JRIIE Journal of Research Innovation and Implications in Education
Center for Research Implications & Practice

Website: www.jriie.com **ISSN 2520-7504 (Online) Vol.4, Iss.3, 2020 (pp. 145-155)**

Innovative Approaches to the Co-production of Climate Services in Rwanda

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Received May 17, 2020; Revised August 23, 2020; Accepted August 24, 2020

***Abstract**: Climate change and variability is associated with increase in uncertainties, more frequent droughts and intense flooding, windstorms and disease outbreaks. These climatic hazards have greatest impact on livelihoods of vulnerable agrarians especially in sub Saharan Africa. The vulnerability of livelihoods to impacts of climate change depends on the extent of exposure, sensitivity and adaptive capacity of the people affected. Dissemination of useful and tailored climate services information to end users need close collaboration between meteorological experts and institutions that are involved in rural activities and work with farmers at grass roots in regard to support. Very little is however known in the existing literature on how the climate and weather information are co-produced. In this study, we aimed at examining the types of innovative approaches used to co-produce and disseminate coproduced climate services; the types of co-produced services (information) provided; and the decisions made on the co-produced climate services (information) by the end users, and the communication channels used to disseminate the climate services. Using descriptive survey design, we collected data on 2102 local farmers across the country using phone survey/interviewing. Data was analysed using VIAMO Platform. Results indicated different innovative approaches employed to enhance production, dissemination, and feed-back of climate and weather information, various communication approaches and decisions/feedback provided by farmers. We recommended that these innovative approaches be strengthened, empowered and expanded to all local farmers in Rwanda.*

***Key words:** Climate change, Innovative approaches, Co-production, Agrarians, Farmers, Rwanda*

How to reference this article (APA):

Byandaga, L. & Gatsinzi, P. (2020). Innovative approaches to the co-production of climate services in Rwanda. *Journal of Research Innovation and Implications in Education, 4*(3), 145 – 155.

1. Introduction

Climate change is one of the most global challenges in the 21st Century. This is because, its variability affects the environment through frequent severe droughts, intense flooding, windstorms, and disease outbreaks. In Europe for example, droughts, floods and heat waves have tremendously reduced crops yields especially in the Southern and Central Europe (European Environment Agency {EEA}, 2017). In Africa, these have negative impacts on the vulnerable agrarians especially in the Sub-Saharan Africa due to the extent of exposure, sensitivity and adaptive capacity. Its negative impacts are felt in the domains of food security, migration, human health, and economic growth (International Policy on Climate Change {IPCC}, 2014).

The change in precipitation, temperature and extreme drought and floods events are the main characteristics of the Rwandan climate. Farmers are most affected by the climate change and variability impacts due to the timing, frequency and intensity of rainfall events and the rainfall distribution. According to the USAID (2019), rising temperatures and variable rainfall impacted rainfed agriculture in the drier Rwanda eastern regions/ provinces that are liable to climate impacts because of increasing dry spells leading to food shortages. In 2016 for example, prolonged droughts affected the regions/ districts of Kayonza, Kirehe, and Nyagatare, leaving 44,000 poor households that sustain 225,000 people) food insecure.

The Government of the Netherlands (2019) anticipated climate changes in Rwanda to result in increased temperatures, intensified rainfall, and prolonged dry seasons in the East and South-east regions resulting into droughts and food insecurity leading to hunger for the communities living there. In addition to that, the severe hailstorms and prolonged rains that occurred in 2018-2019 and the first quarter of the 2020, had severe effects on the urban and rural livelihoods in regard to destroying houses, infrastructure (Roads, bridges, schools, health centers, etc.) eroding away soils downstream and destroying crops in the valleys due to flooding, and loss of lives across all provinces in the country (MINEMA, 2020).

The Goal 13 of the UN 2015 global agenda on sustainable development stress for urgent measures to tackle and mitigate climate and its impact (Climate-Kic, 2017). This is supplemented by the 2015 United Nations Framework Convention on Climate Change in Paris which adopted the use of innovations in mitigating climate change effects (Touzard & Boutillier, 2017).This has resulted into producing climate services that inform decisions on climate adaptability. This climate services production is however, at its young stage in the developing countries. It is emerging because the availed climate information has not been effective in leading to climate adaptation.

Furman, Roncoli and Bartels et al. (2014) define climate services as "institutional arrangements and processes that generate and disseminate climate information to promote improved preparedness to climate impacts" (p.1).Thus, climate services production signifies that relevant and usable information about climate be availed to the end users (farmers in this case) as well as be designed to improve climate adaptation (Vincent, Daly, Scannell & Leathes, 2018).

To attain that, the dissemination of useful and tailored climate services information to end users need close collaboration between meteorological experts and institutions that are involved in rural activities and work with farmers at grass roots to pay a support like extension agents, local authorities and local non-governmental organizations. All these different stakeholders need to be trained to read and interpret forecasts so that they could advise scientific producers (meteorologists) about information needs of farmers (Ziervogel & Downing, 2004; Vincent, Daly, Scannell & Leathes, 2018). Many authors have recognized that a weather forecast to be understood, effectively used and incorporated in the institutions, it cannot be one directional communication types (Hansen, Mason, Sun & Tall, 2011; Patt, Suarez & Gwata, 2005; Carmen, Kirchhoff & Ramprasad, 2012; Roudier, Muller & d'Aquino et al., 2014).

It has been widely identified that two-way dialogue is vital for realizing improved understanding, behaviour change and improved communication (Kniveton et al., 2015). But highly iterative modes of knowledge production are also limited in their ability to reach a large audience because of the disparity in size between the knowledge of the producer and user communities. To enhance reach and rates of adoption beyond these intense and dedicated producer–user relationships, innovation theory suggests creating systems of interacting actors/organizations (for example, private and public firms, universities and government agencies) that initiate, modify, import and diffuse science and technology (Carmen, Kirchhoff & Ramprasad, 2012).

Rwanda like other sub-Saharan African countries experiences climate change and climate variability with its associated effects on food security, malnutrition, and health throughout. Partnership of Rwanda Meteorology Agency (Meteo Rwanda), International Center for Tropical Agriculture (CIAT) and other NGOs and radio Huguka's listening clubs engage the farmers in the process of co-production of climate services. Through workshops organized by CIAT, experts from Meteo Rwanda and Rwanda agriculture Board (extension officers) engage with farmers to plan for the season. Farmers and the extension officers compare the climatology of the area basing on the information on the MAPROOM with indigenous knowledge of farmers to facilitate farmers to plan for the season. This process helps Meteo Rwanda to evaluate the accuracy of their forecasts but at the same facilitates farmers to make informed decisions on the crops and varieties to plant depending on crop characteristics in terms of water requirements.

Roudier, Muller & d'Aquino et al. (2014) concluded that the production of climate services of weather and climate forecasts facilited the Senegalese agricultural farmers to adapt to climate variability which further resulted in increased yield gains. Despite climate services of seasonal forecasting which improves agricultural management and rural livelihoods, their effectiveness is hampered by access, data scarcity, capacity to respond by the end users, and understanding/interpretation of the meaning Hansen, et al., 2011). Furthermore, one way communication; difficulty in interpreting the information; communicated information that is not timely, reliable and accurate; previous negative experience of the communicated information; established practices; local knowledge; and insufficient, technical financial and human capacity (Carmen, Kirchhoff and Ramprasad, 2012).

Climate and weather co-production services is new in Rwanda and its literature is very limited in regard to how they are co-produced, and used. This study therefore, aimed at assessing the current innovative communication approaches designed to coproduce climate and weather services, evaluating types of climate and weather information coproduced, establishing the types of communication channels used to deliver coproduced information to the users, and how the end users respond/use the communicated information.

2. Literature Review

The literature (Vincent, Daly, Scannell & Leathes, 2018) highlight characteristics of co-production services as decision-driven, process-based, and time-based. Climate services have to be developed so as to address the identified needs of the users. That is to say the producers and users for decision making purposes which the provided services can address. For example, weather forecasts services can be provided daily by the weather services providers to farmers other than monthly or weekly so that they make decisions on which farming activities they would engage in. Process-based implies developing mutual relationship and trust between the service producers and end-users of the climate services. A well-established relationship results into collaboration and shared knowledge exchange. Time-managed signify managing the whole process of co-production and co-delivery of a solution so that the intended climate product reaches on time to inform decision. For example seasonal forecasts can be delivered to the farmers before the planting season starts so that they decide on which crops to plant depending on the durability of the rain season (Vincent, Daly, Scannell & Leathes, 2018; Tarchiani, Rossi, & Carnacho et al., 2017).

The OECD (2011) postulates that "climate and innovation policies provide the right incentives for the development and diffusion of climate-friendly technologies" (P.1). Climate-Kic (2017) suggests innovative approaches to climate service production which include weather information products to facilitate farmers' decision making and increased technology to equip them with information and adaptive capacity in agriculture sector. The Climate Technology Center Network (2020) stress for innovation as fundamental in dealing with climate change impacts at the local and national level so as to enable local communities adapt accordingly. Furthermore, early warning systems that provide timely weather information can help communities to prevent loss of lives and improve food security. Forecasting services allows to pre-determine grain yields shortfalls and are beneficial to food security as forecasts are communicated to the farmers and this allows them to adapt their farming decisions as well as help mitigate drought effects (Patt, Suarez & Gwata, 2005).

Carmen, Kirchhoff and Ramprasad (2012) observed that how climate information users perceive their information needs and their capacity to use knowledge impacts their willingness to utilize that information. Therefore, Agro-meteological coproduced information and services can meritoriously facilitate farmers in making decisions that improve productivity thereby increasing incomes (Tarchiani, Rossi, & Carnacho et al. (2017). Despite that growing need for climate information to inform decision making, its applicability (climate information) is viewed as not easy as well as not straightforward. This is because, some information is received and the receiver might take action about it or just leave it (Carmen, Kirchhoff, & Ramprasad, 2012). Furman, Roncoli and Bartels et al. (2014) also note that the socio-cultural context vitally determines how the information produced by the climate services is accessed, processed and assimilated into decision making.

Touzard and Boutillier (2017) stress that the effectiveness of the impact of climate services innovations is influenced by the local agro-ecosystems- soil, climate, farming systems, NGOs, mobile phone operators, radios, extension services, and administration. Carmen, Kirchhoff and Ramprasad (2012) analyses literature on the constraints to effective climate services usability. Their findings indicate one way communication; difficulty in interpreting the information; communicated information that is not timely, reliable and accurate; previous negative experience of the communicated information; established practices; local knowledge; and insufficient, technical financial and human capacity. The reverse is true for the effective information usability. The effectiveness of the co-production of these climate services is also hampered by access, data scarcity, capacity to respond by the end users, and also understanding/interpretation of the meaning (Hansen, et al., 2011).

The EEA (2017) established that flooding, heat waves and droughts as affecting negatively the crop yields in South and Central Europe. Tarchiani, Rossi, & Carnacho et al. (2017) assessed the climate change effects on the farmers' production in West Africa and established solutions to food security. They found that climate services of weather forecasts were crucial innovations to maintain farming activities. Such services were also found to assist farmers in improving crop productivity, marketing decisions and family incomes. Asayehegn, Iglesias, and Triomphe et al. (2017) investigated climate services innovations in Kenya's coffee and diary sectors. They found that the coffee sector focused on technological innovations while the diary sector had many partners for innovation which focused on capacity building and organizational change. Empirical studies in Zimbabwe by Patt, Suarez and Gwata (2005) revealed that farmers who adjusted their farming activities to seasonal produced forecasts had significant improvement in the harvests. Furthermore, those who attended brief forecast workshops had likelihood of using the forecasts than those who used nonparticipatory channels.

Similarly, Roudier, Muller & d'Aquino et al. (2014) studied climate services usage in the two smallholder agriculturalists communities of Senegal. They found that the most climate services used were the forecasts which impacted farmers' decisions by changing sowing dates as well as using a variety of crops in planting. Subsequently, these led to increased yield gains. Other findings also indicated that farmers' information usage varied due to forecasts predictions and accuracy, as well as farming strategies employed. Furman, Roncoli and Bartels et al. (2014) assess how the African American farmers were engaged in climate services co-production. The study results revealed that farmers were liable to droughts, and had limited access to resources and risk management mechanisms.

Ministry of Environment (2019) assessed the usability of meteorological information generated by the Rwanda Meteorology Agency. The study found that majority economic sectors didn't use the provided meteorological information because of its inaccuracy, not area specific, being too general, and lack of awareness by the users.

3. Methodology

We employed a descriptive survey design to document innovative approaches used to co-produce and disseminate weather and climate services in Rwanda, evaluate types of information provided/feedback, the decisions/reactions made, and the communication channels used in the co-production of the climate services. The study was conducted in 2019. Both secondary and primary data were collected. Secondary data was retrieved from monitoring and evaluation reports, and blogs from Meteo Rwanda, CIAT, NGOs, Climate services Agencies, Journal articles and empirical studies. Primary data was collected through phone surveys/interviewing using a structured and semi-structured interviews (Aker & Mbiti, 2010). The study population was 8000 smallholder farmers who had been trained on the co-production of climate services in all the 30 districts of Rwanda. A sample of 2,102 participated in the survey. They were randomly, purposely and conveniently selected and reached. .

In data analysis, VIAMO Platform was used to code, transcribe and analyse data. It is a software that uses IVR (Interactive Voice Recording) in a phone to do data description and categorization in frequencies and percentages. Meaning that as the phone interview was being conducted, VIAMO automatically coded, categorized, analyse it through running descriptive statistics and then providing immediate results from the collected interview responses. The analysed data was then presented in tables and bar graphs according to each study objective/question as highlighted in the following section

4. Results and Discussion

This section discusses the main findings of the study with the existing literature. Findings are discussed and presented according to each research question as illustrated in the following sections.

4.1 Types of Innovative Communication approaches

The first research question endeavored to investigate the types of innovative communication approaches used to deliver the co-produced climate and weather information services, the following are the established innovative approaches developed and used to enhance coproduction of Rwanda climate services- Listeners groups, PICSA, 5Qs approach, Toll free, and web-based maproom.

4.1.1 Listeners groups

There are about 225 listening groups located under Huguka community radio station coverage zone that is the partner of the project. Group members meet in the beginning of the agricultural season to listen together seasonal forecasts, discus on the information content provided, take decision and provide feed-back (appropriateness of information provided, the timeliness, sufficient for decision making acoustics) to the source. And continue to meet within the cropping season to adjust decisions and plan operational decisions based short-term forecasts that inform changing weather conditions like dry spells and floods. With the assistance of different stakeholders involved in the project, climate information is disseminated with package of advisory services that play significant positive impact than solely weather forecasts dissemination in terms of application and increase awareness of building capacity.

4.1.2 PICSA

PICSA approach is a Participatory Integrated Climate Services for Agriculture. It is a process that encourages farmers to take decisions by providing them with weather and climate information, the skills to interpret it, and range livelihood, crop and livestock options that best fit their needs and expected weather. Through this approach, agricultural extension staff, farmers' promoters under Twigire Muhinzi, development partners and other intermediaries are trained to integrate climate services into their ongoing work with farming communities across the country. In the gathering farmers lead and interpret historical recorded seasonal graphs to take general decisions before the season start and got enough time to share traditional indicators that they rely on to anticipate weather and climate conditions such as flowering of trees, wind direction, dark clouds, birds, frogs and invertebrates such as termites.

4.1.3 Web-based maproom

The maproom is a collection of maps and other figures that monitor climate and societal conditions at present and in the recent past. The system is made of combination of stations data with satellite estimates at a resolution of 4km by 4km. The dataset is on daily and Monthly format with Daily and Monthly rainfall, maximum temperature and minimum temperature. It represent 30 years climatic information for rainfall and temperature from 1981-2010. The current climate Maproom include historical climate analysis, climate monitoring, climate prediction, and Information about climate and healthy. Maproom systems enable users to compute historical onset dates for their region of interest. It explores historical rainy season length and total rainfall amount based on user defined definition of onset.

4.1.4 5Qs approach

The 5Q approach is a novel approach developed to incorporate feedback mechanisms and two-way communication loops in monitoring and evaluation processes. It complements traditional methods with low-cost ICT tools, such as automated voice calls, to ask a set of five “smart” questions to farmers at regular intervals. This approach provides near real-time feedback on crucial agricultural parameters, such as the start of the season or the use of fertilizer, that are relevant to improve climate and weather information products. The approach put farmers in the center of the decision-making process by listening to their needs and translate climate services into mutually beneficial feedback loops.

4.1.5 Toll free

Rwanda meteorological agency (Meteo-Rwanda) has made available free of charge line **6080.** Users of climate and weather information dial free to ask information that are specific to their location and provide feed-back to the information producers that are relevant for adjustment.

These innovative communication approaches have been found in literature as ways to produce climate services and their extension to local people. For example, Saray, Tiani, Touko-Tchoko, and Tchatchou (2014) found radio listening platforms as one of the approaches used in disseminating climate information services to local farmers in the Congo Basin. Besides, these authors stressed the need for radio use since it is a powerful tool in changing behavior, capacity building and policy impact in regard to behavior change. Evidence from literature in Rwanda on PICSA indicates that over 85% of farmers use the climate information (Rwanda Climate services for Agriculture {RCSA}, 2018).

4.2 Types of Co-produced Climate Services

The second research question identified climate and weather information co-produced. The results were found from reports made for monitoring and evaluations reports. The current products are onset of the season, cessation of the season, the total seasonal rainfall, length of the rain season and daily weather information about the rain and temperature. This co-produced information were described in percentages as illustrated in the following figure.

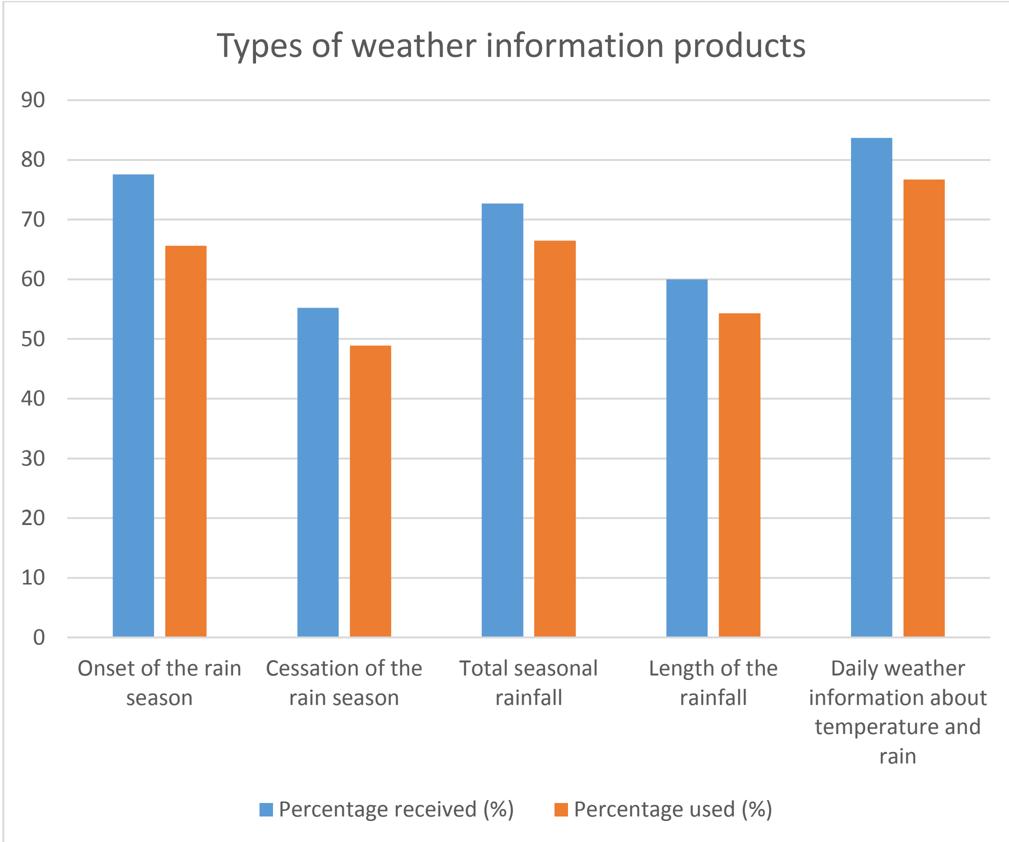

Figure 1: Types of weather information products

Big percentage of climate and weather information users in Rwanda (farmers) are interested more to get information about onset date of the seasonal rainfall, seasonal rainfall amount and daily forecast. The information about onset of the rain helps farmers set the planting date, seasonal rainfall amount support them to determine crops and crop varieties to be grown in that season, while daily forecasts helps farm operational planning such as fertilizer and pesticides application, weeding etc. these findings are thus in conformity with the existing literature (Dayamba, Ky-Dembele and Bayala et al. 2018; Mapfumo et al., 2013; Ofoegbu et al., 2018; Patt and Gwata, 2002; Roncoli et al., 2009; Roudier et al., 2014).

4.3 Decisions made based on co-produced climate and weather information

The third research question investigated how decisions are made basing on the co-produced climate services. Findings revealed that co-produced climate services help in making decisions related to changing planting date, changing the type of crops or crop varieties for planting, fertilizer and pesticides application, crop residue management, and crop diversification. Kgakatsi and Rautenbach (2014) stressed that climate information provision strengthen response strategies of vulnerable farming communities. Climate and weather forecasts that are accompanied by strategically formulated response strategies for climate risks adaptation has influenced decision making such as selection of crops and crop varieties, planting date, fertilizer application . More than 50% of farmers who received climate and weather forecasts have made changes for crop varieties and changed planting date. No farmers who changed from growing crops to livestock, this signifies greater reliance on farm yield for household consumption. This data is illustrated in in percentages in figure 2 below:

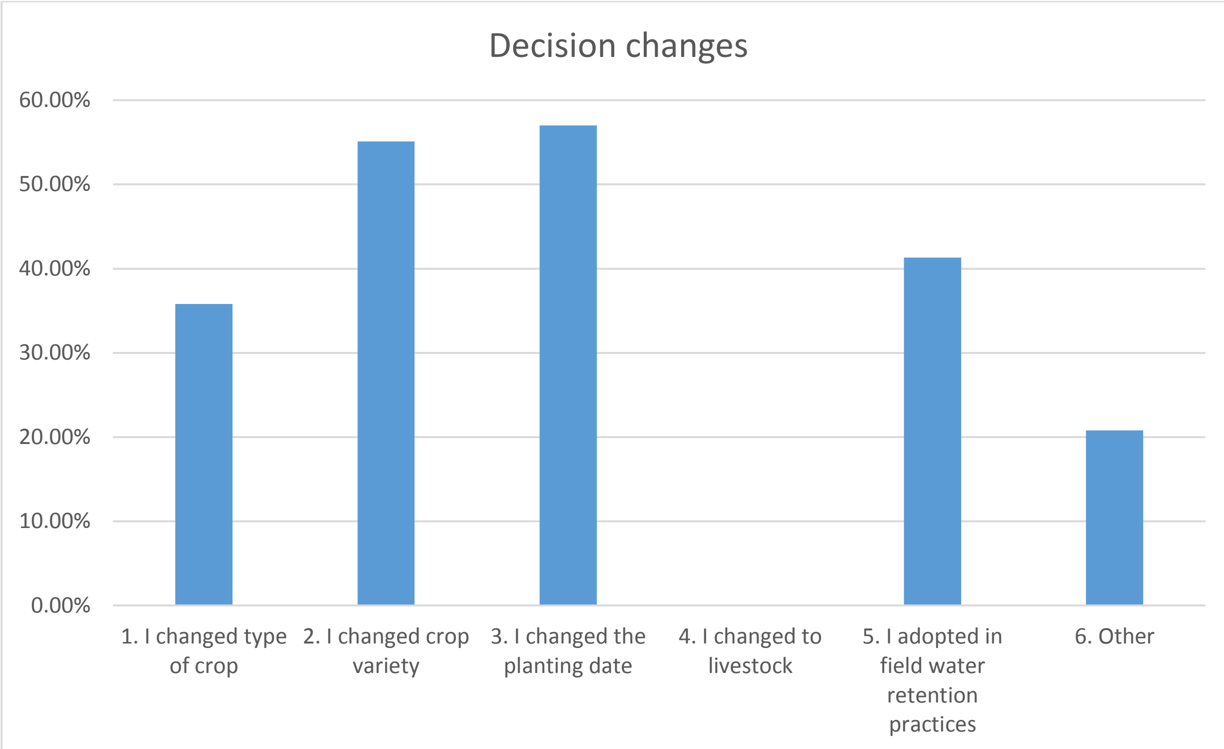

Figure 2: Decision changes

4.4. Main Communication Channels used in the Co-production of Climate Services

The fourth research question explored the communication channels used to co-produce the climate services according to the findings, the Radio, Television, Mobile phones, Workshops and trainings, Extension agents (Farming promoters), Web-based platform (Maproom), and printed bulletins were the main communication channels which are illustrated in percentages in figure 3 below:

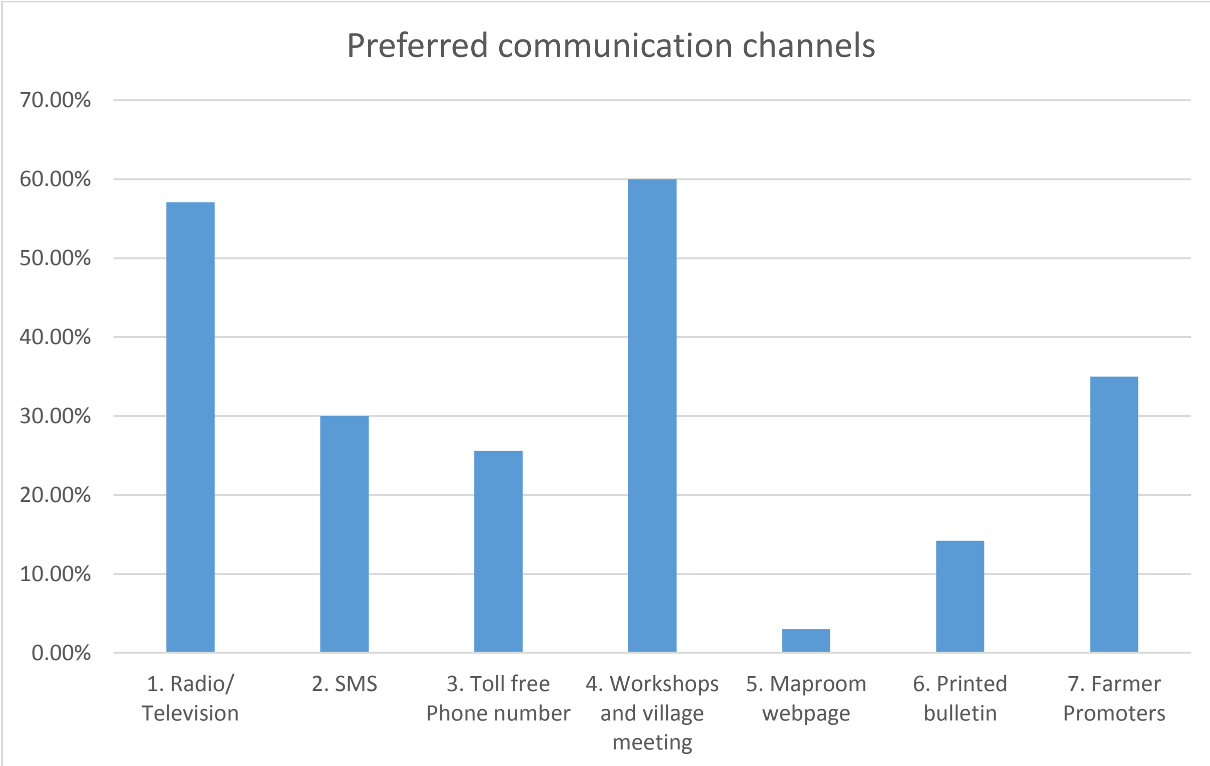

Figure 3: Preferred communication channels

As indicated in the above figure, the main preferred communication channels were- the radio(a mass media communication channel) which is available and affordable throughout rural areas to poor and illiterate farmers who constitute the majority of Rwandan farmers (Ayubu et al., 2012; Cherotich et al., 2012; Kgakatsi and Rautenbach, 2014). It is also notable from the table that farmers prefer interpersonal communication among their neighhours and extension workers and other stakeholders in village meetings where they find an arena to discuss on the information, advise each other how to apply acquired knowledge into practices (Ayubu et al., 2012). Extension agents known as farmer promoters are also preferred by farmers because their role to translate and interpret climate information probabilities to their neighboring farmers (Mtega, 2012). It is also notable that farmers are starting to incorporate use of ICT-based communication channels such as mobile phones to get agricultural and climate information via SMS and toll free line. The use of ICT in co-production of climate services is related to the mobile phone penetration in rural societies and increased ownership by the rural communities as well as governments' established ICT infrastructures (Aker & Mbiti, 2010; Ayubu et al., 2012; Rashid & Elder, 2009).

Tiani, Touko-Tchoko, and Tchatchou (2014) stressed the importance of radio usage due to its great potential in the sharing of information and knowledge and is viewed as a driver to rural development because of its availability, less technical usage compared to other channels like internet and televisions.

5. Conclusion and Recommendations

5.1 Conclusion

This study assessed the current innovative communication approaches to the co-production of climate services in Rwanda**.** We employed a descriptive survey design that used structured and semi-structured interviews to collect data on the types of innovative approaches used to co-produce and disseminate coproduced climate services; the types of co-produced services (information) provided; and the decisions made on the co-produced climate services (information) by the end users, and the communication channels used to disseminate the climate services. Both secondary and primary data were collected. Primary data was collected through phone surveys from a sample of 2,102 local famers spread across all 30 districts of Rwanda. They were randomly, purposely and conveniently selected and reached. In data analysis, VIAMO Platform was used to code, transcribe and analyse data. Analysed data was presented in frequencies and percentages using descriptive statistics according to study objectives/questions. The following are the summary of the main results:

The main types of Innovative communication approaches in the co-production of climate services were established as: - Listeners groups, PICSA, 5Qs approach, Toll free, and web-based maproom. The types of co-produced services were identified as- the onset of the rain season, cessation of the rain season, total season rainfall, length of the rainfall, and the daily weather information (temperatures and rain). The decisions made on the co-produced climate services were indicated as changing the growing crops, using crop variety, determining the planting date, retaining field water, and applying fertilizers and pesticides. The main communication channels used to co-produce climate services included SMS via phones, toll-free lines, radio/Television, farmer promoters, workshops and village meetings, web-based maproom, and printed bulletins.

Basing on the above findings, we concluded that the two way co-production of climate services in Rwanda greatly increased local farmers' awareness of the climate/weather changes and significantly influenced their farming decisions. The implications of this study are that it is of great value as it significantly adds new insights and extensive knowledge to current literature in regard to the co-production of climate services especially in less developed countries where farming activities on a small scale are the main sources of employment and income to the local vulnerable farmers. It also highlights the need for accessibility and affordability of communication channels to local farmers on a wider scale so that they receive and react to the produced climate information which would impact their farming decisions.

5.2 Recommendations

We do recommend for the improvement and extension of the existing approaches so that they complement each other in an integrated way, and the spaces for the integration and learning are created to enable questioning, learning and experimentation. Climate services policy makers need to consider capacity building of extension officers for the sake of interpreting weather data, disseminate climate information, providing feed-back, protecting and building rural communities in support services. More information communication technology channels need to be developed in rural areas for farmers' easy accessibility of climate information. That is to say, communication network coverage infrastructure need to be developed across the country so that farmers have a variety of communication channel access like internet, radio frequencies, and phones without network disruptions. Further studies need to be conducted in regard to challenges faced by the farmers in using the available innovative approaches to provision of climate information.

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