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Institute for Water and Energy Sciences (Including Climate Change)

The role of community based organizations in transferring climate change information:
a case of Eastern province farmers community, Rwanda

Aboniyo Josiane

06/08/2017

Chair:

Prof. Nemdili Ali

Supervisor:

Dr. Khaldoon A. Mourad

External Examiner:

Prof Masinde Wanyama

Internal Examiner:

Prof Abderrazak BOUANANI

Academic Year: 2016-2017

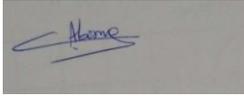
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DECLARATION AND RECOMMENDATION

DECLARATION

I **AboniyoJosiane** hereby declare that this thesis represents my personal work, realized to the best of my knowledge. I also declare that all information, material and results from other works presented here, have been fully cited and referenced in accordance with the academic rules and ethics.

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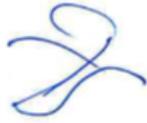
Name: **AboniyoJosiane**

Reg. No.: **PAUWES/321/15**

CERTIFICATION

This thesis is the candidate's original work and has been prepared with our guidance and assistance. This thesis is therefore recommended for examination with our approval as official University Supervisors.

Signature:



Date: **29/07/2017**

Dr.Khaldoon A. Mourad

Lund University.

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Dedication

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Executive Summary

In Rwanda, agriculture is the main important sector of the economy and is the engine of growing the economy and its modernization. The change in precipitation, temperature, and extreme events such as drought and floods are the main characteristics of the climate. Farmers are the mostly affected by the climate change impacts. The main purpose of the study is to identify adaptation strategies that are transferred to the farmers to withstand the climate change negative impacts, and challenges that face the Community Based Organizations (CBOs). Three districts (Kirehe, Rwamagana, and Ngoma) and two active community based organizations (RWIRRI, RADO) were selected for data collection. 100 farmers that belong to the community based organizations and 40 members that do not belong to the CBOs were interviewed. The instruments for data collection were interview, questionnaires, observation, Focused Group Discussion (FGD) and document analysis. The collected data were analyzed both qualitatively and quantitatively. The findings revealed that 88% of the respondents agreed that they have experienced the impacts of climate change. Drought was rated the top 42% as the most experienced effect. 90% of the respondent claimed that their productivity has increased after joining the CBOs and they gave supporting factors that they have enough for the market and have been able to improve their livelihoods. It concluded that the CBOs have played a role in increasing the farmers' awareness regarding to climate change adaptation strategies. Financial means was mentioned as the most frequently barriers that face the CBOs. However, there is a lack of predicting the long-term impact of the adaptation practices to climate change. Sustainability ideas are not well established to the communities.

Key Words: Community based organization; Community based adaptation, Agriculture, Climate change adaptation strategies, Sustainability.

Sommaire exécutif

Au Rwanda l'agriculture est le principal secteur important de l'économie et est le moteur de croissance de l'économie et sa modernisation. Le changement dans les précipitations, la température, et les événements extrêmes tels que la sécheresse et les inondations sont les principales caractéristiques du climat. Les agriculteurs sont les plus touchés par les impacts du changement climatique. L'objectif principal de l'étude est d'identifier des stratégies d'adaptation qui sont transférées aux agriculteurs de résister aux effets négatifs du changement climatique, et les défis auxquels fait face l'Organisations Communautaires de Base (OCB). Trois districts (, Kirehe, Rwamagana et Ngoma) et deux organisations à base communautaire (RWIRRI, RADO) ont été choisis pour la collecte de données. 100 agriculteurs qui appartiennent à l'organisation communautaire de base et 40 membres qui n'appartiennent pas à l'OBC ont été interviewés. . Les instruments utilise pour collecte les données ont été interview, questionnaires, l'observation, l'accent de la discussion en groupe (DGC) et l'analyse des documents. Les données recueillies ont été analysées de manière qualitative et quantitative. Les résultats ont révélé que 88 % des répondants ont convenu qu'ils ont vécu les impacts du changement climatique. La sécheresse a été classée au top 42 % comme l'effet le plus expérimenté. 90 % de l'intimé a soutenu que leur productivité a augmenté après l'adhésion à l'OCB et ils ont donné des facteurs qu'ils ont suffisamment pour le marché et ont été en mesure d'améliorer leurs moyens de subsistance. L'études à conclu que les organisations communautaires ont joué un rôle dans l'accroissement de la sensibilisation des agriculteurs à l'égard de stratégies d'adaptation aux changements climatiques. Moyens financiers a été mentionné comme le plus souvent les obstacles qui font face à l'OCB. Cependant, il y a un manque de prévision de l'impact à long terme des pratiques d'adaptation au changement climatique. Idées de durabilité ne sont pas bien établies pour les communautés

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Lists of Terms

List of terms	Definition
Climate change	Climate change is the gradual warming of the earth's atmosphere caused by emissions of heat-absorbing greenhouse gases, such as carbon dioxide and methane. The term is generally used to reflect longer-term changes, such as higher air and sea temperatures and a rising sea level.
Impacts/risks	The effects of climate change on natural and human systems
Adaptation	Adaptation means doing something new or different to what you or your community did in the past in order to adapt to climate change
Community based adaptation	Is the community-led initiative and is it based on local priorities, needs, knowledge and capacities which can both empower and help those people to better cope with and plan for the impacts of climate change.
Capacity	Describes all the strengths and resources available within a community, society or organization that can reduce the level of risk or the effects of climate change hazard. Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may

	also be described as capability
climate variability	Climate variability reflects shorter-term extreme weather events, such the El Niño Southern Oscillation (ENSO) and the La Niña Southern Oscillation (which results in drought conditions in Rwanda). While there is some evidence that climate variability will increase as a result of climate change, many uncertainties remain.
Vulnerability	Describes a person's inability to cope with, withstand and recover from climate change hazards like drought.
Resilience	Refers to the ability of a community, society or other system to continue functioning during or after a climate change hazard.

List of Abbreviations

AMSL	Above Means of Sea Level
CBA	Community Based Adaptation
CBOs	Community Based Organizations
CCA	Climate Change Adaptation
CDMP	Comprehensive Disaster Management Program
COP	Conference of Parties
DAE	Department of Agricultural Extension
EICV3	Integrated Household Living Conditions Survey
FAO	United Nations Food and Agricultural Organization
FGD	Focus Group Discussion
GHG	Greenhouse Gas
IPCC	Inter-Governmental Panel on Climate Change
KII	Key Informants' Interviews
LACC	Local Adaptation to Climate Change
MINAGRI	Ministry of Agricultural and Animal Resources
MINIRENA	Ministry of Natural Resources
MINITERE	Ministry of Lands Environment, Forests, Water and
NAPA	National Adaptation Programme on Action
NGO	Non-Government Organizations
PLA	Participatory Learning and Action
PRA	Rural Appraisal
REMA	Rwanda Environment Management Authority,
SSF	Small Scale Farmers
UNFCCC	Nations Framework Convention on Climate Change

CHAPTER ONE

1. Introduction

1.1 Study area

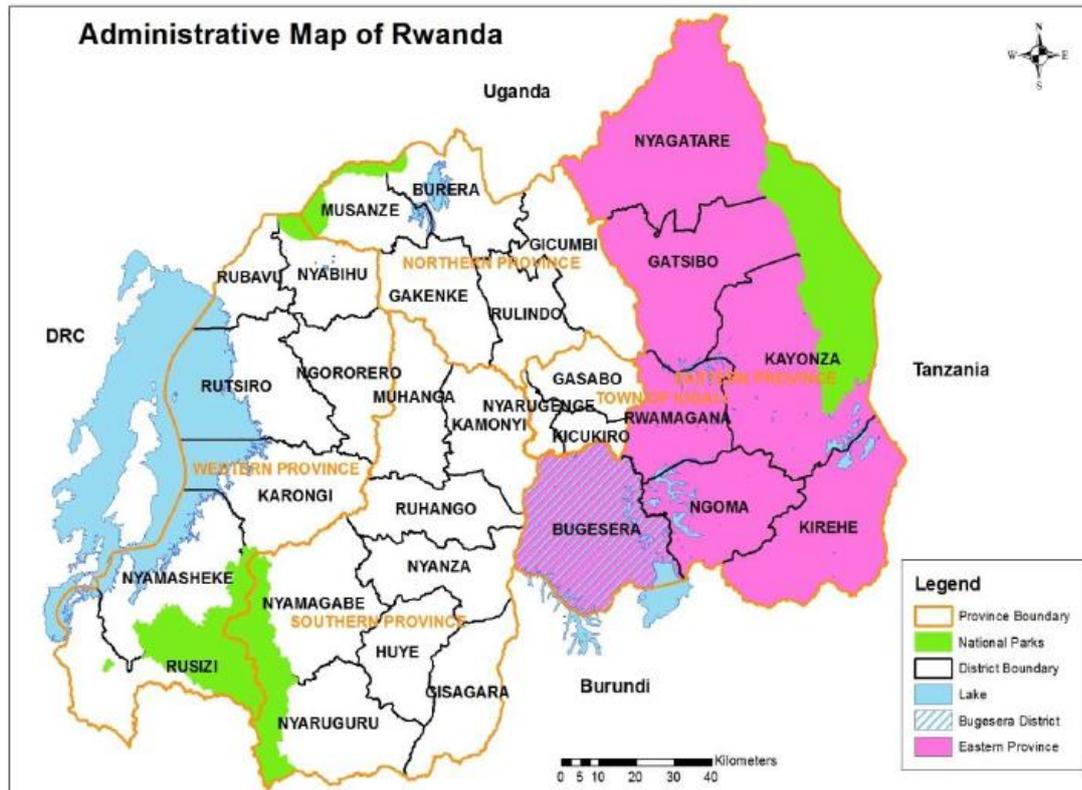


Figure 1-1 Administrative map of Rwanda (MoLG, 2017).

1.1.1 Location, topography and Climate Characteristics

Rwanda is divided into five provinces: City of Kigali, Eastern Province, Northern Province, Western Province and Southern Province as presented in figure 1. This research focuses on the Eastern province, which was created in early January 2006 as a part of a government decentralization program that reorganized the country's local government structures. The Eastern Province is located at $1^{\circ} 45' 00''$ S latitude and $30^{\circ} 30' 00''$ E longitude. It is the largest, the most populous and the least densely populated

of the five provinces of Rwanda. The lowly inclined hills and the dry valleys are the topography that characterizes the province, a long drought period (June–October), hot temperature, and a little rain quantity. The monthly distribution of the rains varies from one year to another. The annual recorded rainfall is about 827 mm/y (Nile Basin Discourse Forum, 2014). This study focused within three districts of Eastern Province: Kirehe, Rwamagana, and Ngoma.

Kirehe district

Kirehe District extends over a total area of 1,118.5 km²; the relief of the district is that of a low plateau area. Although there is a chain of mountains which divide the region into two geographical entities; these are characterized by a low altitude plain of more or less than 1350 m above mean sea level (AMSL), separated by isolated hills and mountains with a plateau at the summits of Mountain Mahama and Mountain Migongo. According to the District Development Plan of Kirehe, the climate in this region is favorable to agriculture. Kirehe District has climatic intervals of 4 seasons per year making it possible to have 2 annual harvests on the same pieces of land. Agriculture is strongly dependent on the seasonal climatic changes, primarily the rainfall. The tropical land relief is more widespread in the District. It is composed of different types of soil components that combine at a lenient level (Kirehe District, 2013)

Ngoma district

Ngoma district covers an area of 867.74 Km². It is part of the lowlands of the East, a region essentially dominated by hills with low slopes, with an average altitude between 1400 m and 1700 m AMSL. The original relief is a plateau strongly dissected by tectonically movements of the quaternary that were progressively gullied by the erosion creating valleys and swamps (Ngoma District, 2013). The annual average temperature is around 20⁰ C. Ngoma experiences four seasons; two are rainy seasons and the rest are dry seasons, a short rainy season that extends from October to December, a short dry season which runs from January to February, and a long rainy

season from mid-February to mid-May and a long dry season from mid-May to Early October. Generally, the dry season begins earlier and ends later compared to other regions of the country. The soil characteristic in Ngoma district is favorable for agricultural activities due to the presence of little sandy-clay soil mixture. In addition the district of Ngoma has three lakes namely Bilira, Mugesera and Sake which provides the region with a beautiful landscape that can attract many tourists if developed and advocated (Ngoma District, 2013)

Rwamagana district

The District of Rwamagana is situated between 1°57'2, 7'' of south latitude and 30°26'8'' of longitude. The District is characterized, in general, by lowly undulating hills separated by valleys some of which are swampy and boggy. This topographical feature constitutes an important potential of modern irrigation system and mechanized agriculture. The climate of this district is mainly characterized by a moderate tropical climate with four seasons of which: two are cold and the rest are dry. During the month of April-May and October-December, every year this region experiences large amount of rainfall quantities. The average temperature ranges between 19° and 30° and it is constant all over the year (Rwamagana District, 2013)

1.1.2 Natural resources and climate change

Kirehe

The district lies on 1500 m AMSL. It is mainly characterized by savanna, acacia trees and few natural forests, together with the existence of Kagera River contribute to a temperate climate in the region. Its most noteworthy feature is Rusumo Falls, the waterfall on the Kagera River, which has been a key to Rwandan history. Although during flooding seasons, wild animals can get close to populated areas and this can lead to dangerous consequences (Kirehe District, 2013)

Ngoma

The economy and the livelihood conditions in Ngoma district are highly dependent on the natural resources such as water, land, air and the ecosystem. Ngoma district is rich in flora and fauna, the natural vegetation of the district is dominated by savanna landscapes. It is a typical vegetation of the east African basin, with vast lands of grass and scattered shrubs of the natural vegetation dominated by savanna landscapes (Ngoma District, 2013). The western part of the district is made up of vast wetlands constituted by depressions of fluvial-lakes of the Akagera that offers a typical landscape of lakes and swamps. As the district's natural ecosystems have disappeared, leaving room for crops and artificial forests which mainly consist of large banana plantations with the combination of avocado, mangoes, sweet potatoes, cassava, etc. Most of the current afforested areas consist of Eucalyptus and Pinus (Ngoma District, 2013). However, the wildlife is still limited in the region except for some birds, small mammals and reptiles encountered in the less frequented places. These natural resources are increasingly threatened due to unsustainable environmental protection that has led to environmental destruction. The challenge is to utilize natural resources to develop the economy while at the same time conserving the environment to avoid the adverse impacts of pollution, soil erosion, deforestation and general degradation.

By now 63.7% of land in Ngoma District is protected from soil erosion against 78.1% at national level. Land registration is under way and so far, 63.3% of Households have been exposed to land tenure regularization. Forest cover in the district is estimated to 3.2 %. The survival rate for planted trees is about 70% (National Institute of Statistics of Rwanda, 2010)

The District Forest Management Plan is expected to be formulated to guide sustainable forest management. Rainwater harvesting at household level is rarely practiced and only 30% of institutions are practicing rainwater harvesting.

Mining is threatened, with mining site that are well mapped or identified to investors and the exploitation of mines causes environment destruction as well as human death if not well managed (Ngoma District, 2013).

Rwamagana

The district has tried to mitigate climate change effects through tree planting; the land covered by forest is 24.4% (Rwamagana District, 2013). There are frequent disaster occurrences resulting from stormy rain and wind that sweeps and dismantles buildings, banana plants and erodes soil. Incidences of lightening have also been witnessed in areas of Karenghe sector (Rwamagana District, 2013)

1.1.3 Population and communities

Kirehe

Kirehe District extends over a total area of 1,118.5 Km² with a total population about 340,983 inhabitants according to the newly provisional results released by the National Institute of Statistics of Rwanda (NISR, 2012).

Ngoma

The total population of Ngoma District is 338,562 inhabitants among which 162,388 are males and 176,174 are females (NISR, 2012). During the intercensal period (2002-2012), the record showed that the population in Ngoma district is higher with a total of (3.7%) while the province total record was (4.3%). The population density is 393 persons per Km² against 416 at national level. The sex composition of the Ngoma District population, as measured by the sex ratio, indicates that, there are 92 men per 100 women in 2012 which is the same at national level. In Ngoma District 97.9% of the population is living in settlement (Imidugudu) compared to 37.5 at the national level. Only 0.6% of the population is living in unplanned urban housing against 8.4% at the national level but none lives in modern planned versus 0.6% at the national level. The urbanization is at the beginning in Ngoma. According to EICV3, around 67.6% of Ngoma households have access to safe water including (74.2%) of households using an improved water source with 40.7% of households using protected Springs, 11.6% using stand pipe, 1.3% having water piped into their dwelling/yard (NISR, 2011).

Rwamagana

National Institute of Statistics of Rwanda (NISR) Provisional Population and Housing Census 2012 results reveal that Rwamagana district population is currently 310,238 people and about 53% are aged 19 years or younger (NISR, 2012). People aged 65 years and above are 4%. Most of the population is young, with about 82% still under 40 years of age. Socially, the District of Rwamagana has been implementing its strategies to improve social welfare of the population despite the big number of needy population that are in need of social assistance because of the 1994 genocide that left thousands of orphans and high number of widows compelled to work for their survival (National Institute of Statistics of Rwanda, 2010)

1.1.4 Agriculture and economy

Kirehe

According to (NISR, 2011), agriculture and livestock are the main economic activities that are dominant in Kirehe, the soils are fertile and serve the best in growing crops like banana, maize, beans, soya beans cassava. The marshlands are suitable for rice growing and fruits like pineapples oranges, mangoes etc. These crops cover 64,500 Ha. Banana plantation is mostly cultivated in the areas of Mushikiri, Gatore, Kirehe and Musaza where it covers 11,500 Ha. According to (Kirehe District, 2013), Kirehe district cultivates maize on a consolidated land that covers almost 25,000 Ha in the swampy areas of the Akagera region in the sectors Kigarama, Nyamugari, Mahama, Mpanga and Nasho. The EICV3 report reveals that, the mean cultivated land per Household (in Ha) is at 0.6%. The district indulges in trade with other districts that it shares the borders with especially in agricultural products like maize, rice, Beans, banana and fruit products like pineapples, Avocado which the district sells to the neighboring district of Ngara (Tanzania), where the district exports more than 4 tons of fruits weekly. Poverty rate is at 47.9% compared to the National average of 44.9%, Extreme poverty rate is at 25.6% compared to 24.1% of the National average, EICV3

also reveals that the District has 8.5% of the wage farm employed people compared to 9.9 of the National average, Wage non-farm is at 7.0% to 16.9%, On habitat the EICV3 indicates that 94.5% people live in Imidugudu compared to 37.5% of the National average, 1.6% Households with electricity as a source of lighting compared to 63% of the national average (NISR, 2011).

Ngoma

Agriculture is the main economic activity in Ngoma District. According to (National Institute of Statistics of Rwanda, 2010), 86.1% of the population is economically active while inactive among the persons aged 16+ is 13.9%. 81% of the Ngoma district population work in agriculture, while 73.5% at the national level. Most of the population (73.5%) works on their own farm against 61.8% at the national level. Women (83.2%) are much more likely than men (61%) to have their main job on their own farm (self-employed). Men by contrast are more than three times more likely than women to have their main job in the waged non-farm sector where they count for 15% gains only 4.9% for females.

Agriculture is also the main source of income for 57% of the households against only 21% who's the source of income is wages, it is important to look at the assets for the agriculture production. Regarding the income from the agriculture products, 23.6% of the agriculture products in Ngoma district are sold compared to 20.9% sold at national level. This shows at what extent the agriculture is for subsistence rather than a market oriented agriculture.

The main food crops grown in Ngoma District according to their importance order are dry beans (96.2%), cooking banana (92.1%), Maize (90%), Sweet potato (84.4%) and Cassava (76.8%). peanut (45%) and rice (8.5%) (National Institute of Statistics of Rwanda, 2010)

The main fruit and vegetables cultivated in Ngoma District are fresh beans (92.2%), Avocado (53.7%), Papaya (41.3%) while main export and cash crops are coffee (18.3%), Sunflower (28.1%), cane sugar (24.6%) and pepper (12.6%). In general,

69.8% of households in Ngoma district raise livestock against 68.2% at national level. Concerning the different types of livestock, 40.1% of households are raising Cattle, 1.5% of households have Sheep, 61.1% have Goats, 32.1% have Pigs, 11.9% have rabbit and 62.4% have poultry. At national level these are 47.3%, 15.7%, 53.0%, 24.1%, 22.9% and 45.5% respectively for cattle, sheep, goats, pigs, rabbit and chicken. Other industry of usual main job is trade (5.6%), Government (4%), utilities and banking services (2.6%), Construction (1.3%), Transport and communications (1.3%), mining and quarrying (0.5%) (NISR, 2011)

Rwamagana

Agriculture and livestock are the main economic activities that employs over 80% of the population in rural areas, and 85% at least practice traditional agriculture. Business related activities are also another economic activity that is practiced in the district mainly in some rural areas. The major crops of the district include bananas, rice, maize, pineapple and coffee. The District is rich in Minerals (Cassitérite, Colombo tantalite and Wolfram) especially in parts of the sectors of Musha, Mwulire and Gahengeri. The infrastructure is somehow developed in this region with relatively big networks of roads that connect it to other districts and also to agriculture production areas, but most of them are in bad condition. Only 102km of feeder road is in good condition. Regarding water transport, there are 5 small motor boats that provide navigation transport in lakes Muhazi and Mugesera.

In the economic front, the EICV3 report (National Institute of Statistics of Rwanda, 2010) reveals that, land use consolidation is at 7.4% compared to the national average of 11.5%, hill side irrigation is at 6.1% compared to national average of 3.0%, Land under erosion control 88.3% compared to 78.1% national average. Through GIRINKA program, the district has distributed 6,168 cows to 14.3% vulnerable families 14.0% Households have electricity subscriptions (20.4% EWSA), 58.3% of the population own mobile phones and 1.3% of the population own computers (NISR, 2011).

1.2 Problem statement

In Rwanda, agriculture is the main important sector of the economy and is seen as the engine of growing the economy and its modernization. The agriculture sector boosted Rwanda's GDP from 7.9% in 2007 to 11.4% in 2008 (Bizimana et al., 2012). Change in precipitation, temperature, and extreme events such as drought and floods are the main characteristics of the climate. Farmers are the mostly affected by the climate change impacts due to the timing, frequency, and intensity of rainfall events and the rainfall distribution of these events (Blignuat, et al., 2009). Temperature and precipitation have a strong relationship and this is likely to affect crop production, the decline of rainfall and increase of temperature will strongly continue to make crop production and livestock more vulnerable (Mbilinyi, et al., 2013). In Rwanda, the certainty of climate change is well accepted and there is emerging evidence that climate change poses a threat for the development in Rwanda (Nile Basin Discourse Forum, NBDF, 2014). Recent projections revealed that the precipitation data are to vary more in comparison to temperature which is expected to vary slightly in 2050 (Muhire & Ahmed, 2014). The decrease of temperature could lead to a damage of the crop productivity especially in the high altitude regions like the eastern province (Verdoodt & Van Ranst, 2003). Previously Rwanda has experienced a significant decrease in agriculture productivity due to climatic change conditions, and this has prompted a worsening food security, poor health, and malnutrition throughout the country (Mutabazi, 2010).

Some of the recorded climate change impacts include periodic extreme events of flooding and droughts that has occurred and caused major socio-economic impacts and reduce economic growth in Rwanda. Major floods events occurred in 1997, 2006, 2007, 2008, and 2009, where rainfall resulted in infrastructure damage, fatalities and injuries, landslides, loss and damage to agricultural crops, soil erosion and environmental degradation. In some regions of the country especially Eastern Province there has been periodic droughts, for example in 1999/2000 and 2005/6 (Ngabitsinze, et al., 2011).

Managing the climate change risks require enhanced forms of actions and new systems to assess the adaptation options and strategies, there is a need for increasing farmers' productivity by building their capacity towards climate change adaptation (FAO, 2016). The mitigation to climate change has been limited (Roberts, 2013). Over all, global discussions have been giving attention to mitigation strategies, but there is an emerging gradual shift in emphasis towards adaptation based on the fact that even if greenhouse gas emission trajectories were to be lowered the climate change will continue to impact the human and natural system (McNamara, 2013). Eastern province of Rwanda is highly affected by the droughts and it was confirmed also by a survey that was conducted in eastern province about the 'community based climate change adaptive survey', drought was rated the top 23% among the other effects of climate change in the province. And this tend to be the most challenge that the eastern province is facing greatly, the population within the district feared that draught will continue to rise the food security issues and water crisis. Climate change implications on farmers were argued to be due to droughts and poor soils management, it was stated that the 2013 drought had frustrated farmers' agricultural productivity capacities (Nile Basin Discourse Forum, NBDF, 2014). Information and capacity development are the important aspects that can help the community in adapting to climate change. The top down approach seems not be producing the effective results when it comes to managing natural resources and conserving the environment. The growing aspects are calling upon community based approach to adaptation. Community-based adaptation operates at the local level by involving the community that are vulnerable to the impacts of climate change, it identifies, assists, and implements community-based development activities that enhance the local people capacity and knowledge to adapt to living in a riskier and less predictable (Ayers & Forsyth, 2009). Rwanda has a current adaptation deficit; it is not adequately adapted to the existing climate risks (Nile Basin Discourse Forum, NBDF, 2014). In eastern province 91% of the communities have not been directly consulted on climate change issues (Nile Basin Discourse Forum, NBDF, 2014). This indicates that at least most of the climate change potential policies and interventions elude peoples' participation. This means there is a

gap in policy related efforts aimed at citizens' inclusion in climate change policy making (Nile Basin Discourse Forum, NBDF, 2014). The Government of Rwanda (GoR) has planned several policies and institutional responses to support smallholder farmer's adaptation to climate change and variability, one of the policies is to empower community based organization to enhance the appropriate climate change adaptation activities for sustainable development. However, the results on the ground are not clear on the role that community based adaptation is playing to enhance the adaptation strategies of the farmers in the Eastern province. This put into question the role of community based organization in transferring the climate change information such as the adaptive strategies, mitigation measures, and the effectiveness of community based organization in building the capacity of farmers in a bid to build their resilience towards the impacts of climate change and variability. As the main objective is to evaluate how effective are community based organization, it is necessary to note that an effective Community Based Adaptation (CBA) requires more than just the understanding of climate change impacts, but they also have to take actions to adapt and alleviate the risks (McNaught, et al., 2014).

1.3 Research Objective

The overall objective of this research is to examine the role of the community based organization in transferring climate change information and building a sustainable knowledge to the farmers. To achieve the main objective, the following are the main tasks:

- To determine the major climate change impacts on the Eastern Province communities, especially the farmers;
- To determine the methodologies used by community based organization to deliver climate change adaptation information to the farmers in the Eastern Province;
- To evaluate the effectiveness of community based organization in building the local adaptive capacity;

- To identify the challenges faced by community based organization in delivering climate change adaptation information to the farmers; and
- To determine the perception of the farmers towards community based organization and community based adaptation.

1.4 **Research questions**

- What are the major climate change impacts to farmers in eastern province?
- What are the methods used by community based organization to deliver climate change information to the farmers in Rwanda?
- How effective are the community based organization in delivering information?
- What are the challenges faced by community based organization in delivering climate change impact adaptation techniques to farmers in Rwanda?
- What do the farmers in Rwanda perceive the role of community based organization and institutions to be?

1.5 **Justification of the study**

This study seeks to generate information that will be useful to the different stakeholders at the community and national level on how to dispense and implement climate change information to form adaptation strategies. This knowledge will help in building their resilience and establishing a sustainable agriculture sector to ensure food security.

The study will also enable the government to attain the 2020 vision and the sustainable development goals, of which include ending poverty in all its forms and dimensions, zero hunger, climate action, ensuring access to water and good health and wellbeing for all.

1.6 **Scope**

This study is designed to create a deeper understanding into the role played by community based organization in transferring climate change information in the agriculture sector. It examined the existing adaptation strategies such as the early

warning mechanisms, the rain water harvesting strategies, the agriculture sustainability and the communication systems present, challenges faced by the community based organization and the expectations of farmers from community based organization. The study also examined the relationship between the Ministry of Agriculture and Livestock with community based organization, such as how they are funded or how they are supported in general. The study was carried out in the eastern province of Rwanda within three district of choice (Kirehe, Rwamagana, and Ngoma), and the study focused on two active community based organizations within those districts (RWIRRI and RADO). In addition the study compared the perceptions of those that are working with community based organizations and those that are not working with them. The results of this study were taken to represent the situation in Rwanda especially in drought prone regions.

CHAPTER TWO

2. Literature review

2.1 Overview of climate change impacts

In Rwanda, environmental degradation is caused by both the anthropogenic activities and climate disturbances. Thus, the floods of 1997 and the drought in the year 2000 respectively associated to the episodes El Nino and La Nina are clear examples (MINITERE, 2006). The climate variables such as (temperature, rainfall, wind speed, sunshine, wind direction, etc.) are the crucial elements of the crop production. Change and variability within these variables cause long-term threats especially in the agriculture sector (FAO, 2008). (Hoogenboom, 2000) stated that the climatic fluctuations contribute around 80% of production variability in the areas that rely on rain fed such as the tropical and subtropical countries. This could be the case in Rwanda more than 85% of the population of Rwanda rely on rain fed agriculture (National Institute of Statistics of Rwanda, 2011). The changes in temperature and precipitation patterns heavily impacts the productivity of land, and crop growing period. Crop productivity in Rwanda is certain to be impacted by the projected changes in rainfall and temperature along with their adverse effects (Muhire et al., 2015). Concerns have also stated that the climate variability will have an adverse impacts on the livelihoods of the rural communities (Below et al., 2010). There have been a significant increase in annual mean temperature of 0.35°C between 1971 and 2010 (David et al., 2011). However (Muhire et al., 2014a) stated that the significance increase in mean and annual temperature between 0.036 °C and 0.066 °C resulted in a high decline in mean rainfall and number of rainy days. The increase in temperature and changes to rainfall patterns have resulted in a prolonged floods and droughts, and this can significantly reduce the crop productivity, impact negatively the livelihoods, food security and earnings. The eastern lowlands are expected to have a decline in most crops productivity due to the anticipated decrease in mean rainfalls and number of rain days (Muhire et al., 2015). Cases of flooding, soil erosion, landslides due to the heavy rainfall have been recorded in the nothern (Bulera, Gakenke, Musanze,

Nyabihu, Gicumbi and Rulindo Districts) and the western (Karongi, Ngororero, Nyamagabe and Nyamasheke Districts, etc) regions of Rwanda especially in 2001, 2002, 2007, 2008 and 2012 (David et al., 2011). Eastern Province has also been the victim of the temperature increase that has resulted into periodic droughts such as in 1999/2000 and 2005/6 (Nile Basin Discourse Forum, 2014). The projection of Climate change has also the potential to affect water security and this would lead to the food insecurity as well, and as a result could increase the level of poverty and force subsistence farmers into informal urban settlements. As droughts reduce the hydropower and dams generating capacity Rwanda's energy would be at a risk, hence hydropower contribute 50% of electricity (David et al., 2011)

2.1.1 Climate change and agriculture

According to (Sirven et al., 1974.), Rwanda has a tropical climate that is moderated by hilly topography, varying between 900 m and 4507 m. It expands from east to west with annual mean rainfall ranging between 750 mm and 1550 mm for 1961-1992 and these figures are projected to be in the range of 750 mm and 1650 mm for the period 2011-2050. From the estimation done by (Muhire et al., 2014) it is estimated that the optimal average rainfall needed to grow the major food crops in Rwanda ranges from 1000 mm to 1200 mm, with a minimum and maximum average of 800 mm and 1500 mm. Rwanda's staple crops such as maize and rice are likely to be affected by climate change based on the projections(Harrison, 2011). The projections revealed that the precipitation data (mean rainfall and number of rainy days) are to vary more compared to temperatures, which is only expected to change slightly in the coming years (Muhire et al, 2014b). Low temperatures could damage the crops in high altitude regions of Rwanda (Verdoodt & Van Ranst, 2003). The projected results on the temperatures are mostly likely to fall within the threshold limit that would allow the better growth of crops in most of the regions in Rwanda, precipitation and elevation are bound to be the most limiting parameters for the cultivation. Despite the fact that the rainfall, temperature and elevation requirements by crops differ from one climatic region to another or one subspecies to another, there are the average rainfall, temperature and

elevation required to realise the optimum crop growth in a given area. It is estimated that the optimal average rainfall needed to grow the major food crops in Rwanda ranges from 1000 mm to 1200 mm, with a minimum and maximum average of 800 mm and 1500 mm, respectively (Muhire et al., 2015). It was observed that on average, there will be a steady decline in temperature, mean rainfall and frequency of rainfall across the country for the period 2011-2050 compared to the period 1961-2010 (Muhire & Ahmed, 2014a). The impacts will not only affect the staple food rather increasing temperatures may also cause a reduction in suitable land for Rwanda's production of tea, compelling farmers to shift into horticultural and cultivation of peas.

The figure (2-1) below illustrates the fluctuations of cereal production leguminous, tubers and roots, banana and fruits as well as vegetables from the year 2000 to 2004. After the evolution realized until 2002 in banana, tubers, fruits and vegetable production, there was a low production particularly for tubers, roots, cereals and leguminous.

Cereal production hardly increased regardless of low production of Sorghum, which represents almost 53% of the total production of cereals. This increase was according to Ministry of Agricultural and Animal Resources (MINAGRI) statistic department, to the efforts of the Ministry, which improved the production of some cereals such as rice and maize in helping the extension of cultivated areas. The leguminous production sensibly went down in 2004 due to heavy rains registered in high altitude regions, which are generally more productive.

According to MINECOFIN's report the low food production from 2002 was due to the irregularities of rainfalls and a dislocation of rainy seasons which took place.

These weakening of agricultural production linked to climate hazards are to be

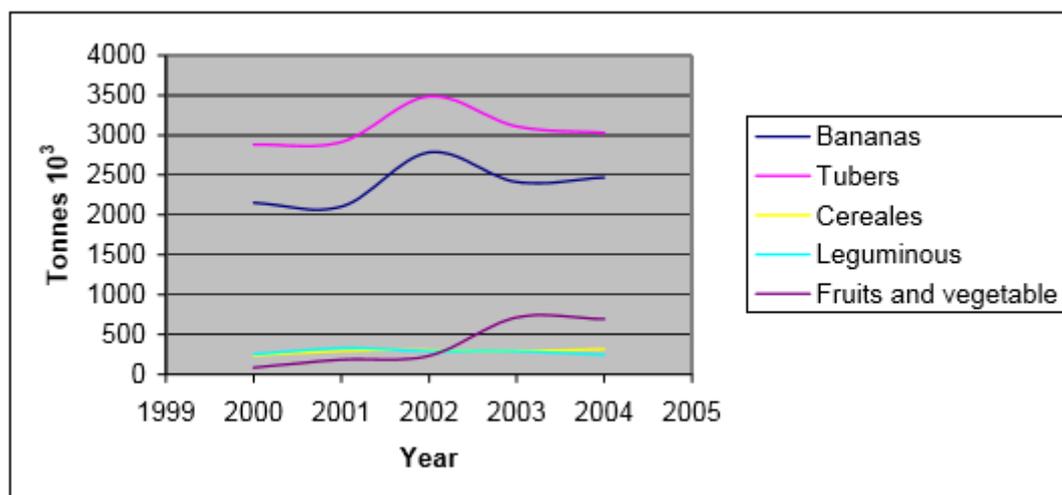


Figure 2-1 Evolution of cereals, leguminous, tubers, fruits and vegetables production during the period 2000-2004

Sources: (MINITERE, 2006)

2.1.2 Climate change impact on water and natural resources

The African continent holds a land of approximately 30 million Km², with a wealthy of natural resources of which few other parts of the globe can match, including minerals, forests, wildlife and rich biological diversity. However most of these wealthy natural resources are not being exploited and this is not reflected in measures of the welfare of the region's inhabitants (UNEP, 2000). Although the African continent has some driest deserts regions and largest tropical rain forests. Key natural resources are unevenly distributed. For example, more than 20 % of the remaining tropical forest is in the Democratic Republic of the Congo, while a major share of the continent's water resources are in a few large basins (such as the Congo, Niger, Nile, Zambezi and Lake Victoria). The Congo watershed contains 10 % the of African population but accounts for about 30 % of the continent's annual run-off (Hinrichsen et al., 1997). Climate change consequences on water resources manifested themselves in such events as floods, droughts, sea-level rise, drying up of rivers, poor water quality, changes in surface and groundwater systems, changes in precipitation and water vapour. These

alterations are already having serious impacts on the economy of several African countries, on food security throughout the continent, as well as on the social welfare and the health status of many disadvantaged people (Urama and Ozor, 2010).

In Rwanda the wetlands networks in various region of the country have lead to the abundance of water resources availability. Wetlands and aquatic lands are generally represented by lakes, rivers and marshes associated with these lakes and rivers (MINITERE, 2005). There are two major drainage basins in Rwanda: the Nile to the east covering 67 % and delivering 90 % of the national waters and the Congo to the west which covers 33 % and handles all national waters. The country's hydrological network includes numerous lakes and rivers and its associated wetlands (Nile Basin Initiative, 2005). In Rwanda, the wetlands are recognized as an important natural resource and explicitly considered in national planning and policy. In 2008, the Rwanda Environmental Management Authority conducted a national inventory and mapping of all wetlands, lakes and rivers (REMA, 2008). Water resources has a number of challenges such as water provision, poor water resources management, population growth, urbanization, droughts and floods that will be increased by the climate change and the lack of water resources management education (Aboniyo et al., 2017). Water and wetlands resources have been experiencing pressure due to differents factors such as population growth. Water resources have been affected both in quantity and quality. Climate change is also contributing to degradation of swamps. With decreasing amounts of rainfall, the hydrological regime of wetlands is being threatened. Climate change scenarios demonstrate that wetlands in particular zones in Rwanda are more sensitive to climate change (Nyandwi et al., 2015). The issue of lakes/ wetlands sensitively expanding, reducing or even disappearing in some parts of the country with climate variations (Nzigidahera, 2007). Some of the recorded climate variability impacts on water and natural resources has led to a major economic loss including the periodic flooding and droughts that occured in Rwanda. Major flooding events occurred in 1997, 2006, 2007, 2008, and 2009, where rainfall resulted into infrastructure damage, fatalities and injuries, landslides, loss and damage to agricultural crops, soil erosion and environmental degradation. In some regions of the

country especially the Eastern Province there have also been periodic droughts, for example in 1999/2000 and 2005/2006. A study of the Nyabugogo River Plain found that floods damages occur each rainy season and has led to a significant environmental and social damage. For example, the 2005 flood damaged crops, bridges and led to environmental degradation. The 2007 flood led to fatalities, agricultural losses, building and infrastructure damage and population displacement (Twagiramungu, 2006). Some of the studies conducted on the hydrography scenario of Rwanda indicated that the floods in Kigali occur in the rainy season from April to June and from September to December the highest increase in rainfall is expected in June to be 30.2% for scenario 2020 and 27% for scenario 2070 in May, and in November 23.6% of the increase is estimated for scenario 2070. It is predicted that the rainfall will increase by 23% in May during 2011-40 and 41.1% during 2071-40. The precipitation pattern of Kigali will be affected by climate change and an increase of extreme rainfall events are likely to happen in the rainy season, which in turn will affect the flood hydrograph of the city (Rukundo & Doğan, 2016).

The following paragraph show the current climate change risks to which vulnerable existence modes are exposed in Rwanda are presented in the following table (1). They are described in relation to their consequences, their length, their geographical area, and their frequency. An exponential scale of evaluation has been utilized.

Table 2-1 Inventory of climate change risks done in 2006

No	Risks	Wording	Impacts	Loss in human lives	Length, days	Spatial area, km ²	Frequency	Tendency
1	Prolonged seasonal drought	Failure of harvest; loss of young seedlings; increased of water	2	1	2	4	2	I

		demand						
2	Short period droughts in rainy seasons (dry spells)	Critical growth of food producing crops and reduced productivity of harvests	1	1	2	3	2	M
3	Recurrent droughts on 2 or 3 successive years	Reduction in water resources and hydroelectric energy; Drying of banana plantations; Pauperization of the population especially in rural areas; Displaced populations; Food aid.	4	4	3	4	2	I
4	Rains with high intensities of more than 50 mm/h	Rise in the water level, floods, landslides, localized landslides; Lost of production in swamps products; Soil erosion on basin sides and expansion of river beds; Malaria	3	2	2	3	3	M

		cases increase						
5	Low precipitation	Critical growth of food producing crops and poor harvests.	3	1	3	4	3	M

Sources: (MINITERE, 2006)

Table 2-2 Legends

Risks*	1	2	3	4	5
Impacts	1.000FRW P/capita	10.000FR W P/ capita	100.000 RW P/ capita	1000x103FR W P/ capita	1000x104FR W P/ capita
Lost in human lives	1Person /event	10persons p/event	100person s p/event	1000persons p/event	10000persons p/event
Lenght	1 day	10 days	100 days	1000 days	
Spatial area	1 km ²	10 km ²	100 km ²	1000 km ²	1000 km ²
Frequenc y	1% probability =1time/10	10 % = 1time/10 years	100 % 1 time/year		

	0 years				
Tendency Indicators	I = important	M = average		N = uncertain	

Sources: (MINITERE, 2006)

*Estimates are calculated on exponential scale

According to the table above, It shows that the most risks that were recorded are:

1. Prolonged seasonal drought, recurrent drought on two or three successive years as well as low precipitations have an important impact of spatial area of 1000 km², leading to a loss of 1000 lives, economic losses of 1.000.000 FRW/capita among the affected population. The occurrence tendency of these events is very important and of high frequency.

2. Particularly intense rains coupled with short droughts (dryspells) alternating with low precipitations in rainy seasons also presents a recurring risk with localized impacts in an area of 100 km², a loss of 100 human lives and economic losses of 100.000 FRW/capita among the affected populations(MINIRENA, 2006). The occurrence tendency of these events is considered as average but of high frequency (MINITERE, 2006).

2.1.3 Climate change and health

Climate change has wider impacts, with the increase of temperatures all over the country the risks of anopheles mosquito will increase, as a function of temperature and rainfall grows as well. This may result in a higher risk for transmission of the infectious disease (Harvell, et al., 2002). Another likely consequence to occur is that the insect might be able to advance to higher elevation, and for a highland country like Rwanda, where many regions fell below epidemiological line a rise in temperatures may now lead to the increased probability of malaria transmission (Henninger, 2013). The incidence of disease is closely related to climate variability in Rwanda (Harrison, 2011). Period of high and low rainfall highly influence the outbreaks of diseases such

as cholera, dysentery, and typhoid. The transmission potential of most neglected tropical diseases in a particular location is partly dependent on biotic factors affecting either free-living life stages and/or those which occur in poikilothermic organisms such as snails and mosquitoes. According to Nicky et al. (2014); both the schistosome parasite and its intermediate host snails are very sensitive to water temperature. With the increase of temperature in freshwater bodies in subtropical and tropical areas may alter the geographic allocation of schistosomiasis. *S. mansoni* infection risk may increase across much of eastern Africa as temperatures increase over the next few decades. In most areas the predicted increases are less than 20%. The risk of temperature increase is much larger in Rwanda, Burundi, south-west Kenya, and eastern Zambia. Other climatic changes, such as changes in rainfall patterns, floods and droughts, will also have an impact on future schistosomiasis prevalence.

2.1.4 Sensitivity matrix of human resources and human groups

While discussing about the impacts of climate change it is crucial to discuss about the sensitivity of unity representing services rendered ecosystems, means and modes of existence. In the following table (2) the sensitivity is analyzed in relation to each climate risk most frequent, as identified above. There is a need to consider that major socioeconomic disturbances (deforestation, desertification, overexploitation of lands and natural resources, dispersed rural habitat and high level of poverty) are already experienced in Rwanda and climate variations of the last decade in Rwanda come to complicate the situation (MINITERE, 2006).

For this study only 4 services rendered by ecosystems that are linked to agricultural production for food subsistence needs, water resources and energy needs satisfaction is taken into consideration. Means and modes of existence are five respectively and representative of all regions of Rwanda (MINITERE, 2006).

The sensibility levels refer to an evaluation scale of 1 to 5. Exposition indicator measuring to risk corresponds to global vulnerability of each unit or subunit analyzed

in relation to recorded most current risks taken into consideration; it is expressed in percentage.

Table 2-3 Sensitivity matrix of human resources and human groups

Most frequent climate risks					Indicator of exposition %
	1.Prolonged seasonal drought	2.Short drought during rainy season	3.Heavy rains	4.Short rains	
SERVICES RENDERED ECOSYSTEM					
Soil humidity	5	3	1	3	60
Water resources	5	2	1	4	60
Pastures	5	2	1	3	55
Timber/firewood	2	1	2	3	40
MEANS OF EXISTENCE					
Food producing crop harvest	5	3	4	4	80
Industrial products (tea, coffee)	5	3	2	4	70
Animals	5	2	1	3	50
Charcoal	2	1	1	1	25
Rain fed agriculture	5	3	2	3	65

Man power	3	1	2	1	35
MODES OF EXISTENCES					
Farmers home plots	5	2	3	4	70
Pastoralists/domestic level	5	2	1	3	55
Big farmers	4	1	2	2	45
Traders/ rural market	4	1	3	3	55
Civil servants	3	1	2	2	40

Sources: (MINITERE, 2006)

Table 2-4 Legends of Sensibility scale

1	Weak
2	Relatively weak
3	Relatively high
4	High
5	Very high

Table 2-5 Scale of exposition

≥70	Very high
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	vulnerability
≥ 55	High vulnerability
≥ 25	Relatively high vulnerability

From this matrix we identify that;

1. Food producing crops and industrial crops (tea, coffee) based on the means of existence they show a high degree of sensitivity especially during seasons of prolonged and frequent droughts.
2. Big farmers and rural traders have a high degree of sensitivity on the means of existence, their vulnerability is due to frequent and prolonged droughts as well, and they are relatively less vulnerable due to their possibility of easy access to financial means and they are aware how they have to easily adapt to climate hazards;
3. There is also a very high sensitivity for almost all services rendered by ecosystems during frequent and prolonged dry seasons and modes of rain-fed agriculture. Both have a high vulnerability.

2.2 Approaches to Adaptation

2.2.1 Adaptation and adaptive capacity

The term adaptation refers to the adjustment in ecological, social, or economic system; adaptation can also be defined as the process of designing, implementing, monitoring, and evaluating strategies, policies, and measures anticipated to reduce climate change impacts (Smit, et al., 2011). The literature has distinguished two types of adaptation;

autonomous adaptation at the household or farm level, and planned adaptation where this one takes place at the national level of the government (Wright et al., 2014). However, these adaptation types are always interlinked (Adger et al., 2003). (Osman & Sanjak, 2008) also identified the difference between the two adaptation terms; autonomous adaptation, when local communities and individuals use the self-traditional knowledge in response to the periodic climate variability. On the other hand, there is planned adaptation where the external organization is the core to initiate the adaptation through assisting the communities to overcome the climate variability impacts. Adaptation consists of practices to diminish the community, regions or activities vulnerability exposure to climate change variability. It is crucial in two aspects one in assessing the impacts and vulnerabilities the other is the development and evaluation of response options (Smit et al., 2011). To know the severity or danger of climate change an assessment must include the vulnerability and the existing adaptation systems. (Smit et al., 1999). Hence understanding the expected adaptation is crucial to the impacts and vulnerabilities and is fundamental in estimating climate change costs and risks (Yohe et al., 1996). According to Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC) that refers to “dangerous” as the influence caused by human on climate conditions in reference to whether, they will allow the ecosystem to adapt, and ensure food production is not threatened, and how they will enable the economic development to proceed in a sustainable manner. The vulnerability of ecosystems ability to restore itself depends on the degree of exposure to climate change effects and the capacity of the ecosystems to adapt to the changing situations. Adaptive capacity is defined as the ability of an ecosystem or society to withstand climate change (Smit et al., 2011). (Smit et al., 2000) stated that by increasing adaptive capacity will promote the sustainable development. Adaptive capacity should be characterized before assessing how it can be influenced at local level. However the direct assessment is not feasible, so it is very important to identify the features that are more likely to influence it (Jones et al., 2010). Unfortunately, the understandings of adaptive capacity are still limited (Vincent, 2007). In the concept of climate change, the vulnerability of a given system or society

is due to the exposure to climate change impacts and the ability of the system to withstand those conditions. There are two distinct aspects of vulnerability: physical exposure to the hazardous agent and the ability to cope with impacts. Therefore, vulnerability identifies the importance of socioeconomic systems in strengthening or diminishing the effects of climate change (Smit et al., 2011). According to the Intergovernmental Panel on Climate Change (IPCC) classification, it identifies nine categories determinants or that characterize adaptive capacity (economic wealth, technology, information and skills, infrastructure, institutions and equity (IPCC, 2001). An overlap has been identified within the basic concepts captured in these terms. For example, on the terms that has been used to differentiate natural from socioeconomic systems or to distinguish the condition of a system before and after the adaptation conditions (Klein, et al., 1999). These peculiarities are important and can be captured without narrowing the meaning of widely used terms. Thus, ecosystem vulnerability is from socioeconomic vulnerability (Smit, et al., 2011). Based on ACCRA's findings there exist another framework that characterize adaptive capacity, this framework identifies five different characteristics that are crucial to adaptive capacity, as illustrated in the table below Table (2-6), these are: the asset base, institutions and entitlements, knowledge and information, innovation, and flexible forward-looking decision-making (Jones *et al.*, 2010)

Table 2-6 LAC's five characteristics and their features (Jones, et al 2010)

Characteristic	Features that reflect a high adaptive capacity
Asset base	Availability of key assets that allow the system to respond to evolving circumstances

Institutions and entitlements	Existence of an appropriate and evolving institutional environment that allows fair access and entitlement to key assets and capitals
Knowledge and information	The system has the ability to collect, analyze and disseminate knowledge and information in support of adaption activities(Jones, et al 2010)
Innovation	The system creates an enabling environment to foster innovation, experimentation and the ability to explore niche solutions in order to take advantage of new opportunities
Flexible forward-looking decision-making and governance	The system is able to anticipate, incorporate and respond to changes with regards to its governance structures and future planning(Jones, et al 2010)

Economic asset or financial means is a key characteristic of determinant of an ability of a system to withstand the changing situations (Burton et al., 1998). It is well accepted that rich countries are able to withstand the impacts and risks of climate change because they can bear the adaptation costs than the poor countries (Goklany, 1995). (Jones *et al.*, 2010) also stated that the ability of coping with the climatic

changes depends on the access, control, and key assets, and it is the poverty that is directly related to vulnerability.

Although, poverty should not be defined as the synonym of vulnerability, either a rough indicator of ability to cope (Dow, 1992), communities with higher income are likely to manage the vulnerable situation such as through the managing floods impacts and invest in the transfer of loss into benefits (Kelly & Adger, 1999). Technology is also another base fact that can prohibit the nation's ability to cope with climate change effects, the nations that has no technologies access are likely to have narrow options towards adaptation strategies implementation (Scheraga & Grambsch, 1998). Institutional framework is also another assets to evaluate the vulnerability of a system. (Jones *et al* 2010; O'Riordan & Jordan, 1999)), defined the role played by institutions in holding the society together and giving it a meaning and purpose and ability to adapt, in the sense that communities with institutional framework in place can respond to a changing environment than the community that lack or have ineffective institutional arrangements. It is indicated that institutions environment that ensure the equitable utilization of resources and accessibility of opportunities are successful to promote the adaptive capacity (Jones *et al* 2010). Local Adaptive Capacity (LAC) framework identified knowledge and information as other characteristics of adaptive capacity and this argument is supported by different literatures. (Frankhauser & Tol, 1997) stated that communities with suitable knowledge and skills related to future threats and who have an understanding of adaptation strategies are more able to cope with the changes. A successful adaptation requires skills to implement the adaptation measures and to analyze the best alternatives among the existing options.

2.2.2 Community based adaptation to climate change

According to (Wilbanks & Kates, 1999; (Bryan & Behrman, 2013)community based adaptation is a significant issue when it comes to the process of climate change adaptation. Besides, most adaptation efforts have been in favour of top-down approaches. Community based adaptation terms (CBA) has been reflected in different aspects such as community based local capacity building, participatory disaster risk

reduction, community based adaptation and community based development efforts (Karim & Thiel, 2017). Although according to (Bryan and Behrman, 2013), Community based adaptation needs participation, collective action, social capital, information access and local knowledge of risk management. With the increase of climate change impacts it is essential to have both adaptations types in place. Therefore autonomous adaptation is not sufficient to address the impact of climate change. combined adaptation measures affects the decisions that are being made and affects the resilience due to climate change and sharing risks (Boahene et al 1999; Bandiera & Rasul, 2006) while it incorporate the long-term disaster management focusing on both scientific and indigenous knowledge (Wilbanks & Kates, 1999), Community -based adaptation (CBA) role is to ensure that the poorest people vulnerable to climate change are able to cope with changing conditions (Reid et al., 2009). And ensure that the community members are involved in planning, decision-making, and evaluation. (Mitchell, 1997) identifies two types of participation, normative participation which bases on the rights and democracy given to people in participating into decision making process while pragmatic participation provides higher quality decision (Reed, 2008). In addition, according to (Warner, 1997), participation can be defined as a 'building consensus' where all participants can live with the results. (Rowe & Frewer, 2000) defined participation as an exchange of information in the form of dialogue or negotiations. The role of participation is described as an effective means to achieve greater adoption technologies among the target groups (Martin & Sherington, 1997), it provides a high quality of information, meet the needs of local community and their priorities while providing higher quality decision (Karim & Thiel, 2017). Several policy documents have given an attention to the participatory approach in order to promote climate change adaptation strategies. The United Nations Framework Convention on Climate Change (UNFCCC) calls for parties to promote and facilitate "public participation in addressing climate change and developing adequate responses" (UNFCCC, 1992). The United Nations Development Programme (UNDP) emphasizes grassroots level participation (Wilbanks, 2003) and Intergovernmental Panel on Climate Change (IPCC) focused

adaptive capacity as the “active Participation by concerned parties, especially to ensure local needs and resources” (Few et al., 2007). Developing countries are more likely to be severely affected due to their vulnerabilities and related geographic, socio-economic contexts (Roberts, 2013). It is in this perspective that community-based adaptation (CBA) is gaining attraction (Spires et al., 2014). Adaptation to climate change risks will need to use bottom up approach starting with the lowest level as family up to government (Ebi & Semenza, 2008). Effective community-based adaptation (CBA) tackle both the motivation of communities to take actions towards an adaptation scheme and understanding of climate change to minimize the risks, it is important to communicate the climate change issues with the communities (McNaught & Warrick, 2014). The capacity of local communities/farmers to adapt to climate changing conditions is in a part of social capital. However there are other factors such as socio-economic conditions, governmental accountability, and institutional. Thus, adaptation can comprise both spontaneous responses by affected communities, planned responses by governments and institutions (Ebi, et al., 2008). There are methodologies that are used to evaluate the effectiveness of adaptive capacity. (Jones, *et al* 2010) identifies and defines five asset and process-oriented characteristics of Local Adaptive Capacity (LAC) framework for evaluating the community adaptive capacity.

2.2.3 Challenges and barriers of community based adaptation

Although, community-based adaptation is a an important approach to addressing the vulnerable communities (Huq & Reid, 2007) it also presents many challenges. The first challenge, it is unclear how much community based adaptation differs from community based ‘. This lack of clear difference has raised many problems for practioners and funding bodies who require firmer signposts of successful community-based adaptation projects to distinguish good practice (Ayers & Forsyth, 2009).The second challenge, is to know whether community-based adaptation consist simply of local responses to existing climate variability, rather than a proactive anticipation of future climate change? Many community-based adaptation projects do not currently use projections of climate change from research organizations or the IPCC (Ayers &

Forsyth, 2009). According to some analysts, the institutional design of community-based adaptation lies in the local deliberations that can identify development needs and cultural preferences, instead of technologies transfer from other regions (Ayers & Forsyth, 2009)

Availability and accessibility of scientific data are one of the biggest challenges. Communities face, data accessibility challenge is a limitation to the planning process. Climate models for projections are limited; weather forecast is not accessible to the local communities(Reid et al., 2009). For example, (Rebecca et al., 2014) pointed out that scientific explanations of climate change cause consequences and uncertainties that can be confusing and disempowering for communities especially if not interpreted in a language that can be understood by the local communities. (Jennings & McGrath, 2009), on another hand stated that most meteorological analysis and climate models focus on mean annual temperature and precipitation rather than the actual time of intra-seasonal rainfall patterns, which are of interest to farmers. The second challenge is knowledge, although communities do not trust the scientific knowledge the scientists also find it hard to rely on locals. Yet the local knowledge can be of use in the absence of weather records and climate change data, CBA could largely depend on the local and indigenous knowledge of past climate trends for forecasting future trends. The issue of participation is also a challenge in implementing CBA. The external influence prohibits the community to be in charge often the priorities and interests of outsiders dominate those of communities. For example, in certain field such as natural resources management shows that for adaptation to be successful and it must draw the knowledge and gives the priorities to local people, build through their existing knowledge and capacities and allows them to make changes (Reid et al., 2009). Participation as defined, a rudimentary level of consultation between community members and professionals are generating an effective and consensual output (Taylor, 2003). The following table(4) identified different typology of participation according to (Reed et al., 2009).

Table 2-7 A typology of participation (Adnan, et al., 1992)

Type of participation	Characteristics
Passive participation	People's response are not taken into consideration, people participate because they have been told to do so. This is a top down approach where the information shared belongs to external professionals.
Participation in information giving	The participation done through the questionnaires. Where people have no influence to proceedings and the findings of the research are neither shared nor checked for accuracy.
Participation by consultation	Here people are involved for consultation, the external people listens to their views though external professionals define both problems and solutions but modification are done by considering people's response. Such a consultative process does not concede any share in decision-making, and professionals are under no obligation to take on board people's views.
Participation for material incentives	People participate in the presence of incentives such as labor, in return for food, Cash or other material incentives. Much on-farm research falls into this category as farmers provide the fields but are not involved in the experimentation or the

	<p>Process of learning. It is very common to see this called participation, yet people</p> <p>Have no stake in prolonging activities when the incentives end (Reed et al., 2009).</p>
Functional participation	<p>People participate by forming groups to meet predetermined objectives related to</p> <p>the project, which can involve the development or promotion of externally</p> <p>Initiated social organization. These institutions tend to be dependent on external initiators and facilitators, but may become self-dependent.</p>
interactive participation	<p>People participate in joint analysis, which leads to action plans and the formation of new local institutions or the strengthening of existing ones (Reed et al., 2009).It is interdisciplinary methodologies that seek multiple perspectives and make use of systematic and structured learning processes. These groups take control over local</p> <p>decisions and so people have a stake in maintaining structures or practices</p>
Self-mobilization	<p>People participate by taking initiatives independent of external institutions toChange systems (Reed et al., 2009). They develop contacts with external institutions for resources and</p> <p>Technical advice they need, but retain control over</p>

	how resources are used.
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(Meggan et al., 2014), identified three barriers of CBA implementation as described in figure (2-2)

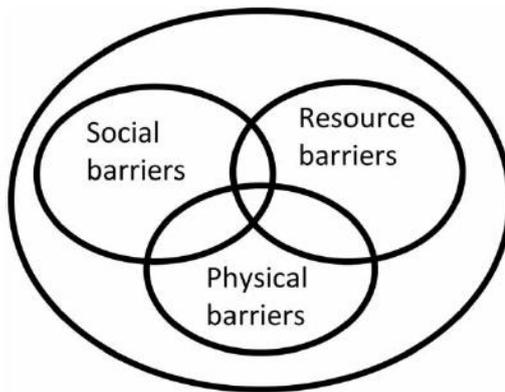


Figure 2-2 Conceptual grouping of barriers to adaption (Meggan et al., 2014)

Lack of coordination and exchange of information within the stakeholders can be considered as a social barriers stated (Srinivasan et al., 2011).

2.3 Climate change communication and knowlegde sharing

One of the objectives of this study is to analyses how climate change information is communicated to the community. This paper analyses the literature that has been done on the communication channels and challenges of climate change communications. However, there is a little or a gap regarding communication of climate change in a developing country and adaptation context is still in its early stages (Moser, 2010). Since the emersion of climate change concepts the question on how should it be communicated effectively was raised (Moser, 2010). The early communication was based on the scientific findings and the reports, an example are the IPCC reports (IPCC); severe extreme events, and sometimes the high-level conferences or meetings (Weart, 2003). Although, knowledge its self is not sufficient to drive the motivations

(Moser & Dilling, n.d.). Nowadays, the communication is not just about the the experts of scientific consensus rather media practices and public awarness have increased in all levels especially at least in many developing countries (Oreskes, 2004). The implications of climate change communication chllenges are; firstly climate change is difficult to perceive and understood by all targeted audiences so it requires a clear and simple communication strategies. It should be explained in a language so that all can understand. Imagery, simple metaphors and mental model should be used to provide an appropriate and cognitive processing. Secondly, it should be noted that in which ever case climate change may seem urgent to experts, now or later. It is mostly fundamentally, ambigious problem formost audiences and can easily be trumped by more direct experiences. This means that lay audiencesneed to receive ample, clear, sufficiently strong, and consistent signals that support the necessary changes (Moser, 2010). Thirdly, Third, however addition education and increase in scientific literacy are crucial for many reasons (Bak, 2001). For climate change communication to be effective some key elemnts should be hightled and followed carefully,

According to (Moser, 2010) the following are some of the communication key elements ; What are the goals (scope and purpose) of the communications, who is the audience (individuals, specific sub-populations, etc.), how is the issue? What language, images, etc. are used, what messages, what information is conveyed and how can the content be made most useful and accessible, Content also relates to questions about the sources of information on climate change and their credibility [e.g., government, media, scientists—directly or scientific institutions, non-governmental organizations (environmental or other civic groups), or industry], who are the messengers (e.g., politicians, scientists, advocates, pundits, business people, celebrities, people of different ethnic or socioeconomic background and of different ages), through which channels and through which media and modes does the communication occur, and how do we know the communication had the intended effect?

While answering these questions, it is simple to highlight the challenges and opportunity for communication. A great understanding between a sender and a

receiver of information is a crucial element to ensure that the conveyed message or dialogue will meet the desired objectives.

Mode and channel of communication are important aspects (Moser & Dilling, n.d.) distinguished certain means of communication; written communication that can be done through (e.g., newspaper, letter, and report) from *verbal* (e.g., lecture, storytelling, and conversation) and *non-verbal* (e.g., gestures, bodylanguage, sign language, and facial expressions) modes of communication. The communication channel through which communication occurs—face-to-face (e.g., a dialogue or lecture) versus mediated (in print, such as newspapers, magazines, leaflets, or electronically via email or the web) determines whether these modes of communication can occur simultaneously or not (Moser, 2010). On another hand it is necessary to note whether the communication is occurring between two people, a small scale group, or mass communication. According to (Moser, 2010) communication campaigns assume that mass media is the best effective channel to reach a high number of audiences that is needed for mobilization of climate change actions. Reaching a large number through television, newspapers, and the internet. This hinder us to see that the mass media communication can lender the information ineffective due to the fact that information passed along media is easily discarded and ignored, and also the structural platforms of the media landscape changes accordingly. Without also forgetting that in rural areas not everyone can be able to access the information that are disseminated through the social media channels. In the beginning the communication of climate change information has been provided by the western science, however this information must include the indigenous knowledge and let the community own their adaptation (Ford, et al., 2013). Ever since the beginning of climate change communication tremendous changes have occurred in the mass media. The increase immersion of the internet as a common mode of information dissemination. Social mobilization, and virtual dialogue are the most visible important aspects (Moser, 2010)

2.4 Mainstreaming community-based adaptation (CBA) in agriculture

(Wright, et al., 2014) defined climate change mainstreaming that it brings about the incorporation of climate change information into the public policy plans at all governing levels within all sectors by involving both public, private and civil actors. According to (Klein et al., 2003) mainstreaming involves the integration of information, policies and measures to address climate change into ongoing development planning and decision-making activities. Mainstreaming activities consider that climate risks projects are addressed and project activities and approaches are adjusted with the assumption that the project have a goal of poverty reduction, livelihood security, well being is improved for the targeted individuals and sustainability (Huxtable & Thi Yen, 2009). It more sustainable, effective and efficient use of resources rather than designing and managing policies separate with activities (Ayers & Huq, 2009a; Klein et al., 2003). Mainstreaming differ from community based adaptation because CBA goal is to build resilience to climate change (Huxtable & Thi Yen, 2009). Mainstreaming climate change has identified as a way in which both adaptation and development can be addressed (Huq, 2001). However mainstreaming practices can have a different meaning to different people (Dalal-Clayton & Bass, 2009). The reason behind mainstreaming is to ensure that the risks posed by climate change are reduced through the project activities by the stakeholders, this term is referred as “climate proofing”, and also to ensure that project or program activities maximize their contribution to adaptive capacity of targeted populations without increasing the vulnerability, instead through the actions designed to build resilience (Huxtable & Thi Yen, 2009). ‘Climate-proofing’ has been criticised for failing to full address the major cause of vulnerability, it has failed to address the maladaptation and realization of the potential interventions to a successful resilience (Ayers et al., 2011). In climate-proofing the Climate resilience is integrated at a later stage (Mousumi et al., 2013). On the other hand, a vulnerability or development-based view of adaptation incorporate a more understandable holistic approach in addition to climate-proofing, here the development approach are aimed to diminish the vulnerability by including all priorities for adaptation (Klein, 2010).

2.4.1 Why mainstream? The linkages between adaptation and development

According to (Ayers et al., 2014) historically, climate change adaptation and development have been managed in different arenas. From United Nations Framework objective' of the UNFCCC climate change adaptation emerged a response to fight with climate change impacts. Therefore, the adaptation emerged under global governance structures from discussions.

approach to adaptation (Burton et al., 2002 ; (Ford, 2008). According to Klein, he defines it as 'technology-based' interventions such as dams, early-warning systems, seeds and irrigation schemes based on specific knowledge of future climate conditions (Klein et al., 2008). Integrating adaptation into development is often referred to as 'mainstreaming'. In general terms, mainstreaming refers to integrating an issue into existing (usually development) institutions and decision-making. Originally the term is well known best in relation to 'gender mainstreaming' (Booth & Bennett, 2002). More recently, 'environmental mainstreaming' entered the development policy agenda. This is defined by Dalal-Clayton and (Ayers et al., 2014) as the informed inclusion of relevant environmental concerns into institutional decisions that drive national and sectoral development policy, rules, plans, investment and action. While talking of mainstreaming and development, we should consider the relationship between the two terms. Mainstreaming, has a long history in both development and environmental policy (Ross & Dovers, 2008). In relation to climate change mainstreaming has been suggested as a key possibility to tackle adaptation and development together (OECD, 2009). Huq and Ayers (2008) propose a framework for mainstreaming at the national level (see Figure 2-3). The context of the framework assumed that the international cooperation would be the mainly drive given that incentives for climate change adaptation planning at the time were generally externally driven (Ayers & Huq, 2009a)

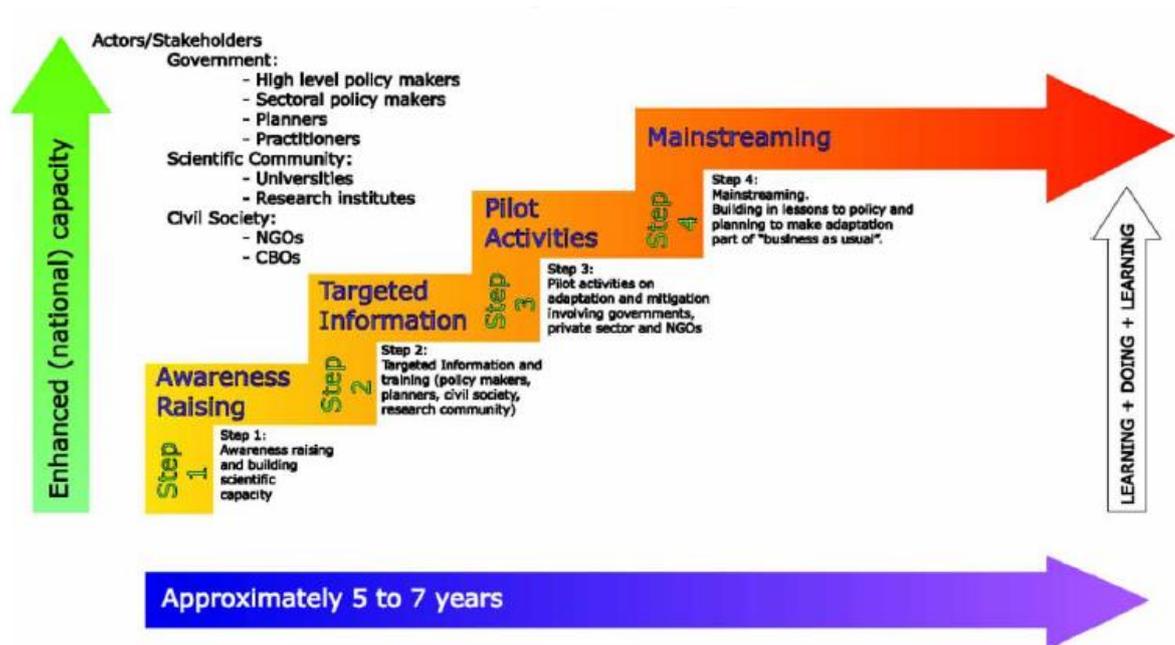


Figure 2-3 Four steps to National Capacity Buildings on Climate Change

Sources: (Huq & Ayers, 2008)

Based on this framework a linear sequence of awareness and scientific capacity-building, targeted information, training of key stakeholders, which is followed up with pilot studies to inform policy-makers and generate incentives to incorporate lessons learnt into policy and planning (Lebel et al., 2012).

2.4.2 examples of mainstreaming CBA in agriculture and how the government of Rwanda is tackling the issue of mainstreaming.

Bangladesh is one of the most vulnerable country to climate change (Huq, 2001). Despite that CBA mainstreaming in Bangladesh faces various barriers, initial steps

have been undertaken to mainstream climate change lessons and process (Wright, et al., 2014). Bangladesh have used both climate change perspective which use development of climate change specific plans, programmes and institution that adress the aspects of vulnerability and also the they have used development perspective which integrate climate risks into development programmes and policies to support the resilience (Ayers et al., 2014). According to (Baas & Ramasamy, 2008) the “Livelihood Adaptation to Climate Change” (LACC) project under the Comprehensive Disaster Management Programme (CDMP) undertook the promotion of livelihood adaptation within the vulnerable communities, and this was implemented with the support of Deapartment of Agriculture Extension (DAE) and UN Food Agriculture Organization (FAO). Bangladesh was one of the first countries to develop its NAPA (Ayers et al., 2014). These studies will show the institutions role , mechanisms and project activities, factors and barriers face during incorporation of climate change mainstreaming.

Rwanda as well has incoporated mainstreaming activities of climate change in agriculture in what is called “climate change mitigation and adaptation”. (FAO, 2009) it has identified certain strategic areas of actions to adress climate change impacts within agriculture sector, the experience of mainstreaming CBA in Rwanda into agriculture range from from national level to local level.

2.5 Government of Rwanda (GoR) response to climate change

For supporting the smallholder and farmers to withstand the impacts of climate change, the GoR has advised several policy and institutional framework;

National Adaptation and programme of Action (NAPA)

Rwanda has put in place the report on National Adaptation Programme of Action to climate change, NAPA, which was adopted by Assembly of the Conference of Parties to the United Nations Framework Convention on Climate Change in November (MINITERE, 2006). This document contains an overview of climate change and its

impacts. Agriculture sector is one of the focused areas where the vulnerabilities of farmers to climate change are highlighted. In addition, water resources and energy sectors are to be considered due to the mutual influences on the agricultural productivity. In agriculture sector, the NAPA report suggested immediate and urgent actions to be undertaken (REMA, 2011):

Some of them are following:

- Integrated management of water resources;
- Establishment of information systems, for hydro-agro-meteorological warning and rapid Intervention;
- Promotion of income generating activities other than agricultural ones;
- Promotion of intensive agri-farming;
- Introduction of varieties resistant to environmental conditions;
- Development of alternative energy resources to replace fuel wood.

NAPA has identified 6 priority options for which projects shall be prepared for funding and implementation in Rwanda. These options are as follows (MINITERE, 2006):

- ❖ *Priority n° 1: Integrated water resources management (IWRM)*
 - Aim: Reduce the vulnerability of ecosystems, population and sectors due to the quantitative and qualitative shortage of water resources and the damages caused by the runoff due to the climate change (MINITERE, 2006).
- ❖ *Priority n° 2: Set up information systems of hydro agro meteorological early warning system and rapid intervention*
 - Aim: Improve information system of hydro agro meteorological early warning system and rapid intervention and reduce the exposure of the population and sectors at risk of extreme events and climate catastrophes (MINITERE, 2006).
- ❖ *Priority n° 3: Promotion of income generating activities*

- Aim: Improve the adaptation capacity of rural population vulnerable to climate change through the promotion of income generating non-agricultural activities.
- ❖ Priority n° 4: Promotion of intensive agriculture and animal husbandry (MINITERE, 2006)
 - Aim: Improve the adaptation capacity of farmers and pastoralists to climate change through setting up agro-sylvo-pastoral systems adapted to real land vocation.
- ❖ Priority n° 5: Introduction of varieties resisting to environmental conditions •
 - Aim: Improve adaptation capacity of farmers and adapt to climate change through promotion of appropriate cultural techniques and the introduction of varieties resisting to environmental conditions.
- ❖ Priority n° 6: Development of energy sources alternative to firewood
 - Aim: Reduce the pressure of woody combustible and hence reduce the overexploitation and degradation of forests through the promotion of energy sources alternative to firewood (MINITERE, 2006). This aim contributes at the same time to reducing the vulnerability to the energy crisis of the country especially the poor rural population.

These priorities have recognized the role played by rural communities in achieving climate change adaptation as seen on the following table 3 below shows the characteristics of the six priority options, so as to put them in relation to target groups and their sectoral or multispectral nature to their mainstreaming to a bigger programme, to stakeholders in charge of their execution and potential sources of funding.

Table 2-8 Characteristics of the 6 priority options

Priority options	Targeted groups	Integration	Crosscutting aspects	Stakeholders	Source of funding

IWRM: Integrated water resource managemen t (IWRM)	Rural communities, agro-animal husbandry, urban population	Rwanda Vision 2020 Poverty Reduction Strategy National Strategy to Combat Desertification	Multisectorial Public sector ,	Private sector, NGO and Local communities	Govern ment Donors NGO
Promotion of non agricultural activities of income generating schemes	Rural communities Poverty Reduction Strategy Rwanda Vision 2020	Multisectorial Private sector and targeted groups (beneficiaries)	Multisectorial	National services for hydro- meteorology Central and local Gvt. NGO and UN Agencies	Govern ment Donors and Private sector
4. Intensive agro-animal husbandry	Rural communities	National agriculture policies Rwanda Vision 2020	Multisectorial	Rural communities	Govern ment Donors and ONG
5.Promotion of varieties resisting to drought	Rural population of the arid eastern and southeast regions of the	National agriculture policies National strategies for the fight against	Multisectorial	ISAR and beneficiaries	Govern ment and Donors

	country	desertification			
6. Development of energy sources alternative to firewood	Urban and rural population	Forestry policies Energy policies, Strategies for the biodiversity conservation	Multisectorial	Researchers Private sector Local laborers	Government Private sector NGO

Source: (MINITERE, 2006)

Comprehensive African Agriculture Development Programme (CAADP)

Refer to the Ministry of Agriculture and Livestock, CAADP program in Rwanda had ratified and domesticated CAADP objectives into the national policies on March 31, 2007. In Rwanda, the program enhanced the implementation of the strategic development and poverty reduction strategy (EDPRS) which linked to the implementation of the Strategic Plan for the Transformation of Agriculture (SPAT, geared toward strengthening and adding value to the country's agricultural productivity which is part of vision 2020 agenda.

Green Growth Strategy

Green Growth and Climate Resilience National Strategy for Climate Change and Low Carbon Development was released (Byamukama, et al., 2011). The strategies aim to make a significant impact on adaptation, mitigation and economic development, and these are likely to produce the greatest return investment for Rwanda. Various projects within the program are in a holistic manner and encompass the long-term directions as well as short term priority. The Strategy is one of the initial steps on a pathway which leads to a sustainable, secure future, where the country will be well prepared to the risks of climate change and the increase of population growth.

National Policy on Environment

Rwanda has formulated a national environmental policy in 2003. And an organ specialized in environmental protection; the Rwanda Environment Management

Authority (REMA) was established. The Organic Law n° 04/2005 of 08/04/2005 determining the modalities of protection, conservation and promotion of the environment has come into effect since 1st May 2005 (O.G. n° 9 of 1 May 2005). It determines especially the guiding principles for conservation and rational use of environment and natural resources. It has in place the climate change information and through the awareness and mainstreaming it has successfully achieved in integrating climate change adaptation and mitigation measures into all sectors in Rwanda national and local levels (REMA, 2010)..

The National Fund for Environment in Rwanda – FONERWA

FONERWA is the National Fund for Environment and Climate Change Strategies in Rwanda. The formation of the fund was provided for under Organic Law No 04/2005 determining the modalities of protection, conservation and promotion of environment in Rwanda (REMA, 2010). The fund goal and objective is to enhance the sustainable financing for environmental related projects and climate change resilience. The first objective is to promote the management at the local level and seek the external source of funds and channel them towards a sustainable development use. The institutionalization of FONERWA comes at an opportunity time when Rwanda has just developed a cross sectoral climate change strategy, Green growth and climate resilient. The Climate Change and Low Carbon Development strategy in which FONERWA was identified and proposed as the primary vehicle to uptake climate change financing to address national priorities (FONERWA, 2016). This also was encouraged by the need for adaptation and disaster prevention funding from the Economics of Climate Change in Rwanda due to the significant economic cost associated with climate change impacts (Byamukama, et al., 2011).

2.6 Community based organizations active in Eastern province Rwanda

Rwanda Rural Rehabilitation Initiative (RWARRI)

It is a non-profit making and nongovernmental organization (NGO) dedicated to the promotion and improvement of social-economic welfare of rural communities in

Rwanda, by acting as a flexible catalyst that provokes their hidden potential. RWARRI came into being in 1994 but started its activities in Rwanda in 1995. The organization was started by a group of professionals and self-motivated Rwandese who felt they should use their experience to make a positive contribution towards the reconstruction of the country following the genocide in 1994. This was recognition that more than 70% of Rwanda's population live below the poverty line and the majority of these are found in the rural area. Depending mainly on agriculture for their survival and remain the most vulnerable and marginalized in Rwanda.

The organization mission is to be one of the most valued and respected nongovernmental organizations in Rwanda and beyond serving the interest of its members, contributing towards shaping national policies and leading the agricultural sector towards sustainable levels.

The goals of this organization are listed below;

- To mobilize and organize small scale farmers into economically viable groups.
- To strengthen the capacity of grassroots groups through provision of training on technical, management and environmental issues among others.
- To facilitate farmer groups in identification of viable enterprises and obtaining markets for the products.
- To promote and provide opportunity to vulnerable groups such as women and youth in social and economic activities.
- To promote all activities aimed at rehabilitation and development of the country's wealth.
- To create awareness on protection and improvement of the environment.
- To advocate for farmers rights by actively participating in decisions that affects their interests in the economic and social sector.

Rwanda Development Organization (RDO)

RDO was formed with the vision of Sustainable development of the people by the people where Rwandans enjoy a good standard of living with ability to sustain their basic and secondary needs (<http://rdorwanda.org.rw/>) . With the vision to empower people so that they are able to have clear perception of what their real problems and potentials are for designing feasible solutions. In this way, people will build better and sustainable socio-economic development.

The vision of the organization is to facilitate rural community empowerment for sustainable development. The organization enables the community to acquire and exercise improved potentials for identifying, analyzing and prioritizing their development problems and for designing and executing feasible plans to address them.

In order to achieve this mission the organization aims at the following goals:

- Human Resource development
- Food security
- Environmental conservation
- Internal resource mobilization
- Community mobilization

RDO has set the following strategic goals in order to attain its mission and vision while keeping within the national and global development context:

- Human and Institutional Capacity Development(HICD)
- Attainment of Food Security and Nutrition
- Social promotion and protection for vulnerable groups

Several project have been established one of them is ‘The Farm to Market Alliance (FAMA)’ the project aims at supporting smallholder farmers to increase on-farm

productivity and market access for their produce so as to improve on their livelihoods. The project has mobilized off-takers willing to offer forward delivery contracts to farmers and cooperatives and also mobilized input dealers willing to provide high quality seeds and fertilizers to farmers. The project supports 24,000 farmers grouped in to 80 cooperatives.

So far the project has achieved:

- Off-takers signed forward delivery contract with 80 cooperatives .Off-takers includes RGCC, PRODEVU/MINIMEX and SARURA
- 20,000 farmers were trained in good agronomical Best practices (GAP) which include planting, Top dressing and Post-harvest handling .This was achieved through training of Lead farmers who trained other farmers .

CHAPTER THREE

3. Methodology

3.1 Sampling design and methodological Approach

This survey study entailed reviewing targeted community who have joined the community based organization, and those that have not joined them, the Ministry of Agriculture and Livestock (MINAGRI), and the community based organizations. The study focused on community responses in the area of climate change and how they perceive the advantage of having community based institutions in place. There was a deliberate assessment of indigenous knowledge of communities concerning climate change impacts, vulnerability and adaptation. This entailed analysis of community perceptions, knowledge on the adaptation measures; however, the focus of the study was on how effectively are the community based organizations in place transferring climate change information and adaptation strategies. Animal and crop farmers around in the study communities were organized in groups which were gender sensitive and then interviewed. Socio-economic impact of climate change involved assessment of various livelihood capabilities of the households (Intra- and Extra- household dynamics) in the study areas. This included the information on climate change adaptation strategies that is provided to the farmers in order to ensure that food security and livelihood are not threatened. The study also included questions on what are the benefits that have been analyzed after joining the community based organization, and the perception of those that have not joined them. Hence the study analyzed the challenges of community based organization in dispensing information. The study evaluated the role played by Government of Rwanda through the Ministry of Agriculture and Livestock (MINAGRI), either technical or any other support to the community based organization or to the farmers. Methods used in the study included the use of the check lists using the Participatory Rural Appraisal (PRA) tools such as Focused Group Discussions (FGD), Key Informant Interviews, and Semi-structured Interviews. The study is based on Quantitative and Qualitative data analysis as it involves discretion and interpretation of the research findings. Data were categorized

under the themes, analyzed by in line with the objectives of the thesis. Tentative themes were identified namely; the community understanding of climate change, the socioeconomic impact, vulnerability and adaptation information provided to the community through community based organization and challenges faced by CBO's in transferring climate change information. The study employed Participatory Rural Appraisal (PRA) family of approaches, methods and behavioural stimulating tools that enabled community members to express and analyze the realities of their lives and conditions amidst climate change. PRA tools used, facilitated the analysis of local problems and the formulation of tentative solutions with local stakeholders. The tools used were of a wide range of visualization methods for group-based analysis to deal with spatial and temporal aspects of climate change social-economic feature and problems. Therefore, PRA tools provided a structure and many practical ideas that stimulated local participation in the creation and sharing of new insights about climate change mitigation and adaptation.

3.2 Organizing the study

The study activity process took two weeks of fieldwork since April 25th till 15th of May into the discussions with study communities and analysis.

Questionnaires: 100 questionnaires were administered to the randomly selected study population that has joined the community based organizations and 40 were administered to those that have not joined them in the four selected districts. 8 questionnaires were filled by the community based organization leaders (RWIRRI), and other 8 questionnaires were administered to the Ministry of Agriculture and Livestock in Rwanda (MINAGRI). For purposes of elimination of bias, the respondents were randomly selected within each group. There was back translation of questionnaire; the original questionnaire was written in English and during interviews it was translated into Kinyarwanda

Document review: In order to understand the context of the problem and suggest feasible recommendations, this study used some reviews of certain documents the

international and national policy documents including literature on the existing policies in the country on climate change adaptation extent.

3.3 Data collection

1. Focus Group Discussions (FGDs):

Participants from community farmers were organized in a group of 6-8 people at each study site. Each group was to present its views in an open environment. Comparisons on emerging issues were drawn. Focus group discussions were conducted in order to get a deep understanding of their answers for this study report. Focus group participants had been interviewed earlier as key informants. For the same reason an open meeting was generally framed in the study activities. Given the context of this kind of study, the following key tools complemented FGDs:

2. Semi-Structured Interviews with Key Informants:

This mainly targeted community based organization leaders and ministry of agriculture officers. Their views, observations, and experiences with regard to the research problem were sought. Face to face interviews were carried out with respondents who participated in the study as key informants. A meeting and discussion were conducted with the key informants of Ministry of Agriculture and Animal Husbandry (MINAGRI)

3.4 Sampling and sample size

This survey was conducted in Eastern province of Rwanda because the area is highly subjected to drought, four districts will be selected. A total of 100 farmers' household was interviewed. A focus group discussion was also conducted in the community, it involved fifteen participants. The survey was conducted. In addition an interview to the community based organizations leaders in the area was also conducted where 8

participants were selected. Another 8 officials that works with the Ministry of Agriculture and Livestock were also.

3.5 Data collection and analysis

During the course of this research qualitative and quantitative was collected. Data collection was done through questionnaire and organization of focus groups to collect data from key informants. The sampled households and community based organization leaders participated in answering of a survey questionnaire

Table 3-1 Number and distribution of respondents

District	Number of questionnaire Respondents / With CBOs	Number of questionnaire Respondents /Without CBOs	Number of FGD s
Rwamagana	35	15	1
Kirehe	30	15	1
Ngoma	35	10	1
Total	100	40	3

This study is both quantitative and qualitative in nature; data collected was edited for accuracy, completeness, uniformity and consistence. Data has been analyzed before, during and after data collection basing on the main study themes. Quantitative data analysis was done using excel. Each form of data entry excel worksheet looked like each page in the questionnaire. This helped to enter data precisely from surveyed questionnaires into computer (in excel). The data in excel was easy to convert into different tables for describing analysis. The questionnaires were cleaned carefully both

before and after the data entry. Before the data entry, the written questionnaires were crosschecked by the interviewers to minimize missing information and to ensure that every interviewer understood the questionnaire well. After data entry, the data set was checked once more to minimize any mistyping mistake.

CHAPTER FOUR

4. Results and Discussions

In relation to the targeted population sample size, this study omitted the farmers that are members of a Community Based Organization (CBO), however we also interviewed and discussed with the farmers that are not members of the organization. This study was assessing the impacts that these organization has provided in transferring climate change information and how such information have contributed to their livelihood conditions and their productivity. According to a survey study that was conducted in Eastern province in 2015 by NBDF, key informant explained that there is a low value of agriculture products, low yield due to low land quality, draught, frequent crop and animal diseases and other disasters lead to low return of agricultural production (NBDF, 2015). However based on the findings of this study there was a slightly change according to the farmers perception on the yield and agricultural production. Farmers argued that after joining community based organization, they have been able to access information that are related on improving their agriculture productivity under a climate change variability.

4.1 Climate change impacts on Eastern province farmers communities

4.1.1 Thoughts about climate change

All respondent either those within community based organizations or those that are not within, were asked whether they have heard about climate change before this study. Interviewers explained in a simple way the meaning of climate change and the characteristics as: “long-term changes in the weather/climate especially a change due to an increase in the average atmospheric temperature: leading to unpredicted rainfall and drought seasons. Afterward questions were asked relating to climate change in order to understand people’s views and perceptions about the notion of climate change. The first question that was asked concerned if they have ever had a term of

climate change before. Respondents were required to answer yes or no. 84% of total respondents both members and non-members have heard about climate change although some of them they could not explain the causes or the characteristics of it, while 16% had not heard about climate change. According to (NBDF, 2015), 57% of total respondents have heard while 41% had not heard about climate change. This shows that climate change awareness has increased. These results were observed to all the participants whether they have joined community based organization or not. Farmers in the study area testified that they have observed several changes in recent years. For those who did not understand the word climate change they were asked to say on how the weather was since like 30 years ago and what has changed. The community testified that there has been a shift in the rainy seasons and that the droughts have increased. It was also noted during the Focus Group Discussions that the community seem to be aware and understand the changes that are happening and the farmers that are within community based organization emphasised that within these organization they have learnt a lot about climate change. However few among those that have not joined community based organization seem to understand well this concept. These results seem to be improved compared to the survey that was conducted in 2014, where only 57% (Nile Basin Discourse Forum, 2014), were aware if climate change is happening, this can be attributed to the effects of strengthening the climate change organizations in the Eastern province.

4.1.2 Perceptions of respondent on the causes of climate change

The community perceptions view on climate change was tested. In the questionnaire that were provided, a question was asking if they know the causes of climate change, respondents were required to list some of what they think are the causes. The following chart shows the findings.

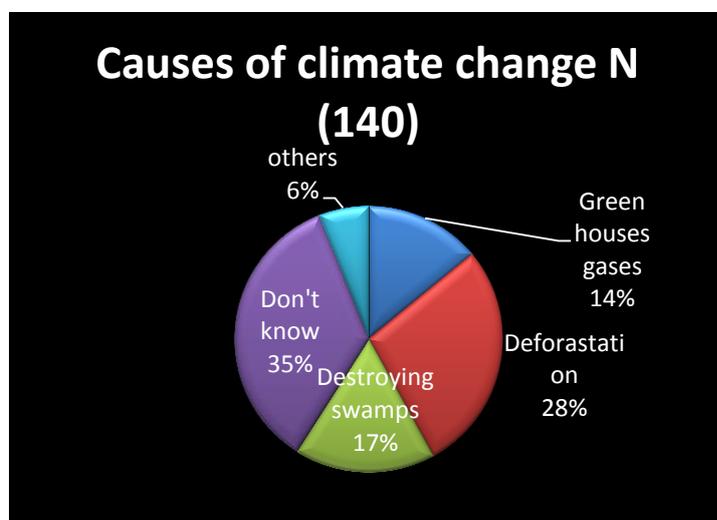


Figure 4-1 Causes of climate change

Figure 4-1 above shows a large number of the respondents 36% don't know the cause of climate change while 29% said that it is caused mainly by deforestation. Only 14% mentioned greenhouse gases emissions. This indicates that there is insufficient knowledge about climate change or the awareness is lacking in these targeted districts because Rwanda contribute a little in green houses gases and also cutting down the trees is not a direct cause of climate change. During the focus group discussion, it seems that the farmers have been informed but did not well understand the context about the direct causes of climate change. This can raise an issue on the means of transferring climate change information that are being employed by a CBO. It should be noted that an effective adaptation should include information regarding the causes,

adaptation long-term adaptation strategies, like information on the cause of climate change and how it should be mitigated or how the causes can be minimized.

4.1.3 The already experienced climate change effects

This study investigated people's experience and knowledge to the extreme events that are caused by climate change. The interviewers first explained some of the likely events that are associated by the climate variability and climate change. Events such as flooding, droughts, diseases were explained. The interviewers explained how extreme climate events can have a serious impact on the environment and society, including loss of life, property and livelihoods. Interviewers had to explain to respondents that a changing climate leads to changes in the frequency, duration and intensity of droughts and floods, and will test capabilities of society's resilience. Thereafter respondents were asked to give answer (Yes/No) whether they have felt the impact of extreme weather event. Chat below shows distribution of responses

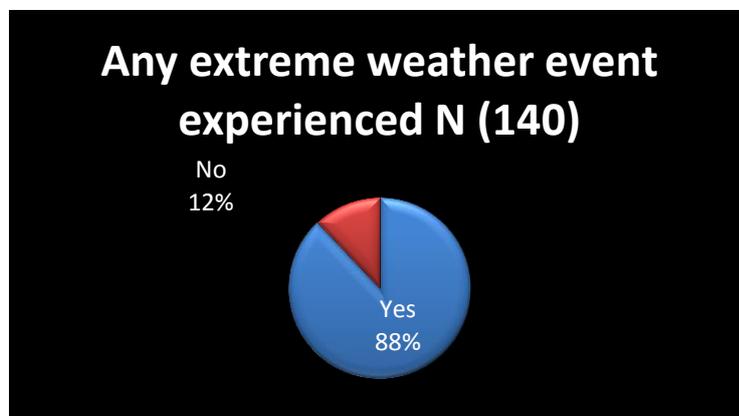


Figure 4-2 any extreme weather event experienced?

As shown above, the vast majority of respondents 88% have felt the impact of extreme weather events while 12% do not notice any changes. The following table 4-1. The study investigated further the specific extreme events claimed by the respondent. Respondent's farmers those who belong in community based organization and those who do not questionnaire were asked to mention their most experienced climate change effects. They were required to select one response from a list of options

pertaining to effects of climate change in their location. The following table shows the responses of the asked question

Table 4-1 Effects of climate change

Variables	District						Total
	Rwamagana		Ngoma		Kirehe		
Effects of climate change	N	%	N	%	N	%	N%
Drought	15	42	10	33	17	48	42
Floods	2	6	2	7	1	3	5
Unpredicted rain fall seasons	10	29	8	27	8	23	26
Extreme hot temperature	5	14	6	20	8	23	19
More diseases	1	3	3	10	1	3	5
Damage of public utilities (roads)	2	6	0	0	0	0	2
conflicts	0	0	1	3	0	0	1
Total	35	100	30	100	35	100	100

According to the findings, drought was rated 42% as the major climate change effect felt in the province. And the respondent during the FGDs show their worries that drought will continue to rise and that this can lead to food insecurities and water crisis. The farmers argued that the implications of climate change are due to the prolonged droughts and unpredictated rainfall. Season changes – hotter temperatures and rain patterns changes: unpredictated rain fall was ranked the second (26%) followed by hotter temperature (19%).

During the focus group discussions the observations were made. The main challenges were highlighted. Firstly, the local community stated that they have observed the decrease in precipitation amount. Secondly they observed the unpredictability of rain fall patterns and the cultivation seasons has changed. However it was observed that the community based organizations that are in place are playing a key role in facilitating the communities to access the information regarding of rainfall season. The respondent said that ' they wait to be told if they should cultivate or not, and they added that irrigation techniques has been put in place to help fight with water issues'.

4.2 The effectiveness of community based organization in transferring climate change information and the perception of community farmers on the CBOs

4.2.1 Perception of the respondent to the community based organization

The respondents that have joined community based organizations were asked to say their views and what they perceive as an advantage in being or working with community based organization. There are two active community based organization in the targeted districts; RWIRRI and RADO, the respondents were randomly chosen as long as they belong to any of these organizations. The first question that were asked was why did they choose to work with the community based organization, here the respondent were given a room to state what they think motivated them to join or what are advantages they perceived they may get by working with the organization. On another hand respondent that does not work with these organizations were asked to say

why they didn't join. The second question that the respondents were asked was to say yes or no if their productivity has increased or if they have seen any change since they joined the CBO. After that question they were required to explain how exactly their productivity has increased. The interviewers also asked all respondents to state the time they have joined and most of them said 2015 while few joined 2016 and 2014.



Figure 4-3 why did you choose this organization?

As illustrated by fig(4-3) a higher number of respondent 41% joined the organization to get knowlegde regarding agriculture and livestock production. And 10% joined to get access to funds and other incentives that comes along with the organization. And 23% said that they joined because the organizations helps them access the market for their harvest. During the FGDs the respondent emphasised that the organization has provided them with trainings and information on farming especially under the pressure of climate changing conditions. The respondent said that now they are aware of changing behaviour, crop rotation as well as the crops that can strive in this region that is under a prolonged drought season. Few of the respondent also said that when they belong in organization they are able to access the loans from the bank and able to get the support from the Ministry of Agriculture and Animal Resources. This point was

emphasized by the fact that after joining they are provided with fertilizers, and improved seeds.

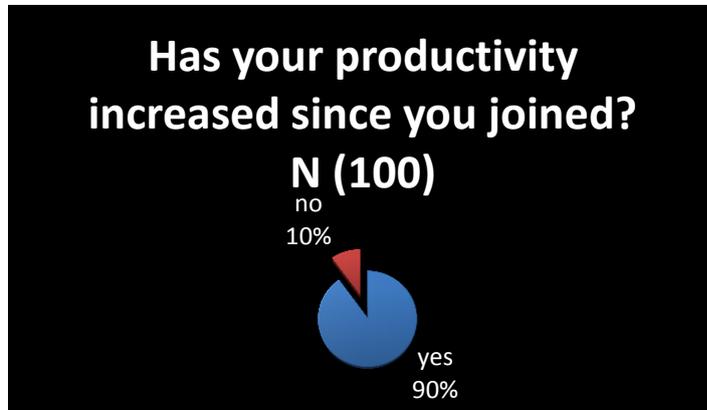


Figure 4-4 has your productivity increased since you joined?

When the respondent were asked whether their productivity has increased or not after joining the community based organization a large number 90% said yes while only 10% said that they dont see any increase in their productivity. Here we either say that there is another facts of their productivity not to increase, like maybe they do not follow what is being communicated from the CBOs. However a large number agreed and stated the facts to support their answers. As illustrated in fig(4-5) those are some of the respondent answers to the question.

Moreover, on the questionnaire both members and non members were asked to mention their monthly income and to say whether they practice farming as their only source of income. Among 100 farmers who belong to the CBOs only 51 have agriculture as their only sources of income while others have another sources of income aside, and also only 25 farmers from the group of non members who also has agriculture as their only source of income. A ststistical test F-test for two sample variance was performed to observe the results. Members who are in a CBO have a variance of 2.9 and a mean of 49000 FRW compared to 7.29 of non members and 20664 Frw, and according to F test our F value (3.98) was higher than the critical

value (1.86), therefore we did not accept the null hypothesis. There was a significant difference of monthly income between CBOs members and non members.

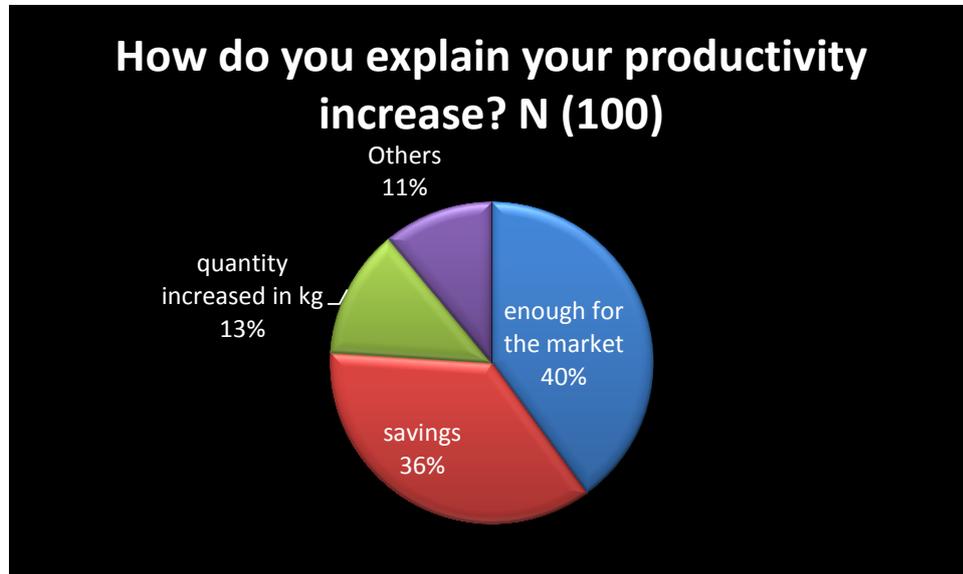


Figure 4-5 how do you explain your productivity increase?

A large number of respondent 41% said that their productivity has increased since joining and that they have been able to have an excess productivity for the market. Here the farmers stated that, before joining their productivity was limited to consumption at home without providing to the market and this was due to the loss of crop production for climate variability conditions that were actuating and they had no knowledge. After joining farmers said that before they could only produce few kg but after getting the knowledge on how to cultivate and being educated about climate variability and know when to cultivate they can save their productivity. With the access on funds and the provision of the fertilizers they can now have enough for the market. 32% of respondent said that they now can be able to save and can do some other projects aside. During the FGDs the local community said that their livelihood conditions has improved as a results of productivity increase, while they can be able to have enough for the market they can pay the healthy insurance (Mituelle), some said that now they have sent their children to schools and others can build houses other

households necessary items. And this was because they could work with these organizations and get knowledge and support for their agriculture activity. Eastern province highly depends on agriculture as the sources of income. On another hand the farmers that have not joined any organization were asked for what reasons they didn't join.

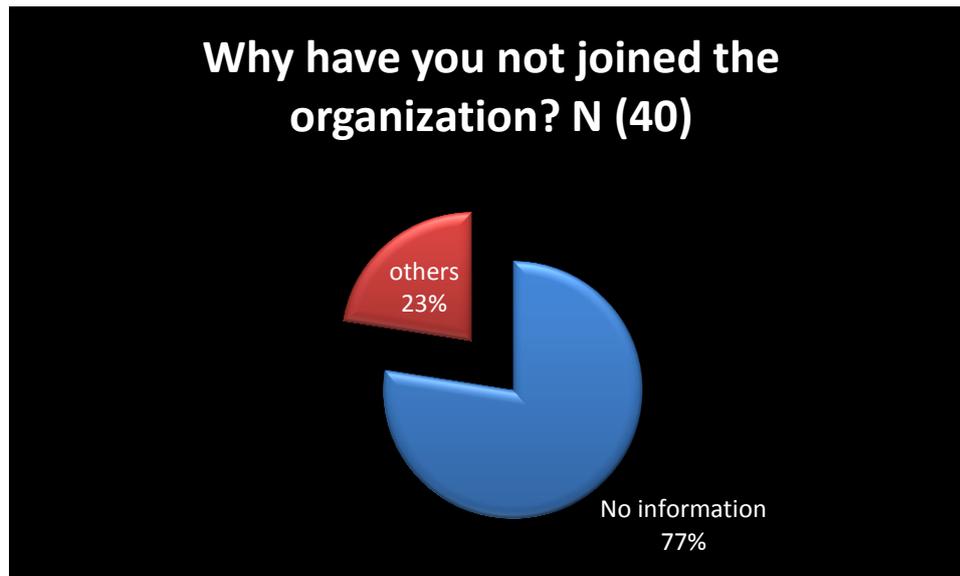


Figure 4-6 why have you not joined any organization?

This study interviewed 40 farmers that have not joined. As seen on the above fig(4-6) 77% of the respondent did not join due to the lack of information and knowledge about the organizations while 23% are due other factors. During the discussion respondent who did not join seemed like they have not been communicated about the organizations. Or on another hand there is still a small awareness efforts of these organization to reach all the community. However as seen on the fig (4-7) 45% are aware of advantage that can be gained by joining, and they said that they are ready to join and benefits from CBO.

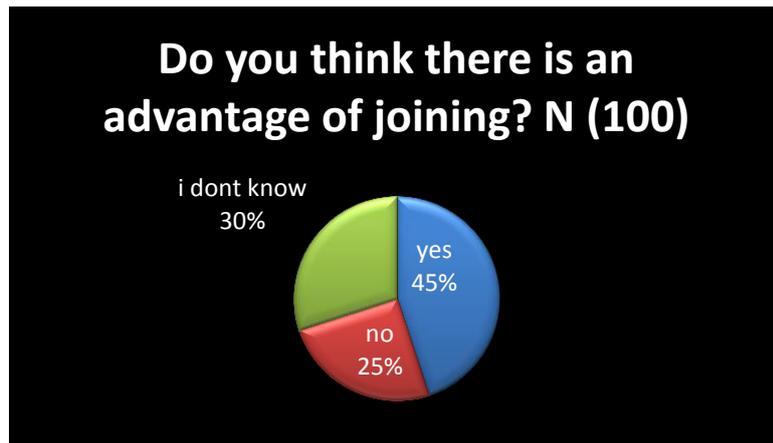


Figure 4-7 do you think there is an advantage of joining the organization?

30% of respondent who are not members, when asked if they think that there could be an advantage in joining; they said that they don't know. While 25% said that they don't think that these organizations would play a role in their productivity. However, 45% who stated that based on success stories they have heard and how those who are members benefits, they would like to join the organization. During the focus group discussions farmers who did not join show how they perceive the CBO would help and that they would like to join. Although there is still a gap in the way these community based organization communicate to the farmers who are not members to join. The community based organizations and the government should communicate with all farmers and provide them with information necessary to understand how important it is to work with CBOs.

4.2.2 Adaptation strategies and information that are provided to the community by the organizations

The study also investigated what are the transferred adaptation strategies and information of climate change that the community based organizations active in the study areas provided to the community. Focus was on a community response to climate change adaptation and information that are communicated to them in order to

increase their adaptability and reduce the vulnerability of climate change impacts on their agricultural productivity. This is intended to assess the capacity and potential of community-based organizations in building the community's capacity to withstand climate change impacts.

Respondents were asked specifically to say if the following strategies or information are provided by the community-based organization. This question intended to identify adaptation actions on the ground. Figure 10 shows the distribution of responses. Respondents were allowed to select more than one strategy.

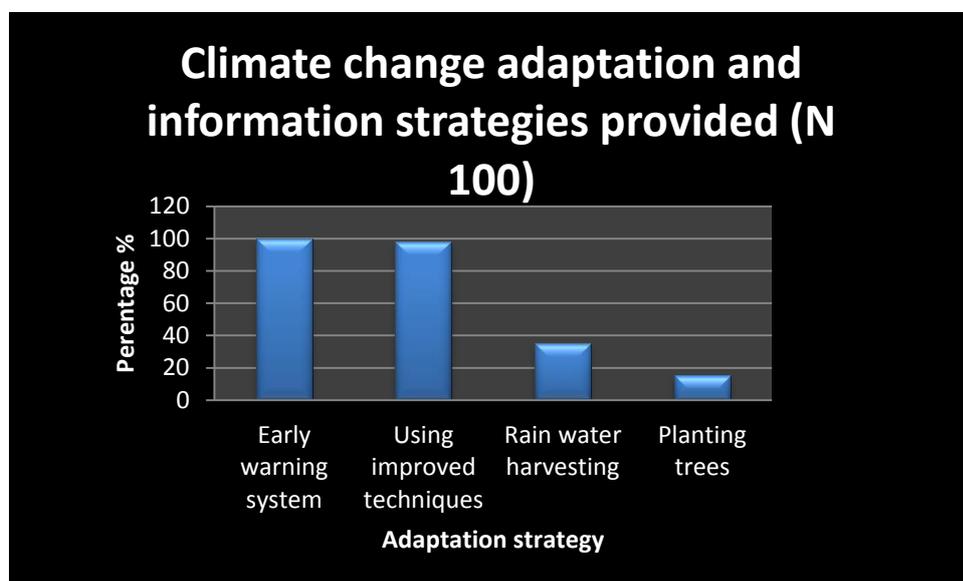


Figure 4-8 Climate change adaptation information and adaptation strategies provided by CBOs

As illustrated on the above fig(4-8), all of respondents 100% that have joined CBO said that they have been given the early warning system. They stated that since they joined the organization they are provided an information about weather forecast, and the time of planting. The respondent agreed that this has been helpful compared to when they could not be able to access such information and it could lead to destruction of their crops due to the climatic condition variability. Also 98% said that the community-based organization have been providing them with cultivation techniques that has contributed to the increase of their productivity. During the focus group discussion the local community said that they have been able to access the fertilizers

and improved seeds, due to the cooperation of community based organization with the Ministry of Agriculture and Animal Resources the community were educated on the improved techniques of irrigation. When the respondents were asked if the CBO have thought them about afforestation there were few respondent 12% did mention that they receive such information. So, from this study the adaptation and information strategies's response to climate change should include both short term and long term adaptation strategies. However community are provided by early awareness and improved techniques but a question of sustainability should be tackled down. "Good" adaptation requires consideration of immediate and long-term vulnerability in climatic and developmental terms, there is little point in in quest of adaptation to climate risks without knowing how social and economic trends make people vulnerable, people's needs (Ayers & Forsyth, 2009). yet based on the reaserch that was done in this district before only 7% of respondents used modern farming methods (fertilizers, modern/improved seeds) (Nile Basin Discourse Forum, 2014) . This indicates that the community based organization have done well in raising an awareness and sensibilizing the adaptation strategies to the community.

4.3 Methods used in transferring climate change adaptation and information strategies to the farmers

Both questionnaire respondent and focus group discussions of those that belong in CBO were asked to mention the channels CBOs use to transmit climate change information and adaptation strategies. The key respondents were specifically asked to tick which means they have been receiving the information. They unanimously agreed that a broad range of channels of communications help aid learning as indicated in figure10 below.

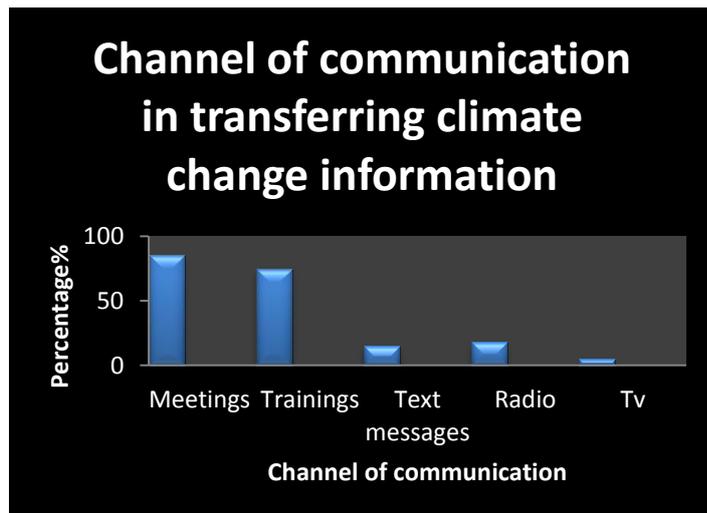


Figure 4-9 Climate change information and adaptation channel of communication

Meetings rated 85% and trainings were rated 75% rated as the top channels that the rural farmers receive information about climate change with. While text message and radio were rated as the last means of communication with TV that got only 5%. With the discussion done with the Ministry of Agriculture and Animal Resources staffs that works closely with community based organization, they mentioned that daily weather text messages, radio and TV are provided to the farmers. It is a great thing that these communities choose the communication means of face to face where they can interact with farmers and provide all the information. However it become trick on the communication of weather forecast. Face to face would not be sufficient to provide such information, another effective means like texts on the phone would be more effective. Obviously, communication on climate change is also another issue. Raising awareness and discussing an issue does not directly result in behaviour change or policy action. Other factors, especially policy options, windows, and barriers, come into play. Therefore, for communication to be effective in providing all the necessary information it must be supported by policy, economic, and infrastructure changes that allow projects implementation to be completed and good communication be realized (Moser & Dilling, 2007).

4.4 Challenges facing community based organization in transferring climate change information and adaptation strategies.

There are two community based organizations active in the study area (RWIRRI and RADO), 8 respondents were picked from each organization based on their position and were interviewed. A question was asked to the staff members of community based organizations to enumerate the challenges that they face while transferring climate change information and adaptation strategies. The first question asked was to say yes or no if they do receive any external assistance. The second question the respondents were given a room to write all the challenges. The respondents were asked to state the strategies that they have put aside to overcome those challenges. The answers are illustrated on the following fig (4-10). The community based organizations were asked to say whether there are existing challenges from working with the rural community.

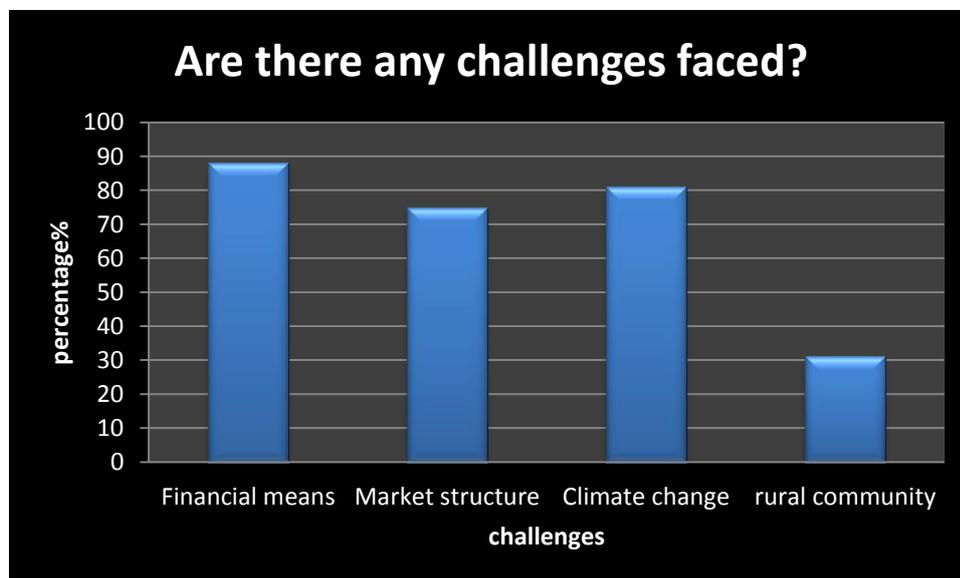


Figure 4-10 Challenges faced by community based organization in transferring climate change information

Financial means was rated 88% as the top challenge faced during the dissemination of climate change information. Although these organizations stated that they are funded

by other organization such as MINAGRI, NGO, and private sector, finance is still a limiting factor to provide all the adaptation strategies and climate change information to the rural communities. Market structure was another major factor, the community staff said it is difficult to deal with the market fluctuations and the delay of buyers. This affects the rural community productivity as some of the crops may get destroyed if they stay long. However, adaptation strategies are not enough if sustainability is left behind, the community organization should put in place storage mechanisms and techniques that rural communities can use to withstand the delays of buyers and protect their productivity from the fluctuation of the market. Few of the members of the respondent claimed that working with the community is also a challenge, like when they introduce a new technology the community tends to favor their habitual behaviour. However, the community-based organization should base on the indigenous knowledge. Some times the challenges are too big to be handled traditionally, instead there is a need for a new technique. However, as stated by (Ayers & Forsyth, 2009) Community-based adaptation takes the approach of adaptation as development. The adaptation concept is locally based because it takes place at local levels where people encounter impacts, build adaptive capacity, and respond. Community-based approaches consider that adaptation strategies are generated through participatory processes, and they should involve local stakeholders development, risk reduction practitioners instead of restricting to scientific inputs only.

The community-based organization has put in place relative strategies to overcome these challenges. As stated by (Helena et al., 2014) approaches and policies are needed in place at all levels to help overcome the CBA challenges. During a meeting they said that they are linking the farmers into cooperatives and get them an insurance company. The population increase puts pressure on farmers to increase yield, community-based organizations are providing improved seeds varieties and access to fertilizers to the farmers as an incentive to switch from traditional crops to maize production. According to the respondent, following the drought event that occurred in 2014 A season, more than 4000 farmers from Kirehe district and another district Bugesera however it was not on targeted study area received insurance payout totaling

42.1 million RWF. The first and new agricultural insurance scheme in Rwanda is said to be the initiative of Syngenta Foundation for Sustainable Agriculture's (SFSA) Kilimo Salama (Nile Basin Discourse Forum, 2014). Community based organizations said that this can be the best option for farmers to reduce losses due to bad weather. They claimed that this can reduce the challenge of crop destotation as the insurance compagnies can take care of it. During this study it was also noted that this insurance is only limited to maize farmers only, however there are plans that it will be extended to other farmers.

Rwanda Society Insurance (SORAS) Company had insured a total of over 200 million RWF through Kilimo Salama weather index insurance project, enabling and following up smallholder farmers to verify their losses like droughts they have experienced in 2013 season. The new insurance estimates farmers' losses by comparing daily rainfall measurements from satellites to the amount of rain a crop requires over a season. On another hand, CBO are putting in place potential methods to fight with climate change such as irrigation systems. However an emphasizy should be done on long term adaptation strategies.

4.5 The role of Ministry of Agriculture and Animal Resources MINAGRI

This study assessed the role played by the MINAGRI in supporting community based organization (CBO). During an interview with MINAGRI staff members of environment and climate change who works closely with the CBO, was asked to state what they perceive as the role of CBO. They said that CBOs help to provide services at the local level and directly support government services. CBOs help to implement the government policies at grassroots level. They added that the farmers' organization is a most effective way of transferring climate change information they serve as an engine of local development whereby, each single development initiatives should pass through this local structures. When they were asked to state the role played by the ministry in facilitating the CBO do deliver the effective information the answer was that they build their capacity in term of technical skills not managerial skills, only for those are involved in agriculture activities.

The techniques provided are:

- Irrigation: Small Scale Irrigation Technologies,
- Investments: Lot of investments on irrigation such as hillside irrigation, marshland irrigation, multi-purpose dams.
- MINAGRI Project (ASAP) : investment for climate resilience interventions through Post-harvest & Agribusiness through farmer cooperatives
- Fund: Matching grant, loan, climate fund through MINAGRI PROJECT (ASAP)
- Awareness on Climate Change:
- Seasonal climate advisory information through workshop, training
- Season outlook: MAM, JJAS, OND Forecasts
- Water harvesting systems: subsidy schemes for water tank, dam sheets through SSIT
- Improved seeds:
- Distribution of improved seed through private companies, all those seeds distributed based on an agro ecological zones (seed for low attitude, seed for middle and seed for high attitude)
- Participatory trials of climate resilient crop varieties through farmer field school

The Ministry explained that while working with the community based organization managerial skills are found to be a big challenge.

MINAGRI has developed an effective way to communicate with the farmers through the support of World Bank; MINAGRI has developed Environmental and Social Management Guidelines (ESMG) which focuses on Grievance Review Mechanism. Now MINAGRI is establishing a call centre and again there is “ask MINAGRI “where famers can ask Minister of Agriculture any questions.

CHAPTER THREE

5. CONCLUSION AND RECOMMENDATIONS

The study examined the role of community based organization in transferring climate change information to the farmers' community. The study concluded that climate change impacts have been felt by the farmers and have played negative role in diminishing their crop productivity based on testimonials given by the community. However after joining CBO farmers were able to access necessary information and adaptation strategies that are helping them to withstand those negative impacts . It concluded that the CBO have played a role in increasing the farmers' awareness related to climate change adaptation strategies. The farmers perceive CBO to be playing a role in disseminating climate change information. The CBO has built capacity level of local community on the improved agriculture methods to withstand climate variability and climate change effects. The adaptation strategies have been put in a place and they seem to be improving the livelihood conditions of the community. There is no doubt that the initiation and institutional arrangement of community based adaptation programme has been achieved good progress on crop diversification and information access, this includes the availability of mechanisms for crop insurance and market facilities of agricultural farm products. CBO have played a good role in disseminating the weather forecast and the timing for agriculture. Local government, NGO, civil partners and vulnerable communities have a good working coordination together. However, there is a lack of to predict the long-term impact of the adaptation practices to climate change. Sustainability ideas are not well established to the communities. Water harvesting mechanisms should be improved by both government and non-government members. Well-developed digital communication system may be developed for disaster early warning alarm. Especially the administrative authority of MINAGRI can take steps to provide communication tools (such as radio, mobile phone) to the most vulnerable members that they can easily be informed in any challenging conditions. Training regarding the causes of climate change should be essential for farmers.

Recommendations

- To solve the deforestation problem, soil erosion and desertification it is recommended that efforts be rolled out to inspire tree planting and increase energy saving methods.
- To avoid failure, CBO should emphasize on the water harvesting projects to store enough water because other sources are not easily affordable and most of the activities of the project are based on water such planting trees,
- CBO should provide an awareness to all community members to join and benefits working together, it should increase an awareness to even the members that have not joined.
- How can CBOs improve the sustainability of their interventions since you said that they rely more on external funding?

Proposed solutions on:

Water issues

Easter province is subjected to a high season of droughts as stated from the literature that were used in this study, water availability is one of the challenges in this region. Therefore, to solve this problem this study proposes that community based organization can usher the construction of valley dams for irrigation; establish canals from each house draining into one big dam. The dam acts as collecting centre for water harvested from several houses which shall be enclosed with security measures to mitigate risks of drowning. Water tanks should be established to serve a big number of households.

Agriculture issues

Although, most of peasants living in selected sites of three districts (Ngoma, Kirehe and Rwamagana) have improved their agriculture methods through the help from MINAGRI to withstand climate change variability there is still some changes to be done. CBO should provide an awareness and knowledge towards crop harvesting and storage to withstand the market fluctuations issues.

Institution management

The study concluded that for community-based organizations to work effectively, strength should be added in the institution management as they are the major contributor of knowledge and skills to the community-based organizations. These institutions that are working with CBOs should enhance their cooperation and provide the necessary information by time. .

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7. APPENDIX 1 SURVEY QUESTIONNAIRE FOR FARMERS

Survey on the role of community based organization in transferring climate change adaptation strategies information in eastern province of Rwanda

Number of questionnaire / ___ / ___ / ___ / ___ /

Province.....

District.....

Sector.....

Number of household.....Female.....Male.....

Date.....

Name of the interviewer.....

Section I Respondent identification

1. Name and surname.....
2. Sex.....
3. Age.....
4. Education level

Primary school / ___ / secondary school / ___ / university school / ___ /

No school / ___ / other / ___ /

5. Marital status

Single / ___ / married / ___ / divorced / ___ / other / ___ /

6. What is your main activity?

.....

7. What is your monthly income?

.....

8. Do you have an additional source of income?

.....

9. Are you a member of a community based organization

Yes /___/ No/___/

10. If yes which one?

.....

11. If no why not?

.....

.....

12. When did you join the community based organization?

.....

13. Do you find them to be useful? yes/___/ No/___/

14. Please explain why?

.....

Section II perception of the community on the climate change impacts

15. Since when have you been into farming activities?.....(in years)

16. How long have you been living in this region?.....(in years)

17. Have you heard about climate change before?

Yes/___/ No/___/

18. Do you know the cause of climate change?

Yes/___/ No/___/

19. If yes can you enumerate some of them?

.....

20. Do you know the impacts of climate change?

Yes/___/ No/___/

21. If yes can you enumerate some of them?

.....

22. Can you tell us when was these climatic variability have affected your village?

Climatic condition	Last 3 months?	Last 6 months?	Last year?	Since 5 years?	Since 10 years?	Since 50 years?
Shortage of rain						
Late rainfall						
Extreme						

temperature						
Droughts						
floods						

23. Was your agriculture productivity affected by any one of the mentioned climatic conditions?

Yes/___/ No/___/

24. Do you remember when last time you were affected by these climatic conditions?

Yes/___/ No/___/

25. If yes would you explain which one was it?

.....

Section III advantage of being in a community based organization

26. Why did you choose this organization?

.....

27. When did you join it?.....(in years)

28. Did your productivity increase ever since you joined them?

Yes/___/ No/___/

29. If yes explain how?

.....

30. How does the organization communicate the information related to climate change? (Meetings, Trainings, Texts message, TV, Radio) please tick the mostly used methods.

.....
.....

31. Are there any methods/strategies that the organization teach you in order to adapt to the climatic change conditions?

Yes/___/ No/___/

32. Please tick among the following information is provided by the community based organization (early warning system; rain water harvesting, improved techniques such as fertilizers improved seeds and irrigation; planting trees?)

.....
.....
.....
.....

33. Do you find this information to be useful in relation to your activity?

Yes/___/ No/___/

34. If yes or no explain how and why?

.....
.....

..... Does your opinion matter in the organization? (Do they value your decision, or your knowledge or concerns?)

Yes/___/ No/___/

35. Do the government/ MINAGRI help your organization?

Yes/___/ No/___/

36. If yes how?

.....
.....

37. What do you think is the advantage of you being in this organization?

.....
.....

38. Would you recommend those who are not in to join?

Yes/___/ No/___/

39. If no please explain your answer why?

.....
.....

Appendix 2 Survey Questionnaire for community based organization

Survey on the role of community based organisation in transferring climate change adaptation strategies to the farmers in eastern province Rwanda

Numérodu questionnaire: // _/_/_/

Name of the organization:

Number of Members:Female:Male:

Province:

District:

Sector:

Respondent name:Gender.....

Respondent position:Telephone.....

Section I: Questions about the Organization

- a) When was this organization established? (in years)
- b) How many employes do you have?
- c) Are you self funded ?
Yes/_/_/ No/_/_/
- d) If no where do you get the funds?
- e) How do you attract community to join your organization?
.....
.....
- f) What are the main climate change impacts in this region?

.....
.....
.....

Section II: Methods used in transferring climate change adaptation information

1. What kind of information strategies/ the adaptation methods do you communicate to the community?

.....
.....

2. Where do you get these information (do you have external consultants, is it indigenous knowledge)?

.....
.....

3. How do you translate the information for the effective communication?

.....

4. What are the communication means of climate change adaptation strategies do you use to to the community, and why

.....
.....
.....

Section III: Challenges faced during transfer of climate change information strategies

5. Does the Ministry of Agriculture and Livestock (MINAGRI) provide any assistance?

if Yes Please explain.....

.....

6. Are there another organizations that works with you or provide assistance ?, if yes please explain

.....
.....

7. What are the challenges has your organization faced since the beginning?

.....
.....

8. Do you have strategies? To overcome those challenges?

.....

..... Do you have any challenge from working with the community?

Yes/___/ No/___/

9. If yes explain them ?

.....
.....

10. Do you have any success stories/ testimonials of community after joining your organization

Yes/___/ No/___/

11. If yes please explain ?

.....
.....

Appendix 3 Interview guides with concerned officials of Ministry of Agriculture and Animal Resources

Survey on the role of community based organization in transferring climate change adaptation strategies information in eastern province of Rwanda

Number of questionnaire/___/___/___/___/

Name of the institute.....

Province.....District.....

Name of the respondent.....

Position of the respondent.....

Date.....

Questions

1. Would you explain to us the relationship between your position and the CBO's?
(how do you work with CBO)

.....

.....

.....

.....

2. What is the role of this institution in CBO's management?

.....

.....

.....
.....

- 3. What kind of help/ adaptation strategies do you provide to farmers or to the community based organization? (like investments, agricultural practices, awareness on climate change, water harvesting systems, improved seeds)

.....
.....
.....
.....
.....
.....
.....

- 4. Do you find community based organization to be a solution to a better way of transferring climate change information?

Yes /___/ No/___/

- 5. Explain your answer

.....
.....
.....
.....
.....

- 6. Based on the record and reports would you confidently say that community based organizations has contributed to a change in farmers (would you compare with the current productivity and the productivity before the introduction of farmers into community groups

Yes/___/ No/___/

- 7. If yes would you provide answers in number of productivity?

Before.....After.....

- 8. What do you find as a challenge that you face while working with the CBO's?

.....
.....
.....
.....

9. Do farmers report their problem on the MINAGRI or the CBO's takes care of them

Yes/___/ No/___/