Indigenous Cognizance Systems of Nigerian Farmers for Climate Change Adaptation and Mitigation in Agriculture

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ABSTRACT

Aim: The study was aimed to analyze indigenous farmer's cognizance systems for adaptation of climate change and mitigation in context of agriculture in southeast Nigeria.

Materials and Methods: Farmers were randomly selected from different places of Southeast, Nigeria. Questionnaire and oral interview were used to collect information from the farmers. Standard statistical formula was used to analyze collected data.

Results: The famers of study area were fully aware of climate change variability as indicated by a high mean score of the various prediction signs such as erratic rainfall pattern, heavy flooding and long rainfall among others. Indigenous practices were used to adapt of climate change, mitigation and for control of different diseases.

Conclusion: The practices which employed by farmers are safe and have proved successful for the region and recommendations of the modern practices in agriculture should be integrated.

Key-words: Agriculture, crops, animals, indigenous knowledge management

Introduction

Climate is the primary determinant of agricultural productivity while agriculture puts heavy burden on the environment in the process of providing population with food and fibre. The role of agriculture in human welfare has been expressed by federal agencies and others regarding the potential effect of climate change on agricultural productivity. Interest in this issue has motivated a substantial body of research on indigenous knowledge (IK) of climate change and agriculture in recent decades [1],[2],[3], [4].

Indigenous communities have long been recognised as particularly vulnerable to the impacts of climate change due to the close connections between their livelihoods, culture, spirituality, social systems and their environment. At the same time, however, this deep and long-established relationship with the natural environment affords many indigenous people with knowledge that they have long used to adapt to environmental change, and are now using to respond to the impacts of climate change.

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Local communities and farmers in Africa have developed intricate systems of gathering, predicting, interpreting and decision-making in relation to climate change problems [5].

The terms indigenous, traditional and/or local knowledge make reference to knowledge and know-how that is accumulated over generations and guides human societies in their innumerable interactions with their surrounding environment. It is defined [6] such traditional, ecological knowledge as "a cumulative body of knowledge, practice and belief, evolving by adaptation processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with their environment." An abundance of labels for IK co-exist in the literature. Common names include, but are not limited to: indigenous knowledge, traditional knowledge, traditional ecological knowledge, local knowledge, farmers' knowledge, ethno-science, folk knowledge and indigenous science or ethno-science.

Valuable local knowledge of relevance to climate change assessment and adaptation is held by rural societies [6]. These knowledge systems are transmitted and renewed by each

succeeding generation, ensuring the wellbeing of people by providing food security, environmental conservation, and early warning systems for disaster risk management. IK is considered as social capital for the poor and is relied upon for food production and to ensure survival. However, IK is gradually disappearing due to the invasion of development concepts, which promise development goals or solutions, but are not sustainable. The tragedy of the disappearance of this knowledge is obvious to the local indigenous communities, and the implications for others can be detrimental when local skills, teachings and expertise are lost.

Most studies on indigenous perceptions of climate change have been carried out in the developed countries of the world, which dominate the uppermost northern region of the earth and where the relationship between scientists and indigenous people is high [7].

Despite the fact that efforts have been made towards the fight against climate change from a scientific perspective, research and policies directed towards the incorporation of IK within climate change strategies are desperately needed. The study of local perception is useful in understanding the true implication of a changing climate [8].

Most third world countries, especially in Africa, have been making serious and frantic efforts to untangle development problems. Persisting problems include economic stagnation, declining agricultural productivity, natural resource degradation, insufficient infrastructure and host of other socio-economic issues. However, awareness, understanding and use of local knowledge systems are one strategy that can help facilitate efforts to deal with these problems [9]. The main objective of this study was to analyze indigenous farmer's cognizance systems for adaptation of climate change and mitigation in context of agriculture in southeast Nigeria.

Methods and Materials

The location of the research was South-east Nigeria, situated east of River Niger comprises five States namely: Imo, Enugu, Anambra, Ebonyi and Abia. The samples were collected through multi-level staging randomly. In first level, three states out of the five states including Imo, Abia and Ebonyi that make up south-east zone of Nigeria were selected randomly for sampling. The second level sampling was done from two agriculture zones of each of the selected state viz; total is six agricultural zones. The third level of sampling was done from two Local registered Areas from each of the zones in number of twelve Areas. The fourth level sampling was of three communities from each Local registered Area in number of thirty-six communities. The fifth level sampling was of one rural area from each selected community. The sixth level sampling was of ten household heads from each of the selected rural area which gave a sample size of 360 household heads for the study. Data collections were both primary and secondary. The primary data were collected with the use of a structured questionnaire, complimented with Focus Group Discussions (FGD). Climate change awareness was measured on a 4-point Likert type rating scale of strongly agree, agree, disagree and strongly disagree assigned weight of 4,3,2,1. The values were added and divided by 4 to get the discriminating mean value of 2.50. Any mean value equal to or above 2.5 was regarded as being aware of climate change and indigenous crop management practices, land management practices, water management practices and pest/diseases control measures.

Results and Discussion:

Awareness of farmers in context of climate change of research area

It revealed that the selected farmers were fully aware of climate change menace based on the signs seen so far by them (Table 1). These were obvious signs of climate change which convinced them that climate change is real and its happening. Awareness of signs of climate change helps the farmers know the indigenous farm practices to employ to adapt and mitigate climate change variability.

The above findings observed changes include lengthening of mid to high latitude growing seasons, populations and altitudinal l shifts of plant and animal ranges, declines of some plant and animal populations, and earlier flowering of trees, emergence of insects, and egg-laying in birds[10]. Moreover sea levels have shown signs of rising, and in some regions, including within Africa and Asia, floods and droughts have been observed to increase in recent years.

Table 1: Farmers Awareness of Climate Change

Climatic signs	Mean	SD
Erratic rainfall pattern	3.25	0.48
Long period of dry season	2.94	0.87
Heavy & long period of rainfall	3.36	1.64
High temperature	2.74	1.55
Unusual heavy winds	3.39	0.83
Occurrence of floods	2.65	0.54
Loss of forest resources	3.00	0.77
Soil erosion occurrences	2.84	0.88
Drying up of streams/rivers	2.67	0.59
Overflowing of streams/rivers	2.54	0.66

Indigenous Crop Management Practices by Farmers: It showed the indigenous crop management practices used by the farmers for adaptation and mitigation to climate change (Table 2). Crop diversification improves soil fertility, controls for pests and diseases, and brings about yield stability, nutrition diversity, and health [11,12]. Crop diversification found an environmentally sound alternative to the control of parasites and in the maintenance of soil fertility in agriculture [13]. Diversified cropping systems tend to be more stable and resilient, agronomically [12]. Moreover, diversified cropping systems can also provide habitats for beneficial insects, and this can help reduce the number of pests by rendering host crops less apparent for colonization by parasites.

Table 2: Indigenous Crop Management Practices

Crop Management Practices	Mean	SD
Use of indigenous grains	2.85	1.09
Crop diversification	3.46	0.93
Crop rotation	2.61	0.96
Mixed farming	2.58	1.01
Cultural pest control	2.83	1.88
Changing time of planting	2.87	1.18
Seed selection by colour	2.93	1.22
Multiple cropping	3.03	1.17
Hand weeding of crops	2.69	1.10
Storage of seeds	2.91	1.13

Planting time

Farmers employed various indigenous practices most of which were cross cutting among the crops grown. Early planting found one of the pillars for both indigenous and improved farming methods practiced. In rain-fed agro-ecological zone farmers take advantage of the early rains which also reduce the incidences of pest and disease leading to high yields for grain crops like beans as farmers ensure that beans are planted as the second crop in the rotation system [14]. Broadcasting the seed before ploughing is still a popular method used as well as early planting is also preferred to allow crops receive enough rainfall and reduce pests and diseases incidences.

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Selection of Seed by colour:

Subsequent to harvesting, the crops are threshed and carefully stored for use according to respondents. The seeds are carefully selected for planting in the next season. Only bright colored and large-sized seeds are selected for planting. Sometimes selection of the best seeds is done by soaking the seeds in water. Only the sinking seeds are selected and the floating seeds are not selected. Nigerian women cull the seeds and preserve them for the next planting season [14]. In Ethiopia, the farmers select healthy crops in terms of maturity period, height, color, and size. The panicles or the spikes of the selected varieties are separately harvested, dried, carefully threshed, and the grains are saved for replanting[15]. Farmers also practice selection of clean planting materials as in the case of formal research to control pests and diseases. For the case of cassava, they ensure that the cuttings are not damaged prior to planting and that nodes face downwards to encourage effective sprouting and root growth. Farmers relied on crop rotation to rejuvenate the soil.

Multiple Cropping:
Sowing of seeds is done haphazardly by hand. All seed varieties are sown simultaneously in the same field. This practice maximises the growth of all crops at the same time in the same field. Inter-planting allows cropping systems to reuse their own stored nutrients. With this system productivity per unit area is higher than in mono-cropping systems with the same level of management. The farmers incorporate a variety of crops with different growth habits in the same field or home-gardens to maximize the chances for production of multiple crops [16].

Storage of Seeds and Crops:
After harvesting and threshing, the crops are stored and prevented from attack by weevils. The crops remain fresh until they are all consumed. The most common preservation practice mentioned by the participants is by hanging the maize, sorghum and millet cobs from the hut roof. Sometimes the seeds are mixed with the ash of *Aloe ferox* and stored into clay-pots and baskets. The seeds could last for more than five seasons. Chili pepper (*Capsicum annum.*) is used to preserve harvested cowpea in storage [17].
Use of indigenous grain crops:
Many farmers prefer the use of indigenous grains such as millets and sorghums that are more drought-resistant than maize and also produce high yields with very little rain. Farmers also prefer specific crop varieties for drought seasons, such as an indigenous finger millet variety as it ripens fast and an early maturing cowpea (*Vigna unguiculata*) variety [15]. Generally, in areas with little moisture, farmers prefer drought-tolerant crops (like *Cajanus cajan*, sweet potato, cassava, millet, and sorghum), and management techniques emphasize soil cover (such as mulching) to reduce moisture evaporation and soil runoff.

Maintenance of Crops:
Weeds are removed when the crops are about four weeks old by hand or hand-hoe to avoid them competing for moisture with the crops, thus disturbing the growth of crops. In Tanzania, when the farmers regard weed competition as negative for crop growth, they perform superficial hoeing and leave the weeds on the soil surface as protective mulch, to recycle nutrients, and to allow nitrogen assimilation through the bacteria decomposing the plants [18]. Tobacco (*Nicotiana tabacum*) plants are used to prevent insect build-up on the cocoa plantation [14]. In Indonesia, the farmers burn the common lake-growing plant called *Jariamun* (*Potamogeton. malaianusmiq*) in the middle of the rice-field to drive pests from the farm [19].

Cultural pest control:
Climate change could have positive, negative or no impact on each pest. Pests are usually controlled by cultural practices, natural enemies, host plant resistance, biopesticides and synthetic pesticides. But many of these control tactics are highly sensitive to the environment and climate change may render them less effective [20]. The traditional techniques used for pest control including hoe weeding, intercropping and rotation patterns and pest resistant seed varieties. Costs and side-effects of pest chemicals can be minimized through implications of integrated pest management techniques.

Land management:
The farmers adapt to climate change by employing a number of land management measures/practices (table 3). These practices are discussed below:
Mulching with a mean score: Water run off and/or soil erosion is reduced using soil bands as soil and trash can be heaped around the plants while weeding in addition crop residues like kitchen waste/refuse and manure from goats, chicken, and cattle to their fields and fallow plots to enhance nutrient status. Farmers mostly use elephant grass and maize stalks to conserve soil moisture [21].
Land Fallowing: The participants agreed with practices which help to regain soil fertility. During fallowing, cattle, sheep and goats are driven in the fields to browse course grass and that their droppings should add to soil fertility [22]. It is widely recognized that forests play an important role in the global carbon cycle by sequestering and storing C[23][24]. Local farmers are known to have practiced the fallow system of cultivation, which encouraged the development of forests.
Zero-tillage: Local farmers in the area have been known to conserve C in soils through the use of zero tilling practices in cultivation, mulching and other soil management techniques [25], [26]. Natural mulches moderate soil temperatures

and extremes, suppress diseases and harmful pests, and conserve soil moisture. Before the advent of chemical fertilizers, local farmers largely depended on organic farming, which also is capable of reducing GHG emissions.

Table 3: Indigenous Land Management Practices

Indigenous Land Management Practices	Mean	SD
Mulching	2.94	1.19
Land Fallowing	2.65	1.20
Use of mounds/ridges	2.81	1.06
Zero-tillage	2.56	1.40
Agro-forestry/tree planting	2.79	0.96
Knowledge of soil types	2.66	1.06
Establishment of sacred bush	3.05	0.98
Soil fertilization	2.98	1.13
Farmstead construction	3.01	0.87

Agro-forestry/ tree planting and establishment of sacred bush:

Agroforestry is another practice that has been very effective in carbon sequestration. Agroforestry is a rational land-use planning system that tries to find some balance in the raising of food crops and forests [27], [28].A practice similar to this has been described in a part of south western part of Nigeria to raise shade tolerant crops such as Dioscoreaspp and cocoyam inessentially a permanent forest setting [29], Genetic traits of these species and the knowledge of cultivators may prove instrumental in future breeding programs to introduce resistance against pests, diseases or endurance for harsh climatic conditions [30].

Knowledge of soil types by colour:

Knowledge of soil varieties by colour, texture and the types of crops do well as particular soil types was evident among the participants. According to the respondents, black clayey soil is rich in nutrients and good for cultivation of maize, pumpkin and gourds. Sandy soil is good for beans, melons and sweet-reed. Another type of soil is a mixture of sandy and clayey soil which is good for all crops [21].

Soil Fertilization:

The respondents agreed on application of poultry manure to make the soil regain fertility, retain moisture and avoid pests which mainly improves soil moisture conservation [31]. In Tanzania, growed weeds protect the soil from heating up or drying out excessively as well as induce a positive competition, which simulates crop growth and reduces erosion during rainfall [14]. In some areas, leguminous plants are used for quick restoration of soil fertility i.e. *Centrosema* spp to fix nitrogen into the soil in order to improve its fertility [32].Farmers also use conservation tillage to respond rapid soil deterioration and degradation [33].

Farmstead construction:

People here built houses of bamboo on stilts, so that floodwater passes underneath the floor of the house without damaging it. During earthquake, the bamboo houses away back and forth but no damage is done. Many dry land areas face severe a degradation, in which marginal areas are turned into wastelands and natural ecosystem are altered through destruction of surface vegetation [34].

Indigenous Water Management Practices

The following traditional water management practices were used by the respondents based on (table 4). In semi-arid areas of Niger, small-scale farmers use planting pits to harvest rainwater and rehabilitate degraded land for cultivation of millet and sorghum. The technology improves infiltration and increases nutrient availability on sandy and loamy soils, leading to significant increases in yields, improved soil cover and reduced downstream flooding [34]. Farmers harvest water from rooftops and divert water from natural springs into tanks to irrigate vegetables and crops.

Table 4: Indigenous Water Management Practices

Water Management Practices	Mean	Std
Use/preparation of planting pit	2.79	1.23
Underground earthen jars/pots/tanks	2.65	0.97
Construction of infiltration pits	2.84	1.04
Construction of wells & basin for water storage	2.74	0.84
Construction of soil/stone bunds	3.06	0.71
Use of large calabashes to store water	3.41	0.64
Traditional taboos	2.94	0.54

Indigenous Pest /Disease control/healthcare Management Practices in Agriculture

The pest control and healthcare management practice were observed in agriculture for crop and animals (Table 5).

Table 5: Indigenous Pest/Diseases control/Health care Management Practices

Indigenous practices	Mean	SD
Use of bitter leaf solution for de-worming	2.53	0.68
Making pepper/salt solution for treating cough	2.88	0.44
Use of banana /plantain peels with salt for delivery	2.64	0.63
Use of ashes for pest control	3.20	0.78
Use of neem solution for termite control	2.68	0.89
Use of urine for weevil/ control of soil borne diseases	2.24	0.74
Use of vegetable to de-worm animal	2.06	0.71
Use of Canabis for control of new castle diseases	2.40	0.73
Removal of eggs by hand to increase number	2.12	0.54

Farmer's local cognizance was to treat their animals and maintain the growth of crops in the field. Chicken are fed on a mixture of millet and paraffin to prevent coccidiosis. Indian hemp (cannabis) is mashed and added to water and used for treating coccidiosis. To destroy pests, farmers apply paraffin and vaseline on affected area especially around the chicken eyes. Old used tyresare burnt in chicken coop to destroy mites. Farmers also cut and place a moist tree branch in the chicken coop to attract and trap mites which is removed and thrown far from the homestead when it is laden with the pests. Farmers also used their own skill to aid goats experiencing difficulties while delivering fetus, cowpea leaves, mixture of water and salt for disengagement of placenta [35].

Conclusion

The study results show that indigenous knowledge is still valuable in the community. The knowledge is embedded in the community's cosmology. Knowledge of plant phenology, and the appearance and shape of the moon and stars is used to plan the planting of crops. The materials used to fertilise the soil, mulch, manage crops, and the seeds are procured at the household level. Soil fertilizers, mulching ingredients and crop management materials are locally developed, always available, affordable, and culture-specific. The study concludes that subsistence farming is sustained by indigenous farming practices and rainfall prediction. The practices involve the improvement of soil structure, maintenance of crops, and the selection and storage of seeds for replanting.

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