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Climate and Weather Informational Services and Products for Maize and Wheat Farmers in Uasin Gishu County, Kenya

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Abstract

With the prevailing climatic variability presenting globally, nationally and at local levels in all countries, availability in real time and the subsequent uptake of climate and weather information by farmers in their crop production planning and production process becomes very critical. This is because attaining improved and sustained high crop yield in a rain fed agricultural system largely depends on accurate timing of rainfall onset and cessation dates during growing and harvesting season. To understand this phenomenon, a study was conducted among maize and wheat farmers in Uasin Gishu County with the objective to determine the types and sources of information on climate and weather available to them for use at the farm level. The study was conducted in Moiben, Kesses and Soy sub counties of Uasin Gishu County. The study adopted stratified and random sampling procedure to capture representative sample of farmers. A sample of 399 farmers participated in the study in addition to 12 key informants. A pre-tested semi-structured questionnaire and an interview schedule were the main data collection tools. Chi-square and independent sample t-test were employed in the analysis using SPSS (V.16). Results were considered significant at α=0.05. The findings showed that 49.2% reported not to receive any product or service for use in their farming activities. However, 19.8% received Farmer's Guide product while 19.1% received targeted information for maize and wheat farmers showing them what variety to plant, where to plant and when to plant. There is low access to supportive climate and weather information by majority of farmers and with the prevailing climatic variability being witnessed locally by farmers at the farm level, farmers will continue incurring losses. The findings further reveal the fact that the experience gained by a farmer over time doing maize and wheat greatly influences their decision at the farm level. Similarly, their traditional understanding on rainfall indicators influenced their activities more and all these form a larger portion of source of climate and weather information to them as indicated by 84.9% and 36% respectively. Agricultural Extension Officers accounted for 46.2% while 50% indicated that their source of information is their fellow farmer. All these reveal a vulnerable farming population in times of climatic variability being witnessed all over the world. The need to repackage climate and weather information to formats accessible and easily understood messages by farmers will be catalytic in aiding access to the information and will help create ownership and sustainability. Agro-meteorological services should target the use of mobile phones especially messaging service to disseminate their products and services to the farmers as they are widely accessible to them.

Key Words: Climate Variability, Weather Information, Climate Information Products and Services, Maize and Wheat Farmers, Indigenous Knowledge, Uasin Gishu County, Kenya

INTRODUCTION

In most parts of Sub Saharan Africa including Kenya; there is a heavy reliance on rain fed agricultural system to grow food with the aim of attaining a food secure nation up to the house hold level. Like most parts of the world over, Kenya's agricultural sector is vulnerable to climate variability and extreme weather events such as droughts and floods, the impacts of which have led to crop damage, food shortages, rising food prices and damage to the national economy. This vulnerability stems in part from the country's considerable inter- and intra-annual variability in rainfall and dependency on rain-fed agricultural production (Parry *et al*., 2012). Climate change is expected to adversely affect the stability of Kenya's agricultural sector with particular concern being raised regarding the vulnerability of the country's millions of smallholder farmers.

To ensure a secure household food security in rain fed agricultural livelihood system requires availability of information on climate and weather that will reflect onset of seasonal rains and absence of the same in the production year. Such information is critical in determination of relative calendar of activities with respect to timing of farm preparation (ploughing and harrowing); planting; application of fertilizer as well as pesticides and herbicides control (Anuforo, 2009).

There are several categories and types of climate information products and services existing in countries for agriculture and food security support among them include the daily weather forecasts; dekadal agro-meteorological bulletins; monthly climate outlooks; seasonal climate outlooks; climate alerts; observed climate impacts; and tailored information for users (farmers) (KMS, 2014). The study aimed at understanding such informational services and products, their sources, availability and access to maize and wheat growing farmers in Uasin Gishu County of Kenya.

Study Area

Uasin Gishu County has a total area of 3327.8 km^2 with arable land covering 2603.2 km^2 and non-arable land covering 682.6 km^2 (Uasin Gishu County profile report 2013). The terrain of Uasin Gishu County is generally undulating highland plateau varying with altitude between 1,500 meters above sea level at *Kipkaren* in the west to 2,600 m above sea level at *Timboroa* in the east. Eldoret town is at 2,085 m marking the boundary between the highest and the lowest altitude of the county. The gentle undulating terrain allows the practice of mechanized farming. The rainfall amounts and regimes are influenced by altitude and wind direction usually high, reliable and evenly distributed with some annual average of around 900 mm in the last few years. It is bimodal occurring between the months of March and September with two distinct peaks in May and August. The wettest areas are found in *Ainapkoi*, *Kapseret* and *Kesses* sub-counties. The other three sub-counties of Soy, Moiben and Turbo receive relatively lower amounts of rainfall (GoK, 2008).

Temperatures range from 25^0C as the highest and the lowest at 8.8^0C and humidity averaging 56%. February is the hottest month while July is the coldest. Uasin Gishu County is basically an agricultural district producing more than a third of the total wheat production in the country. Similarly, maize ranks second both as food and cash crop (Kenya Food Security Steering Group, 2009). The study was conducted in Uasin Gishu County, Kenya as shown in the map in fig.1. The county has 6 sub-counties namely:- Turbo, Soy, Moiben, Anabkoi, Kesses and Kapseret.

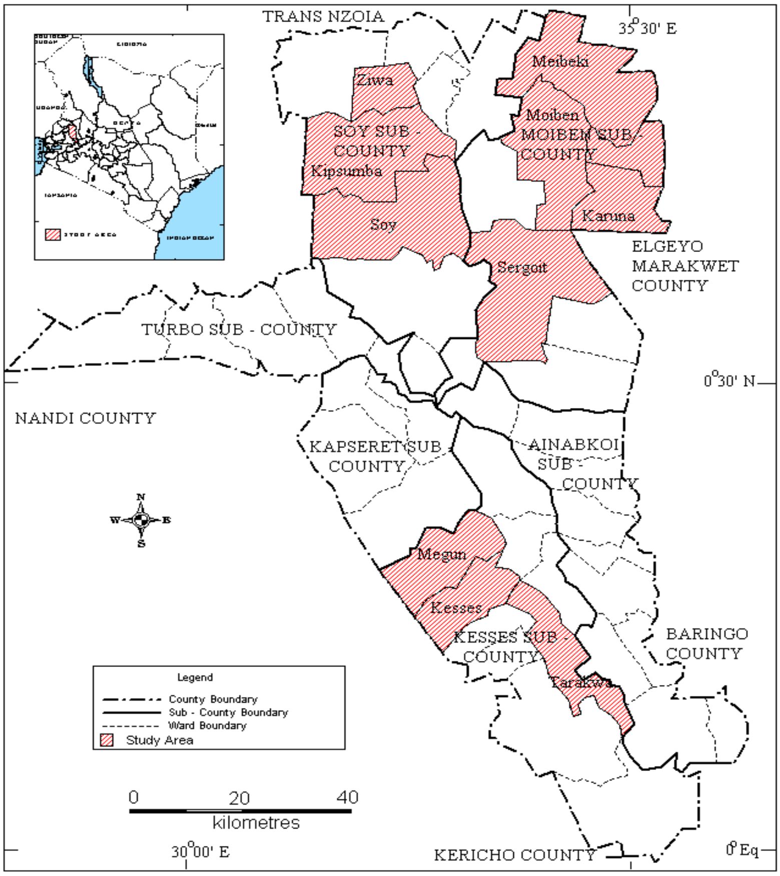

Fig. 1. Map of Uasin Gishu County Showing the Study Area

MATERIALS AND METHODS

The study adopted a mix of purposive, stratified and random sampling procedure to be able to capture a representative sample of farmers. The entire 6 sub-county areas of Uasin Gishu County were analyzed to identify sub counties exhibiting both maize and wheat production. Based on this criterion, 3 sub-counties namely Moiben, Soy and Kesses were selected purposively. A further stratification was done at ward level. Wards that grow both maize and wheat were purposively selected again resulting to selection of Soy, Kipsomba and Ziwa wards in Soy sub-county; Moiben, Sergoit and Karuna/Meibeki wards for Moiben sub-county and finally, Kesses, Tarakwa and Megun were picked in Kesses sub-county.

The sampling frame for the study was 129, 384 farmers distributed as follows: - *Soy* Sub-County = 61, 138, *Moiben* Sub-County = 38, 950 and *Kesses* Sub-County=29, 296. A sample of 399 farmers was included in the study. In addition 12 key informants were interviewed; one from each ward totalling to 9 and also 2 from Directorate of Agriculture and Directorate of Meteorology in Uasin Gishu County and one from the Kenya Meteorological Services in Nairobi. In order to determine the number of farmers to be picked in the selected wards, the use of data from households mapping done by the Kenya National Bureau of Statistics (KNBS) through the Kenya Population and Housing Census, 2009 was utilised where the randomly generated census numbers from SPSS were used to pick the households.

The completed questionnaires were analyzed using both access database and SPSS V.16. For quantitative data, frequencies, mean and standard deviation were used to summarize the data. Chi-square was used to check for significant relationship between categorical variables. Significance level was set at α=0.05 while qualitative data was analyzed by use of theme generation.

Conceptual Framework

Climate variability brought about by climate change has seen maize and wheat farmers encounter changes in the growing periods known to them over time. There has been a shift in seasons and rainfall patterns have changed from the normal occurrence making the farmers' knowledge and experience in maize and wheat production difficult to comply with as the case has always been. Similarly, climate and weather information availability and in the right format and quality is paramount if a better and beneficial adaptation strategy is to be implemented by famers hence attaining improved livelihoods and sustainability. The utilization of climate and weather information can reduces farmers' vulnerability to weather related risks, ensures that informed decisions are made on time, and reduces the risk of agricultural losses as well as indicating to farmers the most marketable crop in respective times.

RESULTS

Analysis of Demographic Data

A total of 399 maize and wheat farmers participated in the study, 83% were male and 17% were female. Majority of the farmers (59.6%) were in the most productive age group of ages 26 - 46 years. The education levels of farmers reveal a population that has largely attained primary level of education at 39.6% followed by those with no formal education at 28.5% and those who had attained secondary level of education given at 22.5%. Most farmers (69.3%) owned farms that ranged from 1-20 hectares followed by 21.1% who owned farms that ranged from 21 - 40 hectares.

Table 1. Socio-Demographic Characteristics of the Respondents in Uasin Gishu County, 2013

Characteristic	Frequency	%
Gender		
Male	331	83
Female	68	17
Age-group(years)		
≤25	20	5.2
26-46	229	59.6
47-59	105	27.3
≥60	30	7.8
Education level		
None	113	28.5
Primary	157	39.6
Secondary	89	22.5
Tertiary	25	6.3
University	12	3.0
Farm size (hectares)		
<1	18	4.7
1-20	266	69.3
21-40	81	21.1
>40	19	4.9

Categories and Types of Climate and Weather Information Services and Products

Close to half of the farmers 49.2% reported not to receive any product or service for use in their farming activities. However 19.8% received Farmer's Guide while 19.1% received targeted information for maize and wheat farmers showing what variety to plant where to plant and when to plant as reflected in Figure 2.

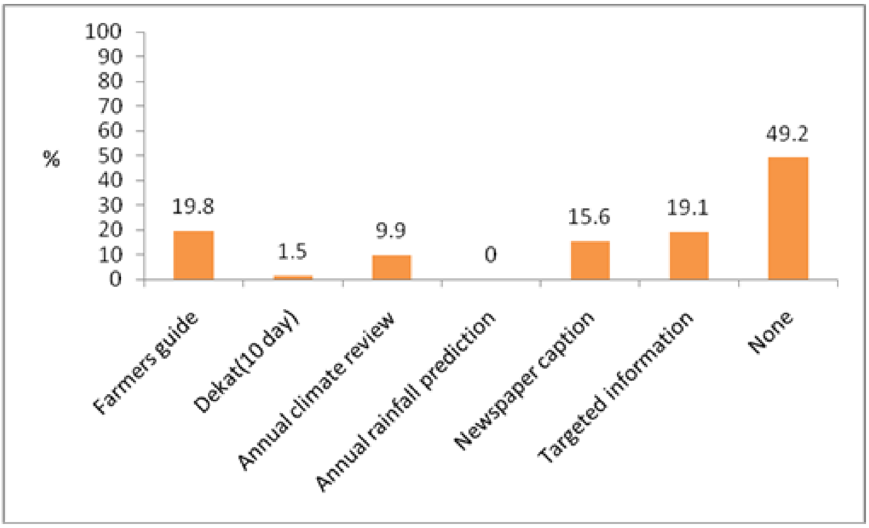

Fig 2. Climate and Weather Information Services and Products Received by Farmers in the County in 2013

Again, the results show that close to half of the farmers interviewed affirmed that there was no informational service or product that they received but they used mainly their own experiences gained over time to make farming decisions. From the foregoing, it is evident that the farming population largely rely on their own judgment to carry out certain crop activities but with the prevailing climate variability, the accuracy of own judgment is at stake. It is important thus for the government through the directorate of Agriculture to carry out sensitization campaigns to educate farmers on the need to understand the importance of accessing and using climate and weather information in their farming decisions. This situation is explained further by studies by Vogel and O'Brien (2006) and Hansen *et al*. (2014) which states that even when climate information is available, incorporation of scientific climate information into local decision making may not often occur because of the way such information is communicated and disseminated. Despite such efforts, climate and weather information seem not to have reached the farmer in right format, time and method to enable them consider it in their farming decisions. This leaves the farmers indeed vulnerable to variability in weather patterns. From the data gathered during key informant interviews, an Agro-meteorologist at the Kenya Meteorological Services stated that large scale farmers get tailored weather information from the business support services section of the Department of Meteorological Services in Nairobi. The rest of the medium and small scale farmers may not access such tailored informational services or products leaving them quite vulnerable to climate variability brought about by climate change.

Sources of Climate and Weather Informational Services and Products Accessible to Farmers

When farmers were asked to explain how they obtained any climate and whether informational services and products that could assist them to make some informed decisions on maize and wheat growing, half of the farmers (50%) said that they consulted with their fellow farmer for

The necessary climate and weather information while 17.6% did not contact anybody because they believed they knew what and when to plant the crops. Those farmers who contacted Agricultural Extension Officer for support to explain more about climate and weather information utilization in maize and wheat farming were 46.2% as shown in Figure 3.

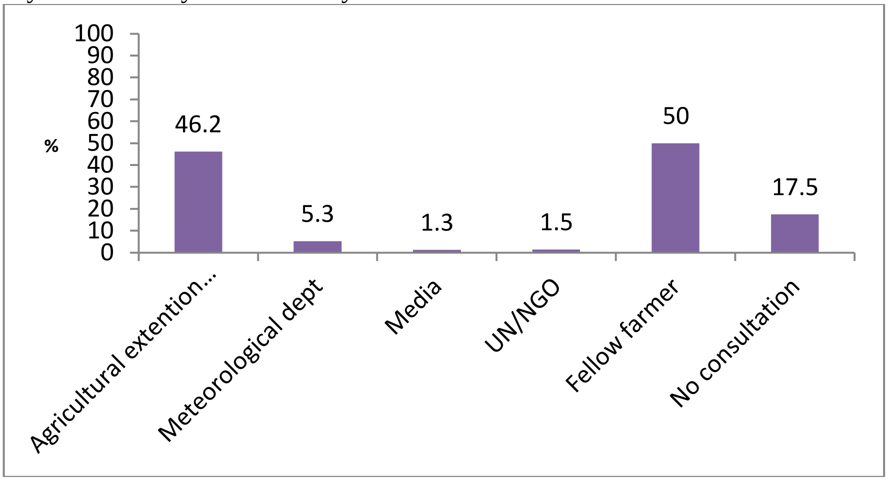

Fig 3. Sources of Climate and Weather Information for Farmers in the County

The results in this study corroborate that by Kadi, *et al.* (2011) stating that farmers in Kenya mainly receive climate information from extension services and through community interactions or fellow farmers. Similarly, the findings agree with those by Konneh, (2006) as cited from (Hansen, 2003; Jones *et al*. 2003; Walker *et al.* 2001) which showed that climate information is likely to have value, if communicated through extension agents or contacts who farmers already know and trust. Seasonal forecast communication, therefore, needs to go through existing trusted institutions or individuals. Such an arrangement albeit may pose other serious challenges if access to climate and weather information is not ensured and with the prevailing climate variability, farmers who obtain information from fellow farmers or extension workers may end up getting information that may not be useful to them at all. Extension officers and farmers need to be empowered with adequate training on climate and weather information utilization through campaigns at the farm level as they remain trusted channels. To further examine if farmers obtained climate and weather information indirectly during the calendar year, they were asked if they had attended any agricultural activity that would enable them access certain useful weather information and the responses were given as shown in Table 2 maize and Table 3 wheat. This was on the assumption that such gatherings usually have informational products for the farmers on climate and weather.

Table 2. Agricultural Activity Attended in the Year by Uasin Gishu Maize Farmers in 2013

Activity Attended	**Frequency**	**Percent**
District agricultural shows	221	55.4
Farmers field day	216	54.1
Agricultural demonstrations	169	42.4
None of the above	69	17.3
**Multiple responses*	N = 399	

As indicated in Table 2, more than half of the farmers (55.4%) reported to have attended District Agricultural Shows while an almost equal number (54.1%) attended field days. Less than half (42.4%) attended agricultural demonstrations.

Table 3. Agricultural Activity Attended in the Year by Uasin Gishu Wheat Farmers in 2013

Activity Attended	**Frequency**	**Percent**
District agricultural shows	197	49.4
Farmers field day	198	49.6
Agricultural demonstrations	162	40.6
None of the above	71	17.8
**Multiple responses*	N = 399	

Among the wheat farmers, 49.4% reported to have attended District Agricultural Shows, 49.6% attended farmers field day while only 40.6% attended agricultural demonstrations as shown in Table 3. From the foregoing, it is evident that maize and wheat farmers receive whatever information they may require be it climate and weather or related information through their own initiatives by way of attending agricultural shows, farmers field day and demonstrations. This is largely a farmer led exercise that may face challenges given the prevailing climatic variations in the agricultural sector. While it is commendable that farmers take their own initiative to seek for information, facilitation of climate and weather information may not be readily available in such gatherings. Both County and the National governments therefore, can target such avenues to reach the farmer with requisite climate and weather information that they may need during their farming decisions at the farm level.

To crystalize this phenomenon, farmers were tested further on how they have been able to operationalize their activities at the farm level with regard to knowledge of climate and weather informational products and services plus other useful agricultural information. They were tested on their knowledge on maize and wheat seeds variety suitable in their farming environment. Majority of farmers (97.7%) stated that they knew the maize and wheat seed varieties suitable for growing in their farming areas. Asked on how they became aware of the various seed varieties and their suitability, 44.9% stated that they have used personal experience over time practising maize and wheat growing. This is followed by those who got the information from fellow farmers who know certain maize and wheat seed varieties which do very well around the neighbourhood at 42.1%. Those who identify Agricultural Extension Officer accounted for 35.8%.

From the responses gathered it is evident that the key sources of information for maize and wheat farmers with regard to seed varieties, their suitability and the best yielding variety in Uasin Gishu County are largely farmer led and also experience related as outlined in the findings. Farmers have clearly indicated that they have used their own experience over time cultivating maize and wheat and therefore know which seed variety is suitable for certain areas. The role of Agricultural Extension Officer is also crucial if climate and weather information is to be relayed across to the farmer. The personnel especially the Locational Agricultural Extension Officer operates closely with the farmers at the farm level hence are in a better position to discuss emerging issues contained in the advisories provided by the Kenya Meteorological Services. The finding in this study tie well with finding by Konneh, (2006) cited from (Hansen, 2003; Jones *et al*. 2003; Walker *et al*. 2003) which states that climate information is likely to have value, if communicated through extension agents or contacts who farmers already know and trust.

With the prevailing climate variability, seasons have shifted and farm timings known to farmers have been distorted leaving a farmer quite vulnerable to unpredictable weather patterns. It is critical that farmers get the right information on the best maize and wheat seed variety to plant to complement what they know based on their experience over time. It is also important that they access climate and weather information at the right time to help them make informed decisions. The National and County governments can support farmers by streamlining access to climate information at the farm level.

Organizations Providing Climate and Weather Information Services and Products to Farmers

When farmers were asked to state the organizations that provide them with the required climate and weather information service, 67.9% reported that Kenya Meteorological Services (KMS) produces information on rainfall onset and cessation dates while 57.9% reported that KMS also produces information on rainfall variability and distribution. Still majority reported that no information is provided on 10-day summaries of crop and weather advisories (Dekad data), Normalized Difference Vegetation Index (NDVI) data in some instances and plant density and soil moisture as shown by 59%, 60.2% and 49.4% of the farmers respectively. Farmers seem to be more interested on rainfall onset and cessation dates unlike the more scientific NDVI, Dekad data and plant density with the associated soil moisture. This makes them miss out on critical information related to farming decisions that can help them improve their crop output at the farm level.

The farmers reporting that they received information on temperature variability, potential evapotranspiration and solar radiation were 48.2% while those who affirmed that no information was provided on the same aspect stated were 41.2%. This also can be explained by the fact that farmers view rainfall amounts as most important in crop germination and most of them may not bother to understand the role of temperature variability, PET and solar radiation. More than half (57.6%) reported to have received information on crop disease/pests and adverse weather conditions from District Agricultural Officers as indicated in table 4.

Table 4: Climate and Weather Informational Services and Products and the Organization Providing it in Uasin Gishu County, 2013

	Provider of Information service and product				
Information Service Provided	**1KMS**	**2AEO**	**3KSC**	**4Farmers**	**5None**
Rainfall onset and cessation dates	254 (67.9)	26 (7)	5 (1.3)	41 (11)	48 (12.8)
Rainfall variability and distribution	213 (57.9)	28 (7.6)	3 (0.8)	11 (3)	113(30.7)
Temperature variability and potential evapotranspiration, solar radiation	173 (48.2)	12 (3.3)	5 (1.4)	21 (5.8)	148(41.2)
Crop disease/pests and adverse weather conditions	42 (11.6)	208(57.6)	7 (1.9)	23 (6.4)	81 (22.4)
10-day summaries of crop and weather advisories	90 (26.2)	28 (8.1)	11 (3.2)	12 (3.5)	203 (59)
Plant density and soil moisture	51 (14.7)	93 (26.7)	28 (8.0)	4 (1.1)	172(49.4)
Normalized difference vegetation index data in some instances	84 (27.6)	23 (7.6)	11 (3.6)	3 (1.0)	183(60.2)
**Multiple responses* N = 399					

(Multiple responses in percent (%)

Key: 1. Kenya Meteorology Services (KMS), 2 Agricultural Extension Officers (AEO), 3. Kenya Seed Company (KSC) 4. Farmers who understand better climate and weather patterns prevailing in the year, 5. None of the information is provided

The results in the study show that most of the climate services especially on rainfall onset and cessation dates, rainfall variability and distribution is obtained from the Kenya Meteorological Services through the seasonal climate outlook bulletin and "*utabiri wa hali* *ya anga*" (daily weather forecasts) relayed on radio and television to the Kenyan public including farmers. The Agricultural Extension Officer is a critical component of delivery of climate services to the farmers as seen earlier and integrating them in the climate information provision will be beneficial. This is because they are able to interact with the farmer at the farm level where consultation takes place on emerging issues as seen on the responses on crop disease/pests and adverse weather conditions climate service provision in Table 4.

According to information from key informant interviews carried out, the Kenya Meteorological Services under the Ministry of Environment, Water and Natural Resources has partnered with the Agricultural Sector Development Support Programme in the County to come up with Participatory Scenario Planning Process where they come up with a weather outlook for the prevailing season and advisories (*Weather Outlook for Uasin Gishu County for March – May 2015 Rainfall Season and Advisories*). Scientific forecast spearheaded by KMS is integrated with elders input on weather forecasting using traditional methodologies. The stake holders include scientists, the community, traditional forecasters and those other entities that rely on such information in managing their activities. The consultative meeting produces a harmonised weather forecast for the county, develop advisories and eventually go to the field to disseminate the information followed by monitoring to check on uptake levels of climate information (Ramtu and Kemei, personal interview May 15, 2015).

The study also reveal that to be able to ensure access and use of climate and weather informational services and products effectively by farmers, it is paramount to understand the local people's knowledge systems as this influences a lot their ability to embrace scientific information. There is need also to establish clear communication channels for the delivery of such information. Such efforts need to be complemented with effective outreach programs coupled with educational initiatives to help users of relevant climate information to realise its full potential. Like this study, the findings of (Sivakumar, 2006; Hill and Mjelde, 2002) showed that giving greater priority to extension and communication activities (including the communication of forecast uncertainties and probabilistic climate information) and improving the relevant institutional and policy environment is of outmost importance.

Climate and Weather Information Services and Products Required by Farmers in Uasin Gishu County

It was found necessary to understand what type of information farmers required in their farming calender so that this could be addressed by the concerned institutions when attempting to provide the needed agro-climate information. The study finding reveal that more than half of the farmers growing maize reported to require information on rainfall onset and cessation dates as affirmed by 63.8%. This information was rated as high in priority. They also rated the importance of accessing information on rainfall variability and distribution at both high level as indicated by 46.5% and moderate by 35.8% respectively. Maize farmers also indicated the need for information on crop disease/pests and adverse weather conditions to a high extend (59.4%) as shown on Table 5. The 10-day summaries of crop and weather advisories and Normalized difference vegetation index (NDVI) data type of information service was rated low by maize farmers. This can be explained by the fact that farmers did not know much about NDVI data and 10 – day summary (Dekad data) as explained during the data gathering period by farmers themselves. They did not know anything about such a service.

Table 5. Extent of Need of Information Services on Seasonality in Maize Production, 2013

Information required	Extent of Need of Information			
	Don't Know (%)	Low (%)	Moderate (%)	High (%)
Rainfall onset and cessation dates	25(6.7)	13(3.5)	97(26_)	238(63.8)
Rainfall variability and distribution	26(7)	40(10.8)	133(35.8)	173(46.5)
Temperature variability, potential-evapotranspiration, solar radiation	48(12.9)	100(26.8)	123(33)	102(27.3)
Crop disease/pests and adverse weather conditions	29(7.8)	45(12)	78(20.9)	222(59.4)
10-day summaries of crop and weather advisories	95(26)	96(26.3)	94(25.8)	80(21.9)
Plant density and soil moisture	60(16.2)	93(25.1)	114(30.2)	104(28)
Normalized difference vegetation index data in some instances	144(41.6)	96(27.7)	62(17.9)	44(12.7)

Multiple responses N = 399

Table 6: Extent of Need of Informational Services on Seasonality in Wheat Production, 2013

Information required	Extent of need of information				
	Don't Know (%)	Low %	Moderate (%)	High (%)	Mean(SD)
Rainfall onset and cessation dates	17(4.7)	17(4.7)	100(27.4)	231(63.3)	3.5(0.8)
Rainfall variability and distribution	8(2.2)	60(16.6)	141(39.1)	152(42.1)	3.2(0.8)
Temperature variability, potential eva-potranspiration and solar radiation	43(11.9)	107(29.6)	121(33.4)	91(25.1)	2.7(1.0)
Crop disease/pests and adverse weather conditions	15(4.1)	38(10.4)	96(26.4)	215(59.1)	3.4(0.8)
10-day summaries of crop and weather advisories	104(29.1)	98(27.4)	85(23.7)	71(19.8)	2.3(1.1)
Plant density and soil moisture	52(14.6)	96(27)	114(32)	94(26.4)	2.7(1.0)
Normalized difference vegetation index data in some instances	157(46.9)	82(24.5)	62(18.5)	34(10.1)	1.9(1.0)

**Multiple responses* N = 399

For wheat growing, more than half (63.3%) of the same farmers reported to require information on rainfall onset and cessation dates to a high extend; information on crop disease/pests and adverse weather conditions at 59.1% to a high extend as well as Rainfall variability and distribution at 42.1% to a high extend as illustrated in table 6. The 10-day summaries of crop and weather advisories and Normalized Difference Vegetation Index (NDVI) data type of information service was rated low in relation to wheat farming or they did not know anything about such a service.

On average, farmers rated information on rainfall onset and cessation dates as high (a mean score of 3.5) though there was a significant variation in the responses as indicated by the standard deviation (0.8). Rainfall variability and distribution, temperature variability, potential eva-potranspiration and solar radiation, crop disease/pests and adverse weather conditions and plant density and soil moisture were rated as moderate (mean score 3) with significant variation in the responses as indicated by the standard deviation (≥0.8). 10-day summaries of crop and weather advisories and Normalized difference vegetation index data in some instances were rated as low.

The farmers growing both maize and wheat seem to consider in order of importance information on climate and weather responsible for their crop success starting with rainfall onset and cessation dates; information seen as the most crucial followed by information on crop disease/pests and adverse weather conditions. Information on rainfall variability and distribution comes in as the third most important parameter as rated by farmers.

The results in this study are similar to findings in the study on “The state of climate information services for agriculture and food security in East African countries working paper no. 05 by Kadi, *et al*. (2011) which argues that for better operational agricultural practices, information provided by climate and weather information providers on the daily and weekly weather forecast and the 10-day climate outlook were considered as important by farmers and other users. Similarly, seasonal rainfall onset and cessation dates, advisories/alerts (extreme climate events), early warnings (outbreaks of pests and diseases), monthly climate outlook, agro-met forecasts, seasonal climate forecast, were found to be very important. On the 10-day climate information provided by National Meteorological and Hydrological Services (NMHSs), the finding differed considerably as farmers in this study rated the said information as low in their needs list while the previous study rated the same information as very useful. This could be attributed to the fact that the two study populations were not homogeneous in any way and had various diverse needs altogether. The levels of understanding may differ significantly hence affecting responses.

CONCLUSION AND RECOMMENDATION

Although Kenya Meteorological Services produces most of the climate and weather informational products and service, access challenges still remains as reported by most farmers. The small percentage noting that they received such services in form of farmers guide are mainly large scale farmers who have deliberately gone out to search for such important information. From the stated findings a general conclusion can be arrived at stating that farmers in Uasin Gishu County do not largely integrate climate and weather information in their farming decisions and practices. This creates a challenge to the farmers when making farming decisions especially with the prevailing climate variability.

Agricultural extension officers and fellow farmers are sources of climate and weather information utilised by maize and wheat farmers in Uasin. This clearly shows that seasonal forecast communications need to be channeled through existing trusted persons; in this case agricultural extension officers and the farmers themselves directly. The fact that farmers consult fellow farmers and agricultural extension officers has its own glaring dangers especially if the trusted channels do not access credible information on climate and weather; farmers may end up getting information that may not be useful at all to their activities.

Access to available climate information and products is generally farmer led and agricultural shows, farmer’s field day /demonstrations are other information outlets that farmers use to access agro-meteorological information. Such channels can be targeted with good quality climate and weather informational products and services.

Indigenous knowledge systems and experience gained over time are other sources of information that informs a farmer’s decision in the farming calendar. As seen from the findings, it is clear that farmers are greatly influenced by their traditional knowledge systems and experience in their farming decisions which make it difficult for them to cope or are left vulnerable to the prevailing climate variability brought about by climate change which has distorted seasons known to farmers over time. Integrating both scientific and indigenous knowledge systems in weather prediction is critical and will facilitate uptake and ownership of climate and weather informational products and services because farmers perspectives will have been given important consideration.

Education level is significantly related to access to climate and weather information (Chi = 17.957, P = 0.001). The more educated a farmer is the more likely he/she will access climate and weather information. It is important therefore to understand the level of education of farmers before attempting to provide such information. If farmers are educated, they are able to access and ultimately use the available climate and weather information. Effective outreach programs coupled with educational initiatives to help farmers understand the use of climate information to realize its full potential is important. This will involve giving greater priority to extension and communication activities and mainstreaming climate information access in all relevant agricultural sectors at National and County levels.

The large number of farmers who do not access climate and weather informational products and services and do not even know the organization producing such products and service is a confirmation that maize and wheat farmers in Uasin Gishu County do not largely integrate climate and weather information in their farming decisions. If they come across it, the same information is not simplified enough (downscaled) to meet the needs of farmers. Deliberate efforts have to be therefore worked out at National and County level on sensitization of farmers on proper use of climate and weather informational products and services and downscaling such information to meet the farmer's needs.

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REFERENCES

Anuforo, A. C. (2009). Nimet's agro-climate information services: A Vital tool for managing food crisis in Nigeria. *A Paper presented by Dr. Anthony C. Anuforo; DG/CEO (NIMET) at the 2009 World Food Day Symposium: ''Achieving Food Security in Times of Crisis. Abuja, Nigeria.* Retrieved November 15, 2012 from (http://www.nignationalagricshow.biz/applications/Vital_Tool_For_Managing_Food_Crisis_in_Nigeria.pdf).

Government of Kenya (2014). Kenya Meteorological Service (KMS) outlook for March-April-May 2014 "long-rains" season. Ministry of Environment, Water and Natural Resources, Nairobi, Kenya Retrieved May 30, 2014 from (http://www.meteo.go.ke/obsv/agro.html).

Government of Kenya (2013). Uasin Gishu County profile 2013. Ministry of Agriculture, Uasin Gishu County, Directorate of Agriculture, Eldoret.

Government of Kenya (2014). Kenya Meteorological Services. Ministry of Environment, Water and Natural Resources, Nairobi, Kenya. Retrieved on June 01, 2014 from (http://www.meteo.go.ke).

Government of Kenya (2009). Kenya Population and Housing Census 2009. Kenya National Bureau of Statistics, Nairobi (https://www.knbs.or.ke)

Hansen, J. and Tall, A. (2014). Challenges and opportunities for supporting smallholder Farmers with climate services. A *World Bank presentation Transcript.* CGIAR/CCAF programme. Retrieved on May 10, 2014 from (http://www.slideshare.net/cgiarclimate/hansen-tall-world-bank)

Hansen, J. W. (2002). Realising the potential benefits of climate prediction to agriculture: Issues, approaches, challenges. In *Agricultural Systems 74: 3, pp. 303 – 330*. Retrieved online from DOI: 10.1016/S0308-52X (02)00043-4

Hill, H. S. J. and Mjelde, J. W. (2002). Challenges and opportunities provided by seasonal climate forecasts: A literature Review. *In Journal of Agriculture and Applied Economics 34.3 (2002): 603 – 632* (Https://econpapers.repec.org)

Jones, P. G. and Thornton, P. K. (2003). The potential impacts of climate change on maize production in Africa and Latin America in 2055. In *Global Environmental Change 13:1,* *pp. 51-59*. Retrieved 12 July, 2013 from DOI: 10.1016/50959-3780(02)00090-0

Kadi, M., Njau, L. N., Mwikya, J. and Kamga, A. (2011). The State of Climate Information Services for Agriculture and Food Security in East African Countries. *CCAFS Working Paper No. 5*. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) pp 1 – 49. Retrieved March, 15, 2014 from (www.ccafs.cgiar.org).

Konneh, K. A., (2006). An Assessment of NOAA Funded Agriculture and Climate Interactions Research 1995–2005. NOAA Climate Program Office Report (draft). Silver Spring, NOAA.

O'Brien, K., Sygna, L., Naess, L., Kingamkono, R. and Hochobeb, B. (2000). Is information enough? User responses to seasonal climate forecasts in southern Africa: *Report to the World Bank, AFTE1- ENVGC. Adaptation to climate change and variability in sub-Saharan Africa, Phase II, No. 3*. CICERO Centre for International Climate and Environmental Research, Oslo. Retrieved April 30, 2014 from (http://brage.bibsys.no/xmlui/bitstream/handle/11250/191938/-1/CICERO_Report_2000-03.pdf)

Parry, Jo-Ellen., Echeverria, D., Dekens, J. and Maitima, J. (2013). Climate Risks, Vulnerability and Governance in Kenya: A review. UNDP Climate risk management report November, 2013. Retrieved June 14, 2014 from (www.preventionweb.net/files/globalplatform/entry_bg_paper~keynaclimaterisksvulnerabilityandgovernanceinkenyaareviewiisdundpjan13.pdf)

Ramtu and Kemei, J. (2015). *Personal Interview*, 15 May, 2015. Agriculture Sector Development Support Unit (ASDSP), Uasin Gishu County

Sivakumar, M. V. K. (2006). Dissemination and communication of agro-meteorological information - global perspectives. In *Meteorol. Appl. (Supplement), 21–30 (2006)*, World Meteorological Organization. Retrieved July 18, 2011 from DOI/10.1017/S1350482706002520/pdf

Vogel, C. and O'Brien, K. (2006). Who can eat information? Examining the effectiveness of seasonal climate forecasts and regional climate–risk management strategies. *Climate Research* 33: 111–122.

Walker, S., Mukhala, W. J., Van Den Berg and Manley, C. (2001). Assessment of Communication and use of climate outlooks and development of scenarios to promote food security in the Free State province of South Africa: *Final Report submitted to the Drought Monitoring Centre (Harare, Zimbabwe) on the pilot project DMCH/WB/AAA 6.02/13/1* , p. 4 – 6. Retrieved January 06, 2014 from (http://www.wmo.int/pages/prog/wcp/wcasp/clips/modules/documents/mod5_assessment_%20commun.pdf)