

ASSESING ACCESSIBILITY AND USABILITY OF THE METEOROLOGICAL INFORMATION BY SMALLHOLDER FARMERS IN M'MINA AND GOMANI VILLAGES

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ABSTRACT

Climate change issues has been increasing in the past decade, the most recent weather extreme in Malawi is the cyclone idai in 2019. Therefore, Meteorological information is critical in making agriculture decisions since it is a climate sensitive sector. Malawi is a country that heavily relay on agriculture for their social-economic development. Most of the meteorological information accessed by the local based farmers in Malawi is through radio. Due to this, a descriptive research was conducted in M'mina and Gomani villages in Thyolo district, to find out the accessibility and usability of meteorological information by the local based farmers. A group of 40 local based farmers was sampled to represent the whole population of all farmers. Accessibility of the meteorological information of the local based farmers was 40% and usability of the meteorological information was at 62.5% of the local based farmers who had access to meteorological information. Utility of the meteorological information was mainly affected by the timing of the weather forecast and the quality of the weather forecast in order to be applicable to the making farming decisions. Therefore, an active collaboration between the DCCMS, agriculturists, and farmers is needed in order to increase usability of the meteorological information by the farmers

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ACRONYMS/ AMBRIVIATIONS

FAO	Food and Agriculture Organisation
WFP	World Food Programme
WMO	World Meteorological Organisation
UNDP	United Nations Development Programme
GPS	Global Positioning System
DCCMS	Department of Climate Change and Meteorological Services

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CHAPTER 1: GENERAL INTRODUCTION

1.0 Introduction

For the past decades, there have been a change in weather and climate pattern of the world. The report, The winds of change: Climate change, poverty and the environment in Malawi (as cited in Oxfam International, 2009), says that an increase in temperatures and intense rain in Malawi over the past 40 years has led to drought and flooding, causing shorter growing seasons, poor crop yield, food shortages, hunger and the spread of diseases in a country were 29 percent of people already live in extreme poverty. This therefore also affects the social-economic growth of Malawi (Malawi government, 2019). For example the cyclone idai in 2019, damaged thousands of acres of farmers land which resulted in shortage of crop yield.

"The global temperature has already risen to 1 °C above pre-industrial levels. The time left to achieve commitments under the Paris Agreement to remain within 2 °C is quickly running out requiring immediate action. The Global Framework for Climate Services was created to provide the scientific basis for adaptation. Climate services investments overall have a cost benefit ratio of 10 to one. The provision of climate services at country level relies on a cascading global-regional-national Climate Information System operated by WMO. More coherent financing is needed specifically to complete this system. Financing invested holistically in the WMO cascading operational system provides a return on investment of 80 to one." PETTERI TAALAS (as cited in Manipur, 2020). In Malawi, the cost-benefit studies of the economic value of meteorological services to the users have not been deeply studied. However the assumption is that the costs of ruining the meteorological benefits far exceeds the benefits to the users.

In Malawi the meteorological policy was developed, aiming at improving the meteorological, which helps to support socio-economic development of Malawi by adding to international talk on climate and atmosphere (Met Policy Feb, 2015). The meteorological department in Malawi is responsible for the meteorological information which benefits different sectors in Malawi including agriculture sector, and this requires timely, site specific and accurate weather forecast and predictions. In the past years' local farmers have been using local knowledge in making farming

decisions but due to the increase in uncertainty of weather there is increase in the need of the meteorological information when making farming decisions.

For weather and climate information to be used at the grassroots level, it needs to be effectively interpreted and communicated so that it is both useful and usable (Nhlema et al, 2019). As highlighted by FAO and WFP, the accessibility of climate services, such as covering last mile delivery to farmers, is especially critical. However, the nature and presentation of climate information means it is not always well understood by users in the agricultural sector; in particular regarding to the level of skill, uncertainty, and the terciles typical of probabilistic forecasts (Patt & Gwata, 2002; Hansen, et al., 2011 as cited in Nhlema et al., 2019). This study intends in helping understand ways in which the smallholder farmers attains the meteorological information so that it is usable. Therefore, the research will address the accessibility and usability of the meteorological information by the local farmers in Malawi. This concept builds upon various researchers undertaken by various researchers in the meteorology and climate science field to bridge the gap of the accessibility and usability of the meteorological information by the local farmers in Malawi to increase the crop yield.

Problem statement

Much of the studies shows that most farmers in different countries use the meteorological information when they are accessible (Vaughan et al, 2019). However, Coulibaly, Kundhlande, et al. (as cited in Vaughan, et al., 2019) discovered evidence that a number of farmers had access to climate information in Malawi but prefer not using it, relying on local knowledge and personal experience which they regard as trustworthy and relevant. In Malawi, the main source in which meteorological information is accessible is through radio. Unfortunately, some of the smallholder farmers does not always benefit from the information, either because the terminology used is too technical or because it is not in the appropriate language, for instance meteorological information in Malawi is communicated using Chichewa and English languages which many other local indeginous farmers do not understand. Some of the goals of the weather services provided to the public and produces by the meteorological department are (DCCMS|Pulic weather, n.d);

- To build high level of awareness of hazards and preparedeness and how to deal with them.
- To increase weather literacy and ensuring that weather warning and forecast provided by the DCCMS is understood by the intended user.
- To strengthen relationships between the members of the hazards community emergency authorities and media in order to minimize the potential for misinterpretation of information and communiction of the misinformation to the public

Therefore, there is a need to formulate strategies to address the meteorological information to the smallholder farmers in which will be accesible and increase awareness, easily understood by the smallholder farmers therefore, increasing usability.

Objectives of the study

General objective

The main objective of this study was to investigate the accessibility and usability of the meteorological information on crop yield.

Specific objective

- To determine the modes of access of meteorological information by local farmers
- To determine if the access to meteorological information influences local farmers' decision-making.

Research Questions

I. How do local farmers access meteorological information?
II. What is the influence of access to meteorological information on local farmers in decision-making?

Significance of study

It is estimated that about 80% of the Malawi economy depends on agriculture of which local farmers contribute 20% of the agriculture products and 80% of the food products. In history, extremes of heat and cold, floods and droughts, and various forms of violent weather has cause havoc in agriculture systems. Hence prior

knowledge of these violent weather may help in risk management of the uncertainty of weather therefore producing adequet crop yield. This research paper will focus on how meteorological information is accessed and the usability of the meteorological information, therefore helping in improving access and usability of meteorological information produced by the Malawi Meteorological Department.

CHAPTER TWO: LITERATURE REVIEW

History of Agriculture meteorology.

Agriculture meteorology can be defined as multidisciplinary field, concerned with the meteorological, hydrological, pedological and biological factors that affect agricultural production (Asia Climate Forum, n.d.). Despite the technological advancements in agriculture sector, agriculture production still highly depends on climate and weather. In history, weather extremes such as drought, flood, cold and heat waves have caused lower production in agriculture systems. Due to this weather extremes, attempts to mitigate and avoid has been made by different farmers to copy up with the uncertainty of weather. Most of the development phases in agro meteorology has happened in the 20th century. The coming of computers and electronic archives in the late 20th century made it possible to compile lot of literature review about the response of the biological aspects to the environmental conditions. It was easy to share and transfer information globally through internet due to the sophistication of computers. By the close of the twentieth century, several thousand computer-based plant and animal dynamic simulation models had been developed to expand scientific insights into complex biological and environmental systems, and their use has resulted in huge economic benefits (Harpals s. mavi Et.al, 2004). It was also easy to share and transfer information globally through internet due to the sophistication of computers

Meteorological information and Services

Many of the current literature agrees that meteorological information plays a huge role in socio-economic of a country, for example Met Policy (2019) recognizes meteorological services to support sustainable development in Malawi and this is highly shown on the role of meteorological information on different sectors (i.e. agricultural). Agrometeorological data is viewed as comprising of different stages rather than one. Harpals s. Mavi Et.al(2004) describes the four stage-approach in agro meteorology.

I. An agro meteorologist first formulates an accurate description of the physical environment and biological responses

II. He or she interprets biological responses in terms of the physical environment
III. He or she makes agrometeorological forecasts
IV. Then the agro meteorologists develops agrometeorological services, strategies, and support systems for on-farm strategic and tactical decisions and to implement them in collaboration with specialists in agriculture, livestock, and forestry

Stigter et al. (2000), also identified the main types services of the agro meteorology which comprises of;

a. Past and pre-historical data derivation
b. Climate prediction/forecasting for agriculture
c. Medium-range and short-range weather forecasting
d. Services to help reduce the impact of natural disasters, including pests and diseases
e. Agrometeorological advisory services
f. Services to help reduce the contributions of agricultural production to global warming

The agrometeorological forecast produced by the agro meteorologist, consists of five components (A.Nkhonjera, 2020);

1. Weather synopsis

   This includes the descriptions and locations of the pressure systems and associated weather systems

2. Interpretation of weather on crops

   This includes the impact of weather on biological aspects of the crops which is used to determine activities on the farm

3. Interpretation of weather on farming operations

   This includes the drying rate of the soil, evaporation loses, application of wind on applying chemicals and other activities

4. Interpretation of weather on livestock

   This includes indexes and the combination of heat and moisture

5. Interpretation of weather for crop and pests and diseases

Investigates the close relationship between weather, insects, animal and plants diseases

Communication of the agro meteorology information

Weather forecast and predications helps in making management decisions aimed at maximizing productivity in different sectors including those regarding the choice of varieties, the timing of agriculture tasks, and use of inputs and negotiation of loans. Despite this, African access to the meteorological information (Weather and climate services) varies base on region, livelihoods strategy, demographic characteristics and information type. In Malawi the accessibility ranges from 27% to 86%, radio being the primary source by which farmer access weather and climate information (Vaughan et al, 2019).

A study as conducted in Zimbabwe on smallholder farmers in different villages during two growing seasons (2002/03 and 2003/04) documented that out of the 75% of farmers who reported receiving seasonal forecast information, 57% reported changing time of planting and cultivation as a response (patt et. Al. 2005). There was observation reported by the farmers that participate in training in uncertainty that surrounds climate forecasting, of an increase of crop yield by 19% in 2003/04 growing season. Hence apart from the access of the meteorological information, farmers should also have access to the management of the uncertainty of the weather and climate.

Approximately 85 percent of Malawi's population lives in rural areas and is engaged in smallholder rain-fed agriculture where the economies are highly dependent on climate hence the need to collect local weather data and analyse it to predict and respond to climate variability (UNDP, 2018). However, It has been recognized that the implementation of the early weather systems in Malawi has been constrained by issues such as, the late release of information by the government, the lack of accessibility (in terms of reception of information by end-users) and reliability of the information, as well as the lack of understanding of the information provided (Venäläinen et al., 2015;Šakić Trogrlić and van den Homberg, 2018).

Seasonal variability of weather is a major source of production risks, Fraisse et al. (as cited in Pulwarty, 2007). However, significant benefits have arisen from the use of seasonal climate forecasts (Pulwarty, 2007). Podesta et.al (as cited in Pulwarty, 2007), states that it is now generally recognized that predictable climate variability and impacts are necessary for effective use of seasonal forecasts, but not enough to achieve effective use of seasonal forecasts . Then this shows that there is a requirement in designing and producing effective mechanisms to use climate information for the benefit of society. Failing to access and use meteorological information may be caused by different reason, from errors made in the forecast that makes it had to understand, to the willingness of the decision-maker to make decision from the forecast. Different people exists within the same community that may be aware of information and have access to it, but may need guidance on use or those who might know information exists but may need improved access and those who may not be aware of existing information and the potential benefits of its use, Rijks et al. (as cited in Pulwarty, 2007).

A report on scaling-up warning systems and use of climate information in Malawi by the government of Malawi suggested that the use of weather and seasonal climate information by farmers taking crops and livestock management is currently minimal for a variety of reasons which includes the timing when information are received (this effects management decisions made), the content of information i.e. average rainfall, seasonal forecast (some meteorological information are irrelevant for a specific type of group), whether the information is applicable for the local environment and the ability to interpret information (some farmers prefer using of local languages for better understanding of the meteorological information). A contrary position is taken in Malawi were radio (media) being the main source of accessibility of meteorological information, which lowers the usage and need to access the meteorological information since the information is not necessarily for a specific group. The report also identifies some factors within the department of climate change and meteorological services that prevent effective early warnings and meteorological information being addressed, this incudes shortage of trained personnel and meteorological infrastructure hence a need of improvement for trustworthy and relevant meteorological information.

One way on dealing with this, was the launching the Participatory integrated climate Services for Agriculture (PICSA), which was launched by the university of Reading. The project involved analysis of the historical climate of the area and use participatory tools to develop and choose crops which will be suitable for the area. Then before and after seasonal forecast the extension staff and farmers would consider implications of the forecast on the plans farmers have made.

A document about Mobile weather services for small-scale farmers by Fiona Van deer burgt, Saskia van Pelt Arnold Lobbrecht (2018) suggested the use of GPS Coordinates and mobile devices to address meteorological information. This is used by CropMon in Kenya, which provides farmers with field level information which is relevant since the system provide the meteorological information to the required group. Hence, a need of national weather services to approve the services in Malawi as well.

A report of Strengthening climate information in Malawi by United Nations Development Programme (Nov 19, 2015) found out that weather forecasted through radio or television are too general, without area-specific details. Hence, this makes it difficult on what to plant or when to plant. This report stated that new forecasting equipment's and new weather stations location were identified to improve accessibility and precision of the weather information received by the farmers.

CHAPTER THREE: METHODOLOGY

Research method

The primary research method employed was both qualitative and quantitative research methodology. In this way, a closed-ended questionnaire (yes or no questions) was used which provided quantitative data in analysis and also open-ended were used in the questionnaire which provided qualitative data. Therefore, this method providing a complete and detailed description of the accessibility and usability of meteorological information by the local-based farmers.

Sampling

There are almost 2 million smallholder farmers in Malawi (FAO). Most statisticians agrees that a good maximum sample size is usually 10% of the whole population as long as it does not exceed 1000. Therefore 10% of 2 million smallholder farmers is 200,000. This exceeds 1000, therefore in this case the maximum will be 1000. The minimum value of sample size that most of the statisticians agree on is 100. Therefore the required research sample size is between 1000 and 100. Due to the resources available and time, the sample size of 40 smallholder farmers was selected instead, to represent the whole population. Purposive sampling method was used in this research to acquire information of smallholder farmers on the accessibility and usability of the meteorological data in the study area.

Study area

This research will be conducted in Gomani and M'mina Villages in Thyolo districts. This includes visiting different households of local farmers as a way of collecting data.

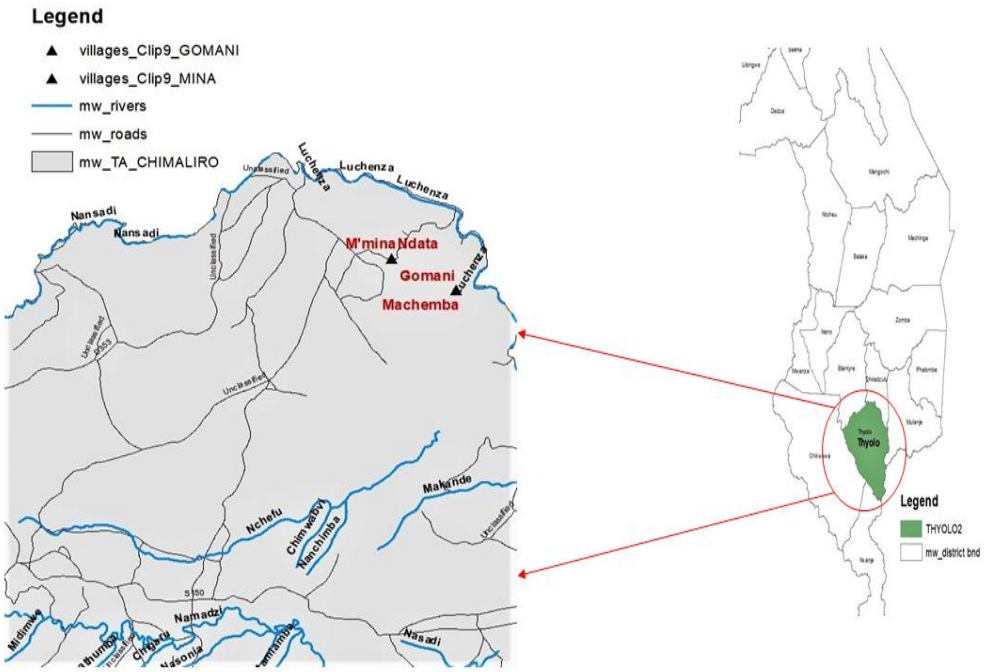


Figure 1: Map showing the study area in Gomani and M'mina Villages, in T.A Chimaliro, Thyolo

Data collection

A questionnaire was used in the specified villages in Thyolo as a way of collecting data. The questionnaire contained a set of closed-ended questions which gave information that can be quantified. The questionnaire also contained open-ended questions which gave qualitative data.

Data analysis

The data was collected in local language hence in analysis, the data was translated first to ensure the original meaning is not lost. The open-ended data was categorized first, then excel was used to draw charts/graphs of the categorized data therefore, giving a

representation of the data collected. The analysed open-ended data was then used to answer the main objective through the specific objectives. Even though there was no open-ended questions, some respondants quotes has been used in the results section which helped in giving in-depth information. Since a questionnaire was constructed to ask the respondents, then an inductive reasoning approach was used in the analysis of the data.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This research was conducted in Thyolo, aiming at finding the accessibility and usability of the meteorological information by the local based farmers. This was a quantitative research. The research complied with the ethical considerations and all participates were interviewed on their free will. The data was collected from 40 participates who were all smallholder famers. All of the participants who were interviewed, 40 smallholder farmers were located in M'mina and Gomani villages in Thyolo.

4.2 Demographic Data

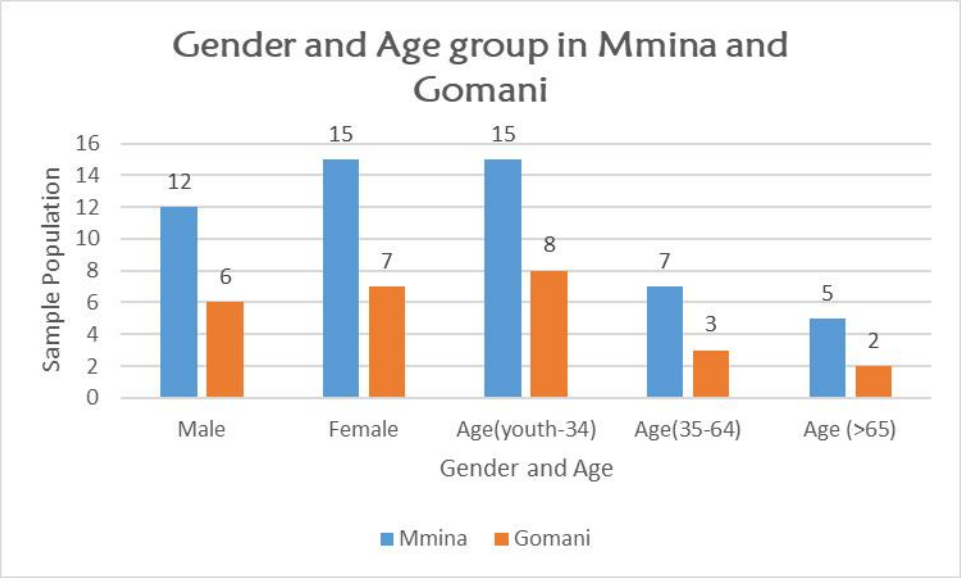


Figure 2 : Gender and Age group

The figure 2 above shows the number of males and females who were involved in this study and the age groups.

Most of the respondents who were interviewed were females, which implies that there were more female smallholder farmers with a percentage of 55% than male smallholder farmers with a percentage of 45%. This therefore does not vary much with the population of Malawi census, which shows that there is a high number of females in Malawi with a percentage of 51.5% than the number of males, which have the percentage of 48.5%.This is according to Malawi census conducted in 2018

Age of the respondents was grouped by defining intermediate elderly as aged from 36 to 64 years old and defining elderly as aged from 65 years old and above. Most of the respondents were from youth group, containing with almost 57.5%. Elderly

group had a lower percentage of 17.5%. This showed that most of the land holdings were that of the youths and intermediate elderly than the elderly.

The researcher believes that the level of education matters when it comes to the understanding of the meteorological information. Therefore, the researcher tried to look into the levels of education in Mmina and Gomani. The figure 3 below shows the level of education in these villages

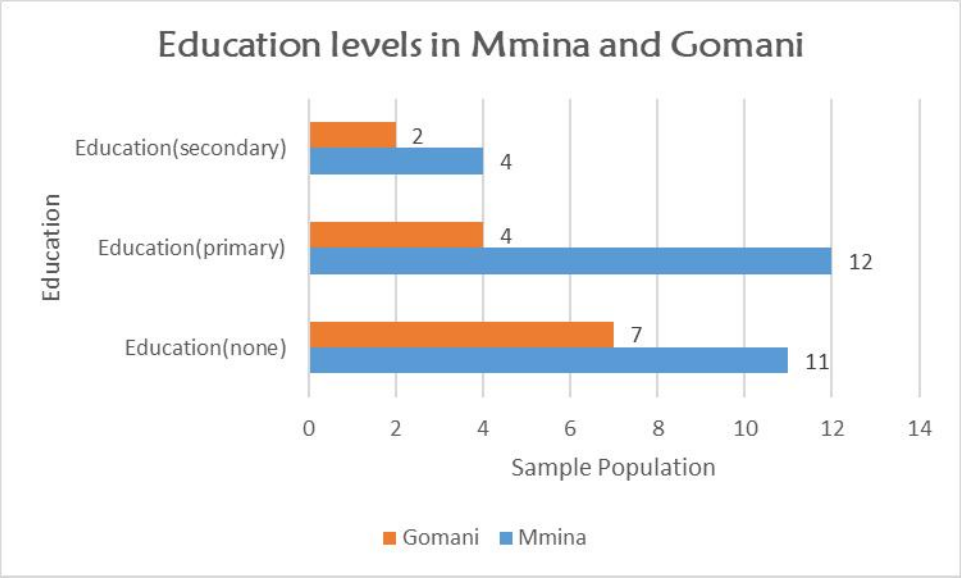


Figure 3: Levels of education

More than half of the smallholder farmers who were interviewed at least attended primary school, with less than 20% attending secondary schools or higher education. This showed the low literacy rate of the smallholder farmers which is required in making farming decision from meteorological information.

The figure 4 below shows the activities, which is a source of income in different households in Mmina and Gomani villages. Their economic activities will also help in determining how much this villages needs the meteorological information.

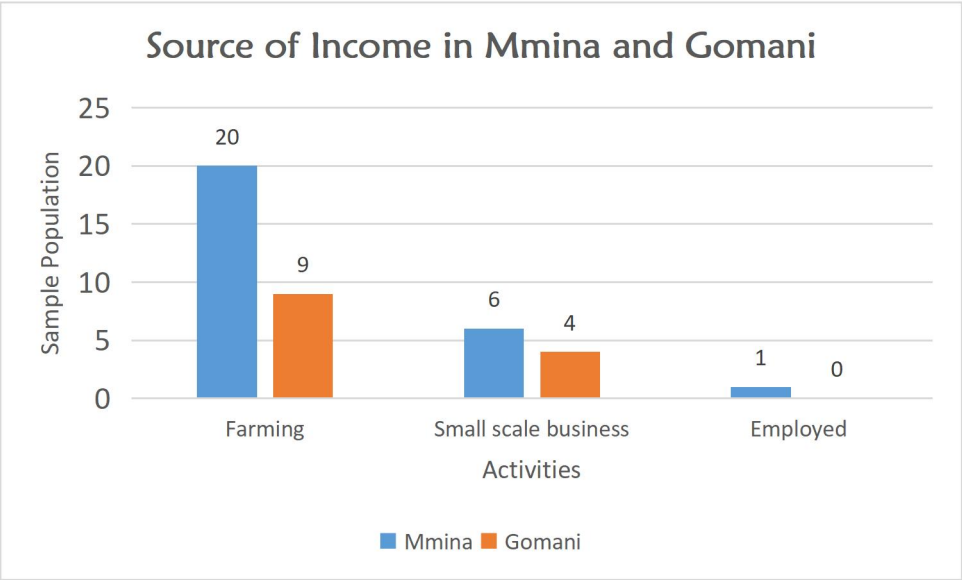


Figure 4: Social-economical activities

Most of the smallholder farmers heavily depended on farming as there source of income however, some of them were also working in other jobs, like doing small business, and some working in other institutions and receiving wages. Therefore, the research interview comprised with a wide range of socio-economic positions representatives within Malawian smallholder farmers population. This also showed that meteorological information is an important aspect to the villages, since most of the respondents depended heavily on farming as their source of income.

4.3 Modes/ways of accessing meteorological information.

Local based farmers in Thyolo, Goliyati mainly acquired meteorological information from radio. Other sources of the meteorological information included extension workers and esoko (a non-government organization). The figure 5 below shows sources of meteorological data and there equivalent number of respondents who access using the source.

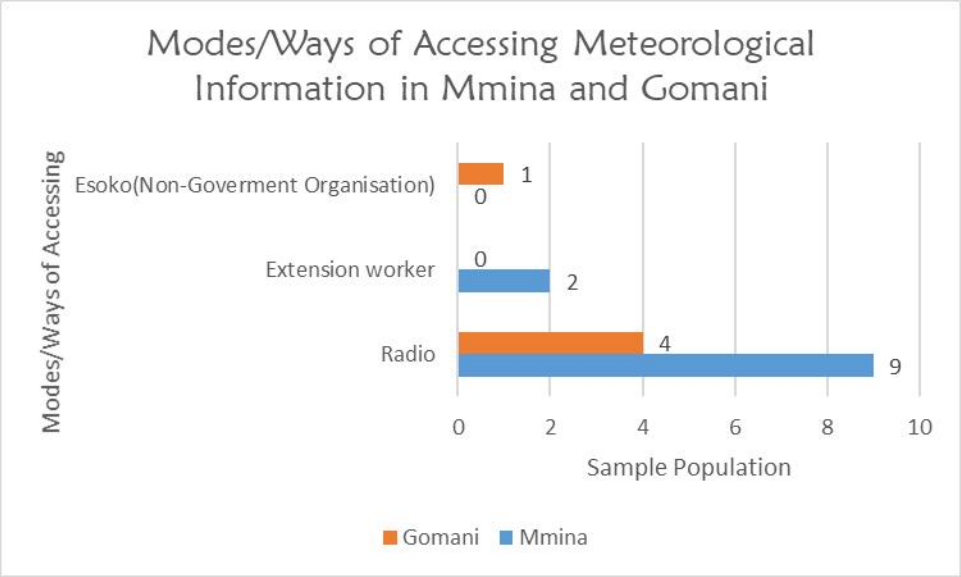


Figure 5: Modes/Ways of accessing Meteorological information

The research showed that almost 40% of the smallholder farmers in M'mina and Gomani had access to meteorological information. The accessibility of the meteorological information was mainly through radio, which broadcast weather forecast. However, this is a low accessibility percentage rate, considering that most of the participates said that farming was their main source of income.

Radio source was the main way or mode of accessing meteorological information in these villages. Radios broadcast weather forecast that are short range and last for a day up to a few days. This weather forecast are considered to be more accurate. However, for farming decision to be made using meteorological information, seasonal climate forecast and long-range climate forecast are also required.

Short range weather forecast was used by the smallholder farmers on determining short range farming plans like days of applying fertilizers or the day of when the local based farmers were supposed to do weeding on their farms.

However, take note that radio as a source does not mainly focus on the seasonal and long-range climate forecast, which is used in making long-term planning for example designing an effective irrigation systems, since some of the local based farmers were involved in irrigation.

Other sources like meteorology Malawi website make seasonal forecast and encourages the local based farmer to seek help from Ministry of agriculture on

applying the weather forecast to in making farming decision. However, the local based farmers due to the inaccessibility of some electronic resources that is used to access the platforms like websites and then acquire the required information do not use these sources.

4.4 Utility of Meteorological Information

Among all 16 local based farmers who had access to meteorological information, only 10 smallholder farmers were able to use meteorological information effectively in making farming decisions. About 6 smallholder farmers did not apply any of the meteorological information in making farming decisions. The figure below 6 shows an overview of the number of respondents who had access to meteorological information and figure 7 below shows the number of respondents who were able to use the meteorological information.

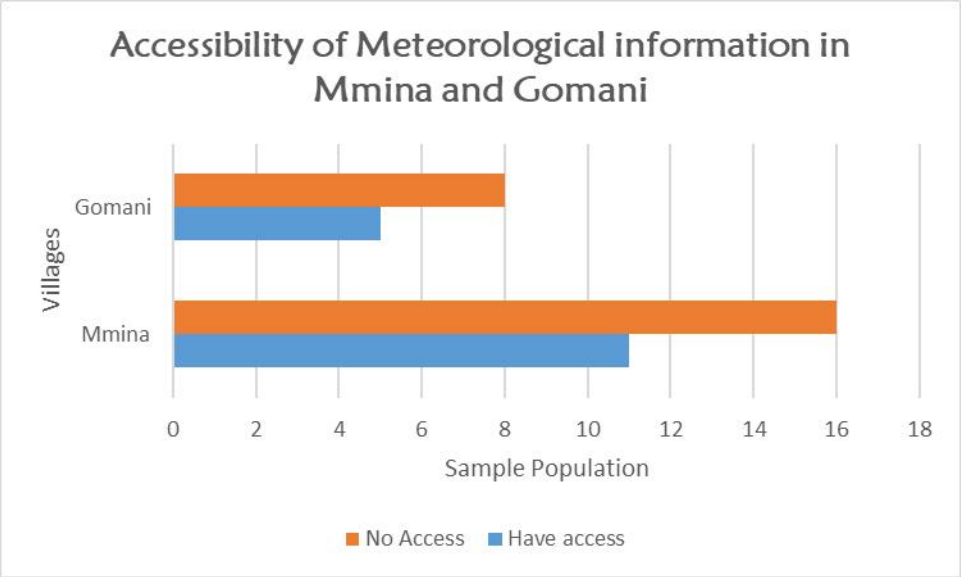


Figure 6: Accessibility of Meteorological information

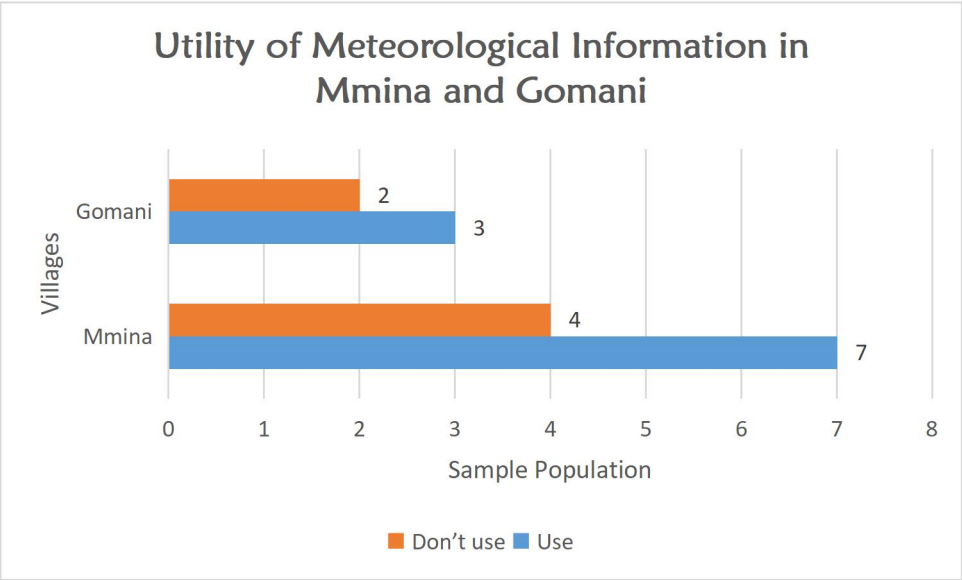


Figure 7: Utility of meteorological information

Even though the accessibility of meteorological information by the smallholder farmers was below 50%, its usability was at better percentage level of 62.5%. This shows that farmers were able to use the meteorological information when it was accessible. The usability of the meteorological information may also have been affected by age of the smallholder farmers, since most of the smallholder farmers, were in between the youth group or the intermediate age group.

Among all the smallholder farmers interviewed, almost 87.5% agreed to have faced weather extremes such as heavy rains, strong winds and shortage of rainfall that have led to the destructions of crops in their fields. However only about 11 smallholder farmers agreed to receive warning about the change in weather or of the coming of the weather extremes, with about 2 of the smallholder farmers claiming not to receive the warning in time. Therefore, this tally with low accessibility of the meteorological information in Gomani and M'mina villages.

Barriers to the utility of weather and climate meteorological information

Most of the meteorological information broadcasted on radio are regional forecast. Nevertheless, the agricultural sector requires site-specific forecast since, for example mean temperature of nearby location may differ. Information on climate and weather phenomena at wide spatial scales are important. However, in order to be used by the decision makers in agriculture sector, the local manifestation of the

climate and weather phenomena has to be translated into variables and processes that matter to local based farmers, for example calculation of heat index using temperatures in order to find design livestock housing or feeding schedules. This was evident when 95% of the smallholder farmers who were interviewed agreed on increasing encounters with the agriculture extension officers' in order to be helped in utilizing the weather forecast at a local based level.

Timing of the weather forecast was also a barrier in meteorological information utility on making farming decision-making in these villages. Farmers' decision-making is a complex process of iterative adjustments mediated by their assets and aspirations, sociocultural and perceptual environments, and larger policy and market regimes, according to research (Gbetibouo, 2009; Singh, Dorward, et al., 2016, as cited in singh, et al., 2018). Local based farmers have a short time period such as days and seasons rather than a large temporal scale in order to make an agricultural decision. Thus, efforts to improve in the use of weather and climate information communication need to factor in timing of information delivery for farmers to make farming decision. For example some of the farmers said that some of the weather broadcast were made after a specific weather phenomenon/extremes had already happened and affected their crops in their farms. Almost 97.5% of the smallholder farmers also agreed to the idea of changing ways or introducing new ways of which the smallholder farmers receive meteorological information.

CONCLUSION AND RECOMMENDTION

CONCLUSION

Weather and climate information is an important aspect in making effective agricultural decisions. This study has shown that not only accessibility to the meteorological information is important for effective use on farmer's decision, but also timing of the access to the meteorological information and comprehensive of the meteorological information. Most farmers accessed the meteorological information through radio, which was affected by timing of the forecast and the meteorological information comprehensive for it to be applied on making farming decisions. Since for meteorological information to be applied farming decision, requires for the description and location of the weather system and then interpretating the weather systems to agriculture. However, in M'mina and Goamni villages in Thyolo, more than half of the farmers were able to interprete the weather forecast.

RECOMMENDATION

Accessibilty of meteorological information by the smallholder farmers was at low level rate of 40%. This therefore calls for new methods in which accessibilty of meteorological information would be increased. Therefore, DCCMS must gain a better understanding of user needs in order to provide timely and useful agrometeorological information. An active collaboration between the DCCMS, agriculturists, and farmers is needed in order to increase usability and accessibilty of the meteorological information by the farmers. One of the ways to increase accessibility and usability is through the PICSA method. This is a participatory method which would include agriculturists, DCCMS and farmers in making decisions on implications of the weather forecast on farming decisions just before and after the seasonal forecast has been forecasted. The accessibilty of the meteorological information would be increased through the use of GPS mobile devices which gives sitespecific weather forecast(Fiona Vam deer et.al 2018)

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