SUSTAINABILTY OF INDIGENOUS KNOWLEDGE IN SEASONAL RAINFALL FORECAST AND FARMING DECISION IN SEMI-ARID AREAS OF KATSINA STATE, NIGERIA

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Abstract
Crop production in semi-arid areas of Katsina state is largely practiced under rainfall condition; hence the local farmers have developed mechanism of forecasting and recording rainfall pattern. This paper examine how farmers of semi-arid areas of Katsina state sustain the uses of indigenous knowledge in forecasting and recording rainfall using local environmental indicators and astronomical factors in influencing their decision in crop production. Participatory rural appraisal methods, key informants interview and focus group discussion were used in the data collection. It has been found that the most widely used indicators in rainfall forecasting include plant phenology at the beginning of rainy season, stars sighting and their position, nature of clouds, wind direction and speed and behaviour of certain animals. Apart from rainfall forecast, the farmers have devised traditional ways of recording and comparing rainfall variability within a season and over the years. Even though the farmers acknowledged the reliability of indigenous rainfall forecast is gradually waning off due to increasing climatic variability, many respondents argued that it is still relevant due to lack of access to conventional weather forecast reports. The study recommends the need for devising ways of facilitating farmers' access to conventional weather forecast report and systematic documentation and coordination of indigenous knowledge into conventional weather forecasting system

Key words indigenous knowledge, rainfall forecast, farming decision, Katsina state

Introduction

In recent time there is a wide growing body of literature on the importance of Indigenous knowledge (IK), which has been describe as a systematic body of knowledge gained by people who settle in a specific location through accumulation of experience, informal experiments and intimate understanding of the environment (Robinson & Wallington, 2012). IK reflects how people living in an area understand their environment and how they use that knowledge to enhance their live (Islam and Banda, 2011). It is the accumulated knowledge, skills and technology of the local people gained from the direct contact with the environment (Tabuti & Van Damme, 2012). Eyong (2007) sees IK as practices developed through trial and error and confirmed by the local people as capable enough to adapt to changing situation. In other words IK "*is the information base of the societies that facilitate communication and decision making (Siyanbola et al., 2012)*

Development indices in developing countries demonstrated that conventional approaches to development have not achieve the desired result hence alternative view of development which is term sustainable development has emerged. (Vanonckelen, Isabirye, Deckers, & Poesen, 2011). Sustainable development is the *"development that meets the needs of the present without compromising the ability of the future generation to meet their own needs" (WCED 1987).* In other words, it is combination of development and conservation. IK has been accumulated over centauries, hence has the potential value for supporting sustainable development. Historical evidence confirmed that many communities have been using their indigenous knowledge and natural resources over centauries without impairing their ability to support them and their successive generation. Thus, it is believed IK could be the basis for sustainable development because efficient local practices are widely believed to be in harmony [1]with nature and tapping IK is viable tool for attaining sustainable development ((Berkes, Folke, & Colding, 2000; Nyong, Adesina, & Elasha, 2007; Winklerprins, 1999)

Despite wide spreads studies on the role of IK for sustainable development, few studies went far long to identified the authenticity of the mechanism of forecasting and recording rainfall as a basis of their in crop production. Eventhough the study of (Berkes et al., 2000; Nyong et al., 2007; Winklerprins, 1999) have attempted to explain the pattern and document IK for weather forecast among the indigenous community. These studies have been marred with measurement error, (Berkes, Folke, & Colding, 2000) concept vagueness, Nyong et al (2007) Missing variables, Winkleprins, 1999).

Their studies focus much attention on how to use IK for achieving development, without providing detailed understanding on the indicators used by rural farmers in forecasting and recording rainfall pattern. Amongs the studis that attempt to explore the pattern of recording and documentation of the IK forecasting strategies in Africa are the works of (Enete & Amusa, 2010; Enete et al., 2011; Nyong et al., 2007; Orlove, Roncoli, Kabugo, & Majugu, 2010; Sanni, Oluwasemire, & Nnoli, 2012). But the problems with these types of studies they heavily draw conclusion on the bases of quantitative approach, which has a number of shortcomings.

It was due to this lack of important understanding the UN Declaration on the rights of indigenous people endorsed by the UN Human Right Council in June 2006 as cited in Dixit and (Goyal et al., 2012) acknowledge that "respect for indigenous knowledge and culture and traditional practices contributes to sustainable and equitable development and proper management of the environment". In essence, knowledge and practices developed by communities over centauries if properly documented and preserve could be used to complement scientific knowledge by creating appropriate technology that could lead sustainable development.

In view of the foregoing this study intends to fill in the literature gaps by examining how farmers of semi-arid areas of Katsina state sustain the uses of indigenous knowledge in forecasting and recording rainfall using local environmental indicators and astronomical factors in influencing their decision in crop production. In filling the literature gaps this study will provide a flat form of comparing and contrasting IK weather forecast with similar knowledge system available elsewhere.

The discussion above constitutes the section one of the paper, the remaining section constitutes the followings, and section 2 will includes the relevance of indigenous knowledge of weather forecast. While

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section 3 will discussed materials and method, while section 4 will present and analyzed the result and finally section 5 draw summary and conclusions

Section two

2.1 Theoretical and Empirical literature

Theoretically, knowledge creation model, developed by Nonaka and Takeuchii, (1995), was used to describe the management of IK in the local communities. This follow the argument build by Nonaka on the three characteristics or element of the KM model which includes socialization, externalization, and combination and internationalization.

Thus even though, IK weather forecast information has been intensively discussed in the literature, but is not the only factor that could influence the decision of a farmer in a crop production processes. However, this call for the need to integrate the utilization of IK and research of IK in weather forecast in an effort to include IK and participatory approach in decision making for sustainable crop production process. Most studies in the literature focus much attention The use of IK in weather forecast is common among many communities in Africa and other parts of the world (e.g. (Agrawal, 2002; Barnhardt, 2005; Battiste & Henderson, 2000; Mauro & Hardison, 2000; Pierotti & Wildcat, 2000; Turner, Ignace, & Ignace, 2000; Warren, 1991). Even in the present information age and advancement in science and technology, many communities have no access to conventional weather and climate information particularly in developing countries ((Rancoli, Ingram, & Kirshen, 2002), (Fullwood et al., 2009). Hence out of necessity and for the sake of their survival, these communities have to depend and make us of indigenous knowledge of their habitat by close observation of physical phenomena to forecast weather and climate dynamics to influence their decision in crop production processes. However, "very little of this knowledge has been recorded, yet it represents an immensely valuable data base that provide mankind with insight on how numerous communities have interacted with their changing environment including flora and fauna resources.''(Chartier-Harlin et al., 1991)

In cognizance with increasing spread of recorded information facilitated by information and communication technology (Elwalid, Jin, Low, & Widjaja, 2001) (Awokola, Abioye-Kuteyi, Ogundele, Awokola, & Oghenerukevwe); the importance of weather forecast information in decision making in crops production and its compatibility with preservation of local environment and sustainable development ((Dahinten, Arim, & Timer, 2008); (Artikov et al., 2006); increasing threat of IK lost at an unprecedented rate due to lack documentation and coordinated research to explore its veracity and reliability particularly indigenous ways of weather forecast (Murphy et al., 2010); It is a known fact that elderly are the main custodian of most of the evolutionary experience of mankind, their IK was gained through years of observation and experimentation, trial and error and is more eco-friendly *system of knowledge* (Mehta et al ,2010). The elderly are believed to be in possession of the past events that can validate contemporary hypotheses (Dixit & Goyal, 2011) when they pass away, the knowledge accumulated for years is lost. This corroborated an old African proverb i.e. ''when a knowledgeable person died, a whole library disappear ''(Pfister et al., 2010). This problem is compounded by change from extended to nuclear family system adopted by many Africans which limits contact with grandparent generation that holds IK (Eyong, 2008)

Therefore a well conceived and coordinated effort need to be made to explored, studied and preserved through documentation of IK of weather forecast for future generation before they disappear under the on-slaught of cultural-colonialism, modernization and globalization. Documentation could facilitate easy access to IK of weather forecast for international development agencies, scientists and other interested persons. Also the recorded and documented IK of weather forecast could be compared and contrasted with similar knowledge system elsewhere. The validity and effectiveness of IK of weather forecast could be tested scientifically and the reliable facets of the forecast could be improved, promoted and potentially used concurrently with scientific weather forecast. This could facilitate better weather forecast, improve farm management decision and sustainable development of our rural communities.

In this study it is argued that IK of weather forecast can contribute meaningfully, boost and enhances weather forecasting precision and reliability if systematically, researched, documented and subsequently integrated into conventional forecasting system. This study was conducted with the objective of identifying and documenting local indicators used in IK of weather forecasting in the semi areas (northern) of Katsina State Nigeria.[2]

Section Three

3.1 Materials and Methods

The research took place from January – November 2009 and was conducted in two phases. The first, an explanatory phase of 3-5 months was conducted to be acquainted with the area. Prior to formal contact with the local farmers/herders, the study and its purpose were explained to the local traditional rulers with a view of getting maximum cooperation from their subjects. A total of 12 villages were purposely selected and these villages are located few meters away from Nigeria – Niger republic border. A pilot survey was conducted to test the reliability and viability of the research tools and techniques. All the research assistants who helped in questionnaire administration have tertiary education, and are well acquainted with the terrain of the area and fluent in Hausa, the local language spoken by nearly all the people residing in the study area.

A baseline questionnaire with open-ended and few closed-ended questions were used to get information on IK of weather forecast, man-environment relations such as size, land holding, livelihood, farming practices, histories of families, and communities etc. This pave the way for asking questions on fluctuation of weather condition, local weather forecast practices and their influence in decision making in crop production process. Only the household head were interviewed. It is important to note that the household were stratified into three (small, medium and large scale farmers), the number of samples taken from each category of farmers takes into consideration their total percentage in each village. Their answers serve as a guide for further discussion in the second phase of data collection.

The second phase took place during the cropping season, May – November, 2009. It was planned, to follow farmer's activities during a 6 month period from planting to harvesting. Information was gathered through PRA methods such as participant observation, timeline and local history, transect walk, daily activity profile, seasonal resources calendars, historical resource matrix, key probe, shared presentation and analysis, etc and a series of Focus Group Discussion (FGD) of 8-12 people were held in each village. The FGD is aimed at weighing and balancing the information generated through interview with a view of getting a consensus and develop generalization about traditional knowledge of weather forecast used among the communities living along Nigeria-Niger republic border. Selection of key informants take into consideration, the age, gender literacy (western and Islamic) and social status of the participants as Case et al (2005) and Mogotisi et al (2011) pointed out that these factors affects variation in traditional knowledge in communities.

Seasonal resources calendar was developed in the course of the interview with key informants in order to increase understanding of temporal classification such as the relationship of seasonal weather to natural

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phenomena and human activities as suggested by Gotzone and Paul (2011). Observations and series of interview in the course of the field survey provide the information to fill in the detail of the seasonal resource calendars. However, seasonal resource calendars should be considered as a conceptual model rather than factual representation of climate related activities, unless it is well substantiated (Vediwn and Rhoades, 2011) since other factors could influence the decision of a farmer to pursue a particular process in a season

Section 4

4. 0 Data Analysis:

This study is qualitative in nature hence most of the data collected were descriptive in nature, hence thee was explained directly.

4.1 **Rainfall Expectation/Indigenous Techniques of Weather & Climate Forecast Practices Used By Farmers**

The people of the study area (Northern Katsina State) have been living in that area for a very long time; hence have a collective memory of weather patterns. The understanding of the historical pattern of the season established the basic framework against which variability and change are observed. The weather forecast is an important cultural component for farmers and pastoralists. They rely on observation and the interpretation of specific phenomena; such phenomena may be found in the surrounding environment, including trees, animals, mountains, sky, et cetera.

Observations of environmental indicators are based on experience and are largely learnt from the elders, although daily interaction on the street, at the market and with family members can influence one's ability to observe and interpret these signs. The indicators which farmers rely on in the study area are the temperature during the dry season, the fruit production of some trees, the intensity and direction of the wind and the behaviour of certain birds and insects through-out the year. In other words, the indicators can be divided into bio-indicators and non bio-indicators.

Bio-indicators are those livig beings/biotic agents, which change their behaviour with any change in the surrounding environment/weather. Non-bio indicators are those non-living phenomena/materials that change in response to the change in the surrounding environment.

4;2 Dry-Season Temperature

In all the villages visited, most of the respondents based rainfall expectation and assessment on the division of the year into two main periods a seven-month dry-season and a 4-5 month rainy season. The dry season includes *sanyi/hunturu* (the hamattan season, November-January) rani (the dry-season, February-March) bazara (the hot-season, March-May) *Kaka* (the harvesting season, October-November). In each of these periods, farmers expect natural processes such as temperature wind, cloud and rain to follow a similar pattern. Once there is a deviation from the normal trend, abnormal rainfall and poor crop performance may likely occur. Hence, the indicators of rain are the starting date, the intensity and duration of the cold dry periods. In other [3]words, whenever a cold-dry period commences early or ends late, farmers expect rain to

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follow the same pattern. Some farmers forecast the beginning of rain by counting 182 days from the beginning of the cold-dry period. That is count 91 days for a cold dry period plus 91 days for a hot dry period before the commencement of the next season. Following a cold dry period is the hot season of March-May, intense heat at this time, e.g. high night temperature is also believed to predict a good rainfall. Cold temperature that continues beyond the early morning is a sign of rainfall failure. Violent and strong winds during the season are a sign of aborted rain.

4.3 The Flower and Fruit of Local Trees

Trees are used by farmers to forecast when the rainfall will begin. In all the villages, farmers used the time of trees flowering and fruiting to forecast the timing of rainfall. See table.5.3. Even though some of these trees are decreasing and some have disappeared in the study area, the respondents in the past used them to forecast and predict the time of rainfall. Some farmers are now using exotic trees, such as neem (*Azadrichata indica*) i.e the full bloom of a neem tree in summer indicates an approaching rainfall season. Also the dried appearance of the neem tree (i e *Azarichta indica*) in summer is a sign of a coming drought. Most of the indigenous trees used for rainfall forecasts begins flowering between March-April and produce fruits May-June. Table 5.3 is the local or indigenous trees used as indicators for forecasting rainfall.

Table 5.3: Local Trees Used As Indicators for Forecasting Rainfall

Sceintific Name of Tree	Hausa Name	Fulbe Name	Fruit Ripening Time	Indicator
Adansona digitata	Kuka	Bokki	June-August	Abundant fruit and leaves yeild mean abundant rainfall
Tamarindus Indica	Tsamiya	Jahmi	May-June	Abudant fruit yield indicate abundant rainfall
Vitex doniana (Sweet)	Dinya	Bununehi	May-June	Abundant yield indicate abundant rainfall
Zimenia Americana (Linn)	Tsada	Chabbali	May-June	Abundant yield indicate abundant rainfall
Magnifera indica (Mango)	Mangwaro		April-May	Abundant yield indicate abundant rainfall

Source: Field Work (2009/201)

Most of the farmers based their forecast on the trees they have been observing for many years. The trees are often located in or near their homes and farms. Good yield from the trees both exotic and indigenous predicts abundant rainfall and a possible favorable season. Some trees were also used in guiding farm work, when the *gawo **(**Faidherbia alabida**)*** lose its leaves, is an indication for a farmer to start land clearance and preparation for planting. *Chediya and Durumi (Ficus phonningll and Ficus polita)* grow where the water table is very close or near the surface. The presence of these trees indicates where herders can dig wells for their livestock and where farmers can plant water demanding crops. The villagers of Bumbum (in Mai' adua LGA) indicated that *cediya and durumi* were the dominant trees within the village but all have wilted and died. The villages attributed the problem to the receding of water table level, which is 5 to 8 metres in the last 15 to 20 years but now is between 15 to 30 metres below the surface.They attributed this problem to the reduction in the amount of rainfall received in the area. The farmers /pastrolist observations is in comformity with the findings of Tomlinson (2010) in Katsina and Kaduna states and Ekpho and Nsa (2011) in Sokoto, Kebbi and Zamfara states.

4.4. Change in Bird and Animal Behaviour

Fulani herders during the pasture of their animals watch the nesting of a quela-like weaver bird called gado in Hausa). When its nest hangs high on trees, the rainy season will be heavy and when its nest hangs low the rainfall will not be much. The jumping and running of cattle during pasture indicate the possibility of rainfall. Many Fulani herders believed that cattle anticipate rainfall a few hours early by sensing a cool breeze developing few hours before rainfall start. The movement of black ant *(tururuwa)* in a row is a sign of rain because increase humidity triggers the ant to carry their eggs to a safer place. Once this change of behaviour is observed among the ants, rain may likely fall in a short period. Other Fulani herders believed that the biting nature of flies is a sign of imminent rain; they observed that flies become active whenever atmospheric humidity reaches saturation. The flapping of the ear by goats is a sign that rain may be likely to fall because increasing humidity causes uneasiness and sweating of goats, hence trigger flapping their ears. The movement of dragon flies is also used as an indicator of immanent rainfall, because when humidity reaches saturation, for a couple of hours dragon flies move in swarms, indicating imminent rainfall.
The Hausa also use the arrival of migratory birds, e.g.the *Cilkowa* from the north to the south indicates the approaching of rainy season, and its movement from south to north is a sign of end of rainfall season. Furthermore, the movement of *Shamuwa* a long neck bird from east to west is also a sign of approaching rainy season. The singing of the bird, *Mutaru Mukwana* is a sign of imminent rainfall. The Hausa and the Fulani also observe the squeaking of owl (mujiya) to forecast rainfall. They believed that even though the owl is blind it, but sensitive to humid conditions. The fear and feeling of increasing humidity and heat released by clouds instigate restlessness among owls. Hence, their squeaking sound, which many farmers believed to be an indication of an imminent rain fall.[4]

4.5 The Timing and Pattern of the Rainy Season

If the rain begins in time, farmers' expectation and optimism of a favourable season increase. Furthermore some herders and farmers used the availability and volume of water in the stream and ponds after the first rain to forecast the amount of rain to be received in the season. If the streams and ponds volume is high after the first rain, farmers expect a favourable season and a bumper harvest, because good rain at the beginning is a sign of a good start. Because of increasing rainfall variability, the number of times farmers sow is also used to forecast the nature of the season. If after sowing, rain continues without a long dry-spell, the expectation of a favourable season increases. The pattern of rainfall is also used to forecast the nature of the season. The rain begins from the southern part of the country and moves northward. If it progresses

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according to this pattern, a good season is expected. Seasonal migrants returning from the southern part of the country bring news about the onset of the rain in the south. This helps farmers to prepare farms for planting. In some instances, they look out for mahauniya (chameleon) on the field after the first heavy rain. If chameleons are observed, they believe that it will take some time before the next rain. In this case, they wait for another heavy rain before planting

4.6 Changes in Wind Direction

Some farmers observe changes in the wind direction from easterlies to westerlies, while others look for shifts from southerlies to northerlies to determine the changes of the season. Many farmers indicated that the ocean was the origin of rain; they suggested that during the dry season, the wind blows westward toward the ocean to pick up water and return blowing eastward. Many farmers believed that rainfall delay and drought may likely occur if the normal pattern changes. Some farmers have argued that even if after the first rainfall and the wind has not changed direction, sowing will not take place because it is assume to be a false rain.

4.7 The Locations and Movements of Stars and the Moon

Majority of the respondents during FGD stressed the importance of the location and movements of stars and the moon in the forecast of rain and farming activities (planting, weeding and harvest). Some elderly farmers can predict suitable times for planting by observing the movement of stars and the lunar phase. For example the appearance of the star *suraiya* indicates the approach of a good rainfall season. Also, the appearance of star *Amintau* is an indication that drought may not likely to occur. The constellations of some stars that appear between May and July signify suitable planting periods for different crops.

Most of the respondents believed that the rainy season starts during the darker phase of the moon and considered the visible phase of the moon to be likely dry than the darker phase. Some farmers and herders admitted that moon-light exerts pressure that prevents rain from falling. Farmers always prefer rain that falls for several hours, particularly in the night, enabling rain water to infiltrate the soil. Such rain normally falls in the dark phase of the moon and is suitable for planting crops that require good soil moisture (cotton and maize, as witnessed in Jibia). Some seven to ten days dry spell ***(ban iska)*** is expected during the visible phase of the moon, particularly in July, to allow the weeding of the planted crops and the wilting of weeded grass.

A halo around the moon is sign of a coming rain; most of the respondents believed that the halo is formed due to high moisture content in the atmosphere.

4.8. Cloud Observations

Farmers are always observing the sky to see the type of cloud, the direction and speed at which the cloud is moving to determine whether the cloud will bring rain or not or will move to another area to drop rain. When different clouds are seen, such as cumulus (bakin hadari) and stratus (farin hadari) are observed, it is an indication that clouds are gathering momentum, forming rain. One elderly farmer explained the way hot air from the earth's surface is trapped by light and cloud. The heated stratus cloud is beyond the heavy cumulus clouds that are made of snow. The warm cloud melts the snow, which results in rain. The elderly farmer even mentions an instance when the snow fails to melt completely; it falls in a combination of rain and ice.

In addition, farmers observe lightening from the far distance; many believed that distant lightening is an indication that rain could come in a week or two. While, several days of heavy clouds indicate a short Interval before the beginning of the rain.

The farmers believed that rainbows appear due to high relative humidity and some have argued that even if the rainbow is visible there is the tendency for rainfall.

4.9 The indigenous Techniques of Rainfall Observation and Recording

Farmers' and pastoralists' observation of' the sign of rainfall increases from late April to early May, but many farmers have admitted that the trend has changed in the last fifteen to twenty years. Now rainfall as they observed starts in late May to early June. Farmers' observations is in conformity with the findings of Oluwasemeri and Alabi (2004) in a part of Sudan and Guinea savanna agro-ecological zone of northern Nigeria, Ekpho and Nsa (2011) in north-western Nigeria and West et al., (2008) in Burkina Faso. Even those who planted after the first rain of the year do not consider it as a beginning of the cropping season, because the rain in recent years is followed by a long dry spell (ban iska) of between three to more than four weeks before the next rain. Many farmers now consider the first rain of the year as ruwan karya rani (rain marking the end of dry season)

Despite that, still some farmers after the first rain scrap soil with their hand or dig with hoes to determine whether enough has fallen for viable planting. Some plant as early as possible after the first rain because of the fear of not getting another rain for several weeks, which may result in planting late which could often result in the risk of the ceassation of rain before crops become mature for harvesting. This is among the reasons why some farmers plant shortly before the commencement of the rain. Some respondents in Bumbum (Maiadu LGA) Yakubawa and Yardaje (Zango LGA) claimed that farmers who planted after the first rain in 2009 experienced a long dry spell. Some of them had to replant. [5]

In all the villages, farmers reported that late start of rains in the last 15 – 20 years have become more frequent. The pattern and duration between rains is increasingly becoming unstable. Many farmers have pointed out that their area received 'big rains' in August in previous years, now the trend has shifted to September.

To know the actual amount of rain received in a year, the farmers have devised a traditional way of recording rainfall by dividing the rainfall events into four categories, based on distribution, duration and intensity of the rain. After every rain, stones of various sizes are dropped in a clay pot to reflect the nature of the rain

After a heavy rain (big rain) that lasts several hours and covers a wide area, a stone of about 2cm diameter is dropped in a pot; rain that last for an hour, and covers small area, a stone of about 1cm diameter is dropped in the pot. While medium intensity rain that lasts less than one hour with a little sign of run-off on the ground, pebble of three-quarter size of a centimeter is dropped in a pot. On the other hand, rain that falls with low intensity and in a very short duration of less than 30-minutes, covers a small area without any sign of run-off on the ground, a pebble of about half of a centimeter diameter size is dropped in the pot.

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Table 5.4: Indigenous Classification of Rainfall

Rainfall Type	Description
Ruwan	It is the first rain of the season.
Karya rani	Mark the end of the hot dry season. The rain is not meant for Planting but indicates approaching of the rainy season
Kwazari	It is the first rain that mark onset of the rainy season. It is meant for planting It last several hours Leaves soil moist for several days; cause good infiltration.
Zirnaniya	It is very localized rain, oddly distributed without much wind or thunder, can fall any time of the day, cover small area. It hardly exceeds 30 minutes to one hour.
Yayyafi	Localized rain falls with low intensity not violent but can be accompanied by gentle thundering.
Bude rana	It can be localized or cover a large area It can be light or heavy. It is followed by clear sky after cloud covering the sun.
Marka	Heavy rain, (big rain), it falls with high intensity, covered a very wide area, lasting several hours, sometimes 10 – 20 hours; leaves soil soaked, causes good infiltration, without destructive wind.
Raba	Fog or water droplets suspended in the air, fall on leaves and roofs. Many farmers believe that if water ceases earlier, fog sometimes can sustain crops.

Source: Field Work (2009/2010)

At the end of the season, all the stones dropped in the pot are spread on the ground and counted. This allows the farmers to determine the quantity of rain received in the year. If the number of 2centimeter diameter stones exceeds the other three categories, the year is describe as *Shekara mai albark**a*** ***(a** blessed year)*. It is based on this assessment that most of the farmers deduced that the number of "big rains" received in the last two decades have reduced drastically. Hence attributed the receding of the water table level in the study area to the reduction in the number of '"big rains"' received in the area. This assertion conforms to the findings of Tomlinson (2010) who found downward trend in the amount of rainfall recorded north of latitude 10ON between 1941-1970.His Regression analysis indicated a reduction in the amount of rainfall recorded in the study area from 700mm to less than 600mm in 2008. He predicted that if the present trend persists, the amount of rainfall will decrease to less than 400mm by the year 2030.

Section five

5.1 Summary and Conclusion

The paper has examined the role of indigenous knowledge of weather forecast among famer in making decision on their harvest. The paper starts with the discussion of the important role of IK in sustainable development. The study explore Participatory rural appraisal methods, key informants interview and focus group discussion were used in the data collection. It has been found that the most widely used indicators in rainfall forecasting include plant phenology at the beginning of rainy season, stars sighting and their position, nature of clouds, wind direction and speed and behaviour of certain animals. Apart from rainfall forecast, the farmers have devised traditional ways of recording and comparing rainfall variability within a season and over the years. Even though the farmers acknowledged the reliability of indigenous rainfall forecast is gradually waning off due to increasing climatic variability,

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