observed events	Months	Translation
Almond tree (*Terminalia catappa*)	Defoliation of Almond tree	November	The start of the dry season
African teak (*Chlorophora excelsa*) - Iroko tree	Defoliation of *Iroko* tree	November - February	Cessation of rainfall (November - February)
Oil palm (*Elaeis guineensis*) - Igi Ope	Maturity of oil palm for harvest	December - January	Harmattan (December – January)
Fig tree (*Ficus carica*) – Opoto	*Opoto* tree blossoms	April	Marks the onset of the rainy season
Pied Crow bird (*Corvus albus*) – Kannakanna	Appearance of the bird	April – October	Bad omen for farmers (drought)
Rain bird (*Cacomantis spp.*) – Elulu	Noisy sound (cry) has the power to cause rain	February – March	Marks the onset of the rainy season
Soldier ant (*Eciton* spp) – Ijalo	When soldier ants are rampant	August – October	Late raining season
Cricket (*Acheta domesticus*) – Ire	Cricket chirp	September - October	The onset of the dry season
African tulip tree (*Spathodea campanulata*) – Orulu	Shedding of leaves in August	August	Marks late rain
Chameleon – (*Chamaeleo calyptratus*) Oga	Chameleon appears	April	Marks the onset of rain
White flies (*Bemisia tabaci*)	When white flies swarm	April	The onset of rain
Termites (Isoptera) – Ikan	When termites build hills	November – March April - October	An indication of drought and Raining season
Oak tree (*Quercus alba*) – Odan	Defoliation of leaves Leaves flourish	December – February May - July	Dry season Raining season
Flamboyant plant (*Delonix regia*)	*Flamboyant* plant sheds leaves	November - February	Dry season
Moonlight	Moonlight occurs between February and March, and the heat intensity will increase.	February, March	Dry season
Cloud	Occurrence of clouds	June - July	Dark clouds signal that rain is coming; Clouds covering the moon mark the peak of rainfall.
Moon and star	Brightness of the moon and star	November - March	Clear moon - end of a rain event

Source: Focus Group Discussions and Key Informant Interviews

Table 4: Accuracy of farming season prediction using Indigenous knowledge system

Farming seasons	Indigenous predictions	Science-based climate data	Farming activities
First rain	Mid - February	February - March	Pre-planting operations: site selection, bush clearing, stumping,
Onset of rainfall	March	March - April	Mound making/ridging, nursery preparation, manure application, seed treatment, ploughing, harrowing, and nursery practices.
Rainfall establishment	April - May	April - May	Planting, weeding, thinning, supplying
Humid period (rainy season)	May - October	May - October	Weeding, fertilizer application,
a.First peak of rain	June - July	June - July	Weeding,
b. August break	August	August	Mulching, weeding,
c. Second peak of rain	September	September	Weeding,
Cessation of rainfall	October - November	October - November	Mulching, harvesting
Dry season	December - February	December - March	Post-harvest practices: processing, marketing, storage, and preservation of farm produce



PP IP HP IP

PP = Preparatory Period IP = Intermediate Period HP = Humid Period

Figure 3: Occurrences of rainfall using climate-based data