CLIMATE SERVICES

Study on the Use of Climate-related Indigenous Knowledge Services to Support Anticipatory Action in Zimbabwe

WFP
World Food Programme
SAVING LIVES
CHANGING LIVES

October 2022

Contents

Acknowledgements

Multiple individuals and organizations made this study a success. WFP staff at the Country and District offices – and particularly Elisha N. Moyo, Munaye Makonnen, Hazel Nyamanhindi, Brian Ndlovu, Sikhanyisiwe Dube, Velaphi Moyo, Yeukai Chikukwa and Rudo Mushonga – provided all the support needed to complete the assignment.

Two members of the Community of Practice in Anticipatory Action (AA) contributed immensely to the study through their vast experience in anticipatory planning and seasonal climate forecasting. Tsitsi Magadza (Food and Agriculture Organization) and Benjamin Kwenda (Meteorological Services Department) provided extremely useful insights during the study.

Many partner organizations assisted with beneficiary lists and attended Zoom interviews. Special thanks also go to all the key informants that attended Zoom and telephone interviews including indigenous knowledge specialists, lead farmers, rural district councillors, AGRITEX Officers, village heads and traditional leaders, among others. The 213 household survey respondents across the four districts patiently went through the questionnaires.

Finally, the research team worked under immense pressure to ensure the success of the study. These are lead researcher Dr Thulani Dube, and assistant researchers Phibion Chiwara, Ethel Muleya, Mitchell Mukande, Simon Mlotshwa, Siphilisiwe B Ncube, Alfred Musavengana and Nozipho Mkwananzi.

Chapter 1: Background

1.1. Introduction

The United Nations World Food Programme (WFP) is piloting the Anticipatory Action (AA) approach in Zimbabwe. AA is designed to manage climate risks by acting in anticipation of severe weather events, based on weather forecasts and pre-positioned financing. This study was commissioned to investigate possible pathways for the integration of indigenous knowledge systems (IKS) in the decision-making processes within the AA approach.

The World Meteorological Organization (2013) notes that '… a climate service is a decision aide derived from climate information that assists individuals and organizations in society to make improved ex-ante decision-making.' Climate-related IKS are used traditionally in many parts of the world to provide climate services. The definition of IKS used for the purposes of this report is given in Section 1.5.

A more complete understanding of current use of IKS in climate forecasting amongst the targeted communities is necessary before their integration into AA. This document details the processes and findings of a study commissioned by WFP Zimbabwe in June 2021 to investigate the current state and use of climate-related IKS in four districts of Zimbabwe: Mbire, Matobo, Mudzi and Binga.

1.2. Objectives of the study

The study was undertaken to assess knowledge of climate-related IKS in the target districts in Zimbabwe and to explore whether IKS can be integrated into AA.

In summary, the objectives of the study were to:

- Assess knowledge of climate-related IKS in Zimbabwe;
- Investigate the extent that climate-related IKS is used in the study population and its possible integration into AA and;
- Provide initial guidance on how to integrate and use IKS in AA projects.

1.3. The role of climate forecasting in Anticipatory Action

The AA programme is an innovative approach that enables the implementation and financing of actions before an extreme weather event has occurred. The anticipatory actions aim to prevent and mitigate the effects of extreme weather on the food security and nutrition of highly vulnerable people.

The success of the AA approach depends, to a large extent, on the ability to forecast adverse weather events with high skill and accuracy to subsequently take appropriate, informed action to adapt to the new situation. Seasonal climate forecasting and other long-term and short-term forecasting systems are therefore integral to the AA approach. When forecasting information is available, decisions to avert climate-related hazards and their impacts can be taken at both individual farming household level and programming level. Dube et. al. (2016) have shown that farmers who access seasonal climate forecasts make important farming decisions based on the information. Such decisions may include the seed varieties to be purchased, the type and quantity of fertilizers to purchase, the time of year to plant, and plant density per planted area, among other issues (Chisadza et al. 2013). In general, climate forecasting assists farmers and stakeholders to maximize yields where conditions are favourable by preparing the right inputs and investments, whereas in a year with extreme weather events, farmers can more effectively protect their families, crops and livestock (Alvera, 2013).

Forecasting is broadly divided into three types, according to the lead time offered by the forecast (Blench, 1999):

- Weather forecast: forecasts limited to lead time of days;
- Seasonal climate forecasts: forecasts that offer a lead time of several months;
- Long-term climate forecasts – long-term forecasts projecting climate over several years.

While the current seasonal climate forecasts obtained through the Zimbabwe Meteorological Services Department (MSD) have played an important role in AA, they have been found to have several limitations, including challenges with accuracy, generalizations/low resolution (spatially and temporally), inaccessibility, and lack of precision at local ward, village and household level (Moyo, 2020). These issues are discussed later in the findings section.

1.4. The need for a complementary forecasting system

Approximately 60 percent of the African population is not covered by early warning systems to cope with extreme weather and climate change. A significant proportion of the rural population in Africa has limited access to scientific forecasts. As a result, they depend on IKS-based forecasting which they have used and relied on over many years. One of the strengths of IKS is that the indicators are locally accessible in different geographic locations, enabling even remote communities to have access to climate forecasting information (Dube et al, 2013). The various challenges related to the accessibility, reliability and use of 'modern/contemporary' meteorology-based weather and climate forecasting methods have led to increasing calls for the utilization or integration of IKS in seasonal climate forecasting to bolster the efficacy and accuracy of forecasts. Most IKS indicators are observable several months before the onset of the rainy season, thus enabling anticipatory planning (Chisadza, 2013).

1.5. Definition of indigenous knowledge systems

The term 'indigenous knowledge' refers to the sum of facts and place-based knowledge known or learnt from cumulative day-to-day experience, or acquired through observation and study, and handed down from generation to generation by individuals and communities (Berkes 2000; Sanga, Ortalli 2003 & Sillitoe, 2007).

Indigenous Knowledge System (IKS) refers to a set of knowledge that is orally passed down from generation to generation and is learned by observing the environment surrounding communities.

This knowledge is also referred to as indigenous technical knowledge (Archaya 2011). This knowledge is a result of cumulative repetitive observation and experience (Chisadza et al. 2013). With regards to climate and the environment, scholars often refer to a more specific type of indigenous knowledge known as traditional ecological knowledge (Dube et. al. 2016). Similarly, Salick and Byug (2007) define IKS 'as the wisdom, knowledge and practices of indigenous people of a particular community and the knowledge should have been gained over time through experience or should have been orally passed on from generation to generation'.

The concept of IKS has increasingly become topical, and in disasters and development discourse it is increasingly being accepted as integral to addressing multiple challenges faced by rural communities due to climate change (Mapfumo et al., 2015; Moonga & Chitambo, 2010 & Saitabau, 2014). The past decade has witnessed an emerging and dominant view that emphasises local knowledge as a key component of an agricultural system and the view that scientific knowledge must enhance local knowledge, rather than displacing it (Jain, 2014; Joshua et al., 2011; Maconachie, 2012; Osbahr & Allan, 2003). Indigenous knowledge has a strongly practical emphasis that is oriented towards planning, and its dynamism enables incorporation of new elements (Flavier et al., 1995; Kolawole et al., 2014; Orlove et al., 2010). More recent studies have shown that resilience building for smallholder farmers in Africa starts with ability to anticipate climatic changes and accordingly adjust farming practices to lay the groundwork for sound food security, particularly in the context of climate variability and change (Kolawole et al., 2014). Mafongoya et al (2021) acknowledge 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.' This is because IKS is considered to form the basis of local-level decision-making in many rural communities on the continent: as such it would be difficult for communities to be resilient without it (Adger, 2012). Chisadza, Mushunje, Nhundu and Phiri (2018) assert that IKS plays an important role in climate forecasting in Africa's smallholder farming communities, particularly in occasionally predicting local weather information and frost. According to Nhemachena (2010), this knowledge only qualifies as IKS if it has significantly helped to solve problems related to climate change and variability, among many other socio-environmental concerns.

Chapter 2: Study materials and methods

2.1. Description of study sites

The data collection for the study was carried out in four districts of Zimbabwe: Mbire, Matobo, Binga and Mudzi. All four districts primarily lie in agroecological regions IV and V and they are characterized by low and erratic rainfall (450–650 mm/year) with very high temperatures and inherently poor soils.

Climate change has worsened the already extreme weather patterns in the districts, resulting in significant food shortages. For example, drought has affected all these districts. Key economic activities include smallholder mixed crop-livestock systems. Maize, sorghum, millet and groundnuts are grown in all the districts, albeit at different scales. Livestock include primarily cattle and goats and there is frequent risk of overstocking, which means that pastures and grazing lands have been depleted. All four districts are in areas that border the neighbouring countries of Mozambique (Mbire and Mudzi), Botswana (Matobo) and Zambia (Binga and Mbire). Adding to the challenges faced by communal farmers in the districts, they all either contain or are close to major national parks or wildlife conservation areas.

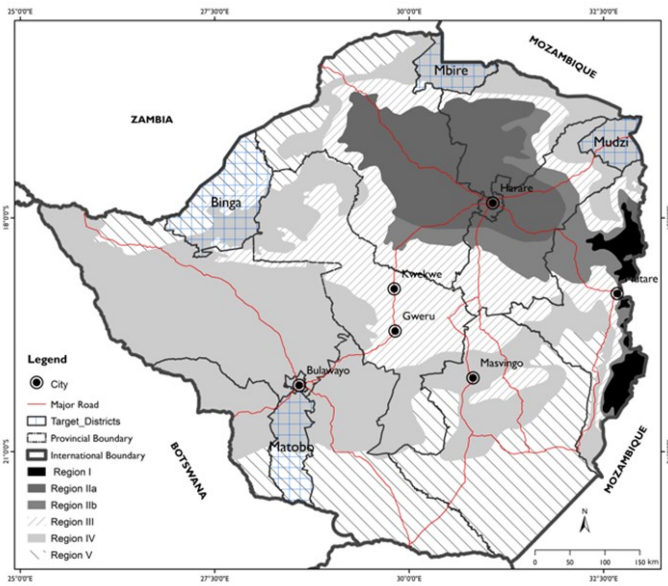


FIGURE 1: The location of the study districts

Table 1: Key statistics about the study districts

Descriptor	Mudzi	Mbire	Matobo	Binga
Province	Mashonaland East	Mashonaland Central	Matabeleland South	Matabeleland North
Number of Wards	18	17	26	25
Population (2012 Census)	133 252	82 380	93 940	139 092
Population density/km^2	32.05	17.96	17.54	10.43
Total land area (km^2)	4 158	4 696	7 245	13 338
Population Growth rate	0.39	17.54	-0.60%	10.43
Female/Male ratio	52/48	51/49	52/48	54/46
Percentage of Rural Population	96.1	100	99.4	96.2

Source: Zimbabwe National Statistics Agency, 2012 and City Population (date unknown)

2.2. Study methodology

The study was conducted using a mixed methods approach that combines qualitative and quantitative approaches. The following data collection methods were used.

2.2.1. DESK REVIEW

Research that has been conducted in Zimbabwe and other parts of Africa was reviewed to establish the current state of IKS on weather and climate forecasting in Zimbabwe and Africa in general. The review focused on the use of IKS in weather and seasonal climate forecasting. The literature review also focussed on the concept of forecast-based-financing to understand how it is operationalized.

Online resources with collections about ecological phenomena such as names of trees and birds were reviewed to confirm the names supplied by the study informants. This website was particularly useful for confirming the names of trees, birds and animals.

2.2.2. KEY INFORMANT INTERVIEWS

Eight key informant interviews were held per district with key programme stakeholders in AA, including selected WFP programme staff, WFP partner organizations, members of the AA Community of Practice in Zimbabwe, Meteorological Services Department officials, district AGRITEX officers, district agronomists, lead farmers at district level, recognised Indigenous Knowledge Practitioners at district and ward levels and traditional leadership representatives. Due to the COVID-19 lockdown protocols, all respondents were contacted virtually over Zoom, with those respondents who could not be accessed by Zoom called on their mobile phones. While this approach generally worked well, in a few instances, respondents' mobile numbers were either unreachable or network challenges prevented a smooth discussion. In most cases, the discussions proceeded well. Network challenges were particularly experienced in Matobo and Mbire. The second challenge with virtual interviews was that many of the indicators being investigated were visual. It was not possible to transmit these visual illustrations over the phone. These visual indicators include trees, animals and insects.

2.2.3. SURVEY

A total of 200 households across the four districts were targeted through a mobile phone-based survey. This approach was taken because the research team could not physically visit the study sites due to the COVID-19 lockdown protocols in place during the data collection period. The household survey targeted respondents in the districts where the AA project would be implemented. Approximately equal numbers of households were selected across the districts, with stratification by ward wherever available sampling frames allowed for this. Within a ward, the selection of household-level respondents was based on available beneficiary lists from partner organizations and stakeholder registers from the district- and ward-level Anticipatory Action Plan validation meetings for the AA project. Where such lists were not available, WFP staff responsible for specific districts were able to source lists from partner organizations implementing WFP programmes within the same districts and wards.

The study also took gender representation into consideration in the selection of respondents. Figures 2 to 4 show the representation of various sample sub-categories. Fifty-nine percent of the respondents were male while 41 percent were females. This may indicate unequal access to communication gadgets such as mobile phones. Most of the respondents reported being in the lowest income bracket, earning US$0-49 per month. This explained the levels of poverty in the study areas, which also contributes to limited access to seasonal climate forecasting information, as households cannot purchase communication gadgets such as radios. The average age of the respondents varied between the districts, from 44 years in Mbire to 56 years in Matobo. As shown later in the study, it appears that average age also directly correlated with levels of knowledge about indigenous knowledge systems and their use.

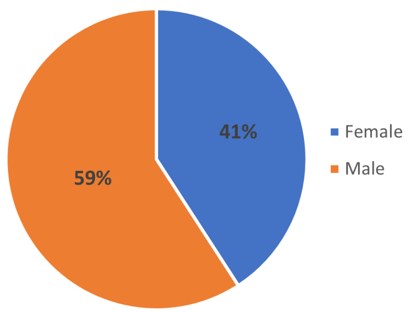


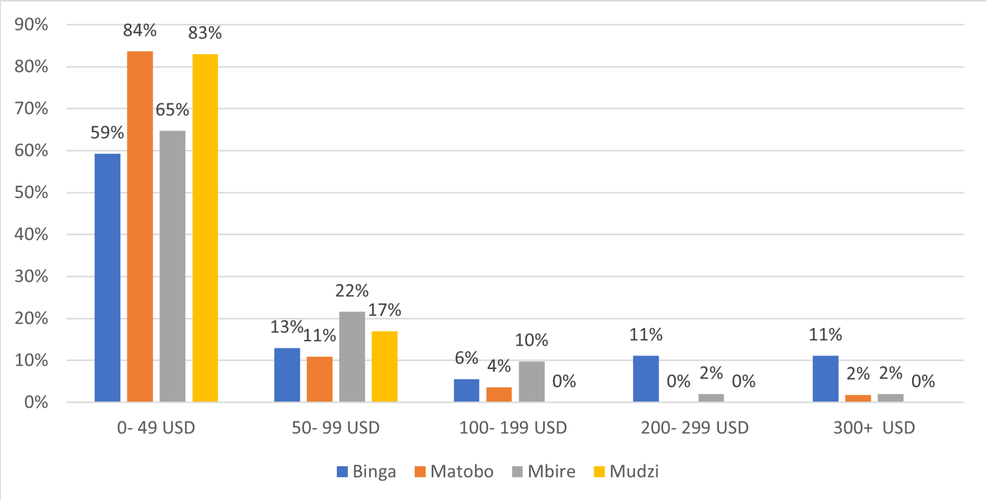
Figure 2: Survey respondents by sex, percentages

District	N. of respondents	Average age	Average n. of years located in the study site
Binga	54	48	33
Matobo	55	56	36
Mbire	51	44	29
Mudzi	53	47	33

Table 2: Average age of survey respondents, by district

The household survey was administered by research assistants using mobile phones. The Kobo Toolbox software platform was used to capture data. Eight research assistants were thoroughly trained and oriented before embarking on the study.

Figure 3: Average household monthly income distribution by district (n=213)



Source: Survey data

The study was guided by the following study questions matrix:

Table 3: Data collection matrix

KEY QUESTIONS/THEMES	TYPE OF DATA TO BE COLLECTED	KEY DATA COLLECTION METHOD
What percentage of household heads utilize IKS in weather and climate forecasting?	Data on the number of households that make use of IKS	Survey, Key informant interviews
What proportion of households utilize IKS together with meteorology reports?	Data on the number of households that utilize IKS and meteorological forecasting information	Survey Key informant interviews
Which method (IKS or meteorological knowledge) is preferred by the communities and why?	Data on preference and attitudes towards the different methods	Survey Key Informant interviews
Which indicators are used in different places to inform IKS forecasting?	Data on the following sources/indicators and how they are used in forecasting: Plants Animal behaviour (including birds and insects) Astrological and atmospheric indicators	Survey Key informant interviews Photographs
How important are each of the indicators, and how well are they trusted?	Data on levels of trust for IKS forecast methods	Survey, Key informant interviews
How are communities currently using indigenous knowledge systems for anticipatory action against climate hazards?	Data on current community uses of forecasting information to reduce the impact of climatic shocks	Key informant interviews
What are the most common types of climate-related hazard in the various study districts?	Data on the most commonly occurring climate hazards in the districts	Survey Key informant interviews
What can be done to minimize the impacts of the climate hazards?	Data on community perceptions of solutions to the climate hazards	Key informant interviews
What is the timing of the most common hazards per district?	Data on when climate hazards are most pronounced and frequent	Key informant interviews Survey
What lessons can development and humanitarian partners learn for anticipatory action integration with IKS?	Data on current practices relating to use of IKS that can be useful for programming	Key informant Interviews

2.2.4. DATA ANALYSIS, VALIDATION AND REPORTING

As the study adopted a mixed methods approach, the data analysis also took a mixed methods approach. Qualitative data were analysed thematically. The consultant read through interview transcripts to identify emerging themes. Data were grouped thematically and then read together to understand the emerging themes. The survey dataset was downloaded from Kobo Toolbox into Microsoft Excel and cleaned. It was then analysed using Microsoft Excel. The consultant cross-tabulated several variables, including district, gender, age and others of interest. The quantitative analysis using Excel shows the distribution of different IKS methods and practices across districts. The study was validated in two meetings: namely 1) a Zimbabwe National Climate Outlook Forum (NACOF) meeting; and 2) a WFP stakeholders meeting.

Chapter 3: The current state of climate forecasting services

3.1. Introduction

This section presents the key findings of the study as guided by the research objectives. It begins by highlighting the common climate hazards in the target districts as perceived by the local farmers and other stakeholders engaged in the study. It highlights the current state of information on seasonal climate forecasting generated by the Meteorological Services Department. In the context of the 'shortcomings', inadequacies or imperfections of 'modern' or contemporary scientific forecasts, the findings section draws from stakeholders' views to show the need for IKS as a complementary forecasting system to scientific forecasts. The section highlights the key indicators used by communities across the districts based on: (i) plants, (ii) atmospheric signs, (iii) astrological concepts; (iv) animals (including insects and birds); and (v) spiritual signs. The section also assesses community perceptions and experiences about the use of IKS and the 'Scientific' approach for climate forecasting.

3.2. Common climate hazards

The study established that the most common climate hazards in the study districts were droughts and floods. Eighty-three percent of the respondents indicated that drought was a common climate hazard in their locations. The second most common climate hazard identified by respondents were floods (51 percent of respondents) (see Figure 4). Heatwaves were associated with droughts in 12 percent of the responses. The impact of droughts was most severe on crops and livestock. Respondents indicated that drought seasons and dry spells led to a reduction in crop yields and increased levels of food and nutrition insecurity. Crop failure was associated with serious household food insecurity, high school dropout rates, child marriage and poor attendance at school. Significant numbers of livestock had been lost in these districts in previous droughts. Hailstorms also occur in the focus districts, damaging buildings and infrastructure. The key informant interviews indicated that climate change hazards significantly affect rain-fed agriculture, the mainstay of livelihoods in the target districts. Too much or too little precipitation leads to negative agricultural outcomes. This means anticipatory actions should be taken to reduce the impact of extreme weather events.

"In Matobo we have had perennial droughts over the years. Production in the fields has been low due to perennial droughts. However, last year we had heavy persistent rains. These rains destroyed the crops through leaching and waterlogging. We also know that droughts have led to the death of a lot of livestock". **Musu Cumanzala, Caritas Meal Officer**

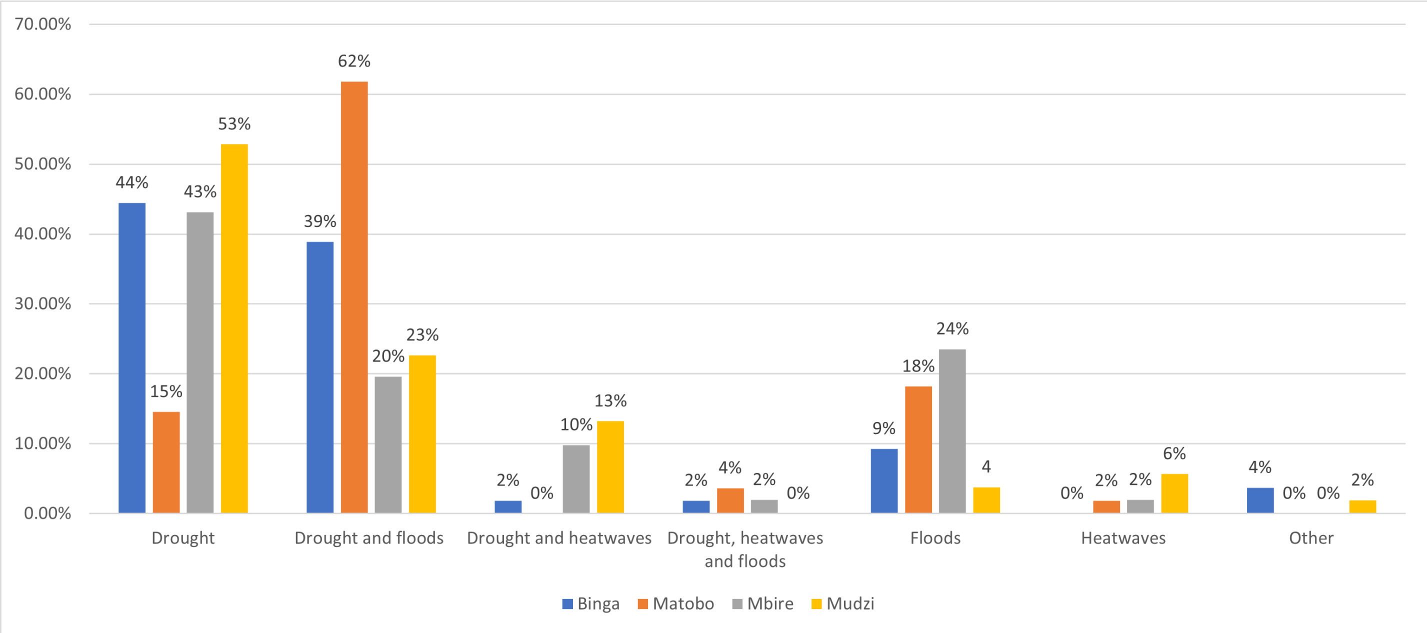
In all four districts, the greatest hazard was drought. Key informants highlighted a general lack of boreholes, which exacerbated water challenges during droughts. This resulted in people drinking water from unprotected water sources. The provision of water sources and small grains (particularly sorghum and millet) was proposed as part of viable anticipatory actions. However, it was noted that various small grains had to be carefully chosen for different regions, as some regions prefer sorghum and others millet. Food assistance was also seen as a necessary stopgap measure across all the districts.

Key informants indicated that the main challenge faced by communities was that the climate was increasingly seeing more extreme droughts or floods. Some seasons were too dry while wet seasons were also often too wet, leading to waterlogging and leaching. These findings corroborate previous findings that show that extreme weather events are increasing in frequency and intensity in Southern Africa (IPCC, 2007; Dube & Phiri, 2016).

Droughts were experienced in various ways. As one respondent noted:

"Droughts come in different ways. Sometimes it's the late onset of rains; at other times the rains come on time, but the season is marked by some dry months (prolonged dry spells). Again, when the rains come it may be too late for the planted crops and sometimes they are too heavy, leading to leaching". Ntando Dube, Farmer, Ward 2, Matobo District, 55 years

Figure 4: Climate hazards identified by district (n=213)



3.3. The common infrastructure for forecasting used in AA

3.3.1 THE ROLE OF THE METEOROLOGICAL SERVICES DEPARTMENT

The agro-meteorology section of the Meteorological Services Department (MSD) provides advisory information services to farmers about prevailing and future conditions for agricultural seasons. In the context of AA activities, the MSD plays a key role by providing both short-term and long-range forecasting information that is used to make decisions about anticipatory actions. The MSD derives its seasonal forecasting data from the Southern African Regional Climate Outlook Forum (SARCOF) process, which produces and issues annual regional forecasts for the Southern African Development Community (SADC) region (SADC Climate Services Centre, 2021). The forecasts are given in probabilistic terms in the categories Normal (75-125 percent of the long-term average), Below Normal (below 75 percent of the long-term average) and Above Normal (above 125 percent of the long-term average). The forecast for each of the categories is given in possibilities expressed in percentages. The highest percentage is the most anticipated forecast (Manatsa et al., 2012). After receiving the SARCOF forecasts the Zimbabwe MSD scales down the forecast to suit local geo-climatic conditions before sharing it with stakeholders such as AGRITEX for onward transmission to farmers. This forecast is, however, still very course and generalized as the whole country is divided into only three 'homogenous' forecasting zones (Moyo, 2020).

3.3.2 THE ROLE OF AGRITEX IN DISSEMINATION OF SEASONAL CLIMATE FORECASTS

The Department of AGRITEX in consultation with MSD was identified as the major provider of climate advisories for smallholder farmers in all four districts. However, it was also noted that traditional leaders such as chiefs, headmen and village heads also play a key role in disseminating both indigenous knowledge and meteorological information received from AGRITEX. AGRITEX was responsible for interpreting meteorological forecasts from MSD, in turn received from SARCOF. AGRITEX is then responsible for disseminating the forecasts to farmers to address their farming needs.

The communities were found to be increasingly aware of the need to conduct climate-resilient agriculture and to be taking increasingly anticipatory actions in their work. Where climate forecasting information could be available, they actively seek it. One respondent pointed out that:

As an example, one AGRITEX officer in Mudzi district noted that the farmers who were able to access seasonal climate forecasting information used it to make farming decisions such as which crops to plant and on which dates.

"Communities are keen to use climate forecasting information with hopes of attaining high yields. Some even go as far as to visit AGRITEX offices and personnel to ask for more information about next season's forecast". **Chisaka Changarama, AGRITEX, Mbire District**

However, it was noted that a significant number of farmers still did not have access to climate forecasting information because they were too poor to purchase the items required to access the information, such as radios, television sets and newspapers. The AGRITEX officer for Mudzi further indicated that if farmers could utilize information from the MSD, they could come up with seasonal plans and decisions, on such issues as the best crop varieties for the season, when to plant, fertilizer application rates, forecasts of hailstorms, weeding regimes and so on. These should all be done according to the amount and timing of seasonal rainfall. It was noted that the primary reason most farmers did not develop effective plans for the planting season was because they were either ignorant of possible planning options or unable to access the forecast. It was also noted that climate forecasting information uptake was generally good, and that households that participated in climate change workshops and programmes tended to make better use of the information that they obtained for decision-making.

> *"However, the challenge is that information on its own is not adequate: it must be complemented with inputs such as seeds. Sometimes, even when farmers have information they may fail to adopt the correct farming practices because they do not have the right inputs and resources".* **World Vision Mudzi, Key Informant**

It was noted that training both AGRITEX personnel and farmers on use and interpretation of forecasting could greatly improve the efficacy of information flow and use. In addition, to enhance the flow of information between AGRITEX staff and farmers, it is necessary to improve mobile phone network coverage, and access to communication devices including phones and radios, as well as data bundles. A lack of vehicles and fuel means that the mobility of AGRITEX personnel is another major challenge hindering information flow.

3.3.3 KEY CHALLENGES RELATED TO MSD SEASONAL CLIMATE FORECASTS AND THE NEED FOR A COMPLEMENTARY APPROACH

While some respondents felt that they were accessing weather and seasonal climate forecasts in good time, others felt that they received the forecasts rather late around September. Farmers observed that by that time they would have already bought their seeds for planting, making it difficult to change what they would plant to conform with the forecast. As one key informant noted:

"The reliability of the SCFs is relatively high. However, the information usually comes at a late stage, sometimes in September after we have already bought seeds, only to be told that they will not do due to the erratic rains coming". Shamu Mafuta – Farmer and Environmental Monitor, Mbire District

IKS, on the other hand, were favoured by IKS practitioners because forecasting information obtained from these indicators was accessible very early in the season, as trees used as indicators would start showing as early as June and July (or August and September). By August most fruit trees would have shown their fruits and IKS practitioners would know the meaning of the forecast. This allowed ample time to plan for the proper inputs.

In all the districts studied, access to weather and climate forecasting information was noted to be a challenge, as the following key informants indicated:

> "*In Matobo most of the information from the Met Department about seasonal climate forecasts is passed mostly through social media. You will find that some remote areas like Bhewula have no access to social media and radios. I think we need to find a better way or strategy to disseminate information*". **Nkosana, Caritas**
>
> "*Currently, in Binga communities mostly rely on indigenous knowledge systems. They do not seem to use a lot of the scientific forecasts. Binga communities trust IKS mostly because it is what is available to them. However, they mentioned that due to changes in the climate, some of the indicators do not seem to be fully reliable lately*". **Sikhanyisiwe Dube, WFP**
>
> "*In Mudzi and Mbire, our technical working groups at district level do not have Meteorological Services Department offices. We would definitely benefit a lot from integrating IKS to improve our forecasting. Secondly, I think that when we use indigenous knowledge systems it will lead to a lot of buy-in from the communities as they will appreciate that if their forecast is tallying with the meteorological forecast, they can trust the forecast*". **Yeukai Chikukwa, WFP**

Although the MSD endeavours to provide information to address the needs in AA interventions, this information still has gaps that need to be filled in. It was noted during key informant interviews that one of the challenges with the current information provided by the MSD was the issue of the spatial/geographic scale of the forecast. Stakeholders believed that forecasts come at a low resolution that was not applicable to the level of local farms. Farmers noted that a district-level forecast often was a miss for local level farmers at the fringes of their districts. On the other hand, IKS-based forecasts were localized to specific communities and geographic areas. This has been emphasized in previous research:

> *"The production and application of local forecasts (that) are deeply localized, derived from an intimate interaction with a microenvironment whose rhythms are intertwined with the cycles of seasonal changes".* **Archaya, 2011**

The second challenge was that there is a gap in the forecast range. Key informants from the MSD indicated that they produce long-term forecasts (three months) and short-term forecasts (three days and ten days). However, there was a noticeable forecasting gap in the period in between (about a month).

In general, although the MSD may be producing relevant climate forecasts for farmers, farmers find it difficult to access the information, mostly due to the latter's remote location. In all the districts some of the farmers interviewed indicated that they either did not have gadgets to access radio broadcasting or that they were too remote to be reached by radio and mobile phone transmission from Zimbabwe. As a result, some of the communities were accessing radio transmission from neighbouring countries such as Botswana and Zambia. **However, even where AGRITEX officers were able to share meteorological information with farmers, farmers were often apprehensive and unsure about the forecasts.**

RECOMMENDATION: Training events and awareness programmes on climate services under AA may thus need to include IKS and contemporary climate services. As one key informant indicated, this is because:

> *"Communities by nature are suspicious of information that is not in a format that they understand. Buy-in is very important here. The challenge is that we use terminology that only we and our colleagues understand, but when we use IKS we get buy-in from the communities. When we use indigenous knowledge systems and talk to communities and show them that we value their knowledge, a lot of buy-in comes into the project".*
> **International organization, Harare**

3.3.4 TRIANGULATING CLIMATE SERVICES

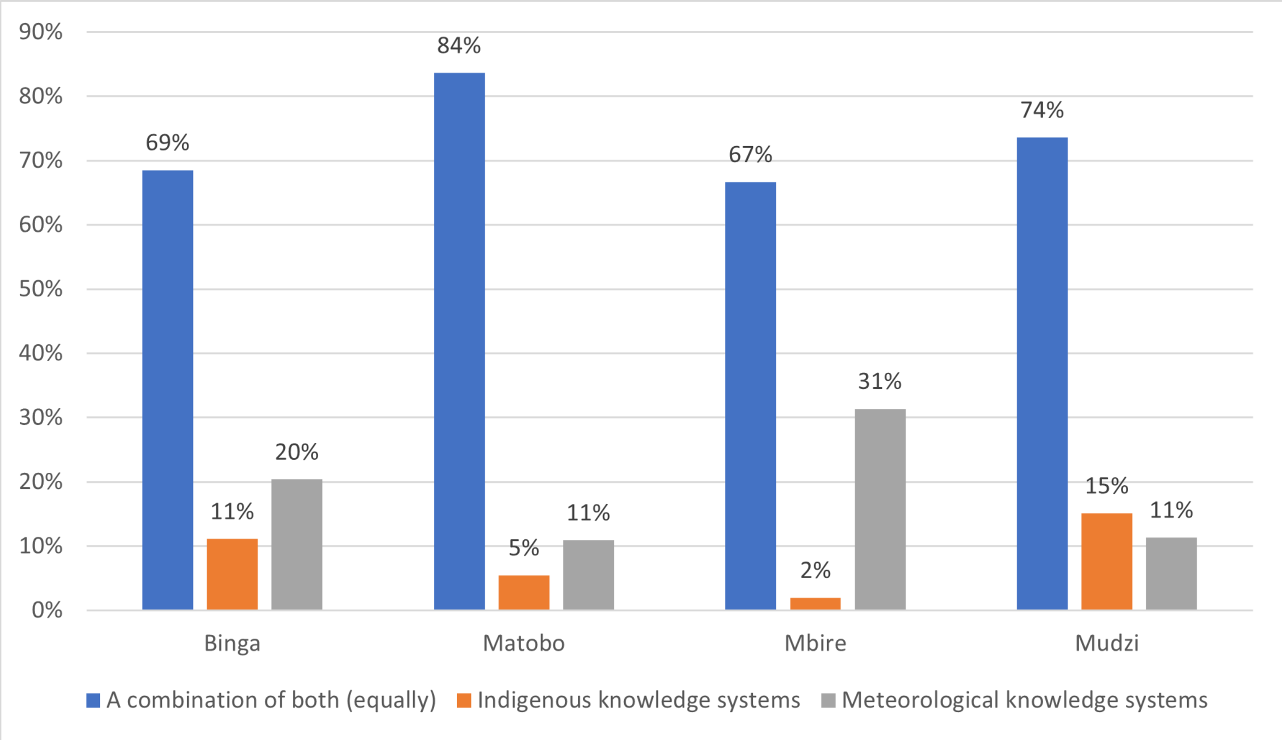
Given the evident hesitancy that communities have in fully trusting the MSD SCFs on its own, it would be necessary to use both the SCFs from the MSD and IKS from the communities to triangulate the seasonal climate forecast. It is important to note that triangulation also happens within the IKS, as various indicators are used which may or may not agree with each other. Triangulation is important because it gives farmers a reasonable level of assurance about the level of precision of the forecast, and the decisions that they must subsequently take. As one key informant indicated:

Some stakeholders also indicated that one of the challenges concerning the information obtained through the MSD was that it sometimes takes a long time to be released when it is urgently needed for decision-making purposes. For example, it was reported that historical information about precipitation for June may only be accessible in July due to long sign-off processes before information is released.

> *"Triangulation helps with two things. Firstly, it helps us to notice if communities are observing the same things that we are observing through the scientific method, and secondly it helps with buy-in when you use their methods".* Anticipatory Action Lead, international organization
>
> *"It came out in the consultations that some communities are still relying on those indigenous knowledge systems more that scientific forecasts. So, it may be helpful to have the two sources of information triangulated to complement and consolidate each other when it comes to anticipatory planning. I think that then communities can start believing the forecasts and taking the right actions in line with the forecasts".*
> **Brian Ndlovu, WFP Programme Associate, Bulawayo**

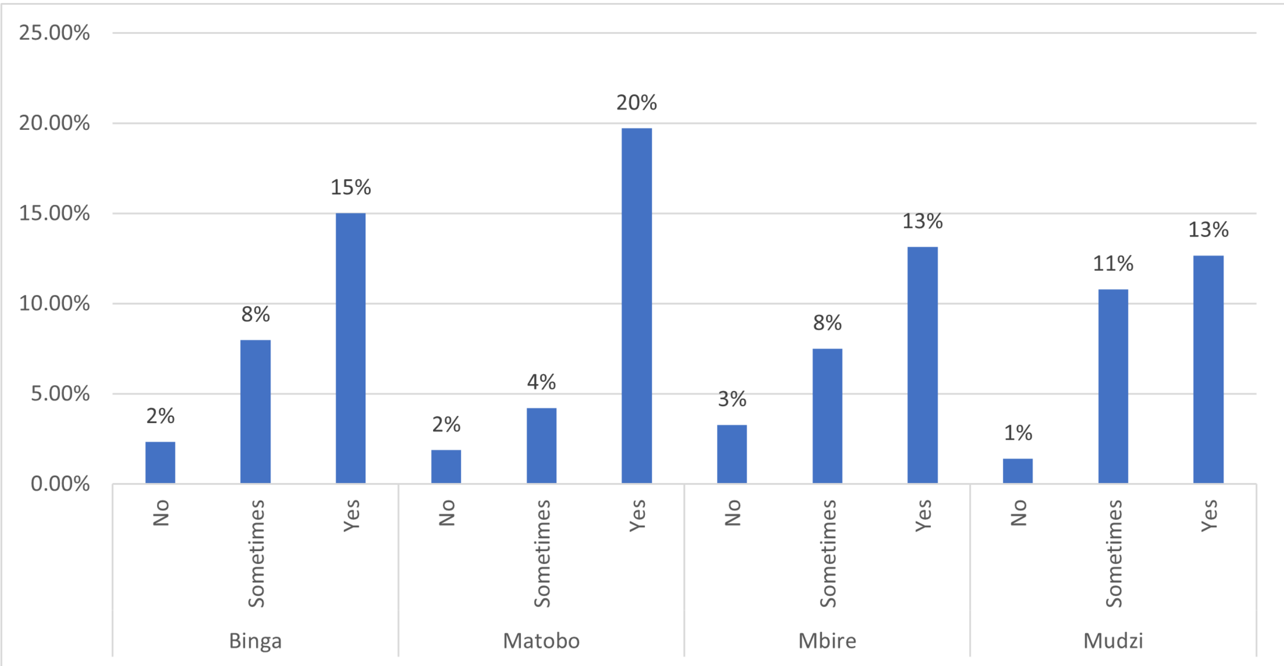
Figure 5 shows that MSD SCFs and IKS are predominantly used in combination across all the study districts. Figure 5 shows community preferences for use of the two forecasting methods across the four districts. Most of the respondents (73.2 percent) indicated that they use a combination of MSD SCFs and IKS-based climate forecasts. Only 8.4 percent of the respondents exclusively used IKS. Eighteen percent of the respondents just used MSD SCFs. In total, 81.6 percent of the respondents utilize indigenous knowledge systems either alone or to complement with the MSD SCFs. This shows that the importance of IKS to the communities for making farming decisions and reiterates the importance of integrating IKS as a decision-making tool in AA.

Figure 5: Predominantly used knowledge system (n=213)



Source: Survey data

Figure 6: Use of indigenous knowledge systems for climate forecasting by district, percentage



Source: Survey data

3.3.5 A NATIONAL DATABASE OF INDIGENOUS KNOWLEDGE INDICATORS

Although evidence shows that communities use both MSD SCFs and the indigenous knowledge-based forecasting methods, key informants observed that MSD forecasts had an edge over IKS in terms of accessibility because the former was documented and organized. One respondent indicated:

> *"Although people use both forecasting methods equally, it can be seen that the meteorological information that AGRITEX disseminates is better packaged and organized, and therefore more likely to reach a higher number of people. Meteorological information has better channels for dissemination to communities through AGRITEX".* **Mukande Fidelis, Farmer and Councillor, Mudzi District**

Key informant interviewees broadly agreed that **there is need to transform IKS knowledge into written form in the form of a national database.**

3.3.6 FACTORS AFFECTING THE CHOICE OF FORECASTING METHODS

Knowledge and application of the IKS was a variable of demographic groups within the area. The elderly had knowledge of the IKS identified in the survey, while the younger demographic group knew and applied IKS to some extent but had doubts regarding their trustworthiness. The younger population group applied both meteorological information mostly acquired through the radio and IKSs. Doubts over indigenous knowledge arise because of inaccurate forecasting (at times). On the other hand, other respondents noted that high levels of deforestation affecting some of the key tree species used as indicators has deterred the use of IKS in the area. As an example, the mukuyu (sycamore fig) tree – which has white flowers prior to a season of heavy rain and purple flowers before a drought – was often targeted in Mbire and Mudzi as it provides quality fuelwood. Some respondents also noted that climate change itself has affected the behaviour of some species used in IKS forecasting.

Figure 7: Sources of climate forecasting information (n=213)

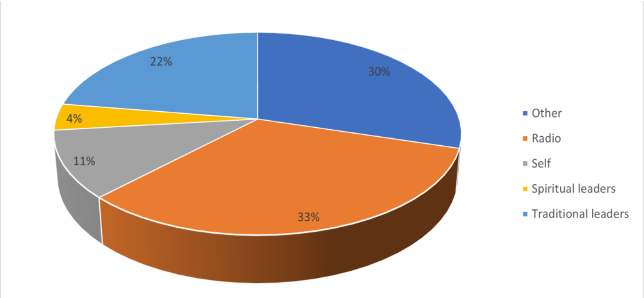
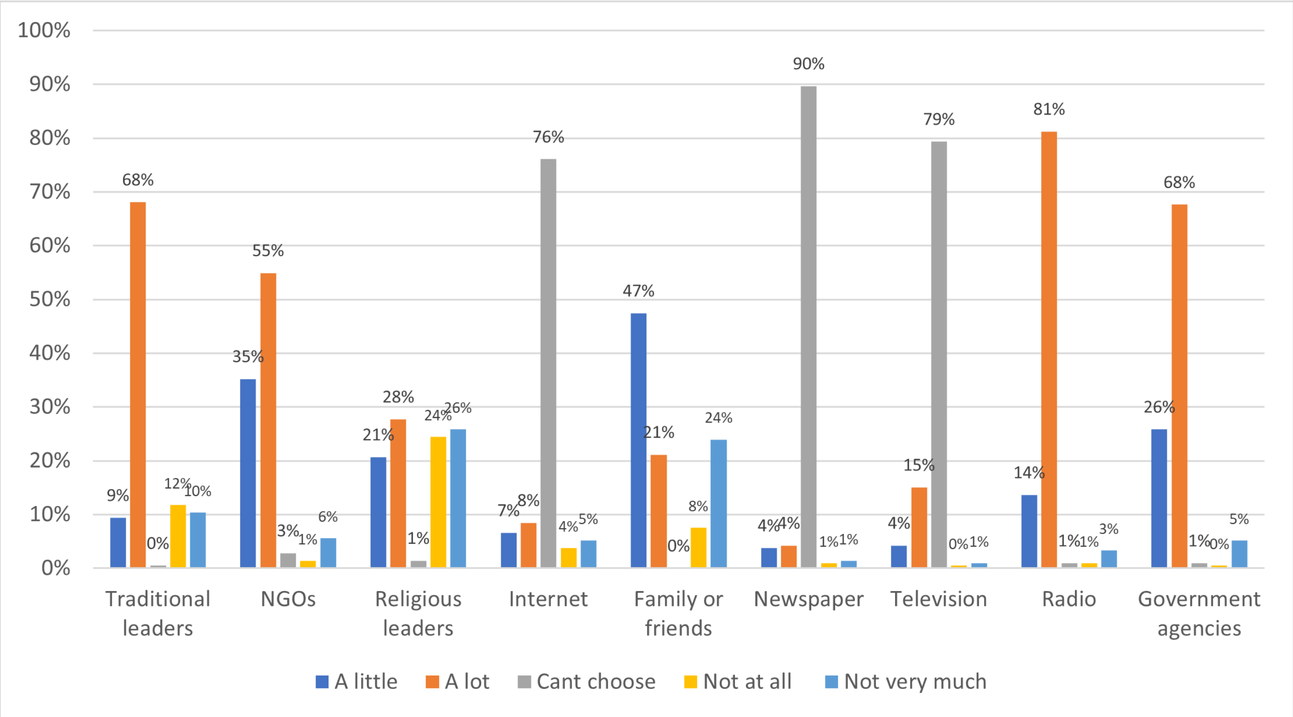


Figure 8: Level of community trust in various sources of information (n=213)



Chapter 4: Indigenous knowledge system Indicators for climate forecasting

4.1. Introduction

A variety of indicators are used for climate forecasting in indigenous knowledge systems. These indicators include plants, animals, birds, insects, astrological and atmospheric features and spiritual premonitions. Holders of IKS knowledge associate the behaviour of these elements with certain weather and climate outcomes. For example, when certain trees – such as the Live-long tree – show high levels of fruitage, this may indicate an abundance of rainfall in the coming season. The appearance of certain birds (such as the black and white stock) and insects (such as crickets) and their behaviour can also indicate heavy rainfall or floods in the coming season. The section shows the indicators that are most used in the various districts.

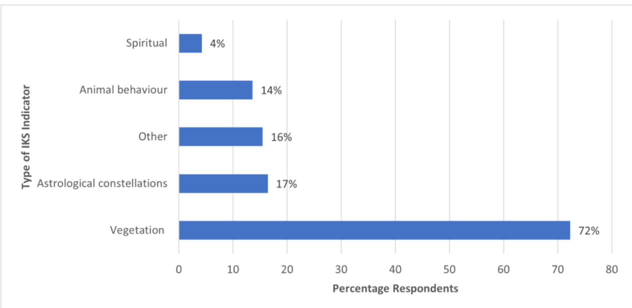
As indicated above, five broad types of indigenous knowledge system indicators are used in climate forecasting:

1. Plants
2. Animals, birds and insects
3. Astrological signs
4. Atmospheric concepts
5. Spiritual premonitions

4.2. The most used IKS indicators

The study established that the most used type of indicators used in IKS seasonal climate forecasting was plants. Over 72 percent of the respondents indicated that they use at least one plant for forecasting. This was followed by atmospheric and astrological signs (16 percent) and animal behaviour (14 percent). Only 4 percent of the respondents indicated that they use spiritual forecasting, which consists of messages given by spirit mediums and prophets.

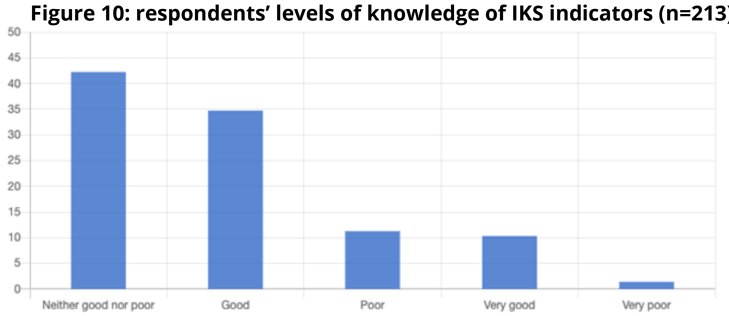
Figure 9: Most used IKS indicators (n=213)



Source: Survey data

Figure 10 shows the self-reported levels of knowledge of IKS indicators among the respondents interviewed in the survey. Most of the respondents (42 percent) reported that they considered their knowledge to be neither good nor poor. A significant number (34 percent) judged their knowledge of IKS indicators to be good. Only 10 percent of the respondents said that their knowledge of IKS indicators was very good. This points to a need to urgently document this source of knowledge, as there is a risk of losing it when the older generation – who are more likely to have good knowledge of IKS – dies.

Figure 10: respondents' levels of knowledge of IKS indicators (n=213)



4.2.1 INDICATORS BASED ON PLANTS

The use of IKS indicators for climate forecasting tends to be area-specific. Many trees are predominantly used as IKS indicators in specific parts of the country. This may be attributed to differences in the availability of tree species across different environments. Annex 7 shows that Matobo District most frequently uses the Mopane tree (20 responses), the Black monkey-orange (12 responses) and the Marula (10 responses), among other plants. In Binga, the most commonly used tree species are the Live-long tree (19 responses) and Mahogany (4 responses). Due to greater geographic proximity, Mbire and Mudzi tended to share a significant number of tree species for forecasting. In Mbire and Mudzi, the most used trees were Baobab, Octopus cabbage tree, Mopane and Mango. It is important to note that the identified tree species may not be exhaustive.

In general, tree species are primarily used to indicate two types of rainfall seasons: either a season with good rains or a drought season. Scenarios in between the two extremes do not seem to be easily indicated. Plants are observed for four variables: (i) flowering; (ii) fruiting; (iii) leafage; and (iv) the timing of the first three variables.

Of the four variables, fruiting is the most frequently used across all study districts. Observing one or all these variables helps indigenous knowledge systems practitioners to forecast climatic conditions. When some trees have high fruitage, this indicates a normal to above-normal rainfall season. However, high levels of fruitage in some tree species indicate an impending drought. Similarly, low levels of fruitage in some fruits indicate normal to above-normal rainfall, while low fruitage would indicate a pending drought in some species of trees. Leafage is used in the same way as fruiting. For example, one study indicated that if the Umtopi tree has few leaves and few fruits between September and October, this indicates an upcoming drought. (Chisadza et al. 2013)

The timing of leafage and budding of flowers for some trees also indicates whether the rains will be early or late. For example, one respondent in Mbire indicated that:

> *"When Mopane and Guyu-uyu tree leaves develop and flowers bud early, around mid-September to early October, it tells us that the rains will fall early that year"*. **Rurai Mufarakamwe, Mbire District**
>
> *"If you see big trees, and umkhaya in particular, greening and blooming early in the year, you know that the rains will be early that season"*. **W. Sibanda, Indigenous Knowledge Systems Specialist, Matobo District**

It is important to observe that structured survey data showed that although communities may agree about which plants and trees are used for forecasting, it is common to get conflicting interpretations.

4.2.2 ANIMALS, BIRDS AND INSECTS

Communities in all four districts use various animals, insects and birds as indicators of weather and climate patterns. The appearance and behaviour of certain birds, insects and animals are used to forecast impending rainfall seasons. For example, the appearance of Abdim's Stork or the White Stork at the start of the rainy season is broadly recognized as a sign of a good rainy season in all four districts. The chirping of birds like the southern ground hornbill and the Jacobin Cuckoo is also broadly recognized as indicating impending rain (in 1-7 days). Some respondents claimed that even the way the birds chirp also indicates how much rain will fall.

Some researchers have argued that the chirping and behaviour of these animals, birds and insects is derived from what they sense in the atmosphere, as extreme weather events such as storms and thunderstorm create certain soundwaves the frequencies of which can be detected by these creatures (Archaya, 2011). It is therefore speculated that these creature act as they do in response to variations in the earth's electromagnetic field that happen before such extreme weather events. Such scholars have argued that animals and insects respond to ultrasound and micro tremors that cannot be picked up by humans which are initiated when extreme weather events are about to take place (Alvera, 2013). Annex 6 shows the main animal, bird and insect indicators used in the different districts.

4.2.3 ASTROLOGICAL AND ATMOSPHERIC WEATHER FORECASTING INDICATORS

The shape, appearance and position of astrological objects such as the sun, the stars and the moon are widely used to forecast the weather (Alvera, 2013). IKS atmospheric indicators for weather patterns also include, but are not limited to, wind conditions and direction, daily and seasonal temperature, types of clouds and humidity. Some of these indicators are also widely used in scientific forecasts. Communities that utilize IKS know that certain wind directions and speeds are associated with rains while others are associated with drought. In this regard, IKS shares some features with scientific forecasting. Two key informant noted that:

> *"...Some of what is being referred to as indigenous knowledge systems are actually concepts that can be explained using science. The use of winds and atmospheric temperatures, for example, are scientific concepts used by meteorologists. The only difference is that, in IKS, they are explained using local languages and local concepts"*. **Meteorological Services Department Official**

> *"For example, in Mudzi it was noted that between August and October the wind normally blows from east to west, but towards the beginning of the rainy season in November, the winds must blow from west to east. This pattern is generally associated with good prospects for a normal to wet rainy season. Using wind patterns and astrology have very long and strong relations with meteorological predictions"*. **Councillor and Farmer, Mudzi District**

4.2.4 SPIRITUAL INDICATORS

The use of spiritual indicators in weather and climate forecasting mostly entails receiving messages through religious leaders who could be spirit mediums, prophets or rain-makers about the seasonal climate outlook. As the findings discussed earlier on have showed, a small number of farmers depend on spirit mediums or religious leaders. Most respondents indicated that they did not trust spiritual leaders. They indicated that they no longer trusted the authenticity of spirit mediums and their messages. For example, one respondent stated that;

> *"The work of spirit mediums is no longer as common as it used to be in the 1950s and 60s. This is because even the spirit mediums have compromised their practices. They used to walk to Njelel; now they want contributions for the bus fare…".* **IKS Specialist, Matobo**

4.3. Usability of IKS and meteorological forecasts compared

Respondents were asked to express their levels of confidence with various characteristics of the different forecasting systems (Table 4). The statements were intended to measure the respondents' level of understanding of the different forecasting systems and their level of trust in the two forecasting systems. A score of '0' meant that the respondent completely disagreed with the statement, while a score of '10' meant that the respondent completely agreed with the statement. The average scores for each statement are captured in Table 4.

Table 4: Usability of MSD SCFs and IKS forecasts

Statements on Forecasting Systems		Score
Ease of Interpretation	1. The information based on indigenous knowledge that I receive about climate forecasting is easy to understand.	8.20
	2. The meteorological information that I receive about climate forecasting is easy to understand.	8.08
Trustworthiness	3. The climate forecasting information that I receive based on indigenous knowledge is trustworthy.	7.86
	4. The climate forecasting information that I receive through meteorology is trust-	8.12

The scores show that respondents generally understood both the scientific and the IKS-based forecasting methods well, and their scores were very similar when it comes to ease of interpretation. While both methods scored high with regards to trustworthiness, the scientific method of forecasting scored marginally higher (8.12) than IKS (7.86).

4.4. Comparison of the characteristics of SCFs and IKS

Table 5 shows the key differences between indigenous knowledge systems and the scientific forecasting system. Some of the key issues noted that differentiate the two systems include calibration. The scientific method is better calibrated and can estimate rainfall volumes. On the other hand, the IKS system works with broad estimates of 'drought' or 'good rains'. This has implications for anticipatory planning. The scientific method is based on probabilistic forecasts while IKS-based forecasts tend to be interpreted more definitively with authority, generally not allowing room for error. The scientific method tends to be more precise in estimating the lead time to extreme weather events compared to IKS-based forecasts.

Table 5: General comparison of MSD SCFs and IKS forecasts

Dimension of comparison	Meteorological information	Indigenous knowledge systems' information
Calibration	Calibrated	Uncalibrated and fuzzy
Probability of forecast	Probability-based	Assumed authority
Frequency of reporting	Can be granulated to as small as one-day forecasts	Not easy to determine the indicator lead time
Dissemination channels	Uses the MET Department, the AGRITEX Officers for official distribution, and the mainstream and social media	Dissemination is informal and unstructured
Methodology of forecast generation	Documented and tested scientific method	Non-documented and orally passed on from generation to generation.
Local relevance	Often uses large-scale forecasts	Uses local-level indicators that speak to spatially granular detail
Objectivity	Meteorological information is measured using objective instruments	IKS indicators are mostly visually measured using individual's interpretation
Forecasting capability	Based on known mathematical relationships and laws of physics	Based on the indicator trends of plants, animals, atmosphere and astrology observed over time.
Indicator integrity (principles)	Integrity maintained regardless of geographical area	Integrity is area-specific

4.5. Weaknesses of the IKS: The time dimension and the calibration challenge

Several weaknesses were observed when comparing the IKS to the seasonal climate forecasting produced by the MSD. The first major weakness of indigenous knowledge systems is that they are problematic in terms of the time dimension. Even though the indicators forewarn that there will be a drought or above-normal rainfall, it is often difficult to determine the exact period when these climatic events will happen. When juxtaposed with or against MSD SCFs we notice that the SCFs can give fairly precise periods in which weather events will take place. Unlike indigenous knowledge systems, SCF can give regular updates, including on a daily basis. In addition, while indigenous knowledge systems can distinguish between good and bad rainfall seasons, they are unable to differentiate, for example between normal and above-normal rainfall: this creates a planning challenge in anticipatory action.

Some researchers have also pointed out that the main challenge in IKS relates to benchmarking. It remains unclear what can be termed normal rainfall, and how many fruits or flowers or insects would precisely indicate a 'normal', 'below-normal' or 'above-normal' rainfall. IKS knowledge remains largely 'fuzzy' and open to various interpretations (Dube at al., 2016). As one key informant from an international organization argued;

> *"The biggest challenge we have is that of standardization. For example, when we say we are seeing the behaviour of quelea birds or termites, if we are calibrating, how many do we need to count to be able to say we are in the green, the orange or the red. However, as far as qualitative information is concerned there is definitely a lot of value in bringing in indigenous knowledge systems although we are not able to quantify and calibrate some of the information we gather through this kind of knowledge".* **Tsitsi, FAO**

Another challenge with indigenous knowledge systems is that the information is not well coordinated though it is easily accessible at local level. Only a few people - particularly elders – had a clear understanding of this forecasting system. However, the dissemination of the knowledge from IKS is poorly coordinated. Most people share this kind of knowledge through informal meetings, especially at beer parties. It was also evident from discussions with key informants that this knowledge largely resides with elderly members of the community and there are fears that if it is not well documented it could begin to fade away in coming generations.

RECOMMENDATION: Urgent steps should be taken to document and disseminate this kind of knowledge. This documentation and dissemination of information should be accompanied by training sessions for younger members of the community, once the efficacy of the IKS forecasting system has been established for seasonal climate forecasting.

4.6. Key strengths of indigenous knowledge systems

Several key strengths can be observed when we examine indigenous knowledge systems and their use in seasonal climate forecasting. Firstly, farmers have worked with indigenous knowledge systems for a very long time in their communities. As a result, they have developed trust in their use and the results they produce. In some studies, it has been demonstrated that farmers, in fact, trust indigenous knowledge systems more than scientific forecasts. As one key informant indicated in Matobo district:

> *"These signs are very reliable, and farmers share this information in their informal meetings so as to prepare for the farming seasons, and this also influences the types of seeds that are shared. When you see the umbumbulu tree (Mimusops zeyheri) bearing a lot of fruit, you know for certain that there will be limited rain that year, and that a lot of cattle will die from the drought. In several cases the meteorological predictions have been wrong but use of IKS has stood the test of time".* **Indigenous Knowledge Systems Specialist, Matobo District**

However, some farmers noted that it was quite possible that these methods could miss the target in terms of forecasting. They noted that the scientific method and the indigenous knowledge systems could misdirect their forecasts. They recommended combining both methods in the forecasting process, so that farmers could have greater assurance about the decisions taken because of the climatic forecasts. It was evident from the farmers' responses that they would be more confident to take decisive anticipatory action where there was agreement in the forecast results of the scientific method and the indigenous knowledge systems methodologies.

Chapter 5: Conclusion

5.1. The extent and provision of indigenous knowledge services

The study established that indigenous knowledge services are widely utilized in all communities in the study districts. It was established that at least 82 percent of the surveyed households used indigenous knowledge systems for climate forecasting. It was also established that in most cases, indigenous knowledge systems were used together with scientific forecasts. The study established that communities actively seek climate forecasting information in order to take anticipatory actions against the effects of extreme weather events at the household farm level. Indigenous knowledge systems were a key aspect of seasonal and short-term weather and climate forecasting because the users significantly trusted the method, having in most cases used it since childhood. Indigenous knowledge systems were also important because some of the remote communities, such as in Mbire and Matobo, had no alternative sources of climate forecasting as Zimbabwe radio and television stations transmission could not reach their locations. Some areas also have erratic mobile network connectivity. Most respondents also indicated that they did not trust either IKS or scientific forecasts in isolation. They preferred to combine the methods to develop a more reliable forecast.

The study observed that certain factors prevent smooth implementation of IKS in formal programming. One of the challenges is that IKS is barely documented. There is a need to promote further documentation of IKS indicators within the context of AA. A database needs to be developed of IKS indicators and trigger thresholds. Available knowledge needs to be promoted and disseminated once it has been proven to be effective.

5.2 Assessment of awareness of indigenous knowledge systems in Zimbabwe

The study observed that although indigenous knowledge systems were widely known in most communities, 'expert' knowledge of IKS resided with elderly members of the community. Due to apparent differences in knowledge levels, some districts seemed to use indigenous knowledge systems more than others. This appears to be driven by average age differences of the respondents. Matobo District had the highest average age of respondents (56 years) and the highest proportion of respondents who used IKS in climate forecasting (92 percent). Mbire had the youngest population – with an average age of 44 years – and also the lowest proportion of people who had knowledge of IKS (80 percent). We conclude that IKS knowledge and use seem to be associated with the average age of respondents.

Many key informants were concerned that without a structured documentation and dissemination process, IKS knowledge would soon be lost. The changes in social structures which previously promoted storytelling and interactions between the young and the elderly inhibit transfer of the IKS indicators and concepts from the old to the young.

RECOMMENDATION: Promote mapping, observations and sharing of various indicators in real-time, for the younger generation using georeferencing tools and image capturing tools and concepts such as citizen science and smartphones, which can.

5.3 Guidance on how to integrate and use IKS in AA projects.

In conclusion, the AA project needs to incorporate indigenous knowledge systems into its processes. Where indigenous knowledge systems and scientific forecasts tend to be in conflict some farmers preferred to trust indigenous knowledge systems forecasts rather than scientific forecasts. Therefore, incorporation of indigenous knowledge systems into the AA project would lead to greater buy-in from farmers.

The question is not whether IKS needs to be integrated, but rather: 'How do we incorporate IKS into mainstream decision-making in the AA project?'.

It is proposed that the AA project should further develop the current informal and unstructured technique being used by farmers who are using a hybrid forecast drawing from both scientific forecasts and IKS based forecasts. Ward-based structures need to be set-up to conduct a participatory process of seasonal climate forecasting at the community level. More detail on this is included in the recommendations section.

FAO is in the early stages of actually using both scientific forecasts and indigenous knowledge to generate what they call a hybrid forecast. This approach is in its early stages and the system has not been clearly developed. The success rate of hybrid forecasts has not yet been established.

This points to the need for longitudinal studies to establish the success rate of such forecasts. Using a hybrid forecast entails analysing the two forecasts separately, and then establishing an average point of convergence between the two. Past forecast performance assessment of the indicators and forecasts could be key, and a precursor to any possible integration.

It must be ensured that the forecasts maintain a level of caution, to avoid making farmers more vulnerable as a result of failed forecasts. Assuming, for example, that the probabilistic forecast and the participatory IKS system suggest a 60 percent likelihood that the rainfall season will be a normal one, planting could be distributed in such a way that 60 percent of seed is planted with the assumption of targeting a normal rainfall season. The risk could then be spread in such a way that 20 percent of the seed planted will assume a below-normal rainfall season, while 20 percent of the seed would be planted assuming an above-normal rainfall season. This spreads the risk such that the farmer can harvest something despite the nature of rainfall received.

Chapter 6: Recommendations

1.- Consider formally adopting indigenous knowledge services in weather and seasonal climate forecasting.

2.- Develop a policy framework to guide the use of indigenous knowledge services.

3.- Develop manuals and standard operating procedures for use of indigenous knowledge services in financing and similar projects.

4.- Develop an expanded and evolving national electronic database of the indigenous knowledge systems indicators used in weather and climate forecasting, building on available open-source data collection platforms like Open Data Kit (ODK) and Kobo toolbox.

5.- Institute a longitudinal study (for example, over five years) to track the results of the IKS and the SCFs in weather and climate forecasting. Current cross-sectional studies do not shed adequate light on the comparative effectiveness of each method.

6.- Develop a scientific method based on GIS and remote sensing to calibrate IKS indicators and the results. Notions such as plant leaf density and greening, and the presence of certain birds can be tracked using GIS and remote sensing once sites have been mapped.

7.- Demonstrate return on investment by tracking the hits and misses of indigenous knowledge systems forecasting outcomes over a period of time, such as three to five years.

8.- Establish annual platforms at district and ward levels to: (1) discuss IKS forecasts, (2) receive and assess MSD seasonal climate forecasts, (3) Develop a consensus participatory hybrid forecast from the two forecasts. The platform can consist of local leaders, AGRTIEX Officers, MSD officers, farmers, the media and academics. This platform will also determine and agree on the relevant anticipatory actions.

9.- Agree timelines for the interpretation of IKS indicators. The period between July and August is proposed as some early IKS indicators are believed to start showing at this time. It is also proposed that IKS presentations should be scheduled at the NARCOF and SARCOF sessions. The bulk of IKS indicators are clearer by end of September when most trees would have flowered. A revised IKS forecast could be done at this point.

10.- Conduct participatory training events with communities and DRR committee members. These meetings should train and sensitize members of the community about using IKS.

11.- Use scientific SCFs and IKS with a view to minimizing the risk of missed hits. For example, if the probabilistic forecast and the participatory IKS system give the impression that there is a 60 percent likelihood that the rainfall season will be a normal one, planting could be distributed in a way that 60 percent of the seed is planted with the assumption of targeting a normal rainfall season. The risk could then be spread in such a way that 20 percent of the seed planted will assume a below-normal rainfall season, while 20 percent would be planted assuming an above normal rainfall-season. This spreads the risk so that the farmer can harvest something irrespective of the volume of rain falling.

References

Alvera P., (2013). The Role of Indigenous Knowledge Systems in Coping With Food Security And Climate Challenges In Mbire District, Zimbabwe. MSc Dissertation. University of Zimbabwe. https://ir.uz.ac.zw/handle/10646/1385

Acharya, S. (2011). Presage Biology: Lessons from nature in weather forecasting." Indian Journal of Traditional Knowledge 10(1): 114-124

Berkes F et al. 2000. Rediscovery of traditional ecological knowledge as adaptive Management. Ecological Applications, 10:1251-1262.

Blench, R. (1999). Seasonal climatic forecasting: who can use it and how should it be disseminated. Natural resource perspectives, 47(001).

Bengtsson T. P. (2018) Forecast-based Financing: Developing triggers for drought. Division of Risk Management and Societal Safety, Lund University

Chanza N, (2014). Indigenous Knowledge and Climate Change: Insights from Muzarabani, Zimbabwe. Doctor of Philosophy Thesis, Nelson Mandela Metropolitan University

Chisadza B, Mushunje A, Nhundu K, Phiri EE. (2018) Opportunities and challenges for seasonal climate forecasts to more effectively assist smallholder farming decisions. S AfrJ Sci. 2020;116(1/2). https://doi.org/10.17159/sajs.2020/4649

Chisadza, B., Tumbare, M. J., Nhapi, I., & Nyabeze, W. R. (2013). Useful traditional knowledge indicators for drought forecasting in the Mzingwane Catchment area of Zimbabwe. Disaster Prevention and Management.

City Population (date unknown). Available at http://www.citypopulation.de

Coughlan de Perez E. C, Hurk B.   Aalst, Jongman B., Klose T. & Suarez P. (2015) Forecast-based financing: an approach for catalyzing humanitarian action based on extreme weather and climate forecasts Nat. Hazards Earth Syst. Sci., 15, 895–904,

Costella C., Jaime C., Arrighi J., Coughlan de Perez E., Suarez P. and Maarten van Aalst (2018) Resilience solutions: exploring social protection linkages to forecast-based financing, UKAID

Disaster Risk Finance Community of Practice, (2020) Crisis and Disaster Risk Finance Short Notes on Covid 19, World Bank Available at financialprotectionforum.org/blogs

Dube, T., Moyo, P., Ndlovu, S., & Phiri, K. (2016). Towards a framework for the integration of traditional ecological knowledge and meteorological science in seasonal climate forecasting: The case of smallholder farmers in Zimbabwe. Journal of Human Ecology, 54(1), 49-58.

Grey, M. S., & Manyani, A. (2020). Integrating local indigenous knowledge to enhance risk reduction and adaptation strategies to drought and climate variability: The plight of smallholder farmers in Chirumhanzu district, Zimbabwe. Jàmbá: Journal of Disaster Risk Studies, 12(1).

Jain, P. (2014). Indigenous Knowledge Management in Botswana Using ICT Applications. Concepts and Advances in Information Knowledge Management Studies from Developing and Emerging Economies (pp.167-191). http://dx.doi.org/10.1533/9781780634357.2.167

Heinrich D, Bailey M. (2020) Forecast-Based Financing and Early Action for Drought, Guidance Notes for the Red Cross Red Crescent, British Red Cross

Jiri, O., Mafongoya, P. L., Mubaya, C., and Mafongoya, O. (2016). Seasonal climate prediction and adaptation using indigenous knowledge systems in agriculture systems in Southern Africa: A review. Journal of Agricultural Science, 8(5),156-172.

Jokinen T. (2019) Forecast-based Financing: Transformation or a faster way to transfer funds? Master's thesis, University of Helsinki

Kupika, O. L., Gandiwa, E., Nhamo, G., & Kativu, S. (2019). Local ecological knowledge on climate change and ecosystem-based adaptation strategies promote resilience in the Middle Zambezi Biosphere Reserve, Zimbabwe. Scientifica, 2019.

Luseno WK, McPeak JG, Barret C, Little PD, Gebru G (2003) Assessing the value of climate forecast information for pastoralists: evidence from southern Ethiopia and northern Kenya World Development 31(9): 1477-1494.

Mapara J (2009) Indigenous Knowledge Systems in Zimbabwe: Juxtaposing Postcolonial Theory in The Journal of Pan African Studies 3(1): 139-155.

Masekoameng & Molotjato, (2019) The role of indigenous foods and indigenous knowledge systems for rural households' food security in Sekhukhune district, Limpopo province, South Africa. Journal of Consumer Sciences, Special Edition Food and Nutrition Challenges in Southern Africa, Vol 4.

Moyo E. N. (2020) Analysis of climate dynamics, climate model selection and impacts on maize production for the Gutu, Chirumhanzu and Zvishavane districts in Zimbabwe. CUT Library, Chinhoyi.

Msimanga, A. (2000). The role of birds in the culture of the Ndebele people of Zimbabwe. Ostrich, 71(1-2), 22-24.

Mugambiwa, S. S. 2017. Knowledge of climate change and the use of indigenous knowledge systems to adapt to climate hazards in Mutoko rural district of Mashonaland East province Zimbabwe. Masters dissertation. University of Limpopo.

Mubaya, C. P., Mafongoya, P. L., Jiri, O., Mafongoya, O., & Gwenzi, J. (2017). Seasonal climate prediction in Zimbabwe using indigenous knowledge systems. in Mafongoya, P.L. and Ajayi, O.C. (editors), Indigenous Knowledge Systems and Climate Change Management in Africa, CTA, Wageningen, The Netherlands

Mugambiwa, S. S. (2018). Adaptation measures to sustain indigenous practices and the use of indigenous knowledge systems to adapt to climate change in Mutoko rural district of Zimbabwe. Jàmbá: Journal of Disaster Risk Studies, 10(1), 1-9.

Munsaka, E., & Dube, E. (2018). The contribution of indigenous knowledge to disaster risk reduction activities in Zimbabwe: A big call to practitioners. Jàmbá: Journal of Disaster Risk Studies, 10(1), 1-8.

Orlove, B., Roncoli, C., Kabugo, M. and Majugu, A. (2010), "Indigenous climate knowledge in southern Uganda: the multiple components of a dynamic regional system", Climatic Change, Vol. 100 No. 2, pp. 243-265.

Poudel S. P (2020). A System Dynamics Approach on Forecast-based Financing for Flood Response in Nepal, Available at: https://ssrn.com/abstract=3506502

SADC Climate Services Centre (2021). Impact of warming ocean on our weather and climate. Available at http://csc.sadc.int/images/documents/ANNOUNCEMENT_SARCOF_25.pdf

Sillitoe P, editor. Local science vs global science: Approaches to indigenous knowledge in international development. New York: Berghahn Books; 2007. p. 280–284.

Tanyanyiwa, V. I. (2018). Weather forecasting using local traditional knowledge (LTK) in the midst of climate change in Domboshawa, Zimbabwe. In Handbook of Climate Change Communication: Vol. 2 (pp. 1-20). Springer, Cham.

World Food Programme (2019a). Forecast-Based Financing (FbF): Anticipatory actions for food security, WFP, Rome

World Food Programme (2019b). Climate Risk Financing: Early Response and Anticipatory Actions for Climate Hazards. WFP Rome

World Meteorological Organization (2013). What Do We Mean by Climate Services?, Available at https://public.wmo.int/en/bulletin/what-do-we-mean-climate-services

Zimbabwe National Statistics Agency (2012) Zimbabwe National Census. Available at https://www.zimstat.co.zw/wp-content/uploads/publications/Population/population/census-2012-national-report.pdf

Acronyms

AA	Anticipatory Action
AGRITEX	Department of Agricultural, Technical and Extension
COVID-19	Novel coronavirus disease
CPU	Civil Protection Unit
DRR	Disaster Risk Reduction
FAO	Food and Agriculture Organization
FbF	Forecast-based Financing
GIS	Geographic Information System
IKS	Indigenous Knowledge Systems
IPCC	International Panel on Climate Change
MECTHI	Ministry of Environment, Climate, Tourism and Hospitality Industry
MSD	Meteorological Services Department
NACOF	National Climate Outlook Forum
ODK	Open Data Kit
SADC	Southern African Development Cooperation
SARCOF	Southern African Regional Climate Outlook Forum
SCF	Scientific Climate Forecast
US$	United States dollar
WFP	World Food Programme

List of tables

Annexes

Annex 1	Structured household questionnaire
Annex 2	In-depth interview guide for indigenous knowledge specialists
Annex 3	In-depth interview guide for technical respondents (MSD, AGRITEX and development partners)
Annex 4	Focus group discussion guide (not used due to COVID-19 restrictions)
Annex 5	List of interviewees
Annex 6	Animal, bird and insect indicators
Annex 7	Flora and fauna indicators
Annex 8	Atmospheric indicators
Annex 9	Astrological indicators
Annex 10	Common tree indicators

Annex 1: Structured household questionnaire

Introduction of the Interviewer and the purpose of the interview

Good morning/afternoon. My name is ………………………………….. We are carrying out a study for the World Food Programme on the use of indigenous knowledge systems for weather and climate forecasting. The study seeks to understand how communities in different parts of Zimbabwe use indigenous knowledge systems for weather and climate forecasting. This study will assist the World Food Programme to better structure programs to assist communities to address climate related risks in the future. Please note that this is not a registration for assistance. Your household has been selected through a random sampling process from households in the ward for this interview. Your identity will be kept confidential. Please note that we are not going to record your name or your household in this interview. The interview will take at the most, 45 minutes. You are free to withdraw from this interview during the course if you feel uncomfortable about issues raised in it.

SECTION A: DEMOGRAPHIC DATA

District Name: Matobo Mbire Mudzi Binga

Ward Name____

Village Name____

Sex of Respondent (Circle): Male Female

Age of Respondent: ________years

Number of years the respondent has stayed in this village.

_________years

Educational level of respondent (Tick Applicable)

No formal education

Primary School

ZJC

O Level

College and Vocational Training

University

Are you the head of the household? (Select applicable)

Yes No

Are you the one responsible for making farming decisions (e.g. what gets planted, where and when?) Tick applicable answer.

Yes b. No c. Partly

What is the total number of people in this household? Please state_______________

Please state your average household income in USD per month.

$0-49

$50-99

$100-199

$200-299

$300+

Age of Household Head_______________

SECTION B: CLIMATE HAZARDS AND RISKS

What are the most common types of climate risks in this area? (Tick all applicable)

Droughts
Floods
Heat waves
Cyclones
Frost
Other (State)________________

In which months are the impacts of adverse weather events experienced the most? (Tick all applicable)

Droughts

January February March April May June July August September October November December

Floods

January February March April May June July August September October November December

Would you say that you have adequate climate forecasting information to mitigate against the risk of such climate hazards?

Yes No

SOURCES OF CLIMATE FORECASTING INFORMATION

What is your most important source for climate forecasting information?

Traditional leaders
Self
Radio
Television
Newspaper
Friends/ Other farmers
Spiritual/ Religious Leaders
Other (State)________________________________

In this household do you use indigenous knowledge systems for climate forecasting?

Yes No Sometimes

On a scale of 0 to 10, indicate how strongly you agree with the following statements. 0 means strongly disagree, 10 means strongly agree.

The indigenous knowledge systems climate forecasting information is easy to access? Score out of 10_________

The meteorological information on climate forecasting is easy to access? Score out of 10_________

The indigenous knowledge based information that I receive about climate forecasting is easy to understand? Score out of 10_________

The meteorological information that I receive about climate forecasting is easy to understand? Score out of 10_________

The information I receive on seasonal climate forecasting from indigenous knowledge systems comes in good time to make useful decisions. Score out of 10_________

The information I receive on seasonal climate forecasting from meteorological services comes in good time to make useful decisions. Score out of 10_________

The climate forecasting information that I receive through indigenous knowledge based climate change forecasting is trustworthy. Score out of 10________

The climate forecasting information that I receive through meteorology is trustworthy. Score out of 10_________

By ticking one box in each row please indicate how much you would trust information about climate change if you heard from it from the following list:

	A lot	A little	Not very Much	Not at all	Can't Choose
34a. Radio					
34b. Television					
34c. Newspaper					
34d. Government Agencies					
34e. Family or friends					
34f. Internet					
34g. NGOs					
34h. Traditional leaders e.g. chiefs					
34i. Religious leaders					

Which knowledge system(s) do you predominantly use for climate forecasting? (Tick appropriate answer)

- Meteorological knowledge systems
- Indigenous knowledge systems
- A combination of both (equally)
- Not applicable (respondent does not seek climate forecasting information)

How important are indigenous knowledge systems in climate forecasting to you?

- Very important
- Important
- Neither important nor unimportant
- Not Important
- Not important at all

How would you rate your knowledge of indigenous knowledge systems in climate forecasting?

- Very good
- Good
- Neither good nor poor
- Poor
- Very Poor

How reliable do you consider traditional ecological knowledge to be in climate forecasting in your household? (Tick appropriate answer)

- Very reliable
- Reliable
- Difficult to tell
- Unreliable
- Very Unreliable

Looking at the indigenous knowledge systems indicators on climate forecasting, what can you tell about the coming agricultural season?

Above normal rainfall; b) Normal Rainfall c) Below normal rainfall d) Drought season

END OF QUESTIONNAIRE

Annex 2: In-depth interview guide for indigenous knowledge specialists

IN-DEPTH INTERVIEW GUIDE FOR INDIGENOUS KNOWLEDGE SYSTEMS SPECIALISTS IN SEASONAL WEATHER FORECASTING

Introduction of the Interviewer and the purpose of the interview

Good morning/afternoon. My name is ………………………………….. We are carrying out a study for the World Food Programme on the use of indigenous knowledge systems for weather and climate forecasting. The study seeks to understand how communities in different parts of Zimbabwe use indigenous knowledge systems for weather and climate forecasting. This study will assist the World Food Programme to better structure programs to assist communities to address climate related shocks in the future. Please note that this is not a registration for assistance. Your identity will be kept confidential. Please note that we are not going to record your name in this discussion. The discussion will take between 45 minutes and one hour. You are free to withdraw from this discussion if you feel uncomfortable about issues raised in it at any point.

District Name: Matobo Mbire Mudzi Binga

Ward Name____

Village Name____

Sex of Respondent (Circle): Male Female

Age of Respondent: ________years

Number of years the respondent has stayed in this village.

_________years

Educational level of respondent (Tick Applicable)

No formal education

Primary School

ZJC

O Level

College and Vocational Training

University

1. Please explain in detail how indigenous knowledge systems of forecasting seasonal weather work. (focus on the signs for particular weather patterns and their interpretation).

i.Trees: Probe on the trees commonly used in this area. Detail each tree and how it is used. Capture photographs if available

What is the lead time between warning sign and weather event?

How dependable/ trustworthy is this sign?

i.Domestic Animals: Probe on domestic animals and their behaviour. Detail each animal and how it is observed. Capture photographs if available.

What is the lead time between warning sign and weather event?

How dependable/ trustworthy is this sign?

iii.Wind: Probe on the wind and its behaviour. Detail each wind type and how it is observed.

What is the lead time between warning sign and weather event?

How dependable/ trustworthy is this sign?

iv.Astrological Constellations: What elements in the sky are used to tell about future weather?

What is the lead time between warning sign and weather event?

How dependable/ trustworthy is this sign?

v.Spiritual Forecasting: Who is responsible for spiritual forecasting of climatic seasons?

What is the lead time between warning sign and weather event?

How dependable/ trustworthy is this sign?

2. Generally, what type of people hold this kind of knowledge in terms of gender, age and cultural background?
3. How widely used are indigenous knowledge systems in forecasting seasonal weather amongst local communities in this district?
4. Can indigenous knowledge systems used in this District be used by any other District in Zimbabwe?
5. How accurate and trustworthy do you consider this method to be in forecasting seasonal weather?
6. Comparing IKS and meteorological predictions, which one would you prefer to use. Explain your answer.
7. How do you use indigenous information systems on climate forecasting to solve climate related hazards problems in your area?

END OF INTERVIEW. THANK YOU FOR YOUR TIME

Annex 3: In-depth interview guide for technical respondents (MSD, AGRITEX and development partners)

IN-DEPTH INTERVIEW GUIDE: METOROLOGOCAL SERVICES DEPARTMENT PERSONNEL AND AGRICULTURAL EXTENSION SERVICES DEPARTMENT PERSONNEL

Introduction of the Interviewer and the purpose of the interview

Good morning/afternoon. My name is ………………………………….. I am carrying out a study for the World Food Programme on the use of indigenous knowledge systems for weather and climate forecasting. The study seeks to understand how communities in different parts of Zimbabwe use indigenous knowledge systems for weather and climate forecasting. This study will assist the World Food Programme to better structure programs to assist communities to address climate related shocks in the future. Please note that we are not going to record your name in this discussion. The discussion will take between 45 minutes and one hour. You are free to withdraw from this discussion if you feel uncomfortable about issues raised in it at any point.

1. Name of Respondent____

2. Name Of Organisation/Department__________________________________

3. District Name____

4. Sex of Respondent (Circle): Male Female

5. Age of Respondent: ________years

6. Explain the role of your Organisation/Department in Zimbabwe focussing on the type of information that you disseminate to communities (especially climate change and weather forecasting related).

7. How has been the uptake of climate forecasting information by communities in Zimbabwe?

8. Do farmers utilise the information they receive about climate change and weather forecasting from your organisation?

9. What challenges and opportunities exist relating to the farmers' utilising climate change forecasting information they receive from your Department/Organisation?

10. What do you think needs to be improved in your organisation in order to promote the dissemination of, access and use of climate forecasting information amongst communities in Zimbabwe?

11. What are your Department's views about indigenous knowledge systems climate forecasting in the context of climate change? (focus on trustworthiness, accuracy, replicability and compatibility with meteorological systems?

11. What is the possibility of using indigenous knowledge systems for formal planning in programs such as finance based forecasting?

END OF INTERVIEW…….THANK YOU!

Annex 4: Focus group discussion guide (not used due to COVID-19 restrictions)

Focus Group Discussion Guide

Introduction of the Interviewer and the purpose of the interview

Good morning/afternoon. My name is ………………………………….. We are carrying out a study for the World Food Programme on the use of indigenous knowledge systems for weather and climate forecasting. The study seeks to understand how communities in different parts of Zimbabwe use indigenous knowledge systems for weather and climate forecasting. This study will assist the World Food Programme to better structure programs to assist communities to address climate related risks in the future. Please note that this is not a registration for assistance. Your identity will be kept confidential. Please note that we are not going to record your name in this discussion. The discussion will take between 45 minutes and one hour. You are free to withdraw from this discussion if you feel uncomfortable about issues raised in it at any point. You are also free not to answer any question you feel uncomfortable to answer. Do you give consent to proceed with the interview? Yes or No

SOURCES OF CLIMATE FORECASTING INFORMATION

1. What types of weather and climate risks and hazards are dominant in your area?
2. What are the main impacts of the hazards that you mentioned above?
3. What can development and humanitarian organisations do to help you prevent the negative impacts of these climate hazards?
4. In which months are the impacts of adverse weather events experienced the most?
5. Do you understand what future climate seasons are likely to be, in terms of their rainfall and temperature and their effects on farming and livelihoods? What do you perceive?
6. There are two common ways of knowing about forthcoming weather and climate i.e. meteorological based systems of forecast and indigenous knowledge based systems of forecast. Which one do people in this area generally use and why?
7. Ask participants to explain how they use indigenous knowledge for weather and climate forecasting.
   i. Trees: Probe on the trees commonly used in this area. Detail each tree and how it is used. Capture photographs if available
      What is the lead time between warning sign and weather event?
      How dependable/ trustworthy is this sign?
   ii. Animals and insects: Probe on animals and their behaviour. Detail each animal and how it is observed. Capture photographs if available.
      What is the lead time between warning sign and weather event?
      How dependable/ trustworthy is this sign?
   iii. Wind: Probe on the wind and its behaviour. Detail each wind type and how it is observed.
      What is the lead time between warning sign and weather event?
      How dependable/ trustworthy is this sign?
   iv. Astrological Constellations: What elements in the sky are used to tell about future weather?
      What is the lead time between warning sign and weather event?
      How dependable/ trustworthy is this sign?
   v. Spiritual Forecasting: Who is responsible for spiritual forecasting of climatic seasons?
      What is the lead time between warning sign and weather event?
      How dependable/ trustworthy is this sign?
8. Compare the two: indigenous knowledge systems and meteorological forecasting on the following issues?
   Trustworthiness – Which one is trusted more and why?
   Accessibility – Which type of forecasting is more accessible and why?
   Timeliness – Which one is more timely for decision making?
   Ease of interpretation – Which is more easy to interpret?
   General usability for decision making – Which one gives more easy to use information and why?

WEATHER AND CLIMATE FORECASTING INFORMATION FOR RESILIENT LIVELIHOODS

9. If you receive information that there will be drought, how do you plan for your livelihoods and safety?

10. If the information says there will be good rains, how do you plan?

11. If the information says there will be floods, how do you plan?

12. Looking at the indigenous knowledge systems indicators on climate forecasting, what can you tell about the coming agricultural season?

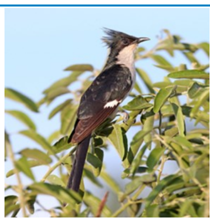
IMPROVING IKS FOR FINANCE BASED FORECASTING

13. How can indigenous knowledge systems be used to help organisations like WFP who want to assist communities to be resilient against climate shocks?

Annex 5: List of interviewees

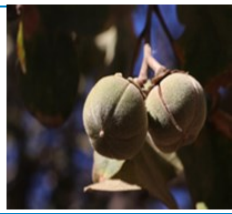
Name	District	Position and organization
Brian Ndlovu	Bulawayo	WFP Programme Associate (Vulnerability Analysis and Mapping) & AA Focal Person (Bulawayo Field Office)
Tsitsi Magadza	Harare	FAO Anticipatory Action Coordinator & Co-Chair: Community of Practice
Yeukai Chikukwa	Mbire	WFP Field Monitoring Assistant, Harare Field Office & Harare Focal Person for AA Project (Mbire)
Rudo Mushonga	Mudzi	WFP, Field Monitoring Assistant, Harare Field Office (Mudzi)
Benjamin Kwenda	Harare	Agriculture Meteorologist & Lead Scientist (Seasonal Forecasts); Meteorological Services Department
Velaphi Moyo	Matobo	WFP Field Monitoring Assistant
Musu Cumanzala	Matobo	Caritas Meal Officer
Sikhanyisiwe Dube	Binga	WFP Field Monitoring Assistant
Mboweni Godrey	Mudzi	AGRITEX/District Crops Specialist/Agronomist
Mukande Fidelis	Mudzi	RDC (Councillor) & Farmer
Mutero Chipo	Mudzi	RDC (Councillor) & Farmer
W. Sibanda	Matobo	Former Educationist and Famer/ IKS Specialist
Peter Dube	Matobo	Farmers and IKS Specialist
Morgan Moyo	Matobo	Village Head
Nkanyiso Dube	Matobo	Farmer
Ntando Dube	Matobo	Farmer and IKS Specialist
Nkosana	Matobo	Caritas, Programs Officer
William Mafarachisi	Mudzi	World Vision, Food Aid Division
Shamu Mafuta	Mbire	Environmental Monitor and Farmer
Chisaka Changarama	Mbire	AGRITEX
Rurai Mufarakamwe	Mbire	Headman and IKS Specialist
Katsito Batanai	Mbire	Headman and IKS Specialist
Matefura Materura	Mbire	Farmer and Indigenous Knowledge Systems specialist
Phillip Nyarugwe	Mbire	Farmer and Indigenous Knowledge Systems specialist
Sophia Mwiinde	Binga	Farmer and Indigenous Knowledge Systems specialist
Laika Munkuli	Binga	Farmer and Indigenous Knowledge Systems specialist
John Thomas Matemba	Binga	Farmer and Indigenous Knowledge Systems specialist
Salvina Sambo Mbano	Binga	Farmer and Indigenous Knowledge Systems specialist
Land Kalima Muleya	Binga	Farmer and Indigenous Knowledge Systems specialist
Zodwa Mutale	Binga	AGRITEX Officer

Annex 6: Animal, bird and Insect Indicators

Local name	English name	Scientific name / Botanical name	Picture of Indicator
Ndebele: Intaka Shona: Todzvo/ Nzvonya bird	Weaver birds	Ploceus intermedius Source: https://cdn.britannica.com/67/8767-050-2C8414B6/Village-weaver.jpg	
Ndebele: Inga-buzane Shona: Shu-ramurove Tonga: Ikhubi	Abdim's stork (Black and white migratory storks)	Ciconia abdimii Source: www.biodiversityexplorer.info/birds/ciconiidae/ciconia_abdimii.htm	
Ndebele: Insingizi/ Amawundundu Shona: Dendera bird Tonga: Moomba	Southern ground hornbill	Bucorvus leadbeateri Source: https://indabukoyakho.com/2019/10/22/insingizi-ingududu/	
Ndebele: Ilanda Shona: Kafudza-mombe Tonga: Inganga yaba yuni	Tick birds (White stork birds)	Bubulcus ibis Source: www.biodiversityexplorer.info/birds/ardeidae/bubulcus_ibis.htm	
Ndebele: Inkanku Shona: Haya Tonga: Njule	The Jacobin Cuckoo	Clamator jacobinus Source: www.sundaynews.co.zw/the-jacobin-cuckoo-clamator-jacobinus/	
Ndebele: Inkon-jane Shona: Nyenganyenga	Blue swallows	Hirundo rustica	
Ndebele: Amacim-bi Shona: Madora	Mopane worms	Gonimbrasia belina Source: https://www.sundaynews.co.zw/amacimbi-rush-deforestation-sex-camps-and-snake-bites	
Shona: Hurudzi (aka. Chipembenene) Ndebele: Inyeza	Crickets	Scientific name not found	

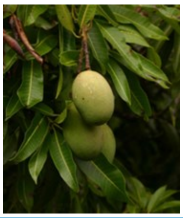
	Indicator Interpretation	Length of forecast	District
	When they build nests facing west from October, this indicates that there will be heavy rains in that season When they build their nests low on riverbed trees, this indicates a drought season	1-3 months	Mudzi
	When the birds are seen in numbers, circling while flying in high altitudes they indicate that heavy rains will fall.	1-3 months	Mbire Mudzi, Matobo Binga
	They make their baritone sounds which indicates rains are imminent	1 to 3 days	Matobo, Mudzi Binga
	The coming of these birds into an area indicates a good rainy season. High influx means normal to above rainfall.	1-3 months	Matobo Binga
	Continuous chirping indicates that the rains will fall within days or within a week		Mbire, Matobo
	Movement within the area. The cloud of rain follows closely behind the birds, so rains fall within a matter of hours	Short term (A few hours)	Matobo
	An abundance of caterpillars is indicative of a good rainy season	1-3 months	Matobo
	High influx of Hurudzi means normal to above rainfall.	1-2 weeks	Mbire Mudzi

Annex 7: Flora and fauna indicators (1)

Local name	English name	Scientific name / Botanical name	Picture of Indicator	
Shona: Chizhenje; Mumbumbu; Mugan'acha' Ndebele: Isigan-gatsha Tonga: Mubumbu	Live-long, tree grape	Lannea discolor		
Shona: Muuyu Ndebele: Umkho-mo Tonga: Mubuyu	Baobab	Adansonia digitata		
Shona: Mutohwe Ndebele: Ux-akuxaku Tonga: Munego	Snot Apple	Azanza garckeana		
Shona: Muchenje	Large-leaved jackal-berry	Diospyros kirkii		
Shona: Mushenje Ndebele: Umdlawuzo Tonga:	Octopus cabbage tree	Diospyms mespiliformis		
Shona: Muhwakwa Ndebele: Umwa-wa/ umkwakwa Tonga: Muteme	Black monkey-orange	Strychnos madagascas-rensis		
Shona: Mudowe, Mugaragora, Mupama Ndebele: Umtopi Tonga:	Shepherd's tree	Boscia albitrunca		

	Indicator Interpretation	Flowering time	Count on survey responses	Percent of respondents in agreement
	High rates of fruitage indicate above-normal rains in the forecasted season	September to October	29	100%
	High rates of fruitage indicate drought	October to December	11	82%
	High rates of fruitage indicate above-normal rainfall, low fruitage indicates a drought	December to May	9	67%
	High fruitage indicates above-normal rainfall	September to November	4	50%
	High fruitage and leafage indicates above-normal rains		11	91%
	High fruitage indicates drought	August to January	14	86%
	High fruitage indicates drought	August to October	3	67%

Annex 7: Flora and fauna indicators (2)

Local name	English name	Scientific name / Botanical name	Picture of Indicator	
Shona: Hakwa (aka.: mutamba, mu-zhumwi, man'ono) Ndebele: Umhlali Tonga: Mukula	Spiny monkey-orange	Strychnos species		
Shona: Mufuna/ Mupfura/ Musho-mo) Ndebele: Umganu, Tonga: Mungoogo	Marula	Sclerocarya birrea		
Ndebele: Umkhaya Shona: Muchinanga	Monkey thorn	Acacia galpinii		
Mopani (Shona) Mupane / Musharu Ndebele: Iphane Tonga: mwaani	Mopane	Colophospermum mopane		
Shona: Mango Ndebele: Imengo Tonga: Mango	Mango	Mangifera indica		
Shona: Mupandapanda (Mbire) Ndebele: Ichithamuzi Tonga: Mupatipatu	Apple-leaf	Philenoptera violacea		
Tonga: Muzwamalowa Shona: Mubvama-kovo Mubvama-ropa Ndebele: Umvagazi	English: Bloodwood	Pterocarpus angolensis		

	Indicator Interpretation	Flowering time	Count on survey responses	Percent of respondents in agreement
	High fruitage indicates drought	October to January	7	100%
	High fruitage indicates above normal rainfall	September to November	12	75%
	High fruitage indicates above normal rainfall	September to October	6	100%
	High fruitage and greening indicates above normal rainfall	October to March	25	72%
	High fruitage and greening indicate above-normal rainfall	July to October	10	90%
	If the tree oozes water from the branches like rain, this indicates normal to above-normal rainfall.	September to November	Indicator obtained via KII – Responses not quantified	N/A
	This tree has red leaves. The level of redness of the tree leaves indicates the amount of rain in the season. More redness indicates more rain.	August - December	Indicator obtained via KII – Responses not quantified	N/A

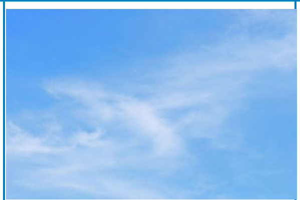
Annex 7: Flora and fauna indicators (3)

Local name	English name	Scientific name / Botanical name	Picture of Indicator	
Tonga: Mukamba Shona: Mukamba, Mungwingwi Ndebele: Umkamba	Mahogany	Afzelia quanzensis		
Busika (Tonga) Musika (Shona) Tamarind (English)	Tamarind	Tamarindus indica		

Credit for botanical names and photos: www.zimbabweflora.co.zw

	Indicator Interpretation	Flowering time	Count on survey responses	Percent of respondents in agreement
	High fruitage indicates above-normal rainfall	July - November	Indicator obtained via KII – Responses not quantified	N/A
	High fruitage indicates above-normal rainfall	November - March	Indicator obtained via KII – Responses not quantified	N/A

Annex 8: Atmospheric indicators

Indicator	Picture of indicator	Description	District	Indicator interpretation	Lead time
Appearance of certain clouds		Rain bearing clouds Source: http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/cld/cldtyp/home.rxml	Mbire	Dense dark clouds with streaks of lightning indicate imminent rains	Hours or less
Temperature		A very cold winter and a hot summer season Source: https://www.vectorstock.com/royalty-free-vector/weather-thermometer-vector-1828294	Matobo	It shows that there is going to be a lot of rain	3-4 months
Whirlwind		Whirlwinds starting in September Source: https://www.newscientist.com/article/mg21729075-400-reap-the-whirlwind-for-cheap-renewable-power/	Matobo	There will be a lot of rain	1-2 months
Wind		Wind direction in different Districts can mean good rains or drought Source: http://www.weather.gov.dm/resources/weather-elements-and-instruments-used-for-measurement	Mudzi	West to East winds in November indicate a good rainy season	7-14 months
Fog		If mountains and hills are covered with fog in the morning Source: https://www.goodfon.com/download/mountain-fog-clouds-stone/1440x900/	Matobo	It shows that there is going to be a lot of rain.	1-3 months
Sky Colour		The appearance of the sky Source: https://elated.co.za/pale-blue-sky-cirrus-clouds-8098499_l-123rf-mark-herreid-x1366/#prettyPhoto[gallery]/0/	Matobo	Around September, if the sky is pale blue, it indicates good rains. Clear blue skies indi-	1-3 months
Mirage (Umfasimbi)		Mirage (Refraction of light) Source: https://fordhaminstitute.org/national/commentary/what-mirage-gets-wrong-teacher-development	Matobo	These appear between September and October. It show that there is a lot of rainfall in that season (above average)	2 – 4 weeks

Indicator	Picture of indicator	Description	District	Indicator interpretation	Lead time
Halo around the sun		Halo around the sun Source: www.local10.com/news/local/2020/05/03/have-you-seen-the-halo-around-the-sun/	Matobo	A circle around the sun indicates impending rains. The bigger the circle the heavier the rains.	1-5 days
The halo around the Moon		Halo around the moon Source: www.astropix.com/html/planetary/lunar_halo.html	All Districts	A circle around the moon indicates impending rains. The bigger the circle the heavier the rains.	1-5 days 1-3 months
Early rains		Early rains before the main rainy season Source: www.chronicle.co.zw/good-rains-continue-to-fall-crops-in-condition/	Matobo	The rains usually fall between 30 September and 5 October. The heaviness of these rains determines the amount of rain in that season.	1 month

Annex 9: Astrological indicators

Indicator	Picture of indicator	Description	District	Indicator interpretation	Lead time
Stars and the moon		Stars. The appearance and disappearance of certain stars indicates good rains or drought. There are few remaining people who understand this indicator. Source: www.dreamglossary.com/m/morning-star/	Binga, Matobo, Mudzi and Mbire Binga	If the moon appears tilted to the side, it is an indication of drought. If the moon has a 'u' shape facing upwards, it indicates normal to above normal rainfall. If the Morning star (Intanda) disappears for some days and it cannot be seen it means that there will be a drought	3-4 months

Annex 10: Common tree indicators by district,

Tree name / District	Binga	Matobo	Mbire	Mudzi	Total
Baobab	1		2	11	14
Mopane		20	2	1	23
Octopus cabbage				11	11
Large-leaved jackalberry			2	2	4
Live-long tree	19	4		6	29
Black Monkey Orange	2	12			14
Mango			2	8	10
Marula		10			10
Monkey thorn		6			6
Mahogany	4				4
Snot Apple	3	2	2	1	8
Longpod cassia		9			9
Shepperd's Tree	1	4			5

Photo Credits

Cover Photo : WFP/Tatenda Macheka

Photo page 10: WFP/Samantha Reinders

Photo page 22: WFP/Samatha Reinders

Photo page 49: WFP/Samantha Reinders

World Food Programme
Climate and Disaster Risk Reduction Service (PRO-C)
Via Cesare Giulio Viola 68/70,
00148 Rome, Italy - T +39 06 65131
wfp.org/climate-services | climatechange@wfp.org