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Original Research Article

Application of Indigenous Knowledge in Weather and Climate Forecast for Planning Farm Activities by Farmers in Imo State, Nigeria

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Abstract

The study assessed the application of Indigenous Knowledge (IK) on weather and climate forecasting for planning farm activities by farmers in Southeast, Nigeria. Questionnaire was used to elicit information from a total of 360 farmers, complement with oral interview. Mean (M) was used to analyze data. Results showed that IK indicators commonly used for weather and climate forecasting fall into 3 categories namely trees, animals and atmospheric indicators. The IK indicators used to predict the dry season and harmattan were-fruits drying/falling off from trees, increase occurrence of termites, shedding of tree (M=2.40), appearance of rainbows (M=2.53) among others. The indicators for onset of the rains included flowering of trees (M=304), heavy budding of acacia tree species (M=300), dormancy breaking in certain tree/fruit species, Others were appearances of large number of ants, frequent sounds of frogs, appearance of ant hill, appearance of millipedes, appearances of army worms, dark clouds appearance, body feels heat at night, increased body pain, mist covering hilly areas among other signs. As a recommendation, the knowledge of indigenous peoples should be included when designing climate change adaptation strategies in SSA.

Keywords: Weather, climate change, planning, forecast, indigenous knowledge

INTRODUCTION

Agriculture is a complex and challenging operation due to a number of factors, such as low soil fertility, changing social and political situations, an unfavourable economic environment and a variable climate (Osbahr and Allan, 2003). Farmers in semi-arid areas depend solely on rainfall, yet this is typically variable, both spatially and temporally. There is evidence to show linkages between droughts and development (or lack of it), given that rain-fed agriculture, which is very sensitive to weather, accounts for 70% of food production across Africa (UNISDR *et al*., 2008; Hellmuth *et al*., 2007). This ushers in the need for effective early warning systems that contribute to addressing the cycle of droughts and subsequently, reduce their negative impacts (Masinde, 2015). Efforts by farmers to address these challenges and their use of indigenous knowledge systems (IKS) as a key component have been highlighted in literature. One of the key uses of IKS includes using various forms of traditional indicators to predict weather and climate and also to respond to climate risks (Joshua *et al*., 2011). There is evidence to show that, as a result, farmers have developed and relied on traditional systems to adapt to variable rainfall. These traditional systems worked for centuries as they relate to local lifestyles, institutional patterns and social systems (Mbilinyi *et al*., 2005).

Reducing the impact of climate variability and change on food production and livelihoods can be achieved. This is in part by using available climate information to anticipate and manage the impacts related to climate risks (Washington *et al*., 2006). Climate information is

available from two main sources: meteorological forecasts and indigenous knowledge (IK). This information can help farmers to manage their crops and livestock to reduce risk during unfavorable seasons and maximise opportunities during favourable conditions. There is scope in Africa to substantially increase the use of climate information and services in planning to reduce

the threat of climate variability and change and achieve development goals. More effective use of climate information and services by both vulnerable groups and institutions charged with managing impacts of changing climate will enable the climate-sensitive sectors of African societies to cope better with the natural variability of the climate system. This will allow better adaptation to the impacts of climate change.

However, little attention has been paid to the connection between indigenous perspectives and observations to potential climate response or adaptation strategies. It is also disturbing that national adaptation plans in Africa, which act as frameworks for implementing adaptation programmes, place limited significance on IKS as shown by studies conducted across the continent (Nkomwa *et al*., 2014). To date, little is known about specific details of farmers' physical and biological knowledge and how this knowledge is used to make farm management decisions (Osbahr and Allan, 2003). This paper therefore, fills that need. The specific objective was to ascertain farmers use of indigenous knowledge in weather and climate forecast in Imo State.

METHODOLOGY

The study was carried out in Imo State of Nigeria. Imo State is located in the South-eastern zone of Nigeria and lies between latitude 4045oN and 70 15 N and longitude 6o 50E with land area of 5,530 km2. There are twenty seven (27) Local Government Areas in the State. The state has a Ministry of Agriculture that supervises Agricultural activities in the state under the state ADP (Agricultural Development Project). Imo State Agricultural Development Programme is structured into three (3) Agricultural Zones viz Okigwe, Orlu and Owerri. Okigwe and Orlu Agricultural Zones have 10 Extension Blocks each, while Owerri has 18 Extension Blocks. The population of the study consists of all registered farmers (within the age bracket of 50 and above, this is for experienced farmers to talk to us) in the 38 Blocks that make the three agricultural zones. A list of all registered farmers in the zone (with age 50 and above) was obtained from the ADP office in the zonal headquarters. The list has a total number of about 3600 farmers and 10% was selected which gives a total sample size of 360 farmers. Data collected from use of questionnaire were analyzed using descriptive statistics. This includes use of mean, presented in table to achieve the objectives of the study, especially objectives 1 and 2, While objectives 1 and 2 will be achieved on a three point likert-type scale of strongly agree, agree, and disagree assigned weight of 3, 2 and 1. The weighted index was added to give 6 divided by 3 to give 2. Any value less than 2 was regarded as not signs for weather forecasting. Any value less than 2.50 was not accepted while values of 2.5 and above was taken as accepted

RESULTS AND DISCUSSION

Indigenous Signs Used by Farmers for Predicting Dry Season

Table 1 revealed that traditionally, rural farmers have for generations relied on indigenous knowledge to understand weather and climate patterns in selecting crops and farming practices. Table 1 showed indigenous indicators comprising trees, animals and the atmosphere for preparation for farming activities. The indicators for dry season included drying of fruits on trees with a mean score of (M=2.11), immature fruits dropping before maturity (M=2.19), increase occurrence of termites (M=2.08), shedding of the leaves, extended cold days in the environment (M-2.96), strong winds when about to rain (M=2.23) , cold weather amid rainy season (M=2.27), morning star appearing in the east (M=3..00), red clouds appearance on sky (M=2.13) and appearance of rainbows (M=2.53)

Indigenous Signs for Predicting Rainy Season – Trees, Animals and Atmospheric

Table 2 showed great signs of rainy season using indigenous weather forecasting. Since most of the agricultural practices in sub - Saharan African is rain - fed, knowledge of the onset and cessation of rains is key to the timing of most farm activities. Based on results from field as shown in table 2, tree indicators of onset of rainy season includes; flowering of peach tree (*Prunus persica*) M=3.04), heavy budding of the acacia tree species (M=3.01), development of young leaves and grasses in fields (M=2,20).

Again animal indicators of rainy season includes- appearance of large number of ants (M=2.41), large number of elephant grasshoppers (M=2.35), frequent sounds of frogs in the bush (M=2.35), occurrence of bees in the field (M=2.23), appearance of millipedes (M=2.81), appearance of ant hills (M=2.71), appearance of migratory birds (stock) (M=2.34), singing nestling of birds (M=2.56), appearance of army worms on trees (M=2.61), frequent appearance of scorpions (M=2.57), termites taking food to their holes (M=2.75)

Atmospheric indicators of onset of the rain were moon surrounded by moisture (M=3.15), moon crescent facing down wards (M=3.20), high frequency in occurrence of

Table 1. Indigenous Signs Used by Farmers for Predicting Dry Season

Indicators	Mean	SD
Fruits drying and dropping from trees	2.11	1.60
Immature fruits dropping before maturity	2.15	1.05
Increase occurrence /appearance of termites	2.08	0.49
Shedding of trees/leaves	2.41	0.69
Extended cold days in the environment	2.96	0.73
Strong winds when about to rain	2.53	0.66
Cold weather amid rainy season	2.27	0.84
Morning star appearing in the east	3.00	0.90
Red clouds appearance	2.13	1.05
Appearance of rainbows	2.53	1.12
Appearance of moon during rainy season	3.01	1.03
Appearance of fog/haze in the morning	2.27	0.68
Appearance of swarms of grasshoppers	2.18	1.88

Decision rule: Mean 2.00 and above accepted

Table 2. Indigenous Signs for Predicting Rainy Season – Trees, Animals and Atmospheric

Tree Indicators	Mean	SD
Flowering of peach tree (*Prunus persica*) apricot (*Prenus armeniaca)*	3.04	1.60
Heavy budding of the acacia specie tree	3.01	1.05
Development of young leaves and grasses in fields	2.07	1.07
Dormancy breaking in certain fruit/tree species	2.20	0.96
Heavy fruit of certain tree species (mango)	2.80	1.02
Heavy fruiting of sunbird tree/wild mango (*Irvingia spp*)	2.74	0.95
Animal Indicators	**Mean**	**SD**
Appearance of large number of ants	2.41	0.76
Large number of elephant grasshoppers	2.35	0.72
Frequent sounds of frogs in the bush	2.25	0.54
High occurrence of bees in garden	2.23	0.65
Appearance of millipedes	2.81	0.81
Appearance of ant hills/red ants	2.21	0.94
Appearance of migratory birds (stock)	2.34	0.65
Singing/nestling of birds	2.56	0.76
Appearance of army worms on trees	2.60	0.67
Frequent appearance of reptiles (snakes)	2.16	0.71
Appearance/movement of butterflies	2.63	0.71
Atmospheric Indicators		
Moon surrounded by moisture	3.15	0.42
Moon crescent facing downward	3.20	0.24
High frequency in occurrence of wind	3.18	0.54
Wind direction from west of east	3.91	1.81
Mist covering hilly areas	2.71	0.79
High night temperature	2.32	0.68
Dark clouds occurring	2.65	0.73
Red rainbow color dominating sky	2,14	0.65
Soil well moistened when tested by hand	2.52	0.69
Appearance of nimbus clouds/red in morning	2.47	0.50
Body feels increased heat at night/day	2.93	1.08
Feeling of body pain (headache, flu)	2.5	0.78
Asthmatic attack	2.81	0.81

Decision rule: Mean 2.00 and above accepted

wind (M=3.18) , mist covering hilly areas (M=2.71), dark clouds occurring (M=2.65), red rainbow colour dominating sky (M=2.14), soil well moistened when tested by hand (M=2.54), appearance of nimbus clouds in the morning (M=2.47), body feels increase heat at night and day (M=2.93), feeling of body pain (M=2.05) and asthmatic attack (M=2.81)

DISCUSSION

IK Indicators of Seasonal Forecasting

Due to the diversified nature of rural livelihoods, farmers' knowledge sources, and their needs, different types of producers and production systems, African farmers do not generally use a single forecasting indicator, rather, they consider signs, indicators and chaos that arise at various times and in multiple settings (Roncoli, 2002; Luseno *et al*., 2003). The significance of forecast indicators also varies for different crop activities.

Early warning systems have proved to be indispensable in preparing for climate events such as the onset of rainfall, floods, cyclones and droughts. In West Africa, Tall *et al*. (2008) and Braman *et al*. (2013) demonstrate how seasonal rainfall forecast information is used to reduce the loss of lives, property and infrastructure caused by floods. Local communities and farmers have developed a new knowledge base for predicting climatic and weather events based on observations of animals, plants and oceanic bodies (Roncoli *et al*., 2003). Understanding how local communities perceive and predict rainfall variability is key to communicating scientific weather forecasts.

Indicators used by farmers to predict the quality of the rainy season are available throughout the year (Roncoli *et al*. 2009). Just like scientific forecasts, indigenous forecasts rely on observation and interpretation of specific phenomena. The indicators farmers mostly rely on include fruit production and tree phenology, animal behaviour, wind and atmospheric phenomena, and spiritual manifestations in the form of divinations, visions and dreams. Elderly male farmers generally have more knowledge than younger male and female farmers. However, indicators are usually gender specific, with men relying more on certain indicators than women, and vice versa. These are discussed below:

Trees

The behaviour of trees in general and fruit trees in particular plays a significant role in determining weather patterns in among the Ibos of Southeast, Nigeria. Fruit trees like mango are and Oha (*Ptericarpus spp*) frequently used to predict the eminence of the rain season and the quantities of rainfall in any given agricultural season. The people have even been able to harness the behavior of exotic trees like the mango trees in their extrapolation. According to one respondent, there is an abundance of fruits towards the encroachment of the rain season, people would know that the season was likely to experience low rainfall patterns. On the contrary, if the fruit trees bear very little fruits, people likewise come to know that they would have plenty of rainfall. Many of our informants pointed out that when the fruits ripen earlier than the usual, the implications will mean that the season will experience a good rainfall pattern. As observed, when Oha leaves wither and peel off, it means that a dry spell is imminent. People may panic and it supplies a moment when people resort to the performance of rituals meant to evoke rain to come. For instance, there are rain makers in Igbo land (rain-making) ritual in which the traditional elders play a significant in their capacity as religious functionaries. The assurance that the traditional ritual has been 'heard' is reflected in the sudden blossoming of tree leaves. The blossoming of leaves is perceived as life-generative, and must be actualized by the coming of rainfall. Trees as part of the natural organic ecosystem do respond to *meta-physical* powers that lie beyond the grasp of the mundane world.

A key informant told us that most local trees that farmers use to forecast rainfall begin flowering before the onset of the rainy season. The phenology of these trees signals good rainfall or drought . The variation of fruit or flower production also influences farmers' expectations. The abundance of fruits on one side of a tree, for example, may indicate in which area the rains will come first. Trees which are located near houses or fields and are observed over a long period are normally used to predict rainfall.

Animals

Certain behaviour of birds can also be a helpful barometer in predicting the arrival and intensity of a particular rainy season. On one hand, once the migratory birds all referred to as stock) begin to surface in a particular environment, then the rain season is said to be imminent. Birds sing melodious songs as signs of rain. The continuous singing, by the day and by the night, heralds the commencement of the rainy season. Mapara (2009) avers that people could also foretell whether rains are going to fall in the next hour or two if they hear the sound of *(*rain bird). On the other hand, however, when the migratory birds vanish from a particular area or region, it signals the decrease of rain and eventually its departure.

Other animals, heralds the imminence of rainfall in a particular area in a particular season. This is true also with the amphibian like frogs. Once frogs begin to 'hiss' incessantly, people come to realize that the rain season is 'around the corner'. There are certain types of frogs that are used to predict the intensity of rains. For example, some big and brownish frogs known as *Akiri and Mbara awo* (bull frogs), once they appear in large numbers in a particular *water* pond, it is an indicator of high rainfall patterns in a given locality.

The Ibo people use a number of certain insects to

predict weather patterns. When insects like

Termites *begin* to surface and continuously move around collecting grass for storage, it means the rain season is imminent. Usually, *cricket (MBUZO)* emerge for two or so days and continuously collect grass in large quantities for storage. After the collection of grass (food), these insects vanish and hibernate, but will not be threatened by starvation should the rains continue nonstop for some time. Based on oral interview with farmers, the behaviour of these insects is an indication that the growing season would be good so much that people are expected to work hard just like the insects.

The above agrees with (Luseno *et al*., 2003) who posited that the behaviour of animals such as livestock, birds, insects and amphibians is also used by farmers to predict the onset of the rainy season. The songs and movements of different birds to signal the onset of rains has been reported in Ethiopia, Mali, Nigeria, Swaziland, Tanzania and Zimbabwe, among other countries in SSA. Farmers predict the amount of rainfall depending on whether the bird is singing with happiness or not. When the bird sings with a clear, sharp voice it means the bird is happy and indicates to farmers that a lot of rain that will fall, and vice versa.

Atmospheric Phenology

The visible phases of the moon are associated with rainfall, drought or a dry spell. The full moon is expected to indicate dry weather. Star constellations and the time of their appearance indicate rainfall patterns hence, when farmers should plant their crops. Changes in the appearances of stars and the moon provide a framework of sequences for expected rain events and mark key points in relation to cropping calendars. During the year and within seasons, farmers expect natural phenomena such as temperature, winds, clouds and rain to conform to certain patterns that they define as the norm (Roncoli *et al*., 2009). The beginning of the cold season and its end follow certain rainfall patterns. Increasing hot temperatures indicate a good rainy season (Isaac *et al*., 2009), whilst violent winds during the dry season may predict a bad rainy season. The direction of winds is also associated with particular rainfall patterns.

Oral discussion showed that the people are good at using the nature of the wind directions to predict rainfall patterns. The direction of wind in the context of a locality is important in the determination of rainfall patterns. For instance, the local farmers know that when wind blows from the eastern side then the rain season is just 'around the corner'. If the wind is continuous, it 'tells' that more rains would come. The moon is another terrestrial object the people utilizes to forecast weather patterns, especially when interpreted in conjunction with the dynamics of cloud cover. The moon is relied upon to predict the imminence and intensity of the rain season.

CONCLUSION

Most agricultural activities in communal areas are closely linked to the weather, and communities often have a store of local weather and natural disaster knowledge. Plenty signs are used by the indigenous people in forecasting the onset and cessation of the rain season. Indicators for the onset of rain, include changes in the behaviour of domestic animals such as cows, calls by particular bird species, the appearance or disappearance of insects, such as termites and grasshoppers, the wind direction, the appearance and movement of migratory birds, the colour of the clouds at a given time of day, and night temperature variations.

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