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INDIGENOUS WEATHER FORECASTING SYSTEMS: A CASE STUDY OF THE BIOTIC WEATHER FORECASTING INDICATORS FOR WARDS 12 AND 13 IN MBERENGWA DISTRICT ZIMBABWE

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ABSTRACT

Residents of wards 12 and 13 in Mberengwa depend on agriculture as a source of livelihood. They have since developed their own indigenous weather forecasting systems which they have been using in conjunction with meteorological weather forecasts in the planning and execution of their agricultural activities. These systems are used singularly or are complimented with the conventional meteorological forecast from the Meteorological Services Department. The main objective of this research was to identify the biotic weather forecasting indicators as well as to acquire information on how they are used to ensure sustainable livelihoods for this community. Questionnaires, focus group discussions and interviews with key informants were used to collect the data. Key informants were those whose time of residence in the wards was more than 70 years. Investigations revealed that the residents rely mostly on environmental indicators for planning agricultural activities. Results showed that birds, creatures or animals and vegetation were the biotic indicators used to derive weather forecasts. The rankings in terms of use as an indicator were as follows (1) Birds: (Rain cuckoo and ground hornbill) for short range and seasonal forecasts. (2) Vegetation: for seasonal forecasts (3) Animals and creatures. (4) There were however differences in the interpretations of the behavioural signs or indicators which were used in the production of the indigenous forecasts. The study recommends that more research should be carried out on the utilization of the weather forecasts derived from the biotic indicators. The indigenous weather forecasting methods should be documented and the knowledge imparted to the locals for sustainable use by future generations. The establishment of an effective indigenous weather forecasting system as part of a decision support system would go a long way in improving food security for this area and on enhancing sustainable living.

Keywords: Indigenous Weather Forecasting; Biotic Indicator; Drought; Livelihoods; Behaviours; Indigenous Knowledge Systems; Residents

INTRODUCTION AND BACKGROUND

Indigenous knowledge systems (IKS) are a body of knowledge used by societies in Africa and the rest of the world for various purposes depending on the needs of the particular society. IKS have been used since time immemorial. There are a variety of definitions for IKS. Mapara (2009) defines IKS 'local knowledge that is unique to a given culture or society'. Altieri (1995) defines IKS as knowledge forms that have originated locally and naturally and have failed to die despite the racial and colonial onslaughts that they have suffered at the hands of Western imperialism and arrogance. Mapara (2009) defines IKS as 'a body of knowledge, or bodies of knowledge, of the indigenous people of particular geographical areas that they have survived on for a very long time'. These knowledge forms are known by other names, and among them are 'indigenous ways of knowing, traditional knowledge, indigenous technical knowledge, and rural knowledge as well as ethno-science or people's science. (Altieri, 1995 cited in Mawere, 2011).

Biotic weather forecasting indicators are a subset of indigenous knowledge systems particularly indigenous weather forecasting methods. Weather forecasts, whether conventional or indigenous are an essential input to agricultural production. Conventional weather forecasts can be processed and disseminated from the Meteorological department and at times are not accessible to most of the rural people. These people rely on weather forecasting indicators derived from their environment to make strategic decisions in their day to day lives especially in agriculture hence the need to study and document the indigenous forecasting indicators.

Zimbabwe's economy is agro-based, and agriculture provides employment for 70 % of the population (Ministry of Foreign Affairs Zimbabwe, 2011). Since agriculture is heavily dependent on weather and in particular rainfall and temperature, in areas where rainfall is erratic and inadequate, agricultural productivity becomes highly correlated to weather. Wards 12 and 13 in Mberengwa are in agro-ecological region 4 where rainfall is unreliable and inadequate. Strategic decision making and planning such as when to plant and which crops to grow for a particular year are all effectively done using weather information derived from certain indicators, Livestock numbers, water resources and pasture management activities all depend on weather forecasts and in particular, rainfall forecasts(Shoko and Shoko, 2011).

Most of the residents of Wards 12 and 13 do not access seasonal and daily weather forecasts from the Meteorological department. Where Meteorological forecasts are received through the radio, lack of skill in interpretation and application of these forecasts becomes a hurdle as this requires Meteorological and Agricultural Extension officers. Therefore, these people need simple and easy to apply agro- meteorological products which are not readily available. Hence these residents are then left with no choice but to use their indigenous weather forecasts as decision making tools in planning their livelihoods.

In a study by Shoko and Shoko (2011) which examined the perception levels of accuracy for indigenous weather forecasts and meteorological forecasts in wards 12 and 13 in Mberengwa, 66% of the respondents indicated that indigenous weather forecasts' accuracy fell in the 'average' to 'good' rating while 59 % indicated that they rated meteorological weather forecasts as 'average' to 'good'. Comparative ratings of the accuracy of indigenous weather forecasts to meteorological weather forecasts showed that 91% of the respondents who had access to both meteorological and indigenous weather forecasts perceived the indigenous weather forecasts as being more reliable than meteorological weather forecasts. The findings clearly illustrate the value attached to indigenous weather forecasts with regards to sustaining livelihoods in this community.

In Chitora communal lands in Zimbabwe, Svotwa, Manyanhaire and Makanyire, (2007) established that the singing of the annual cicada in large numbers signify the beginning of a normal to above normal rainfall season and this can also signify approaching wet conditions. This result is area specific and cannot be generalised to other areas with different biotic environments such as wards 12 and 13 in Mberengwa district, The major question that the current study will attempt to answer is: 'Which biotic weather forecasting indicators are used by the residents in wards 12 and 13 in Mberengwa and how are they utilised to sustain livelihoods?'

To effectively utilize land and make precise agricultural management decisions appropriate early warning systems on rainfall, agriculture and market data are essential. Therefore efforts must also be made to build on farmers' indigenous knowledge systems. Mararike (1999) discusses the use of indigenous knowledge systems in predicting rain or drought seasons. The people try to make meaning out of the environment in which they live. This knowledge is key to any planning process at the lowest level and enables locals to act in a timely way. So it is important to identify and document effective IKS in wards 12 and 13 in Mberengwa Zimbabwe. According to studies carried out by UNEP (2002), the Hausa of Northern Nigeria, for example, developed a wealth of indigenous knowledge systems to cope with vulnerability to drought and famine in sub-humid to arid regions of the Sahel. These included inter-cropping with nitrogen fixing legumes, intensive manure application, soil conservation works, poly-cultural production of different cereals to cope with variable soil moisture regimes and exploiting different ecological needs to support wet and dry season production respectively. Studies carried out by Mararike (1999) in Buhera reveal that there are a lot of indicators for rain or drought seasons for example the singing of a bird called 'haya' (rain cuckoo) in the early summer is believed to herald the start of the rainy season. There is little documentation in of the weather forecasting methods and how they are used for sustainable livelihoods in Mberengwa wards12 and 13 Zimbabwe

Out of all the various factors which control agricultural production, weather is the only factor over which man has no control and hence it has overwhelming dominance over the success or failure of an agricultural enterprise. Weather induced variability of food production ranges from 10% to 50% in arid and semi arid regions (FAO, 1998). In order to reduce risks of loss in food production due to the vagaries of weather, weather forecasts should be taken into account in all agricultural planning to ensure sustainable livelihoods. Thus the development of weather prediction systems and expert indigenous weather systems is important and has been a necessity since time immemorial. In the absence of improved technologies for weather forecasting, farmers could derive their prediction from the biotic environment. Some of these are:

- *Weather prediction through birds.* This is done by observing closely different activities or behaviours of birds. According to FAO (1998) an example of a bird indicator is the lapwing bird (Tatihari) found in Australia. When it lays its eggs on the upper part of the field then good rains are expected and poor or no rains when it lays eggs on the lower part of the field. It is further believed that if it lays one egg then rains will fall for one month and two eggs imply that rains will fall for two months. The rainfall season lasts for four months in this region (Australia).
- *Weather prediction through creatures/animals.* An example of an animal indicator is the camel. When there is a swelling on the lower parts of the camel's legs, rainfall is expected any time. Creatures such as centipedes and spider nests just to name a few are also used (FAO,1998).

People in rural or remote areas rely mostly on indigenous weather forecasting systems to get daily and seasonal weather forecasts. These indicators are derived from the environment and differ from place to place. The current study identified the biotic weather forecasting indicators as well as documenting how the weather forecasts are derived from these indicators in wards 12 and 13 of Mberengwa in Zimbabwe. The results can be used to improve the accuracy of weather forecasts and to make adept agricultural strategic decisions not only in this area but in other areas with a similar environment in Zimbabwe and worldwide.

In a related study Acharya (2011) argues that traditional phenological(TPK) relates to indigenous knowledge of seasonal timing of growth, development, reproduction and migration of organisms, which occur in a predictable manner based on temperature thresholds, daylight length, moisture or other environmental determinants. Animals respond to subtle variations of the earth's magnetic field that happen prior to extreme weather events such as tornadoes, tropical cyclones and even freak thunderstorms. These animals may be reacting to ultrasound or micro-tremblors not significant enough to be picked by humans, (Acharya, 2011). Studies of shark movement during tropical storm Gabrielle and hurricane Charlie showed that sudden barometric pressure drop causes sharks to swim to deeper waters where there is more protection. Another example is the green frog called laubfrosch in Germany which is very popular for accurate prediction of weather conditions (Acharya, 2011). The green frog is kept in a big glass jar with a ladder. If the frog remains at the bottom of the ladder the rain is imminent. The higher up the ladder the frog climbs the better the weather will be. It has been observed in nature that this type of frog(hyla regilla) tends to climb up the branches the warmer the weather gets (Acharya, 2011).

Plants and fungi can accurately forecast the certainty of wet and dry weather (Acharya, 2011). This is supported by some fascinating facts recorded for dandelions (Taraxam officinale), wild indigo (Baptisia australis), clovers (Trifolium repens), and tulips (Tulipa gesneriana), which all fold their petals prior to the rain (Sivanarayana, 1993). Plants respond to radiation, temperature, pressure and humidity thresholds human beings cannot sense without the aid of scientific instruments. So acquiring indigenous knowledge about these weather responses prior and after a weather event would be valuable knowledge in planning rural livelihood activities.

There are a number of uses to which indigenous weather forecasts can be applied. The rural community of Ilocos Norte Province of the Philippines rely heavily on Indigenous weather forecasts to plan and prepare agro forestry activities as well as in disaster prevention. These farmers derive their weather forecasts from observations of the atmosphere and astronomical conditions, indicator plants and the behaviour of organisms such as animals, birds, and mammals. Using their indigenous weather forecasts, farmers prepare their upland farmlands in time to ensure that vegetative cover is established before the heavy rainfall season. This helps to prevent soil erosion during the heavy rainfall (Galacga and Balisakan, 2009). Warren, (1991) and Tekwa and Belel, (2009) also argue that indigenous knowledge is the basis for local-level decision making in areas such as health care , food preparation, education, natural resource management, agriculture and a host of other livelihood activities in rural areas.

The Maori of New Zealand exhibit a good ability to predict the weather through their interactions with the local environment for centuries. Environmental knowledge has been utilised in both traditional and modern practices of agriculture, fishing, medicine, education and conservation. A pilot project is on going in the community called NIWAS Maori Research and development Unit (Kind, Skipper, and Tawhai, 2008). This project is involved in identifying and documenting Maori environmental knowledge of weather and climate in New Zealand. The knowledge includes the indigenous nomenclature for local weather and climate phenomena, the oral recording of weather, climate based events and trends and the `identification of environmental indicators to forecast weather and climate. This knowledge enables one to understand what has helped the Maori to adapt to climate, weather and climate variability in the past (Kind etal, 2008). This treasure of knowledge is vital in understanding the climate, climate variability and trends in New Zealand. A study of a similar nature in wards 12 and 13 of Mberengwa district in Zimbabwe will contribute to our understanding of how the indigenes have managed to survive in these harsh climatic conditions.

Manyatsi (2011) carried out a research in Swaziland on the use of indigenous knowledge to manage hydrological disasters. The study revealed that a variety of methods are used to predict weather such as environmental cues and the behaviour of animals. The nesting position of Ploceus ssp bird is used to predict floods. The cry of *cuculus solitaries* bird signals the start of the wet season between August and November. On hearing this cry, the farmers assemble their inputs. Manyatsi (2011) also established that when there is abundance of creatures such as butterflies, locusts and grasshoppers during the farming season then drought would be imminent. Large swarms of swallows are taken as a sign of wet conditions approaching and farmers embark on land preparation in anticipation of the wet rainfall season. On the other hand the breeding of waterfowls on the ground under cover of grasses and reeds would imply imminent drought. Farmers use this information in agricultural decisions and plant drought tolerant crops such as sorghum and millet (Svotwa et al, 2007). The chirping of the *centropus burchellii* in October to April is a cue for thunderstorms within a few hours.

Mawere (2011) carried out a study on the potential of IKS to re-establish a moral and virtuos society in selected areas in Zimbabwe and Mozambique and established that indigenous methods of weather forecasting are very useful, especially in summer and immediately after harvesting when crops, like finger millet, would be in need of thrashing and winnowing. The current study sought to explore and analyze the uses of indigenous weather forecasts in wards 12 and 13 of Mberengwa district in Zimbabwe which has a different environment and agronomic practices.

Nyong, Adesina and Elash (2007) carried a study in the African Sahel on the value of indigenous knowledge in climate change mitigation and adaptation strategies show that indigenous knowledge has been applied in this region in climate change mitigation. In the area of adaptation, indigenous weather forecasts have been utilised in the assessment of vulnerability and implementation of adaptation strategies. Nyong et al, (2007) further asserted that although research is gradually recognising the importance of indigenous knowledge systems in developmental studies, the value of indigenous knowledge in climate change studies has received little attention. This neglected indigenous knowledge includes indigenous methods of weather forecasting and their utilisation in climate change to sustain the rural livelihoods in a changing climate.

There is need for all sectors involved in agriculture to make adept decisions to capture the full benefit of agriculture. The focus for this research was on identification and analysis of indigenous weather forecasting methods and their utilisation by the community in wards 12 and 13 in Mberengwa district of Zimbabwe to ensure sustainable livelihood.

Statement of the problem

Meteorological forecasts are highly technical in nature, such that most people can not understand them hence they derive minimal or no benefits from such forecast. Besides, these forecasts are available at a cost which the rural people can not afford. This leaves them vulnerable to all the vagaries of weather that may lead to poor yields and food insecurity. So the thrust of this research was to find indigenous forecasting solutions to the problem cited above by tapping indigenous forecasting knowledge, which is less technical in nature and inexpensive to the user.

Objectives

The aim of this research was to investigate the biotic weather forecasting indicators being employed in Wards 12 and 13 of Mberengwa district in Zimbabwe .The objectives of this research were to:

- identify the biotic indicators used in indigenous weather forecasting systems in Wards 12.and 13
- document the behavioural signs and their interpretations for various biotic environmental indicators.
- rank the indicator categories according to their utilization in sustaining livelihoods for the community.

Justification of the study

Timely planting, selection of the appropriate crop cultivars, as well as practicing an animal husbandry system suitable to the local climate are imperative. Decision making is based on anticipated rainfall and to a lesser extent on the availability of agricultural inputs. Conventional meteorological weather forecasts and in particular seasonal rainfall forecasts have limited accessibility. This leaves most of the farmers with no option but to rely on forecasts derived from indigenous indicators. Where the Meteorological forecasts are accessed, limited understanding of the forecasts and poor skills in making appropriate agro-meteorological decisions become a hurdle. As a result, most of the residents are left with no option but to use their indigenous knowledge based on biotic and abiotic components of their environment, which they understand better.

Identifying the indigenous weather forecasting indicators and acquiring information on how they are used will not only improve food production in this area, but will also be useful to other people, living under similar environmental conditions elsewhere. It is also anticipated that knowledge on the interpretation of the behaviours or symptoms from the biotic environmental indicators will be documented, so that the indigenous weather forecasting system can be improved. The behaviours or signs that are similar should have the same weather forecast inferred from them for a particular area, so it is hoped that the findings from this research will help bring this much needed alignment and thus solve the existing problem where a multitude of differing forecasts are derived from the same indicators and behaviours. This should add value to the indigenous forecasting system and also improve its precision. Finally, the indigenous weather forecasting system should be blended with the Meteorological forecasts to produce a more accurate and user-friendly weather forecasting system. It is also hoped that knowledge will be imparted to all the residents on how to use the indigenous weather forecasting system for their benefit.

Area of study

Mberengwa is a district in Zimbabwe situated 180 km south of Gweru and 24km southwest of Zvishavane and the district extents over Natural Farming Region I V and V, falls in Natural Farming Region IV (Figure 1). The study area falls under Natural Farming Region I V. The majority of the people in this area depend wholly on farming for their survival. Farming in this area is however affected by rainfall variability. Rainfall in this area ranges from 300-500 mm per year and the length of the growing season is only about 111 days. Droughts are very common in this area and it has been noted that there are usually 4 moderately dry years in 5 years, which means there is only one good season in 5 years. Mid-season droughts are also very common. Intra-season dry spells occur without fail even in good years and the average is about 10-20 days mainly in January. The study was carried out in Mberengwa West where wards 12 and 13 are situated. The wards comprise six villages and the population is about 5987 (CSO, 1992). There are 948 households in the ward.

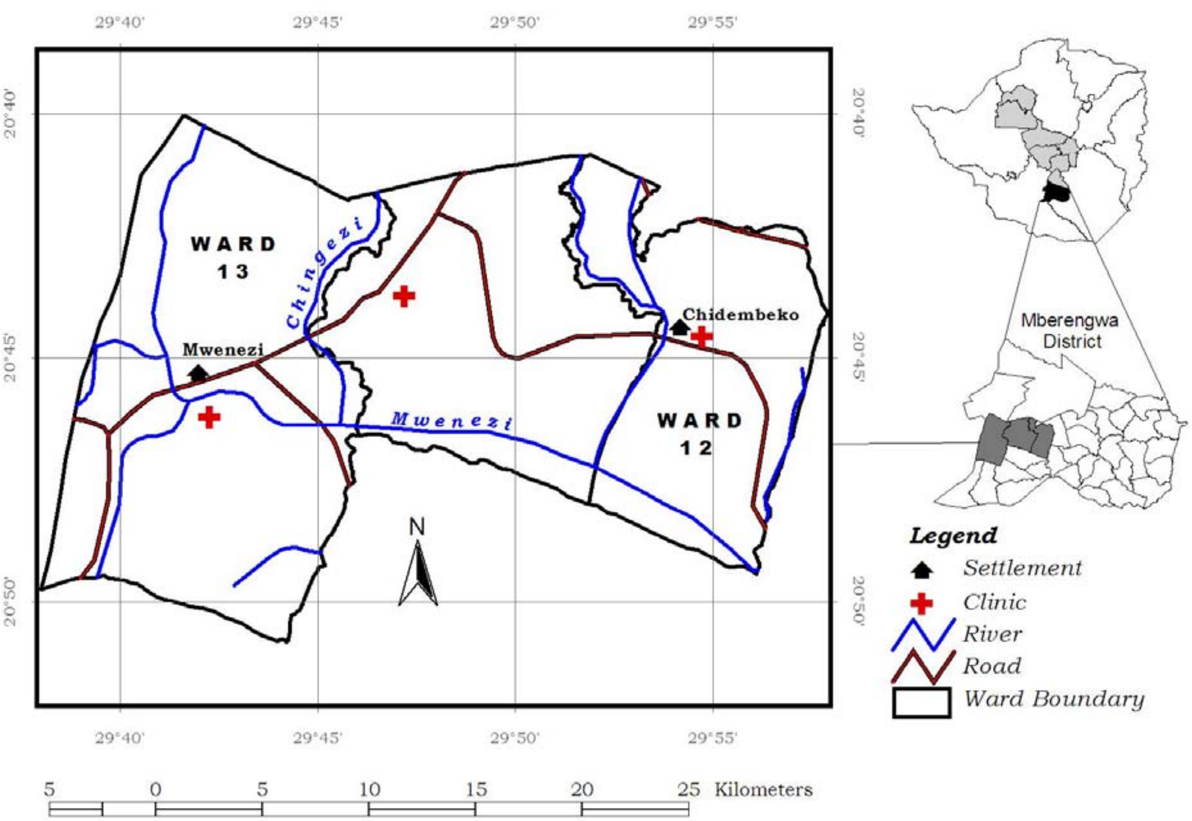

Figure 1: Map of the study area

METHODS AND MATERIALS

The collection of data was done through questionnaires and focus group discussions. A total of 79 questionnaires were administered, 45 in ward 12 and 34 in ward 13. One focus group discussion was conducted per ward to compliment information gathered from questionnaires. The questionnaires were administered to selected persons aged 20 and above. Interviews were carried out with key informants above 70 years. The minimum age limit of 20 years ensured that only respondents with good indigenous knowledge of the area were interviewed. This helped to ensure both validity and reliability of the data collected.

Questionnaire

The questionnaire sought to elicit information on the following aspects:

- Identification of the indigenous weather forecasting systems (biotic) used in the two wards
- Documentation of the indigenous weather forecasting indicators and their interpretations
- Recommendations to improve the weather forecasts derived from the biotic weather forecasting indicators.

Focus group discussions

Focus group discussions were done after the questionnaires. One focus group discussion was conducted in each of the two wards. These discussions were aimed at establishing consensus on which indicators were most popularly used, the ranking of the indicators and to enlist suggestions on the best possible ways of improving the indigenous forecasts.

Interviews with selected key persons

These interviews were carried out after the administration of the questionnaires and the focus group discussions and they were restricted to persons over 70 years. This ensured the acquisition of authentic information since these persons had resided for long periods in this particular environment. Four and two persons were interviewed in wards 12 and 13 respectively. During these discussions, all the indicators and particularly the behaviour of animals and creatures and birds were discussed and documented.

Analysis Procedures

Information on how the forecasts are derived from the indicators was documented. The indicator or the behavioral signs were noted as well as the corresponding forecast from the indicator. The environmental weather indicators for the study were divided into categories as follows:

- Creature /animals indicators
- Bird indicators
- Vegetation indicators

Creature/animal indicator refers to either a creature or animal whose behaviour is observed with the intention of generating a weather forecast. *Bird indicator* refers to a bird whose behaviour is studied to derive a weather forecast. *Vegetation indicator* refers to *a condition* or prevailing characteristics of specific vegetation, used to derive a weather forecast.

Inferences were made from graphs, pie charts and tables. The most used indicators were identified and matched with the corresponding signs or behaviours. Ranking of the indicators per category was also done.

PRESENTATION OF RESULTS

The findings were presented under the following headings, demographic characteristics, and identification of the biotic indicators and derivation of the weather forecasts from the various biotic indicators. Ranking of the biotic indicators in terms of utilization was also done. The data from questionnaires was analyzed and the results are presented below beginning with demographic characteristics of the sample.

Demographic Characteristics

Table 1: Period of residence by gender in the wards

Period of residence	Ward 12 n=26	n=19	Ward 13 n=25	n=9
	Male	Female	Male	Female
20-30 years	15.3%	21%	8%	22%
31-40years	11.5%	15.7%	20%	22%
41-50years	11.5%	21%	12%	33%
51-60years	34.6%	26.3%	40%	0%
61-70years	7.6%	10.5%	8%	0%
71-80 years	7.6%	0%	8%	11%
Over 80 years	11.5%	5.2%	4%	11%

N=79

Table 1 shows the number of people who have resided in the ward for a given period. For example 15.3% males have resided in ward 12 for over 80 years and 52.6% females of the same ward have been resident for 51 -60 years. Males and females who participated are shown against their corresponding age groups.

Means of livelihood for the residents of wards 12 and 13.

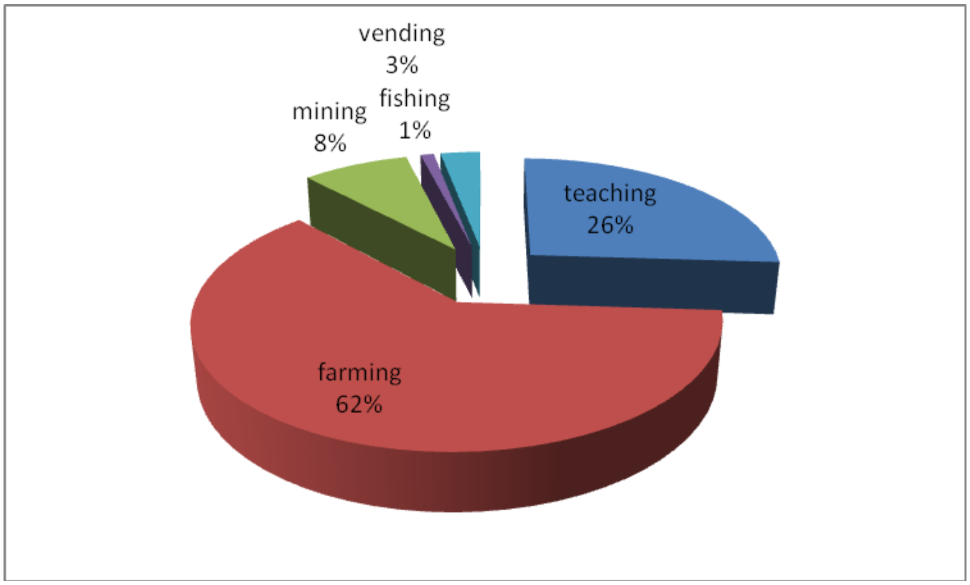

Figure 2: Means of livelihood

Figure 2 shows the distribution of the participants according to their means of livelihood.

The salient feature about Figure 2 is that 62 % of the respondents derive their livelihood from farming which in turn is directly affected by the weather and 26 % are teachers.

Identification and Ranking of Indigenous Weather Forecasting Indicators

Bird Indicators

Table 2: Ranking of bird indicators according to frequency of use

Bird's Identity	Ward 12		Ward 13		
	% response	Rank	% response	Rank	Combined Rank
Rain Cuckoo	30	2	33	1	1
Ground hornbill	34	1	29	2	1
Migratory Stork	0	9	26	3	2
Tinker Bird	11	3	0	6	3
Striped Kingfisher	10	4	1	5	3
Swallows	2	7	5	4	4
Black Kite	5	5	1	5	5
Fork-tailed drongo	3	6	0	6	6
Black crow	3	5	0	6	6
Nightjar	1	8	1	5	7
African hoopoe	1	7	0	6	8
Ducks	0	9	1	5	8
Greater honey guide	0	9	1	5	8

Salient observations from Table 2 are that for ward 12, the ground horn bill was ranked 1, the rain cuckoo was ranked 2, the tinker bird 3, the stripped king fisher 4, the black kite 5, the forked-tailed drongo 6, the migratory stock 7 and the duck 8.

In ward 13 the following rankings were obtained, the rain cuckoo 1, the ground horn bill 2, the migratory stock 3, the swallow 4, the night jar 5 and the fork-tailed drongo 6.The combined rankings for the two wards ranked the rain cuckoo and the ground horn bill 1, and the migratory stock 2 despite the fact that the migratory stock is rare in ward 12 as evidenced by the 0% response in this ward.

Table 3: Derivation of weather forecasts from Bird Indicators.

Bird's identity	Behavioral sign	Forecast
Ground hornbill	1 Hooting in the morning	Guti within 12 to 48 hours
	2 Hooting any time of the day	Imminent cold weather
Rain cuckoo	1 Cuckooing continuously during the rainy season	Rains expected within 1-2 days
	2 Cuckooing sporadically in October	Rain season about to begin
	3 Cuckooing frequently in October/November	Good rainfall season expected
	4 Cuckooing during the night	Rains expected to come soon
Black crow	Crowing very early in the morning	A very hot afternoon is expected
Stripped king fisher	1Singing in the rain	Signifies the end of the rain spell
	2 Singing when there is no rain/dry	Rains expected shortly
Ducks	1 Flapping wings frequently	Rains expected within two days
	2 Moving about restlessly	Stormy weather expected
Migratory stock	Presence in large numbers	Sign of a good warm rainfall season
Swallows	1 Flying haphazardly in large numbers	Imminent Rains
	2 Few and flying at great height	Dry spell expected
Night jar	Singing	Impending Rains
Tinker bird	Singing	Hot days expected shortly
Fork-tailed drongo	Singing over a number of days	Imminent Rains
Greater honey guide	Singing	Rains about to come

Creature or animal indicators

Table 4: Ward rankings and combined ranking for various animal or creature indicators

	Ward 12		**Ward13**			
Creature or animal indicator	Total (freq)	**Rank**	**Total** (freq)	**Rank**	Combined total (freq)	Combined Ranking
Termites	15	1	17	1	32	1
Cicada	13	2	15	2	28	2
Frogs	5	4	9	3	14	3
Baboon	5	4	7	4	12	4
Rock rabbit	6	3	4	5	10	5
Ants	3	5	2	7	5	6
Crickets	3	5	0	Nil	3	7
Jerrymunglum	2	6	1	8	3	7
Cattle	1	7	3	6	4	7
Rock duiker	2	6	0	Nil	2	8
Mole rat	2	6	0	Nil	2	8
Millepede	2	6	0	Nil	2	8
Monkeys	2	6	0	Nil	2	8
Snake	1	7	0	Nil	1	9
Goat	1	7	0	Nil	1	9
Kudu	1	7	0	Nil	1	9
Grasshoppers	0	Nil	2	1	1	9
Army worm	0	Nil	2	1	1	9
Fish	0	Nil	2	1	1	9
Beetles	0	Nil	2	1	1	9

Table 4 has a number of interesting observations, which are:

- Termites were ranked one in both wards and retained the same ranking when the two wards were combined.
- The cicada was also ranked two for both wards and retained the same ranking when the two wards were combined.
- Frogs assumed a combined ranking of three.
- Baboons were ranked four and retained the same ranking when the two wards were combined.

Table 5: Derivation of weather forecasts from creatures or animals

Creature's Identity	Behavioral sign	Forecast
Frogs	1 Croaking profusely	Signifies Rains
	2 Producing sharp shrills	Drizzle expected
	3 Bull frog croaking with high tone	Rains expected the next day
Termites	Stock piling grass	Guti or rainy weather expected
Cicada	Singing loudly in large numbers	Very hot weather expected or Signifies the end of winter
Jerymunglum	1 Moving at night	Rains around the corner
	2 Moving restlessly	Imminent Rains
Millipede	1 Moving around in large numbers after a rain spell	Expect the rain spell to persist for some days
	2 Moving around when it is very hot	Rains are nearby
Rock rabbit	1 Chattering at night	Rains are nearby
	2 Chattering the whole day	Drizzly weather expected
Baboons	1 Raising their heads towards the direction of wind	Rains expected within hours
	2 Moving in troops of large numbers	Good rainfall season expected
Ants	Appearing in large numbers	Sign of heavy rainfall to come
Crickets	Singing loudly in large numbers	Rains near or next day
Cattle	1 Sniffing the air with heads raised up	Expect immediate rains
	2 Bellowing on dry riverbeds	Rains expected soon
Sheep	Huddling together facing one direction	A dangerous storm is approaching from that direction
Rock duiker	1 Making plenty singing sounds	A good rainfall season expected
	2 Moving about frequently	Plenty rains expected soon
Monkeys	Moving in large troops	A good rainfall season expected
Snake	Presence in large numbers	Rains are nearby
Goats	Bearing lots of kids	Sign of a hot and wet season
Fish	Jumping into the air frequently	Rains are about to come
Army worm	Presence in large numbers	A dry spell is expected soon
Grasshoppers	Appearing in large numbers	Rains expected soon

Vegetation Indicators

Table 6: Vegetation indicators, percentage frequency and rank according to use

Indicator (Botanical or English)	%Frequency	Rank
Spring foliage	6	5
parinari curatellifolia	14	2
Wild custard apple tree	1	11
serenia griegufolia	1	11
Musongoma	1	10
Prickly Pear	1	11
Lannea discolor	14	2
diospyros lycioides	18	1
Uapaca kirkiana	8	3
mimusops zeyheri	3	8
Vitex mombassae	1	11
Azanza garkeana	7	4
Marula tree	2	9
Kigelia pinnata	1	11
Aloe, arborescent	4	6
Ficus capensis	8	3
Brachystegia spiciflora	4	6
Brachystegia glaucescens	1	10
Euphorbia ingens	4	7
Syzygium guineense	1	11
Lannea edulis	1	11
MulberryTree	1	11
Berchemia discolor	1	11
euclea linearis	1	11

Table 6 shows the percentage frequency and the ranking of vegetation indicators used by the two wards. The ranking was as follows; diospyros lycioides ranked 1, lannea discolor ranked 2, uapaca kirkiana ranked 3, azanza garkeana ranked 4 and parinari curatellifolia ranked 5.

Table 7: Derivation of the weather forecasts from vegetation

Vegetation identity	Behavioral sign	Forecast
Ebony tree(Diospyros kirkii)	Abundant fruits	Good rainfall season expected
	2 Abundant fruits	Chances of drought exist
Wild loquat tree(Uapaca Kirkiana)	1 Abundant fruits	Good rainfall season expected
	2 Abundant fruits	Chances of drought
Live long tree(Lannea discolor)	Abundant fruits	Good rainfall season expected
Marula tree(Sclerocarya birrea) a	Abundant fruits	Equal chances of drought and wetness
Candelabra tree(Euphorbia ingeno)	1Blooming of flowers abundantly	Good rainfall season expected
	2 Opening of flowers	A sign of heavy rain in the afternoon
Julbernardia globiflora/Brachystegia spiciformis	1 Lots of spring foliage	A good rainfall season expected
	2 Blooming in August	Early rains
	3 Late blooming	Drought expected
Brachystegia spici flora	Plenty of new shoots	Good rainfall season expected
Mimusops zeyheri	Abundant fruits	A good rainfall season expected
Aloe tree	1 Blooming	Rains expected within 48 hours
	2 Producing green or red flowers	Signifies a drought
Chocolate berry (Vtex mombassae)	Plenty fruits	Good rainfall season expected
Azanza garkeana	Abundant fruits	A good rainfall season expected
Prickly pear	Abundant fruits	A sign of wet rainfall season
Parinari curatellifolia	1 Abundant fruits	A good rainfall season should be expected
	2 Abundant fruits	Drought expected but not as much as a wet year
Fig tree(Ficus carica)	1 Plenty of fruits	A good rain season
	2 Shooting	Rains are near
	3 Shading leaves	Rain season close by
Buffalo thorn(Ziziphus mucronata)	Abundant fruits	Good rains expected
Mulberry tree(Boussonetia papyrifera)	Plenty of fruits	A good rainfall season expected
Lannea edulis	Abundant fruits	A wet rainfall season expected

FOCUS GROUP DISCUSSIONS

Two focus group discussions were conducted, one for each of the two wards. Ward 12 group discussion was comprised of 20 people, 13 males and 7 females while ward 13 group discussion comprised 16 people, 10 males and 6 females. Group discussions were important in this study because interpretations of indicators at times differed with respondent. So there was a dire need to synchronize these and come up with a consensus interpretation for each of the indicators. Where there was disagreement, the interpretation given by the majority was adopted. Clarification of issues where there were differences was necessary and it was achieved through these group discussions.

Vegetation indicators

Respondents were in agreement with regards to the identification of the indicators. However, there were divergent views on the interpretation of indicators for the parinari curatellifolia, ficus capensis and uapaca kirkiana. Some said that plenty fruits indicate a good rainfall season while others said this was a sign of drought. The majority went for plenty fruits as indicating a good rainfall season and few or no fruits as indicating an impending drought. Responses from the questionnaires indicated the same trend.

Creature or animal indicators

In this category of indicators, focus group discussions concurred with results from questionnaires which indicated that termites, cicada and frogs are the most used. The only variations were that Ward 12 group discussions ranked the cicada as 1, termites as 2, while Ward 13 focus group discussion ranked termites as 1 and cicada as 2. The differences in ranking may be explained by the fact that ward12 offers a better habitat for the cicada than ward 13, while on the other hand ward 13 has a better habitat for the termites.

Bird indicators

The two focus group discussions concurred with the identification and ranking obtained from questionnaire responses from their respective wards. Ward 12 group discussion ranked the ground hornbill as 1 and the rain cuckoo as 2, while ward 13-group discussion ranked the rain cuckoo as 1 and ground hornbill as 2. The reversal in ranking is due to the differences in the physical environment for the two wards. Ward 12 is hilly and this is an ideal habitat for the ground hornbill, while ward 13 has mostly grass with scattered trees making it a good habitat for the rain cuckoo.

Interviews with selected key persons

Very few persons were selected because of age restriction and senility. Four and two persons were interviewed in ward 12 and ward 13 respectively. These interviews were carried out after the administration of questionnaires and group discussions.

Vegetation Indicators

Responding to a question that asked how they determine drought or good rainfall seasons using vegetation, two of the respondents gave the following answers.

Respondent A: *Abundant spring foliage is indicative of a good rainfall season while abundant fruits for diospyros, kirkii(ebony tree) and parinari curatellifolia signaled a poor rainfall season .*
Respondent C: *If the fig tree and lannea discolor and have plenty of fruits, these are signs of good rains while plenty of fruits for diospyros, kirkii and parinari curatellifolia are signs of drought.*
Respondent E : *When the Candelabra tree(Euphorbia ingeno) blooms abundantly then a good rainfall season is expected*
Respondents B, D and F echoed similar sentiments to respondents A and C.

Bird Indicators

When asked about how they derive forecasts for drought and good rains from birds. Respondent B said: *We know that there will be a good season if rain cuckoo sings sporadically in October and if migratory stocks appear in large numbers beginning of November. .*
When asked about the most used and reliable bird indicator used to derive weather forecasts, respondent C said: *The ground hornbill hooting is a sure sign of drizzle weather the following day.* The other four echoed similar views on bird indicators and it was also interesting to note that their sentiments concurred with views raised in the focus group discussions and from the questionnaires.

Creature or animal Indicators

In this category for both wards the key persons concurred with the identification and interpretations from the group discussions and questionnaires although they stressed that frogs croaking profusely was mainly an indicator of a good rainfall season. Answering a question on the most widely used creature or animal indicators, respondent F said: *Frogs croaking, songs from cicada and crickets are the most used.*

Ranking of Indicator Categories

Ranking of the indicator categories was done using information from the questionnaires, group discussions and interviews with the selected key persons. The ranking was done for each of the two wards from which the combined ranking for the two was derived.
The respondents were asked to rate on a scale 1 to 3 the most used or important indicator categories where 1 stands for the most used indicator and 3 the least used indicator. The results for the two wards are shown in table 8.

Table 8 : Ranking and combined ranking of indicator categories for wards 12 and 13 from questionnaire

	Ward 12		**Ward13**			
Indicator Category	**Response**	**Rank**	Response	**Rank**	*Combined %* Response	Combined Ranking
Bird Indicator	33	1	25	1	73.41	1
Creature or Animal	8	2	6	2	17.72	2
Vegetation indicator	4	3	3	4	8.8	3

From the ranking shown in table 8 the following observations can be made:

- The bird indicator is ranked 1 for both wards.
- The creature or animal indicators are ranked 2 for both wards and vegetation indicators are the least preferred in both wards.

DISCUSSION

Findings from the demographic information were the first to be presented and the following aspects were noted. Period of residence in the wards revealed that the majority of the residents had a resident time ranging from 31 to 60 years. This could mean that most of the respondents had a good knowledge of the local environment and had the opportunity to use environmental weather forecasting indicators in their weather sensitive planning decisions. For both wards, 50.6% respondents have been resident in the area for 51 years and above. This implies that the information they gave was reliable and authentic.

On the means of livelihood for the residents 62 % of the respondents indicated that they derive their livelihood from farming which in turn is directly affected by the weather. This implies that they should have a better understanding of indigenous forecasts that they use in their agricultural activities.

Ranking and identification of bird indicators reveal that the ground horn bill and the rain cuckoo are the most utilized biotic indicators in the two wards. In wards 12 the ground horn bill was ranked 1 and ward 13 ranked rain cuckoo as 1. The differences in ranking are attributed to differences in the physical environment for the two wards, which in turn offer habitats for flora and fauna.

The results on identification and ranking of the creature or animal indicators reflect consensus in the two wards on the use of individual animals and creatures as weather forecasting indicators. The termites, cicada and frogs were ranked 1, 2 and 3 respectively in both wards. This in line with Mararike (1999)'s observation that locals use indigenous knowledge systems to predict rain or drought.

There were divergent interpretations with regards to the identification of vegetation indicators and ranking for diospyros lycioides as a weather indicator. The majority went for plenty diospyros lycioides fruits as indicating a good rainfall season while a significant number indicated that this was a sign of drought. Similar variations in interpretation were obtained for uapaca kirkiana, parinari curatellifolia and ficus capensis. All the respondents concurred that plenty fruits for llemoni leuceana was an indicator for a good rainfall season.
However, the top three ranking was as follows; diospyros lycioides ranked 1, lannea discolor ranked 2, uapaca kirkiana ranked 3.

Ranking of biotic indicator categories for the two wards were identical and were as follows : bird indicator 1, creature or animal indicators 2 and vegetation indicators 3. The findings revealed that bird and creature or animal indicators can be used to produce short range and long range rainfall forecasts which are vital to the livelihoods of the residents of wards 12 and 13. Vegetation indicators are made use of mainly in long range forecasts. It is apparent that the residents of wards 12 and 13 in Mberengwa in Zimbabwe have like the Hausa of Nigeria (UNEP, 2002) developed a wealth of indigenous knowledge systems to cope with vulnerability to drought and famine.

With regards to exploring the areas of utilization of the biotic weather indicators, responses from the data collected indicated the following areas of utilization:

● *Agricultural planning*

(i) preparing agricultural equipment and seeds

(ii) making decisions on choice of crop cultivars to grow as well as planting and harvesting dates

(iii) making decisions on modes of agricultural produce processing and storage

(v) choice of appropriate days for winnowing and thrashing small grains. The planning of these activities based on indigenous weather forecasts concurs with Galacga and Balisakan (2009) who point out that farmers in the Philippines rely heavily on indigenous weather forecasts to plan and prepare agro-forestry activities.es

● *Other livelihood activities*

(i) Choice of daily attire for a particular situation for school children and adults

(ii) determination of appropriate days for fishing

(iii) making decisions of suitable dates to go to the grinding mill

(iv) choice of appropriate weather sensitive activity for the day

The areas of utilization mentioned by the respondents are all life sustaining. The indigenous forecasts can be utilized to mitigate the adverse impacts of climate change and can also be used in vulnerability assessment. This is supported by a study carried out by Nyong, Adesina and Elash (2007) in the African Sahel. It can be argued that the utilization of biotic weather forecasting indicators contributes to sustainable development of the Mberengwa community. This view is further supported by Warren(1991), Tekwa and Belel (2009) , who argue that indigenous knowledge is the basis for local level decisions in such areas as food preparation, education , natural resources management, agriculture and health as well a host of other livelihood activities in rural areas. Mapara (2009) concurs with the views of the residents of wards 12 and 13 by arguing that indigenous knowledge can be used in food preservation, weather sensitive decisions and land use planning as well as planning social and cultural activities.

CONCLUSION

Based on the research findings it can be concluded that despite modernization and global change, indigenous knowledge systems such as the use of biotic weather indicators to predict weather still play an important role in decision making in rural livelihoods. The study also concluded that there is inadequate research and documentation of the biotic weather forecasting indicators used in the wards. The study also revealed that skill in the interpretation of cues from the environmental indicators was a function of age. The elderly contributed a lot of valuable knowledge while the young tended to look down upon the indigenous weather forecasting systems. This result stresses the need to document and impart the knowledge on the use of biotic weather forecasting indicators to derive weather forecast so as to ensure that the forecasting methods are available for the present and future generations and to eliminate the problem of divergent interpretations from the same biotic indicator. The study also concluded that the accuracy of the forecasts derived from biotic indicators needs to be scientifically validated to enable indigenous weather forecasts to compete on the same level with conventional weather forecasts. This requires that the indigenous weather methods should be part of the curriculum for weather forecasting training. Research on presage biology using the local biotic indicators needs to be carried out. This will provide the missing scientific rationale for use of indigenous weather forecasts.

RECOMMENDATIONS

The findings from this research reveal that there is need to utilise the Indigenous weather forecasting systems to augment the conventional weather forecasts from the Meteorological department. In view of this, the following recommendations are made:

- Synchronisation of the Indigenous weather systems and the conventional Meteorological forecasts to come up with a product that is a hybrid of the two forecasting systems is essential.

- There is need for documentation of indigenous weather forecasting systems, clearly indicating how they are used so that they could be readily accessible to every one. This should be done for all meteorological forecasting zones.

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- Communities could assign or employ someone to assess and gather information on indigenous forecasting indicators prior to the onset of the rainfall season. This information could be used to produce a seasonal forecast

● There is need to teach people how the indigenous weather forecasts and Meteorological forecasts can be used for planning purposes. For example choice of a crop to grow that season and irrigation scheduling. This should be done for both seasonal and short period forecasts.

●Research on the presage biology of the biotic weather forecasting indicators needs to be carried out to provide the missing knowledge on the rationale of using indigenous knowledge.

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