Socio Economic Factors Influencing Utilization of Seasonal Climate Forecast Among Smallholder Farmers in Semi-Arid Lower Eastern Kenya: A Case of Masinga Sub-County

Gideon Kyalo Masesi[1*] Stephen K. Wambugu[1] Charles W. Recha[2]
1.Department of Social Sciences, Chuka University, P.O. Box 109-60400, Chuka, Kenya
2.Department of Geography, Egerton University, P.O. Box 536-20115, Egerton, Kenya

Abstract
This paper discusses the influence of socio economic factors influencing utilization of Seasonal Climate Forecasts (SCF) by smallholder farmers in semi-arid lower Eastern Kenya in Masinga Sub County. Questionnaires were administered randomly to a total of 274 respondents in four administrative locations namely; Masinga Central Location, Musumaa Location, Musingini Location, and Katulye Location. Data on socioeconomic factors influencing utilization of climate forecast information was collected using questionnaires. Both descriptive and inferential statistics were used in data analysis and in particular, Pearson correlation was used to test the relationship between socioeconomic characteristic and utilization of SCF. Results established that there exist a positive relationship between gender, age, education level, income, land size and utilization of seasonal climate forecast (p=.007,p=.000,p=.005,p=.000 and p=.003) respectively. The study concludes that socio economic factors cannot be ignored in dissemination of climate forecast information because they significantly affect utility. If these socio economic factors are observed in the entire process of climate forecasts production, and dissemination there is likelihood of increasing utility of climate forecasts by the households hence reaping benefits of forecasts. This study recommends that, socioeconomic factors be considered in the entire process of forecasts access and dissemination in order to reap benefits of the forecasts. This is because these factors have not been sufficiently prioritized as a fundamental instrument to enhance access and utilization of climate forecasts.
Keywords: Lower Eastern Kenya, Perception, Seasonal Climate Forecast, Semi-arid, Smallholder farmers.

1.0 Introduction

Climate and weather information used in Africa is drawn from global data sets for example CMIP5 and other projects, which cover large geographical areas. Other agencies such as national meteorological and hydrological agencies play vital role in generating and disseminating climate information within African countries (Singh, Urquhart, Osbahr, & Dorward 2016). Although different national agencies in Africa have different capacities, they have a common responsibility of collecting and maintaining observational data and ensuring communities, private sectors and government departments get climate and weather forecasts in time. Regional hubs give additional support in dissemination and coordination of climate forecasts. It is the responsibility of IGAD Climate Prediction and Application Centre (ICPAC) to give early warning climate hazard information to East African countries while the primary role of Agro meteorology and Hydrology Regional Centre (AGRHYMET) gives advices on food security and environmental issues for countries in the Economic Commission of West African States (ECOWAS). According to Traore, Kouressy, Vaskmann Tabo, Maikano, Traoré, & Cooper (2014), AGRHYMET have an additional service of climate change impact assessment for agriculture and water resources. This is due to increase in occurrence of climate extremes in West Africa countries. It is the role of Southern African Development Community – Climate Service Centre (SADC-CSC) to advice on climate forecasts occurring in Southern and Central Africa countries. It majorly deals with prediction of extreme and hydro meteorological products and covers operational services for climate monitoring.

According to Njau 2010, advancement in climate modelling has led to increased ability in rainfall prediction with a lead-time range from a few days to a few months. This has been made possible by use of statistical methods or dynamical forecasts. Klopper, Vogel, & Landman 2006 observed that, the African rural household majorly rely on rain fed farming systems and this is among the major source of livelihood, therefore African farmers can maximize the opportunities when favourable rainfall conditions are predicted and this will thus reduce vulnerability to climate extremes including drought.

The assessment of potential opportunities that may arise due to early prediction of climate forecasts has led to ignition of scientific and institutional processes aiming at developing and disseminating climate forecasts in Africa. According to Patt, Ogallo and Helmith, 2007, regional Climate Outlook Forums (COFs) was launched in 1990s with the role of producing seasonal rainfall forecasts for different parts of Africa. Similarly, COF known as the *Prévisions Saisonnières pour l'Afrique de l'Ouest* (PRESAO) in West Africa, meets prior to the onset of main rain season in may each year. World Meteorological Organization 2013 established a Global Framework for Climate Services to address issues of application of predictive climate information for risk management including severe droughts, destructive flooding and climate change.

Meza, Hansen and Osgood 2008, observed a limited progress in assessment of forecast use among vulnerable groups in Africa countries. In cases where some assessment has been tried theoretical models were used thus Msangi, & Rosegrant, 2007, saw the need to recommend a study to evaluate socioeconomic factors affecting forecast use including impacts of any management practices based on the forecast. Incorporation of socioeconomic factors in forecast dissemination and utility can increase preparedness, thus leading to better and improved social-economic and environmental outcomes within the agricultural systems. Incorporation of these factors can lead to making agricultural related decisions such as the cropping pattern to use, amount of fertilizers to invest in, choice of pesticides, planting periods, and other decisions to ensure maximum production. These decisions can only be guided by the nature of rainfall variability or specific climatic prediction variables for a specific year or season.

Although scientific forecasts has for a long time been issued by the relevant bodies such as Drought Monitoring Center (DMC) and the Kenya Metrological Department (KMD), Strachan, 2008, observed that these forecasts are formulated to cover a larger area. These forecasts are also presented in a way unfamiliar to the farmers, making it difficult for farmers to adequately utilize climate outlooks generated by these bodies. Climate forecasts can be predicted to a degree that would make it possible for farmers to respond effectively to the forecasts. If this is done, it would have a major positive impact on worldwide food security. Farmers would well prepare for climate anomalies. However, Stern and Easterling 1999 noted a gap between the information provided by meteorological services and that needed by household. Although seasonal climate forecasts are attractive, they pose problems in relation to testing of their predictions. A forecast can only be useful to a recipient only if it is skillful, timely and relevant to actions the household farmer can take to make it possible to impress the outcomes.

Studies have revealed that household farmers of Masinga Sub County always experience difficulties in accessing, interpreting and applying forecasts for their own benefit. Forecasts on planting time, onset and ending of the rains, and the possibility and timing of drought, would be useful to the community, and would enhance the decisions farmers make based on the near-normal, below-normal or above-normal rainfall categories if socio economic factors are put in to consideration. Despite advancements in computing and satellite technologies and improvements in various atmospheric model's scientists use to predict climate, there are still significant socio economic uncertainties in climate forecasts (Michalakes, Dudhia, Gill, Henderson, Klemp, 2004.) Almost everyone has his or her own anecdotal experiences about the unreliability of climate forecasts.

The widening incompatibility of climate forecasts as viewed against the needs of the farmers in agriculture coupled with the erosion of the integrity of these climate forecasts provided the rationality of this study to evaluate Socio Economic Factors Influencing Utilization of Seasonal Climate Forecast among Smallholder Farmers in Semi-Arid Lower Eastern Kenya: A Case of Masinga Sub-County

2.0 Methodology

2.1 Study Area

Masinga Sub County is an Arid and Semi-Arid region in the Eastern part of the larger Machakos County of Kenya. The Sub County experiences a bimodal rainfall pattern with annual rainfall averaging between 500 - 700mm per year (GOK, 2010). The short rain season occurs in March/May while long rains are received in the October/December period. Generally, rains in Masinga Sub County are erratic. Temperatures range between 27ºC - 33ºC, though at certain periods they can rise to as high as 40ºC (ibid). Food crops cultivated in the area are millet, pigeon peas, sorghum, maize, green grams and cowpeas. Cash crops are hardly cultivated but if done, they comprise cotton, sunflower and castor.

The Sub County is divided into four administrative locations, namely, Masinga Central Location, Musumaa Location, Musingini Location, and Katulye Location. Masinga Sub County covers an area of 213 square kilometers and comprises of a total population of 7241 persons (3240 males and 4001 females). It is comprised of 1978 households of which 954 are farm families (Ministry of Agriculture & Livestock [MoA&L] Office, Masinga District, 2011). The study area was chosen for the study because it has salient characteristics of Arid and Semi-Arid Lands (ASALs) areas. Climate forecasts is one of challenges of concern in such areas.

2.2 Sampling and data sources

Households were drawn from across the four main sub locations namely Katulye, Musingini Musuma and Masinga sub locations. Sample size for the farmers was determined using the formula below (Mugenda and Mugenda 2003)

$$n = \frac{Z^2 pq}{d^2} \quad \text{--------------------------------} \quad (1)$$

Where:

n = the desired sample size if the target population is greater than 10,000

Z= the standard normal deviate at the required confidence interval

P= the proportion in the target population estimated to have the desired characteristics being measured

q= 1-p

d = the level of statistical significance

In this case, the total sample size was less than 10,000 therefore; the formula below was used

$$n_f = \frac{n}{1 + n) / N} \text{ -- } (2)$$

Where: nf = the desired sample size (when the population is less than 10,000)
n= the desired sample size (when the population is more than 10,000)
N= the estimate of the population size

A systematic random sampling procedure was employed. This approach was chosen because it ensured an equal probability of inclusion of each unit in the population than simple random sampling (Nassiuma and Mwangi, 2004). Data on Socio Economic Factors Influencing Utilization of Seasonal Climate Forecast was collected from household using questionnaires..

2.3 Data Analysis

Inferential and descriptive statistics were used in data analysis. Pearson's correlation coefficient was used to describe the strength of the relationship between the independent and dependent variables. The correlation coefficient is a measure that determines the degree to which two variables are associated. The range of values for the correlation coefficient is -1.0 to 1.0. If a calculated correlation is greater than 1.0 or less than -1.0, a mistake has been made. A correlation of -1.0 indicates a perfect negative correlation, while a correlation of 1.0 indicates a perfect correlation. A value of exactly 1.0 means there is a perfect positive relationship between the two variables.

3.0 Results and Discussion

Socio economic characteristics of smallholder farmers may influence utilization of seasonal Climate forecasts. This include gender, age, education level, income and land size. Pearson Correlation was used to test the relationship socioeconomic characteristics and utilization ofSeasonal climate forecast. The results are shown in table 1

Table 1: Correlation between Socio Economic Characteristics and Utilization of Climate Forecast Information

Variable	Pearson Correlation Coefficient	Significance
Gender	.836**	.007
Age	.666**	.000
Education level	.744**	.005
Income	.628**	.000
Land Size	.596**	.003

** Significant at 0.01 level * Significant at 0.05 level

The study found that 69% of the respondents were male while 31% of the households were female. A Spearman's correlation coefficient analysis was carried out to find out the relationship between gender and utilization of climate forecast information. Results showed that there is a strong, positive correlation between the two variables (gender and utilization of climate forecast information) (r= .836, p=.007, α=.01) as represented in table 1. From the results, female respondents (31%) were more likely to make use of climate forecast information than their male counterparts. Gender has an effect on access to information from different sources. It influences the information seeking behavior and ability to make decisions. Nhemachena and Hassan (2007) argued that female households are more likely to utilize climate forecasts when issued and received in good time since they are responsible for much of the agricultural work hence have greater experience than men.

Respondents ages range was from 20- 80 years with a mean of 50 and standard deviation of 14.68. Majority of the respondents aged 50-59 years representing 38%. On calculating a Spearman's correlation coefficient analysis between age and utilization of seasonal climate forecast information, positive significant correlation (r= .666, p=.000, α=.01) was found. This therefore means, age has an effect on utilization of seasonal climate forecasts. Young farmers are more likely to utilize seasonal climate forecast information when received compared to old people. According to Ziervogel and Zermoglio (2009), older farmers are perceived to have more knowledge on indigenous methods of climate forecasting and their agricultural decision are based on indigenous knowledge. In addition, age increases experience and perception of climate forecasts hence likelihood to utilize. Therefore, seasonal climate forecasts might be of less significance if passed to the old generation who might not utilize them. Shirferaw and Holden (1998) argued that older farmers may be less willing to take risks associated with scientific climate forecasts issued. More so, younger farmers have more access to education and exposure thus making them more receptive to change (Vogel & O'Brien, 2006). Feleke (2015) reported that majority of the younger farmers are more active and receptive to information and could withstand the test and scientific climate forecasts when dissemination is done on time. This means to increase utility of scientific climate forecasts age must be taken in to account.

Findings from the study showed that 33% had primary education, 28% attained secondary education, 16% had attained technical colleges certificates while 4% are university graduates. A few farmers (11%) had no formal education while 8% were able to read and write. Results from correlation coefficient (Table 1) shows that there is a strong, positive correlation between the two variables (education level and utilization of seasonal climate forecasts) (r= .744, p=.005, α=.01). This means education level has a positive effect on utilization of seasonal climate forecast. Thus, access to formal education can increase the likelihood of utilizing climate forecast information for farming purposes. Formal education therefore can make a person to make informed decisions of when and what to plant in relation to the anticipated weather patterns. Uddin, (2014) found that more educated farmers are better able to utilize climate forecast when given to them and even forecast future scenarios.

Majority of the respondents (55%) earned a total of Ksh. 10,000-20,000 while a few (6 %) earned more than Ksh. 40,000, some 11% earned below Ksh. 10,000 while 20% earned between Ksh. 20,000 and 30,000. Results from correlation coefficient showed a positive significant relationship (r= .628, p=.000, α=.01). This means income has a positive effect on utilization of seasonal climate forecasts. Income increases the capacity to make choices and access to information. It also reduces risk averseness and discount rate hence greater willingness utilize information. This finding is in agreement with Nhamachena and Hassan (2007) who observed that a higher income farmer may be less risk averse, have more access to information, and are more willing to utilize climate forecasts. Property ownership increases the propensity of a farmer to utilize climate forecasts for agricultural purposes. This is also in agreement with Conway (2009) who found that rural households with diverse income sources are most able to maximally make use of climate forecasts. He also observed that usability of scientific climate forecasts can be enhanced through diversification of rural livelihoods by increasing their on-farm and off farm income opportunities.

Very few residents (5%) had a land of average size 0.1-0.5 hectares. However, majority of the respondents (38%) had a large land size exceeding 5 hectares. Some 26% of the households had between 3-5 ha, 20% between 1-2 ha while only 11% had land size of between 1-2 ha. A Spearman's correlation coefficient analysis was conducted and results showed that a positive relationship (r= .596, p=.003, α=.01) between the variables. This indicates that land size has a positive effect on utilization of seasonal climate forecasts. Households who have large farm sizes are more likely to consult on climate forecasts before making any decisions. This is consistent with the finding by Feleke (2015), who found out that in Central Kenya, utility of climate forecasts was influenced by land size. This is because such large land sizes require a lot of capital investments for any viable agricultural purposes and as such, farmers felt that it was inappropriate to gabble with climate uncertainties thus consulting climate forecasts on the likelihood of a certain season. A study by Curry (2001), found that large-scale commercial farmers used climate forecasts more rapidly than small holders. This is because large-scale farmers were willing to experiment them with new farming techniques and technologies.

4.0 Conclusion and Recommendation

Results showed a positive relationship between utility of climate forecast information and various socio economic characteristics such as education level, age, gender, and income. If this socioeconomic characteristics are observed in the entire process of climate forecast production and dissemination, there is likelihood of increasing utilization of climate forecasts by the households hence reaping benefits of this information. The study recommends that there is need to sufficiently prioritize socio economic factors as a fundamental instrument to enhance access and utility of climate forecasts. These factors need to be considered in the entire process of forecasts access and dissemination in order to reap benefits of climate forecasts.

5.0 References

Curry, J. (2001). *Use of climate information in the Greater Horn:* Assessing the needs of institutional users. International Research Institute for Climate Prediction. Technical Report 01-02, IRI, Palassade, New York.

Feleke, H.G. (2015). Assessing Weather Forecasting Needs of Smallholder Farmers for Climate Change Adaptation in the Central Rift Valley of Ethiopia. *J Earth Sci Clim Change. 6: 312. doi:10.4172/2157-7617.1000312*

Government of Kenya. (2010). *Kenya population and housing census, Vol. 1a: Population by administrative units*

Klopper, E., Vogel, C.H., Landman, W.A. (2006). *Seasonal climate forecasts* – Potential Agricultural-risk management tools? *Climatic Change 76, 73–90.*

Meza, F.J., Hansen, J.W., & Osgood, D. (2008). Economic value of seasonal climate forecasts for agriculture*:* review of ex-ante assessments and recommendations for future research. J. Appl. Meteorol. *Climatol. 47, 1269–1286.*

Michalakes J., Dudhia J., Gill D., Henderson T., & Klemp J. (2004*). The weather research and forecast model:* Software Architecture and Performance*.*

Msangi, S., Rosegrant, M.W., & You, L. (2006.) Ex post assessment methods of climate forecast impacts. *Clim. Res. 33, 67–79.*

Mugenda, O.V & Mugenda, A, G. (2003).*Qualitative and Quantitative approaches* .Research Methods

Nassiuma, D.K., & Mwangi, J.W. (2004). *Statistical Methods For information analysis*. An Introduction. Egerton

University Press. Kenya.

Njau, L.N. (2010). *Seasonal-to-inter-annual climate variability in the context of development and delivery of science-based climate prediction and information services worldwide for the benefit of society.* Procedia Environ. Sci., 1 (2010), pp. 411-420

Nhemachena, C., Hassan, R. (2007). Micro-level analysis of farmers' adaptation to climate change in Southern Africa; *International Food Policy Research Institute: Washington, DC, USA, 36*

Patt, A., L. Ogallo and M. Hellmuth. (2007). *"Sustainability*: Learning from 10 Years of Climate Outlook Forums in Africa." *Science* 318(5847): 49.

Roncoli, C, Just C., Kirshem, P. & Hongerboom, G. (2009) *Risk management and social learning in farmers response to seasonal climate forecast in three agro-ecological zones of Burkina Faso*. In American Association of geographer. August meeting, Denever, Colorado

Salack, S. B., & Muller, A.G. (2011). Rain-based factors of high agricultural impacts over Senegal. *Part I: integration of local to sub-regional trends and variability. Theoret. Appl. Climatol., 106 (2011), pp. 1-22*

Shiferaw, B. & Holden, S. (1998). *Resource degradation and adoption of land conservation technologies in the Ethiopian highlands*. Agricultural Economics 27, 739-752

Singh, C., Dorward, P., & Osbahr, H. (2016). Developing a holistic approach to the analysis of farmer decision-making: Implications for adaptation policy and practice in developing countries. *Land Use Policy, 59, 329–343*

Sterm, P. &W, Easterling (Eds). (1999). *Making climate forecast matter*. Washington D.C: National Research council, National Academy Press

Strachan, K. (2008). *Predicting Weather with Science and Spider Webs*. The IUCN World Conservation Congress. http://www.ipsterraviva.net/tv/IUCN2008/currentNew.aspx?new=1224. (Accessed on 01/04/2017)

Traoré P.C.S., Kouressy, M., Vaskmann, M., Tabo, R., Maikano, I., Traoré S.B., & Cooper P.
(2007). *Climate prediction and agriculture*: What is different about Sudano Sahelian West Africa? In Sivakumar M V K and Hansen *J eds Climate prediction and agriculture: advances and challenges* World Meteorological Organization 189-203

Uddin, M (2014). Factors affecting farmer's adaptation to environmental degradation and climate change effects: A farm level study in Bangladesh. *Climate, 2,* 223-24

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

WMO, (2013) GFCS – Intergovernmental Board on Climate Services. *Special Bulletin 62*.Zievogel, G., & Zermoglio, F. (2009). Climate change scenarios and the development of adaptation strategies in Africa: Challenges and opportunities. *Climate research, 40,* 133-146