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Indigenous knowledge system weather forecasts as a climate change adaptation strategy in smallholder farming systems of Zimbabwe: Case study of Murehwa, Tsholotsho and Chiredzi districts

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The smallholder sector is vulnerable to climate change due to its reliance on rainfed agriculture and has the least ability to adapt. Based on appropriate weather forecasts, farmers can mitigate and adapt to climate change through sound crop management decisions. A study was conducted to explore indigenous knowledge system (IKS) weather forecasts as a climate change adaptation strategy in smallholder farming systems of Zimbabwe. Eighty six farmers from three agro-ecological regions with different agricultural potential and cultural backgrounds were involved in the study. Questionnaires and focus group discussions were used to collect data on climate change perceptions, access and interpretation of meteorological forecasts and IKS weather indicators and their use in crop production. Most farmers (93%) believed that there is climate change, citing low rainfall, late rains and rising temperatures as some of the indicators. Sixty five percent of farmers had access to and can interpret the meteorological forecasts disseminated through print and electronic media, though arguing that the forecasts are not timely disseminated. Sixty seven percent of the respondents were using IKS weather indicators such as wild fruits, trees, worms and wind for predicting seasonal quality in addition to meteorological forecasts. Basing on IKS forecasts, farmers are changing varieties, staggering planting dates, varying fertilizer rates and cropping land area. The study showed that IKS forecasts indicators are different in the three agro-ecological regions, are being used by farmers in making farming decisions and if properly documented, disseminated and integrated with scientific seasonal climate forecasts can be used as a climate change adaptation strategy.

Key words: Climate change adaptation, indigenous knowledge systems, meteorological predictions, seasonal climate forecasts, smallholder farming.

INTRODUCTION

Most of Zimbabwe's population (70%) live in communal areas and derive their livelihoods from rainfed agriculture and natural resources (FAO, 2010). Regrettably, the smallholder communal farmers grow crops against a background of limited, erratic and poorly distributed rainfall in space and time resulting in frequent crop failures. This makes smallholder farmers food insecure especially now when the varying and changing climate makes droughts more common. The smallholder sector is particularly vulnerable to climate change and variability due to its reliance on rainfed agriculture and has the least ability to adapt. It is therefore important for farmers to integrate the issues of climate variability into resource use and development decisions (Siyakumar, 2006).

Seasonal climate forecasts (SCFs) had been used by farmers to make appropriate crop management decisions related to crop choice, planting time, fertiliser use, area planted to a given crop, timing and tillage type (Patt and Gwata, 2002; Ziervogel, 2004; Patt et al., 2007). Siyakumar (2006) also argued that the introduction of seasonal climate forecast into management decisions can reduce the vulnerability of rainfed agriculture to droughts and reduce its negative impacts. Seasonal climate forecasts can be conducted based on indigenous knowledge systems (IKS) indicators or scientific meteorological predictions.

The term ‘indigenous knowledge’ is used to describe the knowledge systems developed by a community as opposed to the scientific knowledge that is generally referred to as ‘modern’ knowledge (Ajibade, 2003). Indigenous knowledge is the basis for local-level decision-making in many rural communities. It has value not only for the culture in which it evolves, but also for scientists and planners striving to improve conditions in rural localities. Incorporating indigenous knowledge into climate-change policies can lead to the development of effective adaptation strategies that are cost-effective, participatory and sustainable (Robinson and Herbert, 2001). Therefore, indigenous knowledge system forecasts are conducted using the local biophysical and mystical knowledge that has been gained through many decades of experience and has been passed down through generations about cropping decisions based on weather and climate patterns of a specific area (Ziervogel and Opere, 2010).

A study in Nigeria, shows that farmers are able to use knowledge of weather systems such as rainfall, thunderstorms, windstorms, harmattan (a dry dusty wind that blows along the north-west coast of Africa) and sunshine to prepare for future weather (Ajibade and Shokemi, 2003). A similar study in Zimbabwe and Zambia shows that smallholder farmers depend mostly on their indigenous knowledge systems for forecasting seasons which they make use of to develop crop management adaptive strategies (Mugabe et al., 2010). The study shows that farmers have several indicators for weather forecasting and some of these are similar in both Zambia and Zimbabwe. Some of these indicators include; floods or excessive rains in the preceding season, strong winds around October, an extended cold season that goes up to August and sometimes September and abundance or scarcity of certain fruits (Mugabe et al., 2010).

The meteorological office offers SCF that is scientific and based on models and empirical data which require skill in interpretation for seasonal quality assessment. The scientific seasonal forecast is based on the fact that lower-boundary forcing, measured by sea surface temperatures, drives future atmospheric perturbations (Murphy et al., 2001). These boundary conditions evolve slowly and so enable predictions of rainfall and temperature to be produced (Parmer and Anderson, 1994). The forecast is usually issued for a period of one, three or six months and suggests the total amount of rainfall expected over that period, but not the distribution of rainfall within that period. If the amount of rainfall forecast were to fall over a few days, the seasonal forecast would still be correct but the impact could be catastrophic (Agrawala et al., 2001). Most smallholder farmers, however, have no access, cannot interpret and use meteorological predications as they live in marginal areas where electronic and print media are inaccessible (Nicholls, 2000).

Despite seasonal forecasts having been issued by national meteorological offices in Southern Africa (O’Brien et al., 2000; Basher et al., 2001), the extent of uptake is limited (Walker et al, 2001; Ziervogel, 2001; Archer, 2003). With an increase in climate stress in most communal farming areas, it is important to establish how best forecasts of variable skill might be integrated into the decision making of vulnerable groups to facilitate improved adaptation to climate variability and change (Washington and Downing, 1999; Sivakumar et al., 2000). However, most studies reported on how farmers are trained to understand, interpret, use the meteorological forecasts and to integrate the IKS and meteorological forecasts in their farming operations (Patt et al., 2005; Mugabe et al., 2010). Only a few studies had looked at the use of IKS forecasts as an adaptation strategy in the varying and changing climates by smallholder farmers. The study sought to increase awareness of the IKS weather forecasts that are being used by communal farmers to adapt to the varying and changing climate in crop production. The objective of this study was to explore indigenous knowledge system weather forecasts as climate change adaptation strategy in smallholder farming systems of Zimbabwe.

METHODOLOGY

Study sites

The study was conducted in Murehwa, Tsholotsho and Chiredzi

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Figure 1. Location of the study sites in Zimbabwe.

districts of Zimbabwe (Figure 1). Murehwa district which is 130 km north-east of Harare (17°45'S and 31°31'E) lies in agro-ecological region (AER) II, where average rainfall is 1000 mm per annum. The soils in the area are classified as Typic Kandiustaff derived from granitic parent material with relatively low water holding capacity and consists of sandy to loamy sands (Vogel et al., 1994). Tsholotsho district is 110 km north-west of Bulawayo (19°45′59.77″S 27°45′00.00″E) and falls in AER IV, where average rainfall is 650 mm per annum, mostly restricted to the summer season from November to April (Surveyor General, 2002). Tsholotsho is composed of mainly three types of soils, the Kalahari Sands, fertile black clay soils and the red soils. Respondents were located on purely Kalahari sands. Chiredzi district is 384 km south-east of Harare (18°55′S 29°49′E) in AER V , where average rainfall received is less than 450 mm per annum through erratic showers (Vincent and Thomas, 1962) and has predominantly vertisols. The three districts were chosen because of their different agro-ecological locations and cultural/traditional practices.

Data collection and analysis

A total of 86 farmers were selected through stratified random sampling technique from Chiredzi (25), Murehwa (30) and Tsholotsho (31) districts respectively. The selection of respondents was limited to wards in which our research partner Community Technology Development Trust (CTDT) conducts farmer field schools (FFS) to promote crop diversity. Thus respondents were composed of FFS participants and non-participants. Looking to the nature of study, the qualitative approach, which is more appropriate in case of studying indigenous knowledge systems and natural resources, has been chosen for the explanation of qualitative data. Personal interviews and participatory methods were used complimentarily to carry out the study. Both approaches have their place and their results can be complementary and possibly cross-validate each other. Using a structured questionnaire and in-depth interviews; quantitative and qualitative data were collected on farmers' perceptions on climate change, their responses to climate change and variability, access to and interpretation of meteorological predictions, IKS seasonal weather indicators and their use in farming operations. Farmers responded either at their homesteads or during farmer field school sessions. Responses from the questionnaires were gathered from August to November 2010. During the data collection process Agricultural Technical and Extension (AGRITEX) officials were engaged in all the three districts. Data collected in the study were analyzed and inferences have been drawn using statistics like percentage, mean and rank using descriptive frequencies in the Statistical Package for the Social Sciences (SPSS).

RESULTS AND DISCUSSION

Perception of farmers on causes and effects of climate change

Most farmers (93%) in all the three districts believed that the climate is changing. Their indicators are low rainfall being received, change in planting season from October to late November or early December, late rains, rising temperatures, disappearance of very cold winters, erratic rainfall distribution and drying of wetlands. The responses are in agreement with the Intergovernmental Panel for Climate Change (IPCC) Report (2007) which dispelled any uncertainty about climate change and gave detailed projections for the 21st century, which showed that climate change and variability exists, will continue and accelerate.

Farmers stated different causes of climate change which can be grouped into scientific, cultural, and spiritual categories (Figure 2). Scientific causes of climate change given by farmers (25%) were deforestation, ozone layer depletion, technological advancement and release of industrial gases into the atmosphere. These findings are supported by IPCC Report (2007) which highlighted that humans play a major role in causing global warming, hence, climate variability and change.

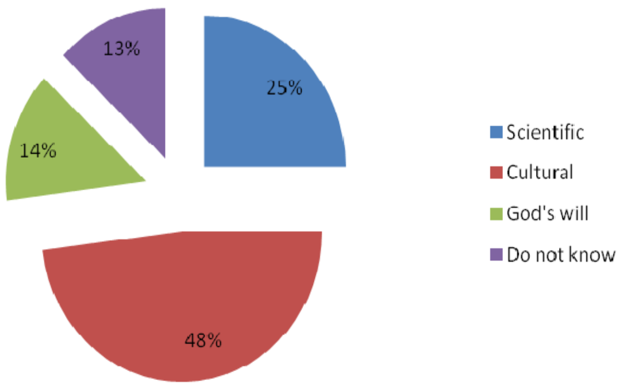

Figure 2. Smallholder farmers' perceptions on the causes of climate change.

However, Muzari et al. (2014) noted that greater proportion of smallholder farmers in Zimbabwe perceives climate change as a purely natural phenomenon, without any human intervention being responsible for climate change. Forty eight percent of farmers believed that change and disrespect of cultural and traditional values like bathing at sacred places, incestuous behaviour, committing suicide, abortion, not brewing ceremonial traditional beer and inappropriate burials could be the causing factors of climate change. However, 14% of the farmers are of the mindset that it was God's will that the climate is changing and nothing can be done about that. They believe that the Almighty might be angry at the way people are living as they no longer follow his ways/commandments. These assertions are supported by Mubaya et al. (2010) who noted that farmers in Lower Gweru in Zimbabwe "state that causes of climate change have also been due factors such as the wrath of cultural spirits and God who have meted out punishment to Zimbabwe. The punishment has been for the failure of people to continue to appease their spirits and conduct traditional rites such as the rainmaking ceremony (*mukwerera*) for asking for rain from God and for showing gratitude for the rains in the previous season".

Communal farmers in the three districts studied noted different effects of climate change being experienced in their areas (Table 1). Some of the effects mentioned were decreased yields, changes in planting time and less water for livestock. Other studies done in smallholder areas of Zimbabwe have observed the following changes in climate in recent decades. First, rainfall patterns have become highly unpredictable. Secondly, the prevalence of mid-season dry spells has increased (Mutekwa, 2009). Thirdly, years of below-normal rainfall are becoming more frequent, worsening the food insecurity situation among smallholders. Fourth, it is not uncommon to experience droughts and floods back-to back during the same season (Mubaya, 2010). Fifth, semiarid areas are getting drier and rainy seasons have become shorter (Mutekwa, 2009). Sixth, temperatures have increased (Mubaya et al., 2009), and farmers have started experiencing warmer winters than before (Muzari et al., 2014). This means climate change is affecting food and water resources that are critical for livelihoods and survival in these smallholder sectors of Zimbabwe. This observation is also supported by Nhemachena and Hassan (2008) who noted that changing climates impact negatively in areas where populations rely on local supply systems that are sensitive to climate variability.

Use of seasonal climate forecasts by communal farmers

Sixty-two percent of respondents in all the three districts studied were using SCFs to predict the quality of a season so as to make informed farming decisions and manage risk in the changing climate. From those farmers who do SCFs, 67% use IKS whilst 56% utilize meteorological forecasts on assessing the potential of a season to rain. The use of these SCFs may be necessary in helping farmers to minimize risks during dry seasons and maximize opportunities during wet conditions. This is supported by Tarhule (2005) and Washington et al. (2006) who noted that the use of SCFs may reduce the impact of climate variability and change on food production and livelihoods through anticipating and managing annual climate related risks.

Indigenous knowledge systems indicators on the quality of a season

48, 72 and 83% respondents in Tsholotsho, Chiredzi and Murehwa districts respectively use IKS indicators to predict the quality of the season before the onset of the rains. The climate indicators that are used to predict if there is rain or drought in the three districts include birds, wild fruits, trees and worms (Table 1). Chiredzi district had many indigenous knowledge weather indicators being used by farmers compared to Murehwa and Tsholotsho (Table 1). Mopani worms (*Imbrassia belina)* (which are found in the drier areas of Zimbabwe), winter, dew and wild animals' indicators are specifically in use in Chiredzi and are not used in the other two districts. The district lies in AER V, where rainfall is through erratic showers and therefore subject to periodic droughts (Vincent and Thomas, 1962). So farmers could be using many IKS indicators as a responsive measure to minimize risks in drier years and maximize opportunities in a wet season. Tsholotsho farmers based their weather predictions on birds and wild fruits. However, wild fruits that are naturally found in the district which is mostly covered by the Kalahari sands, such as untundulula *(Facourtia indica)*, umviyo *(Vangueria infausta)*, inhlokotshiyane *(Ximenia arnericana)* are mostly used.

Table 1. IKS indicators farmers in different districts use to predict the quality of a season.

District	Indicator	Wet year	Drought year
Murehwa	Births	Birth of too many girl child.	Too many boy child.
	Wild Fruits	Plenty of wild fruits such as hacha *(Perinari capensis*) or mazhanje (*Vapaca kirkiana*) in October and November.	Less wild fruits such as hacha *(Perinari capensis*) and mazhanje (*Vapaca kirkiana*) in October and November.
	Trees	Early flowering of trees such as msasa *(Brachystegia spiciformis)*, munhondo (*Julbenardia globiflora).*	Late flowering of trees such as musasa *(Brachystegia spiciformis)*, munhondo (*Julbenardia globiflora).*
Tsholotsho	Birds	Prevalence, singing and movement of certain type of birds like stocks.	No singing and movement of birds like stocks
	Wild fruits	Plenty of wild fruits just before the rain season like untundulula *(Facourtia indica)*, umviyo *(Vangueria infausta)*, inhlokotshiyane *(Ximenia arnericana)* umhakawuwe (*Securinga virosa),* isigogwane *(Pappea capensis)*	Very few wild fruits just before the rains like untundulula *(Facourtia indica)*, umviyo *(Vangueria infausta)*, inhlokotshiyane *(Ximenia arnericana)* umhakawuwe (*Securinga virosa),* isigogwane *(Pappea capensis)*
Chiredzi	Wild animals	Heavy sounds of wild animals such as lions around October	Less or no sounds of certain wild animals like lions around October.
	Birds	Prevalence, singing and playing of many different types of birds at the beginning of the season.	Less singing and playing of different types of birds at the beginning of the season.
	Dew	Falling of dew early in the morning after the first rains.	No dew in the morning after the first rains.
	Trees	Early flowering of certain trees such as mupfura *(Sclerocarya cattra).*	Late flowering of certain trees such as mupfura *(Sclerocarya cattra)*.
	Worms	Many mopani worms *(Imbrassia belina)* just after the first rains.	Few mopani worms (*Imbrassia belina)* after the first rains.

The fruits are common in the district and are rare in most parts of Zimbabwe. In Murehwa; births, wild fruits such as hacha *(Perinari capensis)* and mazhanje *(Vapaca kirikiana)* and trees are being used as weather assessment indicators. The trees and wild fruits in use are specific to the district and are different to those being used in the other two districts.

The results show that indicators being used by farmers are different for the different districts as natural resources available, cultural/traditional and social backgrounds vary with location of an area. Ziervogel and Opere (2010) also noted that IKS forecasts are conducted based on local biophysical and mystical knowledge that has been gained through many decades of experience and are specific to an area. However, there are some indicators such as wind and clouds that are common to the districts. The interpretation of these indicators in use is almost the same amongst the different farmers in the different districts (Table 1). Strong easterly winds around August and September indicates a good season whilst weak winds are a reflection of a dry year. In all the districts, heavy dark clouds before a rain season are interpreted to mean a wet season whereas light white clouds mean a dry year.

Basing on the IKS predictions, most farmers in Murehwa and Chiredzi districts anticipated a good 2010/2011 rainfall season. Indicators like many mopani worms, early flowering of certain trees, strong easterly winds and many wild fruits indicated that the season was going to be good. This was in agreement with the rains received and scientific forecasts of Meteorological Services Department of Zimbabwe which predicted normal to above normal rains for the two districts for 2010/2011 season. Farmers in Tsholotsho district predicted that the 2010/2011 season would have below normal rains. This was supported by most local indicators such as very few wild fruits, light winds and late flowering of some trees which indicated that the season was not going to be good. However, this was in disagreement with the rains received and scientific forecasts of Meteorological Services Department of Zimbabwe which predicted normal to above normal rains for the district for 2010/2011 season.

Use of IKS weather predictions in smallholder farming operations

All respondents in Tsholotsho and Chiredzi districts, who do IKS weather forecasts, grow crops and adopt specific farming operations basing on the quality of the season. Surprisingly, Murehwa district which had 83% of

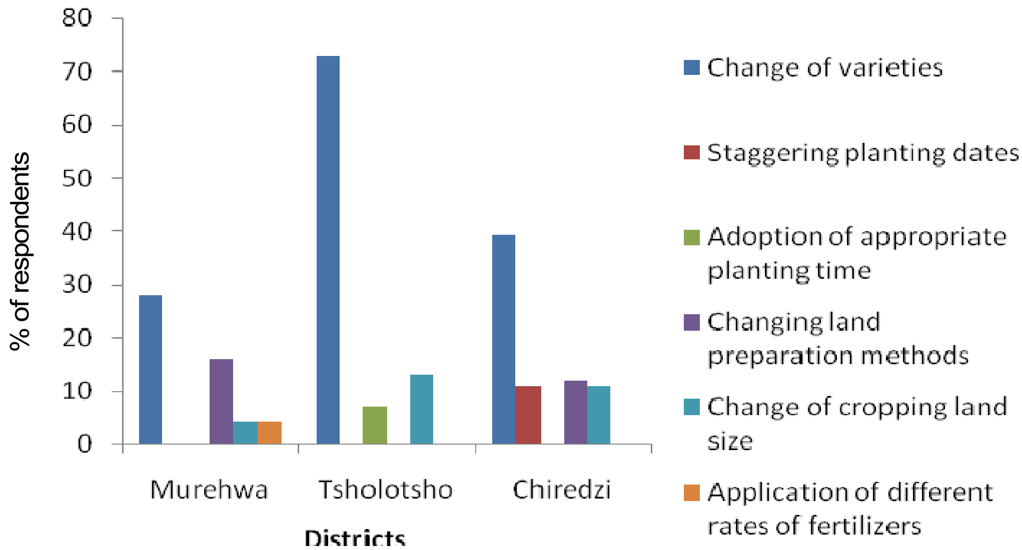

Figure 3. Different farming operations being adopted by farmers basing on IKS forecasts.

respondents conducting IKS weather predictions had the least farmers (24%) growing crops basing on the forecasts. Maybe it is because most Murehwa farmers who are only 130 km from Harare (87%) have access to meteorological forecasts compared to 52% and 61% for Chiredzi and Tsholotsho respondents respectively through print and electronic media hence base their farming decisions on that.

The different farming operations that are being adopted by farmers basing on IKS forecasts include changing varieties, staggering planting dates, dry planting and use of hoes for land preparation (Figure 3). This is correct as seasonal climate forecasts have been used before for assisting farmers make appropriate crop management decisions like correct crop choice, fertilizer rates, planting dates and tillage type (Patt and Gwata, 2002; Ziervogel, 2004; Patt et al., 2007). Ziervogel and Calder (2003) also demonstrated that farmers who used SCF forecasts for planning purposes significantly improved their yields.

73, 39 and 28% of respondents in Tsholotsho, Chiredzi and Murehwa districts respectively are changing varieties to suit the quality of the season as per IKS predictions they could have done (Figure 3). Short season varieties are being adopted for drier years whilst medium to late maturity varieties can be chosen for a good year depending on the agro-ecological region of the district. This is so because different agro-ecological regions have different potential for different varieties (Surveyor General, 2002). For example, Murehwa farmers used to grow medium to late maturity varieties but are now changing to short season varieties if they forecast a dry year. Tsholotsho and Chiredzi farmers who used to prefer medium maturity varieties are now shifting to the short season varieties in drier years so as to minimize production risks. Bourdillan et al. (2003) also noted that short season varieties are attractive to farmers who are risk-averse as they have superior tolerance to heat and drought, as they silk faster, making them less susceptible to mid-season drought and mature quickly. Some farmers also noted that open pollinated varieties (OPVs) perform better compared to hybrids in drier years. This could be because OPVs are more drought resistant compared to hybrids which are sensitive to moisture stress (Chiduza et al., 1994).

In Chiredzi district 11% of respondents are staggering planting dates as a response to the IKS season quality assessment done. If the forecast indicates good rains, farmers usually plant all their fields with the first effective rains. However, if indicators forecast a dry year farmers may start planting the first fields as early as end of October with the first rains, then wait and assess how the season proceeds. Depending on the rainfall being received, they then stagger planting of the remaining fields accordingly. Last season (2009/2010) most farmers planted the first fields in mid November and only planted all the other fields in January (Personal communication, 2010). This was because the district witnessed a dry spell from November after the first effective rains to January.

13, 11 and 4% of respondents in Tsholotsho, Chiredzi and Murehwa districts are changing the cropping land size depending on the IKS predictions on the quality of the season. If indicators predict a wet year, maximum possible land area is planted so as to maximize opportunities of a good harvest. In drier years farmers tend to reduce the cropping land thereby concentrating their labour and inputs on small pieces of land. This is done to reduce drought costs and to implement soil water conservation strategies to small pieces of land where it is manageable. This implies that there will be less wastage on resources and land maybe rested.

Few respondents (4%) in Murehwa district are applying different fertilizer rates depending on the quality of the season. If predications are of a wetter season, recommended fertilizer rates are applied. However, this will depend on the ability to buy and availability on the market. Mubaya et al. (2010) observed that apart from SCF and how to respond, it is equally important to understand the socio-economic status of the recipient because wealth endowment decides on which adaptation strategy to adopt to cope with the predicted climate risk. This means farmers may be willing to apply recommended fertilizer rates in a good year but cannot because they have no ability to buy. If the season is dry, micro dosing is done. This is because the use of low levels of fertilizers especially N has consistently given better grain yields in dry years (Hove et al., 2010).

16 and 12% of respondents in Murehwa and Chiredzi districts, respectively are changing land preparation methods basing on IKS forecasts. In drier years' soil water conservation strategies that include basins, tied ridges and infiltration pits are being implemented. Use of these techniques in combating the drought by crops has been reported to be effective (Unganai and Murwira, 2010; Jerie and Mugiya, 2010). There is also an increase in use of hoes for land preparation in the study sites that can be attributed to the promotional work by Community Technical Development Trust a Non-Governmental Organisation (NGO) which is advocating for conservation agriculture. Increased uptake of hoes can also be due to the decline in draught power due to droughts and socio-economic hardships of 2008 which resulted in most farmers selling livestock so as to survive.

Knowledge of the meteorological season climate forecasts by communal farmers

Most respondents in Murehwa (87%) and 61% in Tsholotsho districts knew about the SCFs that are done by the Meteorological Department office through print and electronic media, AGRITEX officials and friends. Therefore it can be noted that meteorological SCFs have become increasingly available to most farmers over recent times (O'Brien and Vogel, 2003; Roncoli et al., 2009). However, less than of 50% of the farmers in Chiredzi district have heard about meteorological forecasts. Most farmers in the district do not have access to the SCF since radio and television transmissions are poor. Nicholls (2000) also observed that use of SCFs is impaired by several constraints that include inappropriate content from a user perspective and communication problems.

In all the three districts most farmers (92%) who know meteorological forecasts understand the meaning of the predictions from the meteorological office. This is because of late the Meteorological Department is simplifying the scientific language of models and empirical data it uses in forecasting to the language that is understood by most communal farmers. The meteorological department after coming up with the percent probabilities and translating them into Above Normal, Normal and Below Normal do not release the percent probabilities to the public. Farmers then understand the predictions as the terms below normal, normal and above normal are easier to understand than the probabilities used in SCF. This however, can mislead farmers in that if a forecast is below normal to normal the take home message is normally that the coming year is a drought for it neglects the probabilistic nature that is associated with the seasonal climate forecast (Mugabe et al., 2010).

Seventy percent of farmers in all the three districts were in agreement that meteorological predictions are similar and useful as the IKS assessments they do. However, they argued that although the meteorological forecasts are scientific there are not timely disseminated, which, makes them not that useful compared to the IKS predictions. For seasonal climate forecasts to have an impact to farmers, they have to be reliable, timely, well presented and readily accessible (O'Brien and Vogel, 2003), which, is not the case with the meteorological forecasts. The IKS indicators are observed early before the season commences whilst the meteorological department can sometimes disseminate the forecasts way after the season had started. This makes the farmers have much more faith in the IKS forecasts compared to the meteorological predictions. Mcrea et al. (2005) showed that adoption and use of SCF by farmers depends on the level of understanding of the forecast, the format of presentation of the forecast, time the forecast is disseminated and the attitude of farmers towards the usefulness of the forecast as an indicator of future rainfall.

Farmers' suggestions to meteorological department for better SCFs dissemination

Farmers in all the three districts were in agreement that the meteorological forecasts can only be useful after being simplified and reaching the farmers before the onset of the rains. They suggested that the forecasts from the meteorological department should be passed through AGRITEX offices and NGOs. They argued that these organizations are always in contact with them before, during and after the rains, so it will be easy and effective to receive the forecasts from them. Moreover these organisations offer them inputs, extension and teach them new farming practices to adopt in the changing climate. Farmers also advised the meteorological department to distribute weather forecasts pamphlets, release the forecasts every month and to do community communication through councillors and chiefs. Chiredzi farmers suggested that radio communication should be improved through disseminating forecasts in different vernacular languages that are used in different areas of the country. As a long term strategy farmers proposed that the meteorological department should build substations closer to farmers so that they give specific predictions for specific areas not to generalise.

Conclusions

The study showed that most IKS forecasts indicators in use in the three agro-ecological regions are different, are being used by farmers in making farming decisions and if properly documented, disseminated and integrated with scientific seasonal climate forecasts can be used as a climate change adaptation strategy. The indicators differ with districts as natural resources, traditional and social backgrounds vary with location. The climate indicators in use include wild fruits, trees, worms and birds. Depending on the interpretation of the indicators farmers are making different farming decisions such as changing varieties, staggering planting dates, changing cropping land size and applying different fertilizer rates to suit quality of a specific season. Most farmers also understood the forecasts from the meteorological office because the department is now simplifying the scientific language it uses in forecasting to the language that is understood by most communal farmers. They agreed that meteorological predictions are similar and useful as the IKS assessments they do. However, farmers argued that although the meteorological forecasts are scientific and more reliable, there are not timely disseminated, which, makes them not that useful compared to the IKS predictions they do. Farmers advised the meteorological department to disseminate the forecasts early before the rains through AGRITEX and NGOs, distribute weather forecasts pamphlets and to release the forecasts every month.

Conflict of Interest

The authors have not declared any conflict of interest.

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