Article

Using Indigenous Knowledge Systems in Seasonal Prediction and Adapting to Climate Change Impacts in Bikita District in Zimbabwe

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Abstract

The use of indigenous knowledge systems (IKS) in seasonal forecasting and adaptation to devastating vagaries of climate change has gained attention in academic discourses. The debates opened contrasting views with the first over-romanticizing IKS' potentials, while the other arguing that it has many setbacks. In this study, we interrogated IKS' roles in seasonal forecasting and chances of informing adaptation among poorly resourced smallholder farmers in ward 24, Bikita. Using focus group discussions, in-depth interviews, and key informant interviews, we identified diverse indigenous indicators and interrogated how they subsequently inform adaptation. We noted that IKS is important in providing seasonal forecasting information, which is critical in making decisions in planning, designing cropping calendars, offering early warnings, as well informing preparedness against disasters. However, we also noted that IKS is under threat from Western education, Christianity, scientific seasonal forecasting (SSF), and climate change. These factors are challenging and reducing IKS' reliability and hence increasing its susceptibility to disappearance. We concluded that IKS can be resuscitated if included in science education and policy frameworks. We recommended governments to formulate policy frameworks, which allow it to work well with SSF in reducing poorly resourced smallholder farmers' vulnerability to climate change disasters.

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Introduction

The burgeoning literature and scholarly interest on the relationship between climate change adaptation and indigenous knowledge in smallholder farming are growing (Kolawole et al., 2014; Reyes-García et al., 2013). In these discourses, indigenous knowledge is scrutinized for its potentials and challenges in building robust adaptive capacity and resilience against devastating vagaries of climate change. Resultantly, two diametrically opposed rightist and leftist views emerged from the ongoing debates. The rightist standpoint notes that indigenous knowledge is the sine qua non for climate change adaptation, since it offers the indigenes (the local people) rights, which help them to achieve multiple development goals (Berkes, 2009; Chang'a et al., 2010; Orlove et al., 2010; Reyes-García et al., 2013). On the contrary, the leftist standpoint puts great doubt on the role of indigenous knowledge in adaptation (Salick & Ross, 2009). They doubted the potential of indigenous knowledge in dealing with unknown future climate change disasters despite having a good track record of dealing with the known disasters in the past. Furthermore, the leftist view argued that local people with strong cultural values and knowledge have the propensity of rejecting new knowledge despite the possibility that it may engineer robust adaptation (Hitchcock, 2009; Turner & Clifton, 2009). This view explains a scenario where indigenous knowledge stands as a hindrance to smallholder farmers' continuous adaptation.

This article interrogates the benefits and possible challenges of indigenous knowledge as a source of seasonal forecasting and its potential in informing adaptive strategies. On seasonal forecasting, the article examines the multiple and complex indigenous indicators, reflecting how they are used in predicting short-term and long-term seasonal outlook. Indeed, it will point out how the forecasting information is used in making substantive decisions in smallholder farming. The substantive decisions to be made here include crafting of cropping calendars and timelines, selection of crop varieties to be grown, storage of harvested yields, and management of moisture during the cropping processes. In the presentation and discussion, the article will also reflect challenges experienced by farmers in using and relying on indigenous knowledge systems (IKS) in seasonal forecasting and adaptation.

Conceptualizing Indigenous Knowledge Systems

IKS is differently conceptualized due to human diversity, as well as the differences in cosmological relationship with nature (Mapara, 2009; Ngara et al., 2014). As a result, IKS ended up receiving subjective names, which include, but are not limited to, ethnoscience, traditional ecological knowledge (TEK), indigenous ways of knowing, organic knowledge, local knowledge, and folk knowledge (Chang'a et al., 2010; Kolawole et al., 2014; Mapara, 2009). Ngara et al. (2014) expressed that despite differences in naming of IKS, the common trend is that the indigenes have an inseparable relationship with their environment and the sympathetic nature. The sympathetic elements of nature are drawn from the existing symbolic moral relationship between nature and human beings. The mutual relationship between indigenous people and nature is traced through history and pragmatic social organization, which has existed since time immemorial (Kolawole et al., 2014; Ngara et al., 2014). Social institutions such as families, marriages, kinship systems, and cultures generated vibrant organic knowledge, which is used in enhancing humanity. The socially created institutions are bound together by good moral code (Ngara et al., 2014). Indeed, the well-generated tacit moral control mechanisms by indigenous people eased mutual reciprocity between them, animals, plant species, and earth.

On the cosmological platform and sympathetic nature, natural assets are changed from their simple context to high rich symbolic features (Ngara et al., 2014). Mountains, biodiversity, rivers, and pools are cosmologically transformed into sacred moral assets. Using newly born moral geography, a regime of sacred sites, shrines, and symbolic signs were culturally and socially institutionalized into the human world. Resultantly, shrines become functional sacred places for hosting important rainmaking ceremonies and libation, which are fundamental in influencing favorable weather and seasonal outlook (Ngara et al., 2014). The increase in sacred places, symbolic beliefs, and mythical beliefs gave birth to African Traditional Religion (ATR) (Mapara, 2009; Ngara et al., 2014). The entrenchment of ATR in the cultural practices sanctified the moral bond between human beings and their power to manipulate nature to suit their day-to-day human needs. Research revealed that the mutual bond between human beings and nature has existed in the past centuries and will remain functional in the future (Kolawole et al., 2014; Ngara et al., 2014). Therefore, it is notable that indigenous knowledge should receive the top priority among other solutions, which are engaged in autonomous and planned adaptation against climate change–induced risks and hazards in smallholder farming.

Though the origin, or emergence, of indigenous knowledge is not clear, there is need to credit the elderly people for inventing the sacred and complex organic knowledge (Kolawole et al., 2014). The elderly people, as the custodians of cosmological-based local knowledge, consciously and unconsciously created a systematic way of generating acceptable livelihood strategies (Eversole et al., 2005). The organic knowledge's emergence was drawn from a wide range of experience, visions, and dreams. As a new ethnoscience tool, the indigenous knowledge become operationalized in agriculture, environmental management, fisheries, and political sectors (Chang'a et al., 2010). The newly developed knowledge, became a permanent and important way of life, transferred across indigenous generations. Indeed, the cross-cutting indigenous knowledge should be credited as the summum bonum science for human livelihoods, particularly in smallholder farming.

Indigenous Knowledge Systems and Climate Change Interphase

In many smallholder farming communities, weather and seasonal forecasting information is obtained from indigenous knowledge indicators and in few cases from scientific seasonal forecasting (SSF) (Marshal et al., 2011; Speranza et al., 2013). IKSs are primarily used because they are cheap and readily available to the local farmers (Chang'a et al., 2010; Muguti & Maphosa, 2012). It is also argued that poverty and limited access to modern technology have reduced poorly resourced smallholder farmers' chances of relying on SSF (Speranza et al., 2013).

Emerging literature suggests that indigenous knowledge has gained momentum in debates related to adapting to climate change impacts in smallholder farming (Makwara, 2013; Shoko & Shoko, 2013). Seasonal and weather forecasting information from indigenous knowledge is mainly gathered from various and complex indigenous indicators such as wild animals, birds, insects, trees, astronomical, and natural features (Kijazi et al,, 2013; Kolawole et al., 2014; Muguti & Maphosa, 2012).

In forecasting using animals, birds and insects, the knowledgeable local farmers interpret diverse behaviors such as mating and breeding patterns, sounds and signs, and appearance or disappearance of certain species. Equally important on trees, flowering, shooting new leaves, and fruiting of certain plant species provide invaluable spatial forecasting information for both short- and long-term seasonal outlook (Kijazi et al., 2013). Local farmers' access to forecasting information is critical for their preparedness on planning and making decisions on farming.

Various case studies drawn from African literature showed the importance of using birds in weather and seasonal forecasting. In Tanzania, Chang'a et al. (2010) discovered that certain birds contribute significantly to providing forecasting information. For instance, the singing of southern ground hornbill (Bucorvus leadbeateri) indicates imminent rains. Indeed, availability of such information is important in increasing smallholder farmers' preparedness in starting a new farming season. Apart from relying on birds, some studies showed that different animals and certain insects' behaviors are also critical in seasonal forecasting and informing adaptation. Experienced local elders interpret wild animals' different breeding patterns and other behaviors in generating the trends of seasonal outlook. For example, Okonya and Kroschel (2013) in Uganda and Kijazi et al. (2013) in Tanzania observed and concluded that wild animals' increased breeding trends are associated with favorable farming seasons. The explanation is that wild animals have natural instincts of breeding only when there are possibilities of good rains. On the other hand, wild animals' reduced breeding patterns are common during dry seasons, and this automatically relates to occurrence of acute food shortages. These trends practically inform local farmers to make wise decisions in maximizing their benefits and, at the same time, reducing their chances of vulnerability to droughts during unfavorable seasonal conditions (Kolawole et al., 2014; Makwara, 2013).

Another important indigenous seasonal forecasting indicator is tree phenology. Existing scholarly research revealed that there are diverse trees and plant species across the world, which are differently used for seasonal prediction (Makwara, 2013; Okonya & Kroschel, 2013). Tree and plant species' shedding and shooting of leaves, flowering, and profuse fruiting are the common trends used for seasonal forecasting and making decisions. For instance, the flowering of coffee trees in Burkina Faso (Roncoli et al., 2002) indicates imminent rains, while profuse flowering of baobab (*Adansonia digitata*) in Tanzania (Chang'a et al., 2010) indicates a season with a bumper harvest. Importantly, like other indicators, tree phenology also offers significant contribution in providing short-term and long-term seasonal trends (Gundhlanga & Makaudze, 2012; Muguti & Maphosa, 2012).

Some scholars have expressed that relying on birds, tree phenology, animals, and insects in seasonal forecasting and adaptation is not enough in Africa (Ngara et al., 2014; Okonya & Kroschel, 2013). Instead, they expressed the importance of rainmaking rituals in influencing weather and seasonal trends. It is argued that performance, or nonperformance, of rainmaking rituals has profound influence on seasonal quality and outlook. Consistent and correct performance of rainmaking rituals is believed to ensure favorable farming seasons. Rainmaking ceremonies are commonly practiced in many parts of African farming communities such as those in Burkina Faso (Roncoli et al., 2002), Zimbabwe (Ngara et al., 2014), Uganda (Okonya & Kroschel, 2013), and others. Rainmaking rituals are performed for inducing rain or thanking ancestors and gods for good harvests. In some cases, rituals are conducted as ways of ending droughts (Roncoli et al., 2002), which make them both a goal and a strategy of avoiding disasters like droughts.

Objectives of the Study

The objectives of the study are as follows:

1. to explore various indigenous knowledge indicators used in weather and seasonal forecasting;
2. to establish how the seasonal forecasting information is used in making decisions in coping and adapting to droughts; and
3. to discuss challenges encountered by smallholder farmers' in relying on indigenous knowledge in forecasting and adaptation.

Materials and Methods

In this study, we used qualitative research methodologies. In selecting the three participating villages and respondents in ward 24, we utilized purposive sampling. On data collection, we used focus group discussions (FGDs), in-depth interviews, and key informant interviews. First, on FGDs, we purposively conducted two focus group sessions in each of the selected villages. Each FGD comprised 12

Table 1. Key Informant Interviews.

Key Informant	Reason for Selection
One extension services officer for ward 24	We selected the ward's extension services officer and provided information regerading reception, dissermination, sharing of forecasting information, and his role in educating local farmers on decision-making. He also provided information regarding combining IKS and SSF forecasting.
Six elderly farmers—65+ years	We slected six elderly farmers above 65 years of age. Two farmers, a men and a woman were selected in each village. Elderly farmers provided ciritical information on using IKS indicators in forecasting, decision-making and adaptation. They also higligthed potentails and challenges faced by IKS.

Source: The authors.

participants of which 6 were males and the other half were females. We did this so as to harness balanced information on potentials and challenges of IKSs in smallholder farming. Second, on in-depth interviews, we purposely selected 20 participants in each village totaling 60 participants. Despite the fact that gender was not a critically needed variable, we balanced participation so as to avoid one-sided or biased responses from one gender category. Lastly, on key informants, we purposively selected six elderly people a man and a woman from each village. The elderly key informants were above 65 years of age and a one extension services officer. Detailed information on key informants is presented in Table 1.

Study Area

The study was conducted in Bikita, which is one of the seven administrative districts found in Masvingo province, Zimbabwe. Most parts of Bikita have arid and semiarid characteristics, which make the district prone to severe droughts. Most smallholder farmers in this area depend on subsistence crop production of small grains such as rapoko, millet, and sorghum. On livestock production, they domesticate cattle, donkeys, goats, and sheep. Bigger livestock like cattle and donkeys are used for draught power and, at the same time, are sold during droughts and times of hardships. Sometimes, during severe droughts, majority of vulnerable farmers depend on food aid from donor communities, while the able-bodied migrate to towns, cities, and other countries looking for greener pastures.

Results

Tree Phenology as Indigenous Indicators in Seasonal Forecasting

Data collected from ward 24, using FGDs, in-depth interviews, and key informant interviews, showed various tree phenology indicators used by local farmers in seasonal forecasting. Local farmers get seasonal forecasting information by interpreting various tree species' shedding of leaves, shooting of new leaves, flowering, and profuse fruiting. The noted information revealed that tree phenology indicators are critical in forecasting seasonal quality, predicting the coming of rains, and coming of dry spells throughout the rainy season. Availability of such information helps local farmers to act in accordance with the anticipated seasonal trends. Table 2 presents various plant species used in seasonal forecasting and also how they inform decision-making.

Table 2. Tree Phenology and Other Plant Species Used for Forecasting.

	Behavior	Action for Farmers
Long-term indicators on seasonal quality		
Mukwakwa tree (*Sclerocarya birrea)*	Profuse fruiting indicates severe drought	Conserve food and collecting more fruits as food reserves
Muuyu tree (*Adansonia digitata)*	Heavy flowering indicates good season	Prepare a good season
Muswati tree (*Dalbergiella nyasae)*	Heavy flowering indicates good season	Good season for cow peas and bumper harvest
Mutuva tree (*Kirurite mucugucugu)*	Profuse flowering means good rains	Prepare for good season
Mushumha tree (*mespiliferims*)	Heavy fruiting indicates good season	Prepare good season
Gavakava—Aloe plant (*Aloe vera)*	Heavy flowering and seeds mean a good season Scattered flowers and seeds mean drought	Be prepared for bumper harvest season Be prepared for drought
Mupanda—Rain tree (*Philenoptera violacea*)	Heavy flowering means a good season	Prepare for bumper harvest and a successful maize growing season
Munhengeni tree (*Ximenia caffra)*	Profuse fruiting indicates good rains	Prepare for bumper harvest
Muunze tree (*Brachystegia glaucescens*)	Shooting new leaves means imminent rain, while Maintaining green leaves means good rains	Be prepared for cropping Be prepared for bumper harvest
Mukamba tree—mahogany Tree (*Afzelia qunzensis*)	Heavy flowering means good harvests	With less flowering, farmers need to be prepared for droughts
Guhunga tree	Heavy flowering means good rains	Be prepared for bumper harvests season
Mumveva—sausage tree (*Kigelia pinnata africana*)	Heavy flowering	Be prepared for bumper harvests
Short-term indicators on seasonal quality		
Muonde—Fig tree (*Fiscus carica*)	Shooting brownish leaves shows imminent rains	Be prepared for cropping
Mupani tree (*Colophospermum mopane*)	Shooting of brownish leaves indicates imminent rains	Be prepared for cropping

Source: Fieldwork.

Information gathered also showed that tree phenology is more commonly used when compared to other indigenous forecasting indicators. Furthermore, it was noted that farmers prefer tree phenology because it is more common and less complex in interpreting them when compared to other sources. Local farmers agreed that interpreting leafing, flowering, and fruiting of trees is simple to farmers of all age groups and hence making it more favorable and popular.

Insects, Small Creatures in Seasonal Forecasting

Data collected through FGDs, in-depth interviews, and key informant interviews showed that insects also play an important role in providing short-term and long-term weather and seasonal forecasting. Just like trees, appearance or disappearance of some insects is used for decision-making after obtaining the weather and seasonal forecasting information. However, it was noted from the study that insects are mainly used for short-term forecasting. Table 3 presents a detailed explanation on how insects and small creatures are used in seasonal forecasting.

Table 3. Insects and Small Creatures Used in Forecasting

	Behavior and Meaning	Action for Farmers
Long-term indicators		
Madora—caterpillars (*Lepidopteran*)	Moving around in abundance means good season	Be prepared for a bumper harvest
Majuru/unheza—termites (*Ancistrotermess* pp)	When seen collecting grass and stocking indicates droughts	Get prepared for severe food shortages
Nyuchi—honeybees (*Appis mellifera*)	When many and flying around mean abundant rains since they depend on flowers	Be prepared for bumper harvest
Makwama—monitor lizard (*Varanus griseus*)	When abundant in numbers, it means good season	Be ready for a fruitful season
Mhashu/magwatakwata/ madowindo—grasshoppers (*Schstocerca americana*)	Appearing in large numbers or swarms means abundance of food	Be ready for a fruitful season
Makurwe—sand crickets (Grylliade)	Appearing in numbers	Be ready for a bumper harvest
Short-term indicators		
Mazongororo—millipedes (*Diplopoda*)	When seen moving around indicates imminent rains	Get prepared for cropping
Nyezhe/nyenze—Christmas beetle (*Cicadas*)	Heavy sounding indicates imminent rains	Be prepared for cropping

(*Table 3 continued)*

(*Table 3 continued)*

	Behavior and Meaning	Action for Farmers
Mashikishira	When going into hiding in the ground rains are imminent	Get prepared for cropping
Rwangachena—white frog (*Litoria caerulea*)	Sounding means imminent rains	Be prepared for cropping
Mukonikoni—dragon fly (*Anisoptera*)	When flying in numbers means coming of rains	Get prepared for cropping
Mabhururungwa—flying termites (*Peticulitermes*)	When flying after rains indicates coming of a dry spell	Be prepared for the coming of the dry spell, and farmers need to intensify weeding

Source: The authors.

Bird's Behaviors as Indigenous Indicators

FGDs, in-depth interviews, and key informant interviews showed the important role played by birds in weather and seasonal prediction. Farmers explained that various bird types were and are still used mostly in interpreting spatial short-term weather events and outlook. However, majority of the participants in the study also explained two main challenges affecting birds as reliable source of forecasting information. First, they pointed out that important birds are slowly disappearing. Second, they pointed out that even some of the existing birds are no longer producing the sounds they used do before. As a result, some farmers lamented the loss of forecasting indicators due to many known and unknown reasons. One key informant interviewee, a 78-year-old man expressed that the remaining seasonal forecasting birds are no longer reliable as they used to do before. He said:

> *Mazuva ano shiri dzacho adzichavimbika, uye isuwo hapana anonyatsoziva kuti chii chirikuitika zvikuru sei shiri inonzi sedendera yataivimba nayo izvezv inongofamba haicharira sezvataiziva kare ichiita.* (These days our birds are no longer reliable and we don't know exactly what is causing them to change, and for example the southern ground hornbill (*Bocavus Lidibiateri*) is are no longer sounding like it used to do before).

Table 4 shows various birds species and their behaviors used in weather and seasonal forecasting.

Table 4. Birds Used in Forecasting.

	Behaviors	Action for Farmers
Long-term indicators		
Ngozha quelea birds (*Quelea quelea*)	Visiting the area before and during farming season	Be prepared for a bumper harvest and also intensive growing of small grain crops such as millet, rapoko, and sorghum

(*Table 4 continued)*

(*Table 4 continued)*

	Behaviors	Action for Farmers
Mherepere—sparrows (*Passerdae*)	Flying over skies usually means a good season	Be prepared for a good season
Usvore—white stock bird (*Ciconia ciconia*)	Visits by these migrant birds mean a good season since the stay in wet and humid places	Be prepared for a good season
Short-term forecasting indicators		
Dendera—southern ground hornbill (*Bucorvus leadbeateri*)	Sounding means imminent rain	Get prepared for cropping
Chivangazuva—sun bird	Sounding means coming of dry spell or rains are still away	Be prepared for dry spell
Kowhera—cuckoo (*Cuckoo cuculiformes*)	Sounding means imminent rains	Get prepared for cropping
Gunguwo—Crow (*Genus corvus*)	Flying in skies indicates dry spells	Get prepared for dry spells

Source: The authors.

Astronomical Indicators

Seasonal forecasting information from the astronomical indicators was gathered mainly from few selected elderly key informants. The elderly key informants highlighted some few and complex indicators, which are mainly used for short-term weather outlook. They also expressed that majority of astronomical indicators are not common, especially among the younger generations. FGDs showed that astronomical indicators and other indicators are not popular since they are only known by the elderly. Despite the knowledge on astronomical indicators coming under the threat of disappearance, some elderly key informants rated it as the most reliable source. The key informants lamented the refusal of younger generations to learn them since they put SSF ahead of their local knowledge. They also noted and complained that education from schools and churches has negatively pushed them away from relying on local knowledge. Table 5 presents key informants' selected list of astronomical indicators used in short-term weather forecasting.

Table 5. Astronomical Signs Used in Forecasting.

Astronomical Indicator	Behavior	Action for Farmers
Mwedzi (Moon) Zuva (Sun)	Halo around sun or moon indicates good season with normal or above-normal rains	Get prepared for intensive farming

(*Table 5 continued)*

(*Table 5 continued*)

Astronomical Indicator	Behavior	Action for Farmers
Mhepo (Wind)	Wind blowing from east to west indicates imminent rains. Wind blowing from west to east indicates dry spells	Get prepared for cropping or vice versa
Mvumi (Nimbus clouds)	Mum indicates onset of good rains	Be prepared for more intensive farming
Mheni (Lightening)	Lightening spells during rainy season indicates coming of dry spells	Be prepared to endure dry spells
Murarabungu (rainbow)	During rainy season indicates coming of dry spells.	Be prepared to endure dry spells
Kupisa/Kutonhora (cold and warm temperature)	Extreme winter temperatures (between May and August) are usually associated with a good farming season	Be prepared for intensive farming

Source: The authors.

Other Indigenous Weather and Seasonal Indicators

Key informant interviews, in-depth interviews, and FGDs pointed out other independent indicators apart from the abovementioned trees, insects, birds, astronomical indicators, and animals. More detailed information on other indicators came from the elderly local farmers. It was expressed that these indicators just like other commonly known vary on their functions and timelines on short-term and long-term prediction trends. Table 6 shows other various indicators used in weather and seasonal forecasting.

Table 6. Other Indigenous Indicators Used in Forecasting

Indicator	Interpretation	Action for Farmers
Mbira (Rock rabbit) (*Ochotona collaris*)	Their squeaking indicates imminent rains or coming of guti (cloudy and humid conditions)	Get prepared for cultivating crops
Kuzvarwa kwevasikana vazhinji (Birth of many girls)	Bumper harvests are expected	More intensive farming
Kuzvarwa kwevakomana vakawanda (birth of many boys)	Associated with drought	Get prepared for coping up with droughts
Makomo anoera (sacred mountains)	Sounds from sacred mountains toward rainy season means imminent rains	Farmers should prepare their fields for cultivating

Source: The authors.

Furthermore, another important indigenous indicator, which is used as a coping and adaptive strategy, is *mukweverera* (rainmaking ceremonies). Through FGDs and key informant interviews, it was noted that performing rainmaking ceremonies reduces chances of droughts. Furthermore, it was expressed that the rainmaking ceremonies are also used as strategies of ending droughts in smallholder farming. However, like other indigenous indicators, rainmaking ceremonies have faced serious threats from churches and schools. Key informant interviewees lamented that these factors have cast serious doubts and threats to the performance of the rituals. They explained that different ages, levels of education, and religious beliefs have negatively affected the proper way of executing the rituals and hence reducing the chances of getting positive results from them.

Discussion

The use of indigenous knowledge indicators in weather, seasonal forecasting, and adaptation to extreme and unfavorable seasonal events is common in many smallholder farming communities in Africa (Chang'a et al., 2010; Kijazi et al., 2013; Roncoli et al., 2002). Though indigenous knowledge is fast getting sidelined, the local farmers have a rich repository of knowledge and assets, which can be utilized sustainably in getting seasonal forecasting information. The slow decline in the use of indigenous knowledge indicators in complex agricultural systems is caused by varying factors, which include, but are not limited to, climate change, ignorance, modern education, scientific technology, and churches. In this study, we observe that these factors have created IKS' consequential erosion. We put the argument forward that there is a big vacuum between the knowers (mostly elders) and the young generation. The break of intergenerational dissemination of indigenous knowledge provides consistent threats to its continuity. In the long run, the disappearance of knowledgeable elders means the demise of IKS. As is noted by Kolawole et al. (2014), the death of an elder is a fatal blow to the already struggling indigenous knowledge. After this observation, we argue that IKSs need to be preserved for future generations.

The noted trends of endowments with functional cosmological resources need to be underscored. As observed, availability of diverse indicators gives a multilayered opportunity for farmers to cross-check and verify the forecasting information among different indicators. For instance, local farmers could compare tree phenology and animal behavior so as to make sure that the information obtained correspond with each other. As we argue, it has never been observed that the indigenous knowledge indicators have ever shown contrasting forecasting predictions. Therefore, reliance on indigenous knowledge should be encouraged, and relying on the indigenous indicators is the best strategy in both forecasting and consequential adaptation. Moreover, only negative shunning on IKS is noted to be driven by knowledge gained from education and churches. Interestingly, few cases are recorded where the indicators are no longer reliable. Truly, it is impossible for all indigenous indicators to concurrently lose their value of forecasting at once despite constant attacks. As noted, only the birds' forecasting roles are affected possibly by climate change. On this standpoint, it can be concluded that indigenous knowledge indicators are the summum bonum for rainfed-based smallholder farming.

While not disregarding the importance of scientific forecasting, the wide range of local forecasting indicators, which encompass tree phenology, insects, birds, astronomical indicators, and other indicators give room for alternating the indicators in the event of failure of others. In this regard, we argue that if diligent care is taken by local farmers, they could construct cropping calendars using IKS. In this scenario, they should score and rate the main functioning versus those that are less reliable. It is only after this exercise that they would know which indicators need to be given priority as they struggle to obtain forecasting information. Having noted the potential of IKS in forecasting, Jiri et al. (2016) encouraged the need for educating local farmers to value the local knowledge, which sustained many generations in smallholder farming. Furthermore, some scholars elsewhere have called in governments to intervene and provide strong policy frameworks in support of local knowledge as they equally do in scientific forecasting systems (Alexander, 2011). Indeed, it is notable to agree to the view that combining the IKS and SSF is important in providing farmers with forecasting information, which may be used for coping and adapting to droughts. Successful cases of combining the two sources of seasonal forecasting are observed in some parts of Zimbabwe such as Mberengwa and Zaka (Muguti & Maphosa, 2012; Shoko & Shoko, 2013;). Truly, this process is credited by many scholars as a landmark decision, which guarantees sustainable adaptation against droughts.

Like other indigenous indicators, rainmaking ceremonies have never been spared from extinction. The main notable forces, which pushed rainmaking ceremonies to the periphery, are churches and Western education. As noted, these factors have negatively increased secularization of the traditional rituals. Consequently, the role of the rituals become greatly disenfranchised from the whole list of other important seasonal forecasting and adaptation tools in the farming enterprise. Despite growing calls from scholars to resuscitate rainmaking rituals, it is still a mammoth task to see them back on their wheels. The direct onslaught made by the abovementioned factors are not only peculiar in Bikita, Zimbabwe, studies conducted elsewhere in Africa reflected similar trends in Burkina Faso and Uganda (Kijazi et al., 2013; Roncoli et al., 2002). Worryingly, a combination of factors disturbed the ritual processes, which were critical in reducing the chances of droughts. In some cases, the rituals were used as an adaptive strategy in pending known and unknown climate change disasters, which affect smallholder farmers.

Conclusion

The study identified multiple indigenous indicators used by smallholder farmers' seasonal forecasting. Various indigenous indicators provide short-term and long-term seasonal information, which is used for planning, decision-making, and adapting to climate change disasters. Knowledge on indigenous indicators is not common among all farmers but found mainly from elderly farmers. Young farming generations' ignorance and non-reliance on indigenous indicators are caused by factors such as unreliability of some indicators, climate change education, and churches. These factors negatively affect the usage of IKS in seasonal forecasting and adaptation. As a result, IKS has faced a consequential demise. We concluded that non-usage of IKS indicators increases local farmers' vulnerability to droughts since they lack forecasting information, which directs them in decision-making. Their vulnerability is also increased due to poverty and limited access to SSF. Availability of forecasting information is fundamental in building adaptive capacity as well as reducing vulnerability through availing well-timed planning and decision-making options among smallholder farmers. Lastly, IKS needs to be preserved and perhaps be well combined with SSF so as to increase access to seasonal information, which is a necessity for smallholder farming.

Declaration of Conflicting Interest

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