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# Impact of Meteorological Information Delivery on Mazie Production in Rwanda

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Abstract: In most poor and developing countries including Rwanda, the agricultural production is still subsistence due to the fact that farmers depend entirely on the availability of rainfall. This study aimed to assess the impact of meteorological information sharing on maize production. The study considered the case Cooperative de Cultivateurs de Mais (COOPCUMA) located in Gatsibo district, Eastern Rwanda from 2015 to 2020. Secondary data on the types, sources, receiving devices and usage of meteorological information along with maize production before and after meteorological information sharing were employed. These data were collected from COOPCUMA management. The Microsoft Excel analyzed and presented the data into tables and Figures while the Pearson Correlation of Statistical Package for Social Sciences (SPSS) analyzed how meteorological information contributed to maize production. The results indicate that the highest maize production was 2.5 tons per hectare before (2015-2017) meteorological information sharing. Between 2018 and 2020 when meteorological information was shared, the lowest production per hectare was 5tons/ha but higher than the last production registered before sharing information. The statistical relationship between meteorological information sharing and maize production generate a very high P value of 0.9 which confirms how much such information sharing to farmers contributes to production. The results of this study are of importance to farmers and policy makers since the initiated program generated good results and hence, can be adopted in other similar regions.

Keywords: COOPCUMA, Gatsibo district, Maize production, Meteorological Information, Rwanda

# 1. Introduction

Climate change has been evidenced to be a challenge affecting development, livelihoods and agriculture production worldwide (Haile, 2005; Huq et al., 2004). Impacts of climate change on agriculture production are reported to be major causes of fluctuation in food production in the developing world due to the rise in surface temperature trends in the last decades (Sivakumar et al., 2005).

In most poor and developing countries, the agricultural production is still subsistence due to the fact that farmers depend entirely on the availability of rainfall. However, in case of high intensity, the production faces decreasing record since farmers well not aware of the upcoming rainfall patterns from which relevant planning would base on (Restuccia, 2016). This expresses the extent to which the delivery of meteorological information can help farmers to recognize the predicted weather change in terms of temperature and rainfall and then plan accordingly.

Within the sub-Saharan Africa (SSA) countries, agriculture largely contributes to employment of the majority of the people in rural areas and significantly to the Gross Domestic Product (GDP) of most countries (Coulibaly et al., 2020). The increasing rise in temperatures and increased stochastic rainfall variations has both direct and indirect grave consequences on crop yields and agricultural productivity (Gebauer and Doevenspeck, 2015; Huong et al., 2018). While agriculture is so important to most developing economies in SSA, most agricultural sectors in SSA have performed poorly relative to other developing world regions (Tadesse, 2010).

In Rwanda, precisely in eastern province, agriculture is mainly practiced for subsistence where traditional methods of farming such as mixing crops and use of organic manure are used (NISR, 2010). This eastern province of Rwanda is known to have experienced more drought than any other part of Rwanda where major floods events reported in the last 10 years caused deleterious damage that resulted into the loss and damage to agricultural crops, soil erosion and environmental degradation (Asumadu-Sarkodie et al., 2015).

However, timely sharing of climate information services to farmers has been subjected to trainings on participatory integrated climate services for agriculture to build a more climateresilient agriculture sector and national economy through improved climate risk management (Akinyemi and Uwayezu, 2011; Dorward et al., 2015). In addition, there no studies which have been conducted to indicate how the provided information reaches farmers, either timely or late. Also, it is good to indicate how the information helps farmers improving their production since the message alerts them on the time when rainfall might fall and its intensity from which further planning can be based on. Therefore, this study assessed how delivering meteorological information can contribute to farmers' production.

#### 2. Methods and Materials

#### 2.1 Description of study area

The study was conducted in Gatsibo district (Figure 1), one of seven districts of the eastern province of Rwanda namely Bugesera, Gatsibo, Kayonza, Ngoma, Kirehe, Nyagatare and Rwamagana districts (NBD, 2014).



#### Figure 1: Location of Gatsibo district

Gatsibo District is characterized by a low rainfall and high temperatures that limit the availability of water where the mean annual temperature of 20.9°C and mean annual rainfall is 874 mm, July being the driest month with 11 mm of precipitation. In April, the precipitation reaches its peak, with an average of 152 mm. The temperature varies with an average of 21.6 °C and August is the warmest month. At 20.4 °C on average, December is the coldest month of the year. The precipitation varies 141 mm between the driest month and the wettest month. The variation in annual temperature is around 1.2 °C (MINAGRI, 2018).

Gatsibo District has a hydrographic network composed of several wetlands whose total area is 17,300 ha. The largest continuous wetlands are found in Akagera National Park and include Akagera River and Lake Milindi. The Topography is characterized by lowly inclined hills and dry valleys. The District experiences low rainfall (830 mm/yr) and high temperatures in two main seasons. The dry season extends 5 months with an annual average temperature of 25.3°C - 27.7°C (Benimana et al., 2021).

It is possibly the above reason of climate change impact on agriculture production in the Eastern Rwanda which attracted the CIAT to approach farmers and share with them meteorological information in order to minimize losses. The researcher also recognized this characteristic of Gatsibo district and the fact that meteorological information sharing was initiated to some cooperatives growing maize in the district. This aimed to analyze the extent to which such information sharing contributes to maize production.

# 2.2 Data Collection

The study employed secondary data related to types of meteorological information shared to farmers. The authors based on the fact that agriculture in Rwanda is rain-fed and then focused on the (a) types of meteorological information shared, (b) frequency of information sharing and (c) access (devices used) and information sources. The authors also employed datasets on maize production before the program started (2015-2017) and after (2018-2020).

Both types of data employed by this study were collected from the COOPCUMA database/report of 2015-2020. The authors also approached the meteorological data provider to farmers namely the Rwanda Meteorological Agency (RMA) and the International Centre for Tropical Agriculture (CIAT) Rwanda through its Participatory Integrated Climate Services for Agriculture (PICSA) program which provided training to farmers on the use of meteorological information.

# 2.3 Data Analysis

For this study, the data on meteorological information sharing were presented into Tables and some texts were employed in case more details were received from the data providers. The data on maize production were subdivided into two parts; before meteorological information sharing with farmers (2015-2017) and after (2018-2020) and all were presented into Charts. The Microsoft Excel analyzed all data and facilitated to analyze the Pearson Correlation between meteorological information sharing and maize production. In order to successfully perform the

Pearson Correlation analysis, the authors based on the fact that a p-value smaller than 0.05 indicated a statistically significant association (at 5 % level) and a p-value larger than 0.05 reveals no statistically significant association between two variables tested. The final results will be presented into Tables and Charts/Graphics.

#### 3. Results

### **3.1 Meteorological information sharing**

Regarding the meteorological information shared to the COOPCUMA cooperative members, as indicated in Table 1, it was realized that temperature and rainfall related information are shared with farmers. This information is mainly shared on daily basis through mobile phones. The results in Table 1 indicate that that after receiving the information and training on their usage, the cooperative members employ it in the determination of sowing period and estimating the expected harvest time, selection of relevant varieties/seeds, applying irrigation alternatives, choosing the daily time of dry up and envisaging their crops 'weed/pests control measures.

Meteorological information sharing							
	Delivery range/frequency	Receiving device	Provider	Trainer on information use/application			
Rainfall	Daily						
	Monthly	Mobile phones, Radio and TV	RMA	CIAT			
	Quarterly						
Temperature	Daily	Mobile phones, Radio and TV	RMA	CIAT			
	Informat	tion usage/applicatio	n				
Determination of sowing period and expected harvest time							
Selection of relevant varieties/seeds							
Choice of	Choice of daily time for dry up						
Envisage	Envisage weed/pests control measures						
Referrin	g to irrigation alternative						

**Table 1: Meteorological information sharing** 

Source: COOPCUMA, 2022

# 3.2 Maize production

For the result son maize production, the authors employed the recorded maize production registered by the COOPCUMA between 2015 and 2020. The results were subdivided into two sections before and after using the meteorological data.

As per the COOPCUMA report, this cooperative cultivates 50 hectares of maize. The authors employed annual data on maize production as illustrated in Figure 2 and 3. The results on maize production between 2015 and 2017 showed that the production of maize was stable in 2015 and 2016 at 1.5 tons per hectare. And the year 2017 recorded increasing production at 7.5 tons per hectare. Hence, between 2015 and 2017, 16.5 tons were harvested per ha which implied that within 50 hectares occupied by COOPCUMA Cooperative, a total of 825 tons of maize were harvested within 50 hectares across three years (2015-2017).



Source: COOPCUMA, 2022

In addition, as the authors aimed to analyze maize production after applying meteorological information shared with farmers, the results in Figure 3 were related to the recorded maize production. The research finding sin Figure 3 revealed a growing trend of maize production from 2018 and 2020 when COOPCUMA cooperative members were growing maize by referring to the meteorological information shared with them. In 2018, 15 tons were harvested per hectare which increased up to 27.5 tons of maize per hectare in 2020. The total production recorded between 2018 and 2020 was 63.5 tons per hectare equivalent to 3,175 tons per 50 hectares owned by the COOPCUMA cooperative (Figure 3).



Figure 3: Maize production between 2018 and 2020

Source: COOPCUMA, 2022

# 3.3 Impact of meteorological information delivery on maize production

Based on the results on both maize productions recorded before (2015-2017) and after (2018-2020) meteorological information to farmers, it is evident that the maize production increased distinctively after farmers received and applied the shared information within their maize growing practices. Although for maize production several factors are considered including soil types, seeds types, fertilizer and many more, only the authors limited the focus on meteorological information by considering other factors as constant.

Therefore, the authors based on the above facts and then conducted a Pearson analysis test in order to examine the extent to which meteorological information sharing contributed to maize production at COOPCUMA cooperative as detailed in the following Tables 2 and 3. In order to better assess the impact of meteorological information sharing on maize crop production, the researcher consider the values of coefficient r suggested in Table 2.

	Coefficient, r		
Strength of Association	Positive	Negative	
Small	.1 to .3	-0.1 to -0.3	
Medium	.3 to .5	-0.3 to -0.5	
Large	.5 to 1.0	-0.5 to -1.0	

#### Table 2: Pearson correlation analysis guideline

For the current study, the Pearson Correlation analysis between the meteorological information sharing and maize production, the estimated P value was 0.968. This was value was considered as largely positive and/or very strongly statistically significant relationship between meteorological information sharing and maize production.

**Table 3: Pearson correlation results** 

		Information usage	Maize production
Information usage	Pearson Correlation	1	.968
	Sig. (2-tailed)		.162
	Ν	3	3
Maize production	Pearson Correlation	.968	1
	Sig. (2-tailed)	.162	
	Ν	3	3

# 4. Discussion

The changing climate is gradually increasing its negative impacts on food security and the poor and developing countries are the largely affected among others. This results from the fact that agriculture as a major source of food employing high number of people in these countries but depending on climate and also exposed to extreme weather events that lead to a reduction in agricultural production worldwide (Pachauri et al., 2014).

It is reported that the impact of climate variability in agriculture mainly is observed either by increased water demand or reduced water availability in the areas suitable for irrigation (IPCC, 2014).

Across the Sub-Saharan African region where Rwanda is located, the agricultural practices count nearly 96% of rain fed agriculture compared to overall production. However, the region is also facing the effects of climate change which weaken agricultural productivity by causing a series of extreme weather events that require high adaptation cost especially in developing countries (Pachauri et al., 2014). This is nowadays recognized and agriculture is receiving more attention worldwide in terms of adapting to the negative impacts in order to meet the needs of poor people who depend directly on agriculture for food (Connolly-Boutin and Smit, 2016).

This study was conducted to analyze the impact of timely sharing meteorological information with farmers on their maize production. The results indicate a growing trend of maize production after farmers started working with the framework. The results of 2015-2017 (Table 1) were also increase but not as that of 2018-2020 (Table 2) when CIAT approached farmers and share with them meteorological information. The results on this study are supported by the recent reports (Chenglin et al., 2018; Mukabutera et al., 2016; Tarnavsky et al., 2014) which state the importance of updating farmers in terms of weather variability and climate change, especially those in poor and developing countries who are still depending on rainfall in order to plan when to sow and/or practice other farming practices.

In most cases, meteorological information is shared through radio and televisions; however, as long as mobile phones of farmers are receiving such alert (Table 1) on daily basis, it is a good option to ensure changes on crop production. Furthermore, the analyzed Pearson correlation (Table 3) generated a positive P value (higher than 0.5) which undoubtedly confirms how much sharing meteorological information with farmers can contribute to their crop production. Finally, despite the fact that the consulted cooperative grows maize, it can be suggested to expand the program to other farming cooperatives engaged in growing other crops and livestock as well.

#### 5. Conclusion

This study aimed to analyze the extent to which sharing meteorological information with farmers contributed to increasing their maize production. The authors considered the case of Cooperative de Cultivateurs de Mais (COOPCUMA) located in Gatsibo district of the Eastern Rwanda. The results indicate that before meteorological information was shared with farmers and used as well, maize production was quite low. The highest production was 2.5 tons per hectare while after the information was shared with farmers, significant changes in terms of maize production were recorded. It was noticed that between 2018 and 2020 during the period when meteorological information was shared, the lowest production per hectare was 5tons/ha but higher than the last production registered before sharing the information (2015-2017) with farmers. In addition, the statistical relationship between meteorological information sharing and maize production generate a very high P value of 0.9 which confirms how much such information sharing to

farmers contributes to production. The results of this study greatly confirm that m sharing meteorological information has an impact on the production of maize. Policy makers can benefit from this research as well as local communities.

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#### References

- Akinyemi, F. O., and Uwayezu, E. (2011). An assessment of the current state of spatial data sharing in Rwanda. *International journal of spatial data infrastructures research* 6, 365-387.
- Asumadu-Sarkodie, S., Rufangura, P., Jayaweera, M., and Owusu, P. A. (2015). Situational analysis of flood and drought in Rwanda. *International Journal of Scientific and Engineering Research* **6**, 960.
- Benimana, G. U., Ritho, C., and Irungu, P. (2021). Assessment of factors affecting the decision of smallholder farmers to use alternative maize storage technologies in Gatsibo District-Rwanda. *Heliyon* 7, e08235.
- Chenglin, Q., Qing, S., Pengzhou, Z., and Hui, Y. (2018). Cn-makg: China meteorology and agriculture knowledge graph construction based on semi-structured data. *In* "2018 IEEE/ACIS 17th International Conference on Computer and Information Science (ICIS)", pp. 692-696. IEEE.
- Connolly-Boutin, L., and Smit, B. (2016). Climate change, food security, and livelihoods in sub-Saharan Africa. *Regional Environmental Change* 16, 385-399.
- Coulibaly, T., Islam, M., and Managi, S. (2020). The impacts of climate change and natural disasters on agriculture in African countries. *Economics of Disasters and Climate Change* 4, 347-364.
- Dorward, P., Clarkson, G., and Stern, R. (2015). Participatory integrated climate services for agriculture (PICSA): Field manual.
- Gebauer, C., and Doevenspeck, M. (2015). Adaptation to climate change and resettlement in R wanda. *Area* **47**, 97-104.
- Haile, M. (2005). Weather patterns, food security and humanitarian response in sub-Saharan Africa. *Philosophical Transactions of the Royal Society B: Biological Sciences* **360**, 2169-2182.
- Huong, N. T. L., Yao, S., and Fahad, S. (2018). Assessing household livelihood vulnerability to climate change: The case of Northwest Vietnam. *Human and Ecological Risk Assessment: An International Journal*, 1-19.
- Huq, S., Reid, H., Konate, M., Rahman, A., Sokona, Y., and Crick, F. (2004). Mainstreaming adaptation to climate change in least developed countries (LDCs). *Climate Policy* 4, 25-43.
- IPCC, C. C. (2014). Mitigation of climate change. *Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*
- Mukabutera, A., Forrest, J. I., Nyirazinyoye, L., Marcelin, H., and Basinga, P. (2016). Associations of rainfall with childhood under-nutrition in Rwanda: an ecological study using the data from Rwanda meteorology agency and the 2010 demographic and health survey. Asian Journal of Agriculture and Food Sciences 4.

- Pachauri, R. K., Allen, M. R., Barros, V. R., Broome, J., Cramer, W., Christ, R., Church, J. A., Clarke, L., Dahe, Q., and Dasgupta, P. (2014). "Climate change 2014: synthesis report. Contribution of Working Groups I, II and III to the fifth assessment report of the Intergovernmental Panel on Climate Change," IPCC.
- Restuccia, D. (2016). Resource Allocation and Productivity in Agriculture. *University of Toronto, Canada*.
- Sivakumar, M., Das, H., and Brunini, O. (2005). Impacts of present and future climate variability and change on agriculture and forestry in the arid and semi-arid tropics. *In* "Increasing climate variability and change", pp. 31-72. Springer.
- Tadesse, D. (2010). The impact of climate change in Africa. *Institute for Security Studies Papers* **2010**, 20.
- Tarnavsky, E., Grimes, D., Maidment, R., Black, E., Allan, R. P., Stringer, M., Chadwick, R., and Kayitakire, F. (2014). Extension of the TAMSAT satellite-based rainfall monitoring over Africa and from 1983 to present. *Journal of Applied Meteorology and Climatology* 53, 2805-2822.

