A thesis submitted to the Department of Environmental Sciences and Policy of Central European University in part fulfilment of the Degree of Master of Science

Building Drought Resilience in Lower Shebelle Agriculture: Somalia in response to accelerated Climate Change

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ABSTRACT OF THESIS

Submitted by: Abdulkadir Kasim FARAH

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Over recent decades, climate change is becoming the major challenge that agriculture is facing, as production is affected by the rising temperatures, more variable rainfall patterns and increased frequency and severity of extreme weather events through the globe (IIED 2011). Agriculture is the dominant source of livelihoods for the community of the Horn of Africa, it is also a major economic sector, including small scale farming and livestock production (WMO 2015). Agriculture is the most important for economy of Somalia; it not only covers the food needs of the population, but also creates income through selling crops and labour forces for the young generation (FAO 2012). But, increasing temperature and the rainfall variances are influencing Somali's agricultural sector and is expected to get worse in the future, which will result in land degradation, soil erosion, and loss of biodiversity, deforestation and extreme droughts that creates more internal displaced people (IDPs) as well as external displaced people. The aim of this research is to understand how the climate change is affecting agricultural production in Lower Shebelle region in Somalia and to help decision-makers and other stakeholders to build drought resilience of agricultural systems in Lower Shebelle region in response of the impacts of the accelerated climate change. The study also explores types of crops that the famers currently cultivate; major drought problems were experienced in the last 5 years and the recommended options to be taken for improving resilience and minimizing impacts of climate change (drought) on agricultural production.

Keywords: Building, Drought, Resilience, Agriculture, Accelerated, Climate Change.

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List of Abbreviations

IPCC	Intergovernmental Panel on Climate Change
FAO	Food Agricultural Organization of United Nations
UNFCCC	The United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Programme
OCHA	United Nations Office for the Coordination Human rights
WFP	United Nations World Food Program
FSNAU	Food Security and Nutrition Analysis Unit, Somalia
SWALIM	Somalia Water and Land Information Management
WMO	World Meteorological Organization
GWPEA	Global Water Partnership Eastern Africa
GEF	Global Environmental Facility
CCAFS	Climate Change, Agriculture and Food Security
IUCN	International Union for Conservation of Nature
FEWSNET	Famine Early Warning Systems Network
USGS	United States Geological Survey
OECD	Organization for Economic Co-operation and Development
SATG	Somali Agricultural Technical Group
IIED	International Institute for Environmental and Development
UNDP	United Nations Development Programme
ASAL	Arid or semi-Arid Land
IDPs	Internal Displace People
NGOs	Non-governmental organization
IGOs	Intergovernmental organization
GIEWS.	Global Information and Early Warning System
HOA	Horn of Africa

CHAPTER ONE

Introduction

This chapter starts with the background information of climate change on agriculture. It highlights how the weather events are changing and the amount of rainfall that Horn of Africa receives per year which dominates extreme droughts in the region that has big challenges on resources including agricultural sectors; while agriculture is dominant sector in the livelihoods of the community in the region, it also highlights the importance of agriculture on Somali community in economically and labour force as well and the places on the agricultural production in the country and the challenges facing agricultural production. It underlines the important of Lower Shebelle to Somali community both the capital and region itself. It also presents aim, objectives and the limitations of the study.

Background information

Over recent decades, climate change is becoming the major challenge that agriculture is facing, as production is affected by rising temperatures, more variable rainfall patterns and increased frequency and severity of extreme weather events across the globe (IIED 2011).

The Horn of Africa, stretching over 5.2 million km^2 and having a population of about 200 million people (GWPEA and WMO 2015), and also experiencing this problem. The region consists of eight countries showed in the (Figure 1).

Figure 1: Horn of African countries

Source: (GWPEA and WMO 2015)

Around 70% of the area on the Horn of Africa is arid or semi-arid land (ASAL) that receives annual rainfall less than 600 mm and is dominated by extreme droughts which significantly affects water resources, crop cultivation, human health and infrastructures that people dependent on (GWPEA and WMO 2015). In the next 20-60 years, these negative effects are expected to increase, because the temperature in the Horn of Africa is projected to rise by 1.5 - 4.3^{0}C (IPCC 2014), as well as anticipated erratic precipitations, climate variability and droughts (OCHA 2017).

Agriculture is the dominant source of livelihoods for communities of the Horn of Africa, and is also a major economic sector, including small scale farming and livestock production (WMO 2015). Agriculture is the most important for the economy of Somalia; it not only covers the food needs of the population but also creates income through selling crops and labour forces for the young generation (FAO 2012). The country is home to the largest number of

pastoralists in Africa (60% of the Somalis) which are either nomadic or semi-nomadic communities. About 50% of the land is determined as pasture land while 13% is counted as land suitable for crop cultivation (UNDP et al 2013).

Agricultural production areas in the country lie between two rivers (Juba and Shebelle) where fertile soil and river water irrigation are available in the southern part. But crop cultivation in southern Somalia has declined due to a combination of severe drought and decrease of land for cultivation as farmers abandoned their land and joined refugee camps either as internally displaced people (IDPs) or escaped to neighbouring countries seeking food, water, shelter and security (Mikael 2012). The crop sector of Somalia mainly relies on rainfall, but the absence of precipitation sometimes for three seasons or more, causing extensive droughts, has largely resulted in severe shortages of food and loss of domestic animals.

Increasing temperature and rainfall variances are influencing Somali's agricultural sector and is expected to worsen in the future, which will further exacerbate land degradation, soil erosion, loss of biodiversity, and deforestation. Therefore, it is important to focus on the current and future food security challenges in the country to overcome famine and the malnutrition in the community, and thus an urgent need to build drought resilience of the agricultural sector to accelerated climate change.

The lower Shebelle region where this study was conducted is one of the broad-baskets agricultural productions in Somalia and feeds around 3.5+ million people living in the capital city Mogadishu and the Lower Shebelle itself.

Aim of the Research

The aim of this research is to understand how climate change is affecting agricultural production in the Lower Shebelle region in Somalia and to help decision-makers and other stakeholders to build drought resilience of agricultural systems in the region in response to

climate change impacts on agricultural production. The study also identifies the types of crops that farmers current cultivate, major drought problems experienced in the last 5 years, and recommended options for improving drought resilience and minimizing impacts of climate change (drought) on agricultural production.

Objectives of the Research

These following objectives were set in this research:

I. To explore farmers' perceptions of how accelerated climate change is affecting agricultural production in the Lower Shebelle.
II. To identify farmers' and local actors' approaches to building drought resilience in the face of seasonal climatic variations.
III. To examine factors influencing farmers' capacity to develop and maintain drought resilience to mitigate climatic risks.

Limitations of Study

To reach the scope of the region was difficult as most region is controlled by Al-Qaida linked terrorist group (Al-Shabaab), especially villages and some districts where the interviewers had difficulty reaching, thus they met with farmers in the markets instead. Therefore, to reach an adequate number of farmers were difficult instead were interviewed 11 farmers in total.

There are also traditionally long delays in communication from government and other institutional actors.

Some respondents were not willing to provide needed information that will be crucial to the study and some of them might misunderstood the questionnaires, since I translated them into Somali language mainly from farmers.

Since Somali government had collapsed in 1991, to receive a correct rainfall precipitation in the whole of the country is another obstacle as the country has not meteorological data collecting station particularly southern Somalia.

CHAPTER TWO -

LITERATURE REVIEW

Introduction

The aim of this chapter is to provide an overview of the literature exploring the negative effects of climate change, in particularly, drought on agriculture in Africa in general and in Somalia in particular. First, the chapter provides a basic definition of climate change, highlights impacts of climate change on agricultural production in Africa and with focus on East Africa, and then explores the state of soils in Africa, describes agricultural production in Somalia, drought occurring in the Horn of Africa, drought effects in Somalia and, finally, introduces the latest resilience-thinking in agricultural production.

The last section of the chapter provides a statement about the research gap related to the topic which has not been conducted before in Lower Shebelle region.

Climate change in Africa

Climate change is one of the negative factors effecting human populations in the last century and as such different scholars gave it different definitions based on their understanding of how it affects ecosystems. The Intergovernmental Panel on Climate Change (IPCC) refers climate change is any change of climate over a period of time, "whether due to natural variability or as a result of human activity" (UNFCCC 2011). It consists of changing in the frequency patterns of large weather events as well as rising and changing global temperature. Another definition from another scholar Ozor states that climate change is the change of weather in a period of time, whether caused by a natural change or as a result of mankind's activity and is generally agreed as the most dangerous threat that our planet is facing this century (Ozor in Ifeanyi-obi and Jike-wai 2012).

NASA refers “Climate change is a change in the usual weather found in a place. This could be a change in how much rain a place usually gets in a year. Or it could be a change in a place's usual temperature for a month or season **”** (MSFC 2015)**.** UCDAVIS also refers “Climate change is a significant change in global temperature, precipitation, wind patterns and other measures of climate that occur over several decades or longer”. These definitions point to the danger coming from climate change and the fact that action is needed to be taken by countries to overcome its negative effects. The climate is not static; the gradual changes are poorly noticeable by the human body, but incremental changes are significant, the same as variations in climate can be substantial.

There is well-documented research done by various experts and scholars in the field of climate change, including the Intergovernmental Panel on Climate Change (IPCC) results which claim that global climate change is threatening not only economic development but also the existence of human species (Oduniyi 2017). The effects of climate change are obvious, bringing negative impacts on many sectors that humans depend on, for example, agricultural and animal sectors on which humans cannot exist without, and it particularly impacts tropical and subtropical countries where rainfall is unreliable.

Over the last decades, climate change impacts have become more pronounced on the world than ever. These changes are caused by variations of earth’s natural ecosystems and human activities mainly emissions from greenhouse gases to the atmosphere which are increasing earth’s warming and this increasing temperature is what initially causes the global warming (Ifeanyi-obi and Jike-wai 2012). Climate change is frequently considered to be one of the greatest environmental challenges that the world is facing in the 21st this century as sea and the ocean levels are rising; increasing evaporation to the atmosphere is causing the drying out of

the water reservoirs; increased droughts cause suffering in vulnerable communities in developing countries which are mainly located in Africa and Asia.

Scientific research shows that the average temperature in the African continent is increasing, and faster than the worldwide average temperature, and will keep rising in the (Senbeta 2009). Africa is one of the continents which is most severely affected by climate change because of the location of the continent in equatorial zones and areas close to the equator where the sun is hotter than in temperate zones. The other reason is low economic development in the majority of the continent and thus the economic improvements of the society in Africa are diminishing because of the effects of climate change on ecosystems and humanity (IFPRI 2013).

The economy of many African nations relies on sectors that are defenceless to climate conditions, mainly agriculture and livestock rearing in addition to forestry production (IFPRI 2013). However, consequences resulting from climate change are affecting economic and sustainable improvement in the continent and are reducing the capacity of African countries to adapt to continue climatic changes (CIGI 2009).

World Bank and FAO studies (2018) have indicated that climate change has no effecting only on human health and animal health but also has effecting on other sources and ecosystems in terms of decreasing water sources, extinction of biodiversity and forest species as well diminishing of coastal and marine ecosystem health. The impacts of climate change lie in reducing water infiltration into the soil and facilitate water surface runoff and soil erosion which eventually results in decreasing of water aquifers increased evaporation from rivers, lakes, and streams, and rapid evapotranspiration results in plant growth retardation (World Bank and FAO 2018).

the impacts of climate change in Africa has already resulted in many disasters including droughts and floods that are affecting the ecosystem in the region in terms of water, agriculture

and other infrastructure that communities depend on. It is predicted the impacts are going to increase faster than others in the future (Greenpeace 2015).

Scientists have underlined that average global temperature on the globe has risen by up to 0.74^0C during the last century (Ifeanyi-obi and Jike-wai 2012). If the global community does not do anything to mitigate this issue, then, the temperate will continue to rise further, and its consequence will be difficult or impossible to overcome in the future.

The African continent has less contribution to global climatic change because it has low levels of industrial development in terms of developed continents. Therefore, the carbon emissions from the African continent are very low compared to developed countries and contributions from the continent are evaluated to be lower than 3% of the world's total GHG emissions. (Hope 2009).

Rich countries are most dominate overall emissions gases to the atmosphere and are collective will take responsibility for the emission which nearly reaches 7 from 10 tons of CO_2 that were released to the atmosphere till the industrial revolution started in the world (Hope 2009).

This CO_2 emission released to atmosphere result in climate instability which can be linked to migration from continent to continent caused by climate change, as it is expected that pressures will increase further. If this trend goes further, the existence of humans might cease because of severe droughts and floods will cause the death of many people and the destruction of many properties including agriculture sectors.

Overall the African continent has experienced declining precipitation since the 1960s due to the location of the continent (Hope 2009). Decreasing and unstable precipitation in the continent and increasing of evaporation from rivers, lakes, and streams due to the rising temperatures cause serious damages about economic development in the continent and will encourage more

droughts to happen. The consequences of these droughts will eventually increase climate induced migration of the African people especially the rural inhabited areas.

The community of the African continent is poor their livelihoods are dependent on agricultural cultivation and natural resources and large portions of the population in the continent are not able to adapt to the effects of climate change droughts, floods, soil erosion (CIGI 2009). It is evaluated that 80% of East African agriculture is done by small-scale farms. These small scale farmers lack financial support and the capacity to buy modern equipment for cultivation and commercial fertilizers to improve their yield (Greenpeace 2015).

Farmers in Africa continent do not get enough knowledge for modern cultivation because of lack of training on climate awareness and the lack of proper application fertilizers on their farms that resulted African farmers more susceptible on climate change issues.

Small-scale farming has been practiced for a long time throughout the globe. In Africa, Small scale farming is the cornerstone of the African community. The United Nation of Food and Agriculture (FAO) defines small-scale farms (FFs) as "farmers who have a land of farm cultivation less 10 hector or usually their farm less than 2 hectors and also these farmers are largely dependent on labour force on the farm" (Greenpeace 2015) and this climate change is seriously affecting to small scale farmers in Africa.

Therefore, if these climate change trend impacts are not tackled soon or not stopped soon for the carbon dioxide emissions, it will result that small scale farmers will abandon from their farms; especially rain fed farmers those have irrigation and count on rainy seasons, and will finally end up as international refugees migrating from their continent to other continents or regionally displace in the continent or internally displaced people (IDPs) in their countries.

Drought the Horn of Africa

In General, drought is a period in which there is a shortage of water in a region or place on the globe, where surface water or underground water is at a deficit and the water level is below as in previous which finally affect the living substances on that area.

Currently, drought is one major challenge facing the East African community which is said to be the worst factor in the last half of the century. Droughts resulted in severe food crises in Somalia, Ethiopia, Djibouti and Kenya which caused many people to require humanitarian aid assistance with many ending up as internally displaced people or outside their borders, especially in Somalia, where many people evacuated from their home to Kenya. These food crises also affected many countries in East Africa like Sudan, Uganda, and South Sudan.

The effects of drought are clear as it decreases the availability of water for agriculture, livestock as well as humans- it has both directly or indirect influence because the water sources have been reduced and demand for food in the region has increased. Long-term or repeated droughts in the Horn of Africa are also resulting in land degradation, increased soil erosions, reducing the availability of food and increased food price (Figure 2) explains the general consequences of the drought on the ecosystem.

Drought has a direct effect on both agro-pastoral and pastoral community in the region as the community has been forced to sell their assets (e.g. livestock) at low prices to escape the effect of droughts.

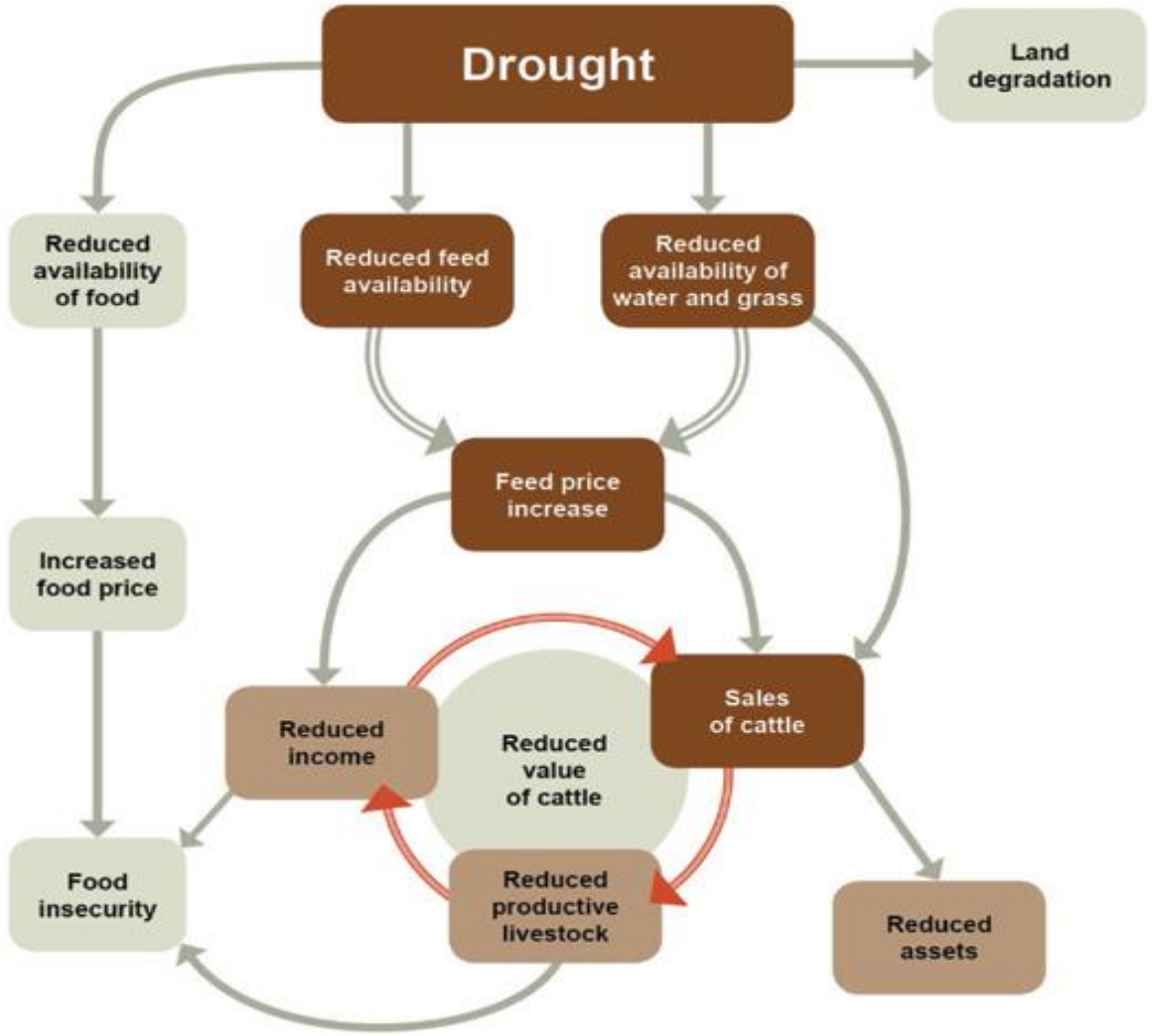

Figure 2: Impacts of drought on agric-pastoral community

Source:(FAO and OECD 2012)

The Genetic Literacy Project has defined drought as "a period of inadequate rain or no rainfall, is the main cause of crop yield loss in Africa"(GLP 2019), which results in ultimately food shortage and famine within the African community. In 2018, more than 15 million people from many countries in the African continent including Somalia, Ethiopia, South Africa, and Kenya were severely affected by drought (GLP 2019). Drought occurs somewhere on the continent every year because of unpredictable weather patterns (GLP 2019).

Forecasts by UNDP, UNFCCC, and GEF (2013) indicate that the horn of Africa (HOA) region in general "will be facing more extreme and frequent droughts and floods". The region is

suffering extreme droughts which effected the community, which are known to have the most far-reaching impacts of all natural disasters (WMO 2015).

Drought occurs when there is a shortage of rain, late precipitation which may occur either in the same region or different region (UNDP et al 2013). The most special effects that droughts have on agricultural production directly is reducing crop yields or for destroying and leading to complete loss of the agricultural yield especially for rain fed crops that are very susceptible to droughts and have less ability to resist climate change (Al-Riffai et al. 2012).

Drought and its consequences like degradation of environmental and natural resources continue largely due to climatic changes, increased human population, inadequate institutional capacities, civil strife and high poverty levels in the region, which are the main factors that the community living in the Horn of Africa region is facing (WMO 2015).

Oxfam (2011) also showed in its report that more than 12 million people in the Horn of Africa region, mainly from Ethiopia, Somalia, and Kenya, need food, clean water, basic sanitation and shelter.

An IPCC report shows the increase of excessive extreme temperatures in the bigger part of the HOA region has been happening over the last 50 years (UNDP et al 2013). Increasing temperature coupled with progressing shortage of rainfall is causing severe droughts which affected the whole region (Oxfam 2011)**.** According to WMO (2015), the average temperatures in the region will increase in the next 20 years up to 1.5°C and will rise further up to 4.3°C in the 2080s. Thus, with increased impacts of climate change anticipated in the future, HOA region is extremely in danger of natural disasters, especially drought, which will have major negative consequences on livelihoods of the people involving crop and animal rearing for their food consumption.

The World Meteorological Organization stated that "Most countries in the HOA region currently have only emergency and recovery strategies to regulate response to drought occurrences; such reactive responses, however, are often ineffective" (WMO 2015). Some countries in HOA, like Ethiopia Kenya and Uganda, have their own national policy plane on disaster risk management. Djibouti, Somalia and Sudan either have old policies that focus more on emergency responses, or have no established policies (WMO 2015).

Negative impacts of climate change on African agriculture

The agricultural sector is the main form of land use worldwide, which includes all types of activities for profitable development, community and educational aspects and is a rich source of ecosystem services. In Sub-Saharan African countries from 60 to 90 per cent of the population is employed in the agriculture sector (IFPRI 2013). However, crop cultivation is very susceptible to climate change and variation, resulting in decrease of output of agricultural production (Shiferaw et al. 2014). Changes in precipitation in the region increase the possibility of short-run crop decline, which causes a drop in agricultural production (Mulinyac. 2017).

Rising temperatures in the region and changes in precipitation already have direct impacts on crops and indirect impacts on irrigation systems (Nelson 2009). Together with other pressures, this is resulting in food shortages in the region (Oduniyi 2017).

Availability of moisture for plants, and temperature can act synergistically or antagonistically with other environmental factors, important for crop growth (Adams et al. 1998).

Small-scale crop producers on the African continent are suffering the most because of their reliance on rain-fed crops and heavy dependence on natural resources for their livelihoods as well as low level awareness about climate change impacts on agriculture, lack of skills

because of shortage of training for farmers, an old cultivation system applied and lack of capacity for diversification of agricultural practices (Oduniyi 2017).

A better understanding of coping strategies of the farmers is essential for designing incentives to enhance their resilience to climate change. Supporting the development of adaptive strategies through appropriate training, investment in sustainable farming implementation and taking collective responsibility actions can enhance the acceptance of tailored adaptation solutions (Sanga *et* al. 2013).

Approximately 90 % of area under maize cultivation, the most consumed cereal crop in Africa, is going to be negatively impacted by climate change, especially in West African countries. This will cause a production drop in between 20 and 40 percent by 2050s (CCAFS 2015).

State and Quality of African Soils

African soils are geologically ancient and thus, are extremely weathered (Greenpeace 2015). In tropical regions of the African continent most soils are reported to be extremely acidic with high levels of iron and aluminium oxides, which gives the red colour to the soils, and depleted of many essential nutrients, mainly macro-nutrients (P, K, Ca and Mg) - those which leach deeply into the ground to levels which plants cannot absorb (Greenpeace 2015). Many areas in the East Africa region have problems of changing soil pH and high soil salinization in irrigated areas, which represents a major issue for farmers, particular for those who are not cultivating salt-tolerant crops (Greenpeace 2015).

The continent has a large area of cleared forest which destroys the balance of essential nutrients, driving soils infertile within a few years and eventually preventing farmers from cultivating their crops on this land (Greenpeace 2015). The decreasing crop production on African soils is caused by a mixture of soil erosion, which mainly results from cover plants loss, and extensive land degradation, which affects the micro-organisms in the soil and leads to low

nutrient content(Greenpeace 2015). The chemical and physical properties of the soil are degraded due to the loss of essential nutrients, such as nitrogen (N), potassium (K), phosphorus(P) and carbon(C), which lead the soil to lose its properties like structure and texture (Greenpeace 2015). Rising temperatures of soil essentially decreases crop yields and encourages weed and pest invasion (Mulinyac. 2017).

Since most East African Agriculture is rain fed, it is essential to focus on adaptation resilience for climate change in terms of proper water management and efficient water harvesting.

A Greenpeace study has identified that "rain-fed agriculture as a key source of future productivity enhancement there is needed for more innovative options for water interventions at the landscape scale, accounting for both green and blue water" (Greenpeace 2015).

Greenpeace (2015) also stated that ecological Farming practice can provide more resilience building on cultivation systems and has capacity to cope with water restrictions through irrigating more resourcefully on the farm.

East African Agriculture and climate change.

In East Africa agricultural production accounts for 43% on average of the regions' yearly gross domestic product (GDP), since the exact number differs from country to country (IFPRI 2013). For instance, agriculture production in Burundi, DRC, Ethiopia, Sudan, and Tanzania accounts for more than 50% of GDP, while for the other countries like Eritrea, Kenya, and Madagascar it is lower than 30% (IFPRI 2013). Despite these variations among countries on the continent, small scale-farmers in all countries rely on rainfall for their agricultural production, and the farming sector of the region in general is characterized by very slow growth and low income per capita for farmers. At the same time, the population of the East African countries is growing rapidly and estimated to be continue its high growth in the coming centuries, especially in sub-Saharan Africa (IFPRI 2013).

Greenpeace (2015) stated that "with high confidence that crop production in East Africa will be diminished because of heat resulted drought stress associated with climate change". This issue will have strong effects on regional, national and household livelihoods in those countries where livelihoods depend on production from the farms.

Water related issues in East Africa are already under significant strain and depletion, caused by overexploitation and poverty, while the demand of water is increasing because of population growth and the water table is declining (Greenpeace 2015).

Decreasing of water sources and mismanagement will increase the challenges facing East African community, therefore, to encourage farm resilience it will be important to encourage the cultivation of legumes mixed with cereal crops since legumes and cereal crops are a major source of food in East African communities and are predicted for reducing yield in between 50-70% in the 2030s and 2050s due to higher GHE (Mfilinge et al 2014).

Agriculture in Somalia

Somalia's farming system is the most important driver of the country's economy.

In general, Somalia's cultivation system mainly depends on rain-fed agriculture apart from the famers living very close to the two rivers (Juba and Shebelle) (UNDP et al 2013). Therefore, the reliance for the greater part of farmers on rain-fed farming cultivation has led the economy to enormous susceptibility to climatic variations (UNDP et al 2013).

Before the Civil war started in Somalia, agricultural production was providing over 19% of GDP and was covering for some 20% of employment(IUCN 2006).

Mikael (2012) indicated that "More than two-thirds of Somalis labour force is working in farming sector and this sector is accounted for over 60 percent of the country's GDP". But,

near to three decades of civil war unrest, particularly in Southern part of the country, and poor environmental conditions have badly injured Somalia's agricultural productivity (Mikael 2012). Moreover, irrigating channels that were irrigating commercial horticultural crop like bananas, sugar cane and sesame in the southern part of the country have degraded and been unrepaired since the collapse of Siyad Barre regime in 1991, sometimes these channels are causing flood that destroys the crops, and became one of the main obstacles for Somali farmers, caused by the lack of governance, and resulted for the Somali community in food shortages in every season and need humanitarian aid assistance from donors (Mikael 2012).

Severe floods in some regions in the country, mainly *Hiran*, region (Figure 3,4), Lower Shebelle, middle Shebelle and Juba-land regions, cause problems to agriculture and community's livelihoods as there are inadequate watershed dams as well as lack of watershed channels, driving the country to be one of the most food insecure nations on the globe (Mikael 2012).

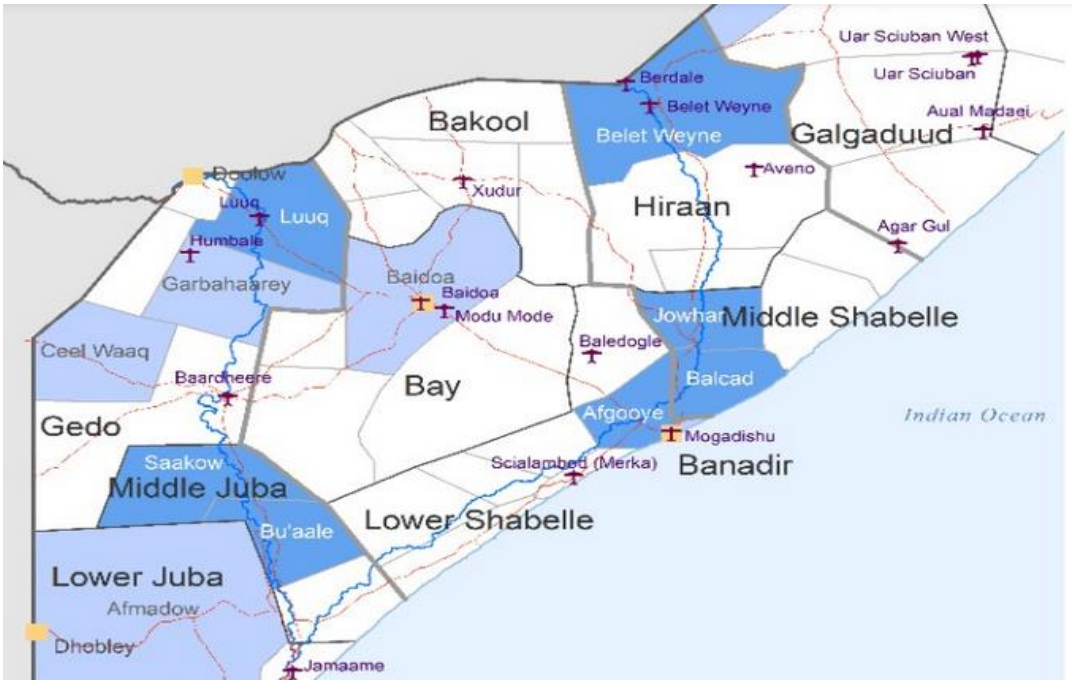

Figure 3: Catastrophic floods hit Somalia, some of the worst the region has ever seen

Source: (Blašković 2018)

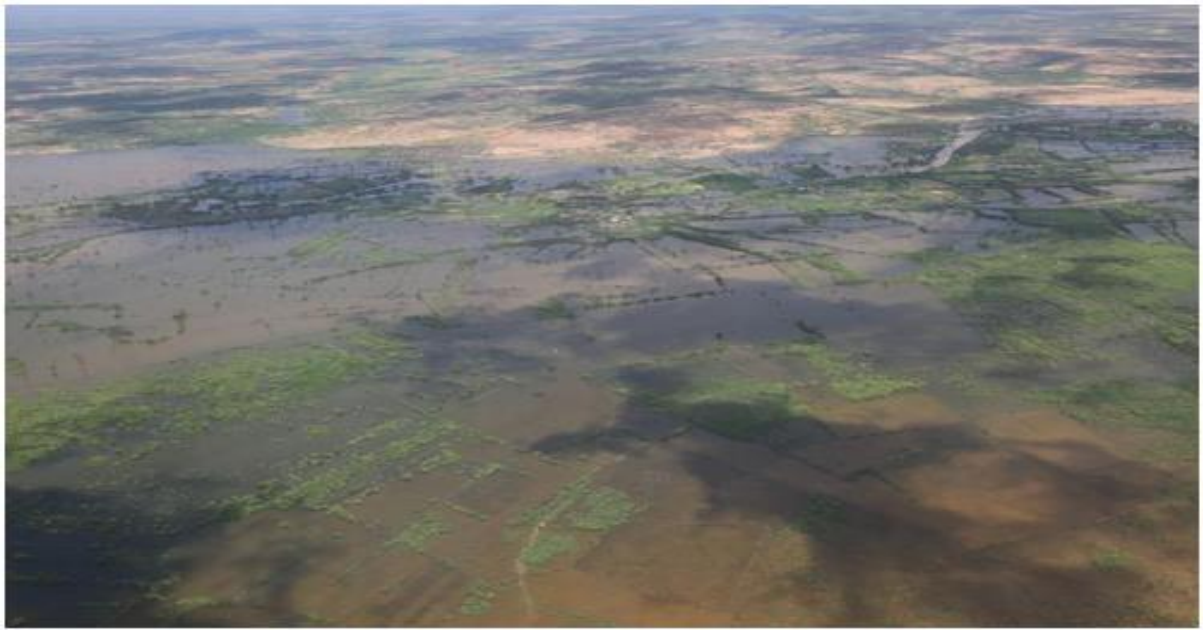

Figure 4: Aerial view of Belet Wayne town, Hiran region of Somalia
Source: (Save the Children 2018)

Current agricultural production in the south of Somalia is low, especially in between the two rivers Juba and Shebelle basins. In previous eras these areas, particularly the Bay region, were contributing to nearly 90% of agricultural production, especially cereal and legume crops (SWALIM 2007).

In the inter-riverine areas in Juba and Shebelle valleys, both rain-fed and irrigated agriculture are practiced, as well as in the northern part of the country in Punt-land and Somaliland states. Agro-climatic conditions are generally different, so is water availability in these zones and some parts of the south where the rivers do not pass (SWALIM 2007).

Although Somalia is in an arid climatic zone, agriculture production is limited particularly in the north-west of the country. But the areas where the Juba and the Shebelle rivers pass are different because they can benefit from water for irrigation on their farms (SWALIM 2007).

But there are some places with favourable climatic conditions, for example, *Buur* areas in between Juba and Shebelle rivers have rain-fed agriculture with some irrigation, supplemented by ground water (SWALIM 2007).Since there is an increased evapotranspiration (PET) rate because of rising temperature and little rainfall or absence of rain, sometimes in the season due to climate change, irrigation is needed to cover the crop water requirement since water tables are almost depleted (FSANAU/SWALIM 2016).

These regions will continue to be very low in water because of shortage of rainfall and lack of irrigation water sources except boreholes (SWALIM 2007).

SWALIM, highlighted that if the crops do not meet their water requirement they will not survive, which increases the likelihood of famine in the community living both in rural and urban areas, because urban people depend on rural people in terms of agricultural production(SWALIM 2007).

Drought in Somalia

Somalia has been suffering from effects of extreme droughts since the 1980s (Islamic Development Bank et al. 2018). The country is highly susceptible to the impacts of drought not only because of heavy reliance on rain for its water and food security systems, but also because of the present vulnerability of the communities, lack of governance and the environmental stress (Islamic Development Bank et al. 2018). The drought in Somalia is exacerbated by the ongoing conflict and instability, which has forced people to migrate from their habitats in rural areas and to seek shelter as internally displaced person (IDPs) in camps in the main cities like Mogadishu, where they are deprived of productive opportunities and are mostly depend on donation support from the international community (Islamic Development Bank et al. 2018).

As the figure 5 shows, this year (June 1-10, 2019) low precipitation of rain was recorded in many parts of the Southern Somalia, but some reports showed that some regions such as *Gedo, Bakool, Bay*, and *Hiiraan* little to no rainfall occurred with similar conditions reported in central regions.

In the northern part of the country it was reported that heavy rains in many areas occurred, however rainfall was low or very poor (Figure 6) in some agro-pastoral zones including *Aluula*, *Bandarbeyla*, and *Iskushuban* districts of *Bari* region Puntland as well as some both pastoral and agro-pastoral Zones of *Awdal* and *Woqooyi Galbeed* regions (FEWS NET and USGS 2019).

Satellite-images of rainfall in June indicated both figures 5 and 6.

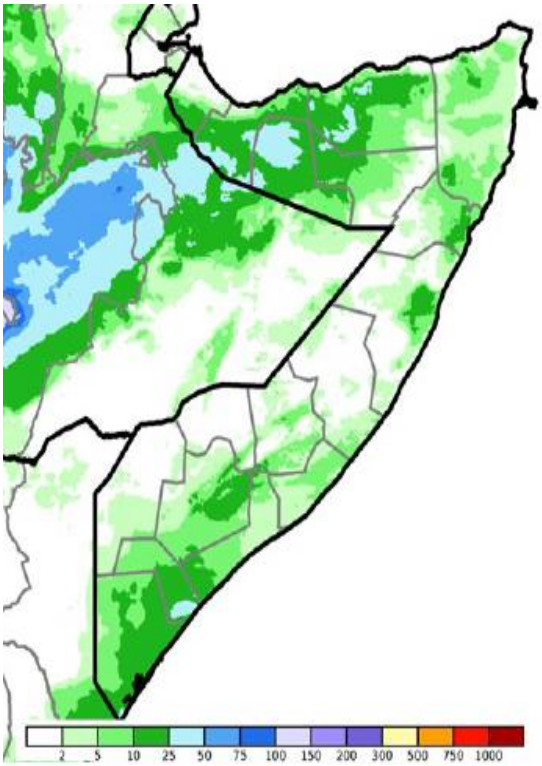

Figure 5: Rainfall in mm June 13-20, 2019

Source: FEWS NET and USGS (2019)

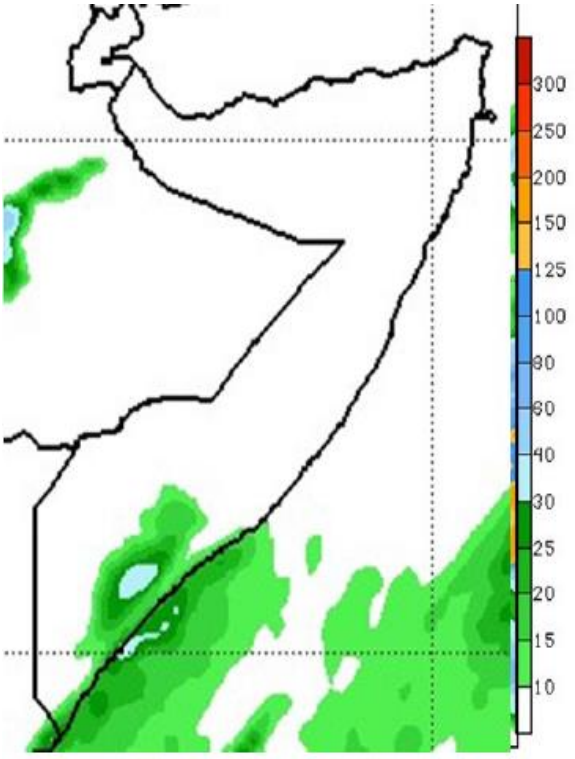

Figure 6: Rainfall in mm June 1-10, 2019

Source: FEWS NET and USGS (2019)

According to the report submitted by WFP (2019), out of 12.3 million of the Somali population (Figure 7), 1.5 million people face acute shortage of food and more than 2.6 million IDPs are in urgent need of life-saving food assistance because of low agricultural production and prolonged drought (WFP 2019).

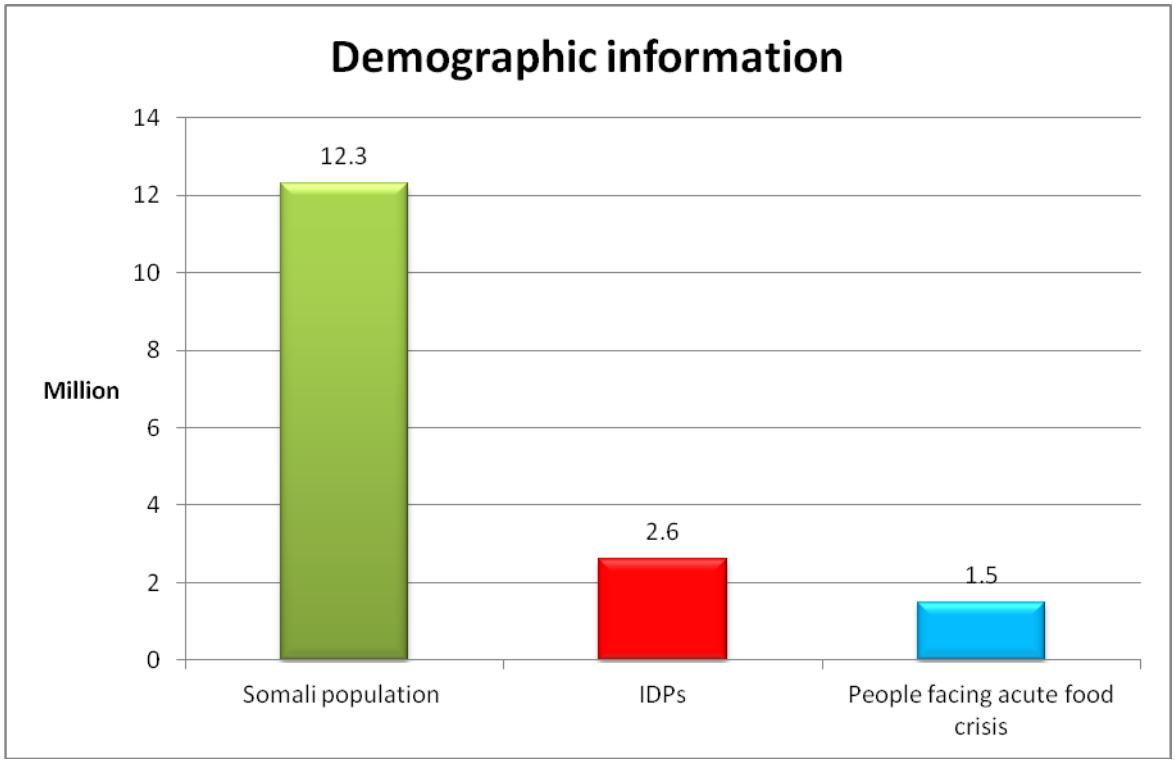

Figure 7: Demographic Situation in Somalia

Source: WFP (2019)

Drought in Somalia is the most shocking and devastating event, which affected Somalia in recent decades and still going on (UNEP 2005), because rainfall patterns in the country have changed facing either lack of rain for a long time, causing dry-up of rivers and other surface water sources; or shortage of rain, which leads many Somalis to require humanitarian aid assistance from international donors. For instance, Lower Shebelle region in Somalia, where over 60 percent of cereal crop maize is grown in the "*Gu*" season, experience severe droughts caused by lack of rainfall during late April and early May (FAO 2019).

Mario Zappacosta, FAO Senior Economist and lead of the Global Information and Early Warning System (GIEWS) said: “Rains in April and early May can make or break Somalis' food security for the whole year as they are crucial for the country's main annual harvest in July, following the "Gu" rainy season"(FAO 2019). He added that "a significant lack of rains in April and early May has rendered dry and barren up to 85 percent of the croplands in the country's breadbaskets, and according to the latest projections, food grown during the "*Gu*" season is likely to be 50 percent below average" (FAO 2019).

Drought situations had also affected some other major agricultural areas, such as the *Bay* regions named "**sorghum belt of Somalia**" in Southwest Somalia, which produce over half of the country's sorghum in the *"Gu"* season, and the "**cowpea belt**" in Middle Shebelle, and central regions *Mudug* and *Galgaduud* (FAO 2019).

FAO Somalia Representative Serge Tissot said "Herders in the worst drought-affected areas - such as central *Galgaduud* and in northern *Bari* and *Sanaag* regions - have been forced to slaughter the offspring of their goats and sheep as they don't have enough fodder and water for all their animals, and try to save the milk-producing female livestock" (FAO 2019).Tissot added in his statement that "many herders have not been able to replace livestock lost during the 2017 drought that ravaged the country, so they already have less resources. On top of this, as food and water become scarcer, they have to pay higher prices for trucked-in water and their daily food" (FAO 2019). This issue has affected many people living in the rural areas of country as they lost their herds which forced them to joint in refugees’ camps in the main cities of the country and many more jointed their relatives living in the cities.

During the civil war, cutting of forest species has escalated, particularly acacia species, which is the dominant tree in the country used for producing charcoal exported to the Gulf States (World Bank and FAO 2018).

Somalia has both extreme droughts and sometimes tremendous flooding events which affects severely the Somali community (UNDP et al 2013). Besides that, there are other climate-related events in the country such as dust storms, heat waves and cyclonic winds, that seriously threaten local livelihoods, and the future climate change is expected intensify and accelerate all of these (UNDP et al 2013).

For Somalia as a developing country, "climate change is the major obstacle for achieving the Sustainable Development Goals (SDGs) and reducing poverty and hunger"(World Bank and FAO 2018).

In terms in agricultural production, cereal crops in the southern part of the country have enormously decreased due to the mixture of constant drought, which negatively affected farmers. The area of cultivated land has also decreased because most of farmers had abandoned their farms which is one of the major problems that Somali current is facing as number of farmers had already joined refugees camps as internally displaced people (IDPs) or shifted another sectors like business rather than farming, joined warring groups like government or Islamists or evacuated to the neighboring countries like Kenya, Djibouti and Ethiopia.

Deforestation of the trees for charcoal production is one of the main causes of desertification, land degradation, gully creation in agricultural land areas and a reduction of land use for agricultural production, which together with droughts negatively impact Somali farmers, agro-pastoral and pastoral livestock community in the country (World Bank and FAO 2018).

Long severe droughts and sometimes severe floods happen continuously in the country which are resulting in large-scale starvation and the death of thousands of people, loss of crops and

livestock (UNEP 2005). And these challenges push many vulnerable people to unsustainably exploit natural resources which is amplifying the country's current and the future vulnerability to climate change (World Bank and FAO 2018).

According to the report conducted by UN OCHA (2004), nearly 200,000 pastoralists in the northern and central regions of Somalia were affected by severe drought which was considered to be the one of the worst droughts in the country in 30 years (UNEP 2005).

In 2005, the United Nation also reported that 500,000 people remain in a state of humanitarian emergency (UNEP 2005). In 2005 there was extensive flood in the Juba and Shebelle regions in southern Somalia, which has resulted in the drop of agricultural production in the country, mainly of cereal crops, below the lowest post-harvest levels (UNEP 2005).

Flooding has continued in the spring *(Gu')* rainy season and did not only affect Juba and Shebelle provinces in the south, but also the central regions (*Hiran* and middle *shabeele* regions) where several thousand households lost their crops and were forced to flee their riverine villages because of the flood of the Shebelle river (UNEP 2005).

In 2019, the poor autumn (*Deyr*) rainy season has been reported which resulted in quick reduction of water availability in the whole of the country (OCHA 2019). This low rainfall in the Ethiopian highlands resulted in reduced flow the two rivers (OCHA 2019).

The report of OCHA stated that "water flow levels in these two rivers have been declining since December 2018, and are being expected to drop further in the coming days and weeks because of the dry season in the area" (OCHA 2019) . Apart from the decline of precipitation, the rivers across the country dried up and has also been reported that there is high sedimentation, lack of regular river maintenance and over-utilization of river waters which

caused the reduction of the river flow. This resulted in insufficient water for pump irrigation channels which affected the farming systems and cultivated crops of these regions, which are mainly dependent on agriculture for their livelihoods (OCHA 2019). FAOSWALIM built a graph (Figure 8) showing the water levels of Shebelle River in *(Belet Weyne)* district in central region, indicating the lowest level in mid-January 2019 (OCHA 2019). If this trend continues, it will affect the community dependent on river water for drinking and irrigation purposes and will increase the number of Somalis who needs Humanitarian Aid Assistance from the international community, which have already achieved more than 2 million people.

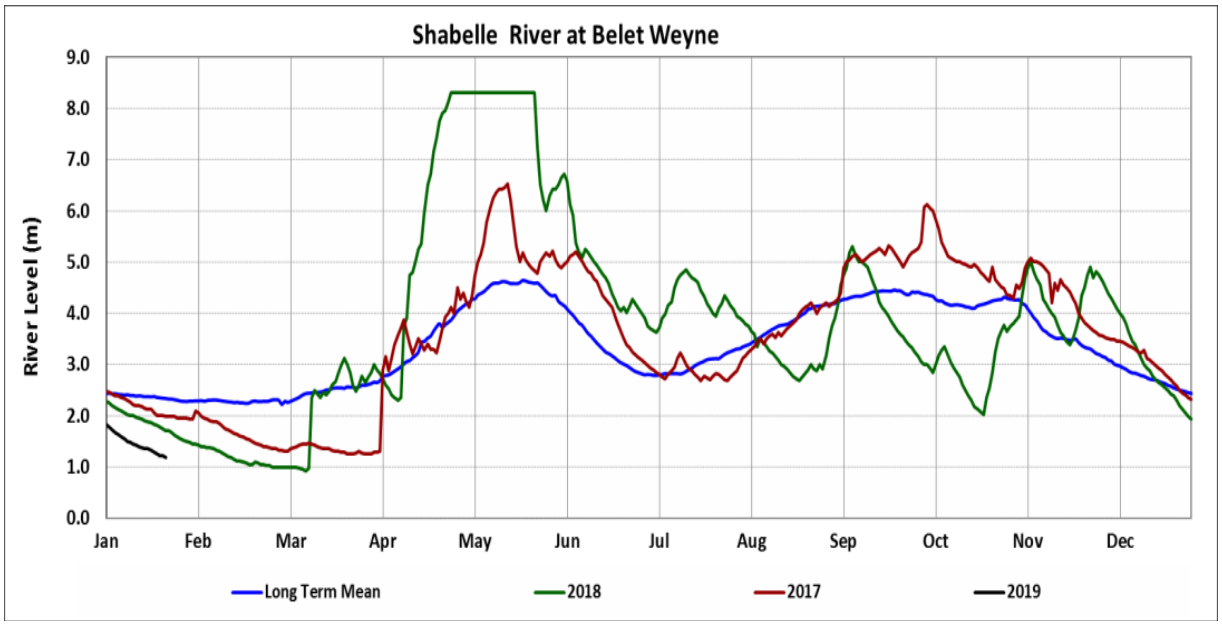

Figure 8: Shebbele River levels at Belet Weyne

Source: (OCHA 2019)

Problems related to water issues are the main challenge facing Somali community especially in rural areas. During 2016 many livestock owners lost their animals. One of the most severe droughts that were recorded after the Civil war in Somalia was 2016 due to the shortage of rain and water reserves had dried up i rivers and artificially constructed reserves (Pools, Lakes).

The reduction of ground water levels resulted international organizations from UN and EU humanitarian support from donors to Somali community

United Nations Office for the Coordination of Humanitarian Affairs (OCHA) stated that "Water shortages alerts have already been reported in South West state of Somalia" (OCHA 2019). Over 6,000 families living in in two districts in Juba land state (*Badhaadhe* and *Kismayo*) in southern part are meeting a serious water crisis (OCHA 2019).

The central region of Somalia, *Hirshablee* state, where Shebelle River passes across has also reported severe water shortages because of declined river flow, especially in *Belet Weyne* and *Matabaan* districts (OCHA 2019).

According to OCHA (2019) reported that the water catchment and water reserves (*berkets)* of these zones where the rural community keep water have dried up and the few boreholes in the area are producing less water or declined. The water flows of the only two rivers that Somalia has - Juba and Shebelle – (Figure 9), are going down and are anticipated to decrease further (OCHA 2019)

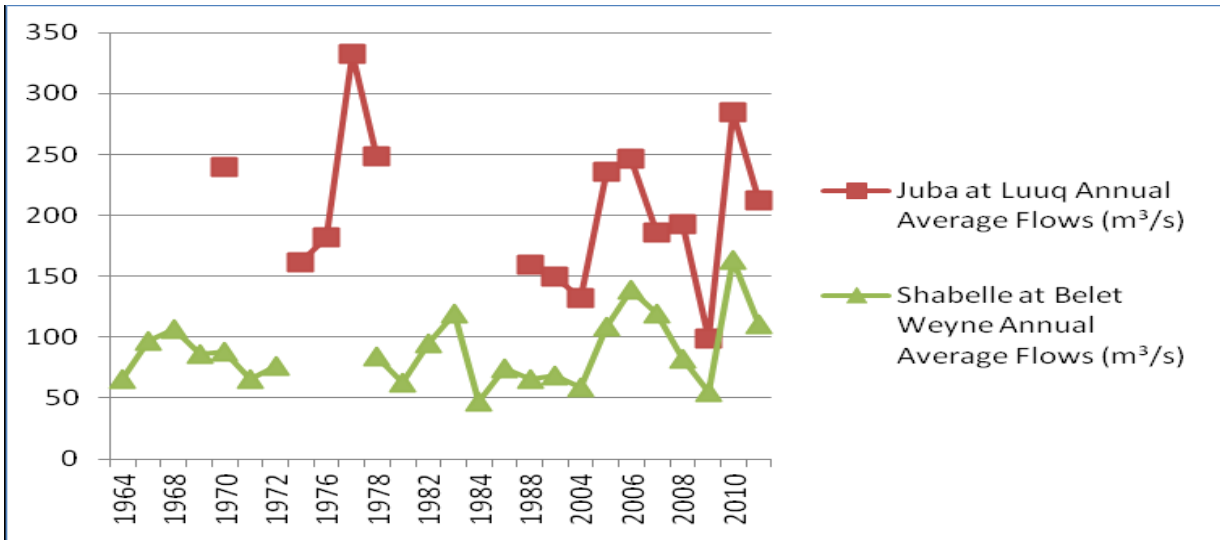

Figure 9: Mean annual rivers flows of Juba (at Luuq) and Shebelle (at Beled Weyne)

Source: SWALIM 2013)

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The centre for Global Development puts Somalia on the top of the list of 167 countries most vulnerable to climate change (World Bank and FAO 2018). The impacts of broad-scale climate events are far more visible than the impacts of conflict in Somalia (World Bank and FAO 2018).

Lower Shebelle region

Climate, soils, water resources and major constrains for agriculture in lower Shebelle

Climate in lower Shebelle

The climate in Lower Shebelle is hot and dry all year round. The temperature in average is between 26 and 28 ^{0}C with the maximum of 35^{o}C (Land info 2014). The coolest months are July and August, when the temperature drops down to 16 ^{0}C. The hottest months are staring from December to March.

There are for 4 seasons (FSNAU 2013):

a) *Jiilaa* (winter*)*, is a long dry season that starts from December till March. Normally this is the hottest season in the country as there is no rainfall and the rivers 'water levels go down and lakes and other water reservoirs dry-out during in this period.

For the community living in Shebelle *Jiilaal* period is often the most difficult season, because Shebelle River sometimes dries out completely at this time of year.

b) *Gu* (spring), is the longest rainy season, lasts from April to June. In this season the country has plenty of rain which results in the overflow of the rivers and cause flooding in the riverine areas, destroying agricultural crops and other sources that population dependent on.

Therefore, *Gu* seasons is the most important period for both farmers and livestock rearing community, who rely on rainfall for crop cultivation and livestock production. The amount of rain can vary greatly from one year to the next one, which can have serious consequences for the population.

c) *Haggai* (summer), is the coolest season in the country which also is a short dry season, lasts from July to September.

d) *Dayr* (autumn), is a period of a short rain season from October to November, but the amount of rainfall is lower than in the spring.

Soils of Lower Shebelle Region

The soils of Lower Shebelle are some of the most fertile in Somalia, having alluvial origin and fine texture. This is a main reason why agricultural production is the main activity in this area (Land info 2014). Crops are generally grown here without applying any fertilizers, nutrients get replenished by river water through farms irrigation. This area was characterized by a developed irrigation system of the canals and dams before the Somali government had overthrown. The combination of these factors made the Lower Shebelle region of Somalia favourable for agricultural cultivation of many crops, such as maize, durra, sesame and bananas. (FSANAU/SWALIM 2016).

Water resources of Lower Shebelle

The only two rivers in Somalia (Shebelle and Juba) basins were reported to decline their water flow or dry up because of the long-term shortage of rain in Ethiopian highlands, where the two rivers enter the country, which are also accounted as one of major challenges facing Somali farmers, in particular in irrigated areas along the two rivers where farming systems are practiced.

Food Security and Nutrition Analysis Unit, Somalia (FSNAU) indicated that "River levels in Lower Shebelle depend mainly on rainfall in the Ethiopian part of the Shebelle River basin and gravity irrigation can only take place when river levels are high" (FSNAU 2013).

Shebelle River is the main source of water for the inhabitants of Lower Shebelle region irrigation of their crops, which they supplement with use of ground water from wells, when the river water level decreases or dries out, especially in *Jilal* season **(**winter period).

For the crops grown in the riverine zone, sowing is typically started before the rainy season by applying irrigation, but rainfall is significant for permanent crops and has no affect on yields.

During the first two weeks of *Gu* season, the water quality of the Shebelle river is poor, because of high salinity coming from Ethiopian highlands, and the farmers must postpone irrigation because to allow the high salinity water to dissipate. In case if they irrigate for the first time during these two weeks, it can destroy their crops and encourage the land to become salinized and inappropriate for crop cultivation. *(*Figure 10) shows the flow of Shebelle River through lower Shebelle**.**

Figure 10: Shebelle River at Janale area

Source: (FSNAU 2013)

Major constraints for agricultural production in Lower Shebelle

Agricultural production in the Lower Shebelle riverine areas is an essential source of food and income generation (FSNAU 2013), and the majority of the people inhabiting this region depend on their farming systems.

In the last decades the region faced several crises. Poor rainfall and collapse of irrigation channels have caused a reduction in agricultural productivity and production. This in turn decreased earnings of the community from agricultural activities, increasing competition for farm labour opportunities. Changing precipitation patterns and climate change provoked the breakout of pests and diseases, which leads to additional crop losses. This coupled with fighting between Somali government backed by the African Union Peace Keeping Forces

(AMISOM) and Islamic Militants (Al-Shabaab) forced people to abandon their land and to move from agricultural areas to cities as refugees waiting for support from international donors.

Resilience-thinking in ecological agricultural production

Origin of resilience

For the first time the word "resilience" was introduced in 1973 by Holling as an idea of helping and understanding the ability of ecosystems to keep original state up in response to perturbations (Pisano 2012). According to Pisano (2012) "resilience is a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables".

Resilience is the capacity of individual, social or socio-ecological system to absorb survive, live with, accommodate instability (Mbae 2014), for instance, climate change effects, while keeping some essential structure and ways of functioning, the capacity for self-organization and the ability to adapt to these changes.

Resilience-thinking for ecological agriculture focuses on decreasing risks by improving the ability of people and agriculture ecosystems, on which they depend, to adapt. In other words, enabling farmers to meet current and future food needs while coping with uncertainty and changes (Greenpeace 2015). UN organizations have long been focusing on the importance of building resilience so as to maintain and to support smallholder livelihoods in order to reach long-term food security under a changing climate conditions (Greenpeace 2015).

Need for resilience-building in African agriculture

Adaptive changes will be needed to build resilience for most African farming systems, which implies to either decrease negative impacts or to benefit from any positive effect of climate change (CCAFS 2015). But experiment work is required for identifying the appropriate adaptation methods for climate change scenarios. Cultivating and growing different varieties of crops at the field level, and well managed soil on the landscape level are some of the reliable ways to improve agricultural production and thus making it more resilient to increasingly unpredictable changes of climate (Greenpeace 2015).

Soils that are rich in humus content are much better at holding water during precipitation, thus decreasing water runoff and improving water infiltration into the soil. Therefore, it would be better to keep straw on the farm to improve organic content in the soil.

Farmers can secure their livelihoods also by cultivating different crops or mixed crops like legumes with cereal crops, so that the final output is more reliable (Greenpeace 2015). Intercropping system is one of the best methods to adapt and improve crop yield which can be a tool for building drought resilience in agriculture.

For instance, mixing legume with cereal crops is an excellent practice for controlling soil erosion, improving soil nutrients and sustaining crop production which can also be one of the best drought resilience measures for agricultural production in Somalia and the whole of the region (Lithourgidis et al. 2011). Mulching and leaving straw crops on the farm is also one of the excellent methods that can increase agricultural production in East African farming systems (Greenpeace 2015). Enhancing ecosystem management systems and protecting biodiversity increase an amount of ecosystem services that help achieving more resilient agricultural production (Kodikara 2010).

Greenpeace (2015) highlighted that in order to reach resilience of agricultural systems of rural communities in East Africa; an essential restoring of the capacities of ecosystems is needed. It would provide more reliable food systems and enhance adaptation of farming systems throughout the region (Vignaroli 2017). Some African farmers add animal manure on their farms which is one of the best techniques of soil management for increasing soil micro-organisms and improves water holding capacity for the soil that ultimately increases crop harvesting and increase the income of the farmers.

High reliance on natural resources and rain-fed agriculture, and low adaptive capacities of African small farmers make them defenceless to climate change (Mbae 2014). An estimate shows that if no adaptation actions are taken to build resilience of cereal crop production, it could cause yield reduction for maize and rice cultivation. Maize yield will reduce in between 5 to 10 percent, while the rice production might also reduce in between 2 to 5 % in the 21st century (CCAFS 2015).

Greenpeace (2015) indicated that "healthy soils can keep nutritional security and several knowledge intensive strategies that include integrating trees and food legumes have been used to improve yields under environmental variability". Proper management through adaptive cultivation in agriculture system also focuses on restoring degraded soil, which can be benefited from again, as well as cultivating different varieties of crops on farm (mixed cropping), which provides micro-climate for crops to become more productive(Greenpeace 2015).

Agronomic conservation practices as adaptive resilience building strategies to climate Change

Positive impact on environment, biodiversity and soils

Applying conservation agriculture practices has important impact in decreasing both soil degradation and soil erosion, improving water infiltration and water storage capacity of soil and increasing soils humus content. A conservation agriculture practice enhances biodiversity on farm and improves the livelihoods of the community by supporting ecosystem services including water and nutrient cycling (FAO 2016). It also controls and reduces flood occurrence by increasing water infiltration in agricultural land.

Climate change mitigation

Agricultural conservation practice can help mitigate climate change by decreasing greenhouse gas (GHG) emissions and increase carbon sequestration in soils and plant biomass. Food Agricultural Organization of United Nations (FAO) indicated that "conversion of all croplands to conservation tillage globally could sequester 25 Gt C over the next 50 years"(FAO 2016). There for, applying conservation agricultural practice is important and it is one of the solutions for climate change in Sub-Saharan Africa.

Conservation agriculture

Moyo (2013) defined conservation agriculture: "It is a way of farming that conserves, improves and makes more efficient use of natural resources through integrated management of available resources combined with external inputs"

Conservation agriculture means less work for the farm as it is not necessary to till the soil and to preserve weeds in all the time. It controls weeds and decreases erosion aspects in terms of

both soil and water. It also improves the soil structure, capacity for the soil to preserve water, retain its humus content and fertility that provides the increase of the yield production of the farm. It gives straight benefits to environmental ecosystems on the earth, including protecting land degradation, air quality control, mitigating climate change, protecting biodiversity loss and improving for water quality(Moyo 2013)**.**

Food and Agricultural Organization of United Nations (FAO) defined conservation agriculture as "a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment".

Positive aspects of conservation practices in agriculture

Zero tillage/ minimum tillage

Improves the integrity of the soil systems in the environment and it provides protection of the ecosystems services in the soil environment. This system enhances the soil organic matter and its stability in the soil and decreases soil erosions, mitigates the affect of climate change, improves carbon sequestration in the soil and it reduces GHG emission (Dumanski 2006). It also reduces the effects of drought by giving protection for soil as cover surface, control erosion and increases infiltration of water into the soil.

Environment, biodiversity and soils

A conservation agriculture practice enhances biodiversity at farm, improves the livelihood for the community and support ecosystem services including water and nutrient cycling (FAO

2016). It also controls and reduces flood because it increases water infiltration in agricultural land and reduces water runoff on land surface.

Conservation agriculture contributes to mitigate climate change impacts by decreasing GHG emission sources and storing carbon in soils and plant biomass (FAO 2016).

Water Management

According to Akinnagbe and Irohibe (2015): "Success of climate change adaptation depends on availability of fresh water in drought-prone areas".

Conservation agriculture is also very important for water management and water-use efficiency enhancement as it increases humus content in the soil, develops proper root density, improves water infiltration in the soil and water holding capacity, which makes water more available in the farming system if the water is used properly and efficiently (FAO 2016).

Greenpeace (2015) stated that ecological farming practice is able to provide more resilience of farming systems and enhance capacity to cope with water restrictions through water-saving irrigation on the farm.

Mulching

on soil surface enhances soil porosity, also increases its penetration and absorption capacity, while decreasing water evaporation from soil surface into the atmosphere. Therefore, all these advantages help to decrease the danger of soil erosion and flooding during heavy rain seasons, improve the aquifer recharge and make much more water available for crops.

Food security

Conservation agriculture practice significantly stabilizes food production and increases the nutritional conditions and food security for communities. It also supports yields stabilization in

the face of climate shocks, including droughts, by decreasing evapotranspiration from the plants and managing temperatures in the soil as well as helps regulating pests and diseases if suitable crop rotation systems and appropriate combinations are applied (FAO 2016). These systems can be crucial for poor and vulnerable farming communities.

Integrated soil fertility management approach

Soil conservation and fertility management aspects are receiving attention in many African countries like Burkina Faso, Kenya, Senegal, and Niger (Akinnagbe and Irohibe 2015). In order to improve farmers' skills in enhancing soil fertility, management approaches (which are also good adaptation practices) for improving soil fertility and reduction of soil degradation, as well as increasing water infiltration and water-holding capacity of soil, should be taught to farmers (FAO 2016). The main actions to be taken include providing education and training for the farmers and encouragement of application appropriate fertilizers, mainly application of organic fertilizers by composting of leftovers, crops residues, and animal manure (FAO 2016).

Applying effective microorganisms

Effective microorganisms (EM) are mixed cultures of beneficial natural fermentative microorganisms that can be applied to increase the necessary microbial diversity needed for living"(FAO 2016). Applying of EM knowledge has increased in the last 20 years from agricultural production to water treatment, odour control, animal rearing, human wellbeing and industrial treatments(FAO 2016). This new technology has newly been developed by the private sector and NGOs. Effective microorganisms enhance the digestibility of animal feed, minimize the composting time and are applied in a lot of agricultural production. The utilization of effective microorganisms is likely to get better production.

Crop residue management

To achieve successful agricultural conservational practice, it is highly recommended to use proper crop residue management (FAO 2014). Crop residues provide shielding over the soil as mulching and improve water infiltration in soil pores. Many researches, previously conducted, showed that "when 35 percent of the soil surface is covered with uniformly distributed residues, splash erosion will be reduced by up to 85 percent"(FAO 2016). However, crop residues are used traditionally for different purposes in many countries around the world, e.g. as building materials, fuel and for animal feeding purpose, which is against agricultural aspects is also a factor destroys agricultural sustainability (FAO 2016).

Cultivating drought tolerant crops

Selection of drought tolerant crops require applying techniques like plant breeding or plant biotechnology, are important to be cultivated to be able to harvest crop yield even in case of lack or absence of rainfall (IPS 2019). However, it might pose some challenges in biotechnological or breeding aspects, takes a long time for applying beneficial traits and it needs to be tested in several locations. Another challenge that might come is the need for investment in breeding drought tolerant crops and distribution of them among the farmers. However, there are many farmers in sub Saharan Africa countries cultivating drought tolerant maize varieties (IPS 2019).

Cultivating drought-resistance crops helps in agricultural farms in stabilizing crops, especially cereal crops in rain-fed areas (Herrero et al. 2016). In Somalia there is a need to conduct breading of drought-tolerant varieties suitable for local conditions, or to conduct research on applicability of drought-resistant crops/varieties grown elsewhere.

Mixed cropping

Food and Agricultural Organization of United nations indicated that "Mixed cropping involves growing two or more crops in proximity in the same field"(FAO 2018). Commonly mixed cropping system is cultivated in many countries in East Africa; for instance, Tanzania mixes cereals crops like sorghum, maize with legume and ground nuts cultivated together in field in one season. The benefits of mixed cropping systems are important, especially when cereal crops like drought tolerant varieties(maize, sorghum) are mixed with legumes (Akinnagbe and Irohibe 2015). Mixed cropping systems contribute to building climate resilience for small scale farmers. Shifting to crop diversification is the step for enhancing productivity and resilience in agricultural production (Herrero et al. 2016).

Crop rotation and intercropping

Practicing these two systems contributes the nutrients and water in the soil and improves the nitrogen fixing bacteria through some plant species which results a greater use and available water and nutrients; enhance the availability of nitrogen, potassium and phosphor in both inorganic and organic sources; and improves humus content in the soil. Crop rotation applying good management practices reduces applying nitrogen nutrients in the rate of (100 kg N) per hectare in annually and reduces GHG emissions mainly nitrous-oxide which has great impact on global warming likely 310 times greater than CO2 gas emission(FAO 2016).

Adaptive strategies of agronomic practice

To adapt to climate change, farmers must come up with proper Agri-management aspects in response to changes in climate conditions. The common recommendations on agricultural adaptation strategies to the farmers are cultivating drought tolerant varieties, applying crop

diversification systems, adjusting seasons of cropping as well as the time of planting, keeping soil moisture content with suitable tillage systems like efficient irrigation system.

Drip irrigation systems

It helps the plants to grow fast and develop good roots into soil that are more tolerant to dry up and improve crop yields. Drip irrigation system also enables the famers use water in an efficient way and reduces the amount of water for irrigation. Globally, this system is practiced about 20 percent of the developing countries and it improves agricultural yield harvested (FAO 2016).

Water harvesting

This system enables the farmers increasing their water sources storage during rainfall patterns by building pools, water dams, water pits and retaining ridges which they may apply on their farms during dry season or water shortages periods**.**

Agro-forestry practices

This system is a kind of combination of animals, trees, shrubs on one land where the farmers can benefit from each of them. The combination of these triple systems can solve the challenges of food security and improves the adaptability of agricultural systems to climate change (FAO 2010). The trees enhance fertility and moisture content in the soil and improve soil organic matter. Enhanced fertility of the soil can enhance agricultural production and might enable the farmer to become more flexible in terms of the crops that he/she cultivates. Therefore, this system is crucial for the mitigation of climate change, reduces the vulnerability and helps building the ability of famers to adapt to climate change (FAO 2010).

An adaptation strategy by improving crop varieties reduces crop losses in the face of climate change, especially for wheat and rice crops in tropical region and enhances food sufficiency for small farmers, and increases their revenues without cultivating additional earth (Herrero et al. 2016).

Planting crops earlier or later

compared to dates in the cropping calendar is considered an important adaptation action in Egypt, Kenya and Senegal, helping to adapt to shifting (due to climate change) seasons (Akinnagbe and Irohibe 2015).

The accessibility of essential nutrients in the soil like nitrogen (N), phosphorus (P) and potassium (K) as well as other important elements that increase yields is crucial, so they have to be applied into the cultivated land, particularly by composting animal dung, which can be applied as organic fertilizer on the farm. (Kodikara 2010)**.**

To summarize, other adaptive farming practices include:

1) Farmers should have more than one variety of the crop on their field to succeed in different extreme climatic situations. Because of the severe floods occurring sometimes, farmers must cultivate alternative crops that have quality of overcoming flooding experience.
2) Planting of seeds and harvesting period requires to be adjusted to new weather conditions.
3) Farmers must cultivate drought resistance varieties.
4) Some crops mature in early time and it is better to be plant them in earlier period to avoid climate change affects.

5) Crops requiring less water for irrigation should be cultivated to harvest good yield and to overcome water scarcity problem. This is because both surface water and ground water availability are expected to decrease, while crop water requirement is expected to increase due to increased evapotranspiration.
6) Therefore, irrigation efficiency method will become an important tool for adaptation particularly in water-shortage or dry periods.

Therefore, this research will focus on how to build agricultural drought resilience in the lower Shebelle region, which is the one of the broad baskets for agricultural production in Somalia, in response to accelerated climate change.

Such kind of research has not yet been conducted in Lower Shebelle region and there is research gap of this area which encouraged me to focus on this region.

The aim of this study is to help decision-makers and other stakeholders to build drought resilience of agricultural systems in Lower Shebelle region of Somalia: in response the impacts of climate change on agricultural production because this region feeds approximately 3.5+ million people living in the capital city Mogadishu and it is the largest province where the community of Mogadishu receives agro-products. Therefore, this region is very crucial to be conducted such kind of this research.

CHAPTER THREE -

METHODOLOGY

Introduction

This chapter focuses on the way the research was conducted. It shows the location where the study was carried out and outlines the seven districts comprising the region. It further presents the ethnicity of the population, sources of the data methods and their collection, analysis, and research ethics.

Study Area

The Lower Shebelle region is located to the southwest, northwest, and west of Somali capital Mogadishu. It has borders with Juba region on the south, Indian Ocean and Mogadishu on the east, Middle Shebelle region on the north and Bay region on west. It covers an area approximately 29,761km^2 (Land info 2014).

This region consists of seven districts:

1) Afgooye
2) Baraawe
3) Kuntunwaarey
4) Marka
5) Qoryooley
6) Sablaale
7) Wanla Weyn

A major part of the Shebelle regions is comprised of lowlands and is crossed by the Shebelle River (Figure 5). Brava, Afgooye, and Marka districts have a coastline of the Indian Ocean,

whereas Wanla Weyn, Qoryooley, Kurtunwaarrey, and Sablaale are inland districts(Land info 2014).

The Shebelle River runs parallel with the coastline from Middle Shebelle in the northeast to the Middle Juba in the south-west of the country. The distance between the coast and Shebelle River is around 30 km (Land info 2014). Fertile soil is available around the river, but in rainy seasons extensive floods occur which destroys agricultural production; the risk of flood sometimes threatens inland areas far from the river zone (FSNAU 2013).

The population living in Lower Shebelle are divided into four categories; nomadic, nomadic agricultural, agricultural and urban sedentary. The inhabitants of the lower Shebelle community is around 850,651 and, after the capital city Mogadishu, lower Shebelle is the most populated region in Somalia (FSNAU 2013).

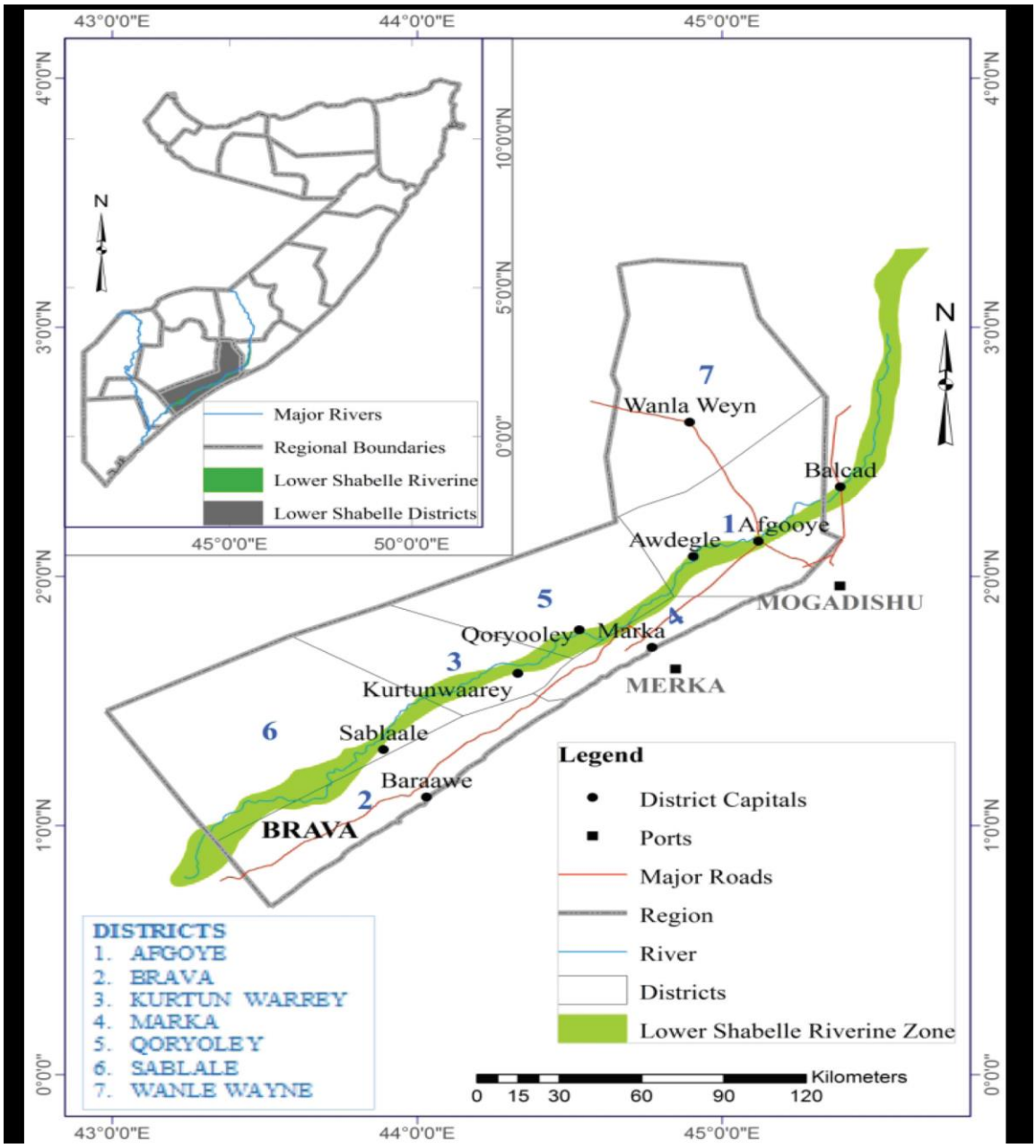

Figure 11: Lower Shebelle region

Source: (FSNAU 2013)

Food conditions

Food security of Lower Shebelle is similar to the rest of the country which means that the families do not have enough financial resources to buy the basic food they need (Land info 2014). Rainy seasons significantly affect the community living in Lowe Shebelle region in

terms of food security(FSNAU 2013). When the rain is low agricultural production decreases. During heavy rains, the agricultural fields are flooded which means these conditions lead to starvation and malnutrition.

The ethnicity of the Lower Shebelle population

The community of Lower Shebelle consists of heterogeneous communities in terms of clan and group association. In the historical background, most of the population is from the *Digil* tribe. This tribe is composed of farmers, are different from the Somali nomadic tribes and their ancestries are not linked in alliance adoption (Land info 2014).

The Wanlaweyn district is dominated by Digil tribe also known as Shanta alemod member of Rahanweyn Clan which is one of the four largest clans in Somalia (Land info 2014).

The Afgooye district is the home of Hawiye Clan Wacdan and Digil tribe Geledi.They are living in the area around Afgoi district and other places(Land info 2014). Marka, which is the regional capital of Lower Shebelle region is dominated by Biimaal tribe from the Dir clan accounted as the largest clan in Somalia. The Bimaal tribe not only lives in Marka but also is found in the other places in the region. Qoryooley district hosts two secondary clans, Garre tribe-associated with Hawiye clan and Jiddo secondary tribe linked to Digil Clan. The tribe of Jiddo is also found in the other districts in the region such as Sablaale and Kurtunwaarrey, while Baraawe is dominated by Tunni clan associated with Digil (Land info 2014).

After the Somalia government collapsed in the 1990s, a large population from Hawiye clans shifted to Lower Shebelle region since some of this clan were found in the region before 1990s but the largest Hawiye clan came to the territory from other provinces and the new arrivers are mainly from Habargedir clan Ayr (Land info 2014). These newcomers settled in the region and eventually integrated to the former communities.

Lastly, other clans like Somali Bantu (*Jareer*), Tumal and Midgan are found in Lower Shebelle region (Land info 2014).

Sources of data

In this research, data were collected from various stakeholders, primarily on how they are adapting to current trends of climate change impacts on the Lower Shebelle region. To reach this goal, two types of research data collection methods were used. Primary data was obtained with the help of open structured questionnaires and interviews with farmers, local scholars and institutional practitioners. Secondary data was collected from written documents and scientific research articles.

Secondary sources

Secondary sources were used in order to give a strong background on the research study area by analyzing the trend that existed before and what types of adaptation approaches are now being applied in the country and the region, and worldwide to build drought resilience in agriculture in response in climate change.

Resources used included existing reports by such organizations as Greenpeace, Intergovernmental Panel on climate change (IPCC), Food Agricultural Organization of United Nations (FAO), the United Nations Framework Convention on Climate Change (UNFCCC), United Nations Environment Programme (UNEP), United Nations Office for the Coordination Human rights (OCHA), United Nations World Food Program (WFP), Food Security and Nutrition Analysis Unit, Somalia (FSNAU), Somalia Water and Land Information Management (SWALIM), The World Meteorological Organization (WMO),Global Water Partnership Eastern Africa (GWPEA), Global Environmental Facility (GEF), Climate Change, Agriculture and Food Security (CCAFS), International Union for Conservation of Nature

(IUCN), Famine Early Warning Systems Network (FEWSNET), United States Geological Survey (USGS), The Organization for Economic Co-operation and Development (OECD), International Institute for Environmental and Development(IIDE), United Nations Development Programme (UNDP), Greenpeace, OXFAM as well as other organizations and academic journals.

Primary sources

Primary data was collected from farmers in the Lower Shebelle region, and relevant institutions such as Somali Agriculture Technical Group (SATG) and other institutions involved in agriculture. The information collected included types of crops that the farmers are currently cultivating and the scope of their activities, as well as what kind of practices they apply in adapting and how do they get support from NGOs, extension officers, local scholars and other related institutions.

Qualitative methods of data collection

Interview method

This study involved semi-structured open-ended qualitative questionnaires. The interviews were conducted via email and face to face interview with different stakeholders including farmers, NGOs such as Somali Agriculture Technical Group (SATG), local scholars, and other environmental institutions involved in agricultural production to find out their role of educating and training farmers and how they are engaging in these climatic aspects.

The criteria of choosing the stakeholders from farmers were being above 18 years old, living in Lower Shebelle region, without gender consideration. The respondents from other institutions

were agricultural NGOs workers, agricultural extension agents, University students involved in agriculture that was considered as an important source of information for the farmers and the local scholars from the region. To ensure the security of the participants, their names are not provided in this thesis.

All participants will be given the possibility to learn about the result of this study.

Questionnaires

Qualitative questionnaires had a cross-sectional survey design applied in this study**.**

Current, the number of population in Lower Shebelle is unreliable in number only estimation was based on this study as the country has been in an unstable situation for nearly 3 decades and a correct census has not been made since the 1980s. But, the Food Security and Nutrition Analysis Unit of Somalia (FSNAU) estimated the population to be 850,651 living in Lower Shebelle (FSNAU 2013).

A number of respondents (experts) were planned to reach as the study was a phone interview, via email and face to face interview for the farmers collected representatives from my site.

Each question was meant to provide a direct answer to one of the three research objectives.

Questions asked to stake holders were included

1) What type of crops do the farmers currently cultivate?
2) What major drought-related problems were experienced in Lower Shebelle in the past 5 years?
3) What factors influence farmers' capacity to develop and maintain drought resilience in agriculture in the face of climatic acceleration risks?
4) What are the recommended options to be taken for improving resilience and minimizing the impacts of climate change on agricultural production?

Data analysis

Questionnaires were used to analyze Microsoft Excel and the results were showed in tables, graphs and pie-chart formats.

Research Ethics

In this study, the CEU research Ethics protocol was used.

Appropriate time with permission was informed to stake holders for participation in the study and the interviews were conducted immediately on an agreed date for each participant. To ensure the security of the participants, their names are not provided in this thesis.

All participants will be given the possibility to learn about the result of this study.

Both the interviewers asking questions to the farmers and the other actors answering via email were enough careful not to ask any embarrassing questions.

Each respondent has rights not to participate in the study was granted.

CHAPTER FOUR -

PRESENTATION, ANALYSIS AND INTERPRETATION OF THE DATA

Introduction

This chapter presents data analysis, presentation and interpretation of data collected from Lower Shebelle in 2019 from farmers and institutions involved agricultural production in the region. The analysis and the interpretation of data were based on the research questions from research objectives; the presentation was divided into two parts.

The first part presents the farmers' respondents and the information they provide with their presentations, interpretations and analysis, while the second part from institutions dealing with agricultural production in the region and with the presentation, interpretations and analysis.

A.) Farmers

1. Farm location and number of respondents

This part presents the location where farmers are from and the number of each in villages/districts. The purpose of this was to find where these respondents are from and show the distribution of the respondents. The respondents were asked their location and other questions concerned them and each question was presented and analyzed separately.

Table 1: Farm location and number of respondents

Farm location	No. of respondents
Afgoi	4
Awdeegle	1
Baladul-Amin	1
Janaale	1
Jeerow	2
Kurtun Waarey	1
Mubarak	1
Total	11

Source: (primary source 2019)

Table 1 indicates that most of the farmers are from Afgoi district where currently main market of Lower Shebelle farmers is. This district Afgoi is controlled by Somali government though some of the villages are under Al-shabaal terrorist group fighting with Somali government and African Union peace keeping forces (AMISOM), Therefore, the farmers prefer to take their crops from villages and to sell in the market. And this district Afgoi is where the interviewers met with the farmers.

2. What type of crops do you currently cultivate?

The participants of this study were asked the varieties of crops they currently cultivate.

The figure 12 below shows the presentation of crops they cultivate on their farms.

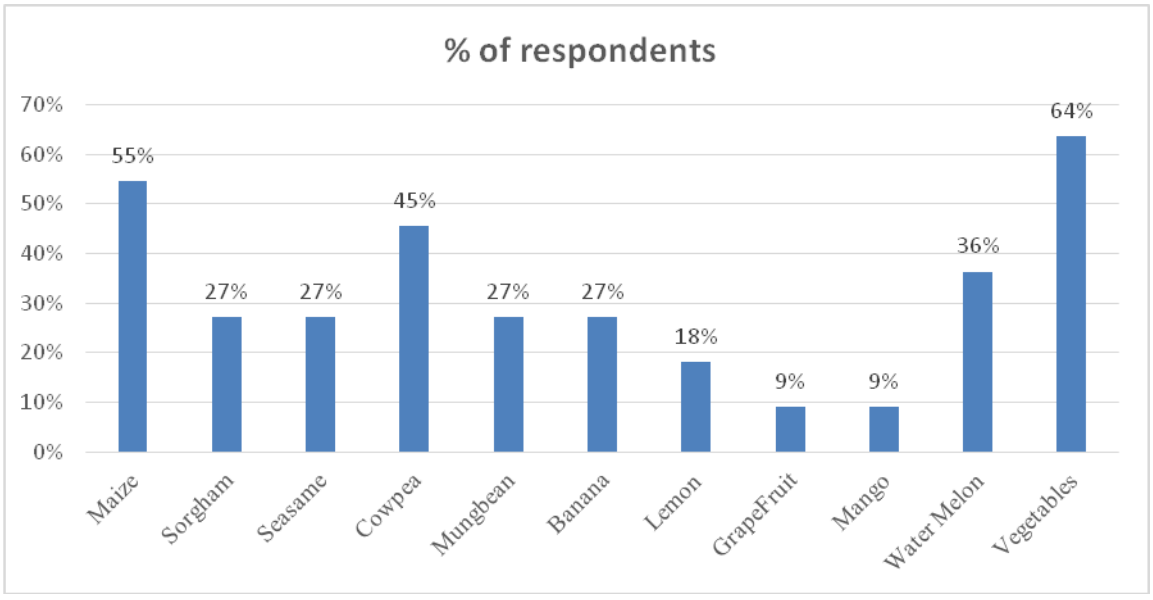

Figure 12: Types of crops Lower Shebelle farmers current cultivate

Source: (primary source 2019)

Figure 11 shows that the highest crops being cultivated in the region is vegetable varieties and second and third is maize and cowpea respectively. Since Shebelle River passes in the region

that is why most farmers prefer producing vegetable varieties as they get irrigation from Shebelle river.

2.a: Any drought resistant crops?

Table 2: Percentages of farmers cultivating drought resistant varieties in Lower Shebelle

No: 9 Farmers	82% respondent
2	18%

Source: (primary source 2019)

Two farmers had mentioned that they cultivate drought resistance crops which are 18% of respondents. One of them mentioned that he cultivates local varieties and the other farmer mentioned some seeds from abroad mainly from Turkey, India and China; while other farmers do not cultivate any drought resistant varieties.

3.a: Irrigation

Table 3: Use irrigation for farming

No: 1 Farmers	9 % respondents
10	91%

Source: (primary source 2019)

91 percent of farmers use irrigation on their farms either from Shebelle river irrigation or drilled wells on their farms. Most of the vegetable farmers are located on the river banks not far from the river; while others use water canals from the river to their farms.

3. b. How would you describe the agricultural production on your farm?

Table 4: Description of agric-production in Lower Shebelle per farmer

Farmer	% of respondents
Good	9%
Fairly Good	27%
Normal	27%
Poor	27%
Very poor	9%
Total	100%

Source: (primary source 2019)

36 percent of the respondents mentioned that agricultural production of the region was positive; while 36 percent indicated that was poor which 50/50 of the respondents is. The respondents replied positive use drought resistance crops, have wells and sow local varieties in their farms; while others provide negative answer do not use any technique apply the positive once.

4. What can you tell about the rainfall over the past 5 years in lower Shebelle?

Table 5: Rainfall over the past five years in Lower Shebelle

Farmers	% respondents
Good	9%
Normal	18%
Low	55%
Very low	18%
Total	100%

Source: (Primary source 2019)

Most of the respondents those are 73 percent showed that rainfall in Lower Shebelle region in the past 5 years was not good. Only one farmer KurtunWarey which is 9% of the respondents replied was good.

5. What major drought-related problems have you experienced in the lower Shebelle in the past 5 years?

All respondents mentioned that they met crop failure, flow water shortage of the river and erosion which effected in general the agricultural production of the whole of the region that resulted in farmers leaving their farms and to join IDPs in the country; while others searched for another alternative solution to keep their livelihood.

6. Droughts affected your farm, the region, agricultural production?

Table 6: Drought affected Lower Shebelle

Farmers	**% respondents**
Your farm	100%
Region	100%
Agricultural production	100%

Source: primary source 2019

All the farmers underline that drought affected their farms in 100% and caused crop loss, migrating from farming and joining IDPs, low production and high production cost for agriculture cultivation in the region.

7. How do you deal with droughts on your farm? What do you do? (e.g., mitigation, prevention, etc.)

In drought mitigation strategies, most of the farmers provide quite similar answers like sowing earlier seeds, conservation technique, ceasing cultivation till rain comes, planting local varieties and drought resistance seeds, drilling wells on the farms to apply for irrigation during lack of rain or shortage of rain and proper water harvesting technique.

8. Are things better or worse than before?

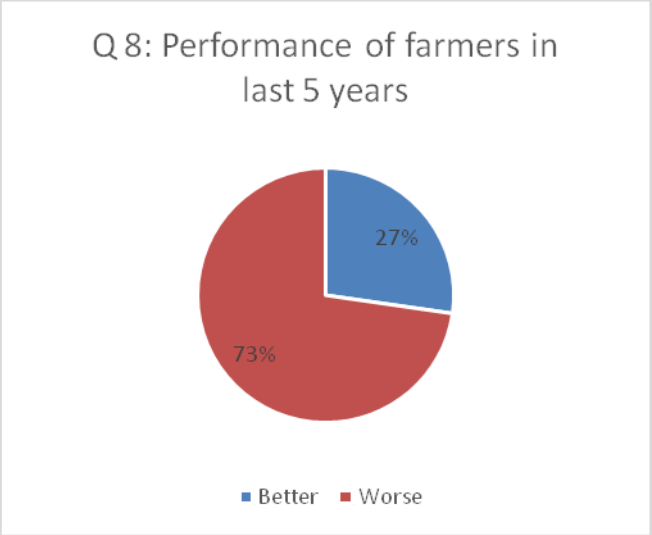

Figure 13: Performance of the farmers in Lower Shebelle in the last 5 years

Source: primary source 2019

Figure 13 shows that 73 percent of the respondents which are 8 farmers indicated that the condition was worse than before; while 27 percent which are 3 farmers showed better condition. These 3 famers showed positive answer from Afoi, KurtunWarey and Baladul-Amin.

9. Who do you work with the most to deal with drought?

Figure 14 below indicates who the farmers work with when dealing with drought.

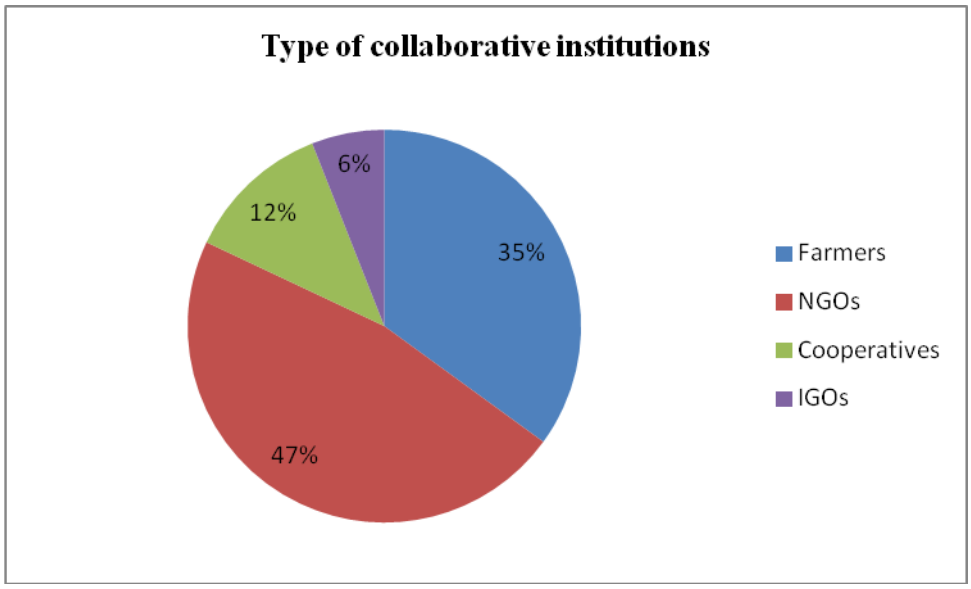

Figure 14: Who farmers work with when dealing with drought

Source: (primary source., 2019)

The pie-chart above shows who the farmers are working with during dealing with the drought. The majority of respondent replied with NGOs in the region and second highest with farmers in collaboration with drought; while the rest work with cooperatives and Intergovernmental organizations.

10. How do you work with them?

During working with stakeholders mentioned in figure 13; respondents indicated that they were sharing information, receiving grants for support from institutions that they are working with.

10.a. What kind of assistance do they provide?

Participants were asked what kind of assistance they get from the institutions in Figure 13 above.

Most of the famers which are 9 (82%) of respondents answered that they get information sharing and support while 2 famers (18) of respondents indicated support only.

Info sharing can be training about drought adaptation strategies; while the support can be seed distribution or cash for the farmers. The two farmers mentioned only support from Afgoi and KurturWarey.

10. b. Has there been more or less assistance over time?

All but two farmers mentioned less assistance over time and the two farmers did not reply the above question, both from Afgoi. The practicably of this issue can be lack of finical aid and insecurity of the region as the institutions can travel the whole of the region due to Al-shabaal terror team those are controlled most villages and some districts in Lower Shebbelle.

11. What information, if any, is the most useful in dealing with drought?

The farmers mentioned that they need meteorological information, early warnings for drought, drilling wells in their farms, training proper water harvesting technique, irrigation crops during dry periods and growing drought resistance crops.

12. Are you able to access that information?

Two farmers (18%) from respondents answered that they are not able to access information and they mentioned to need government assistance and finance.

The one replied for government assistance from Afgoi and the other one from Janaale; while the other 9 (82) famers replied yes.

13. What do you think can solve the challenges presented by drought?

The proposal solutions that the farmers suggested and showed that they need training for capacity building like conservation agricultural practices, availability of drought tolerant varieties and early sowing seeds and control the viability of the seeds coming into the country;

most of them underlined that they need proper water harvesting technique like building water catchments like building canals, digging wells in their farms, smart irrigation techniques, to stop deforestation and strong government and good leadership in the region.

B.) Institutions

1. Occupation

Table 7: Institutions and number of respondents in this category

Institutions	No. of respondents
NGOs	5
Extension Officer	1
Graduate Student	1
University Student	1
Local scholar	2
Total	10

Source: (Primary source 2019)

The above table indicates the stakeholders involved in agricultural production and training facilities to the farmers.

2. What type of crops do the farmers in Lower Shebelle currently cultivate?

Figure 15 shows types of crops that Lower Shebelle farmers are current cultivate.

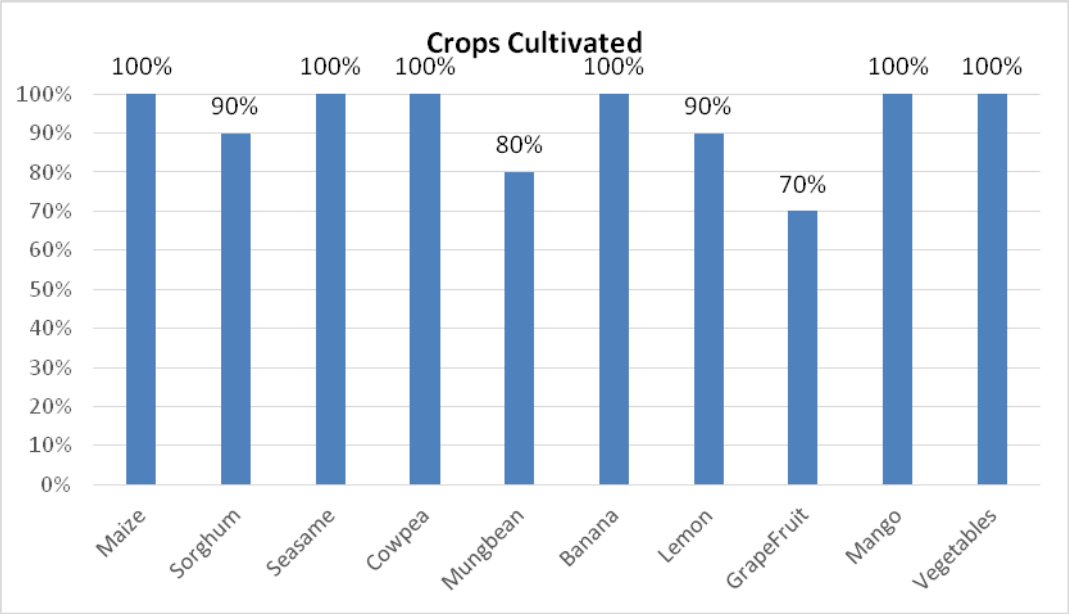

Figure 15: What type of crops do the farmers in Lower Shebelle currently cultivate?

Source: (primary source 2019)

Figure 15 above about the institutions shows that all the farmers cultivate maize, cowpea, sesame cowpea, and horticultural crops; while sorghum, Mungbean and grapefruit are the lowest.

If I compare the answer gave the farmers and institutions are different; in terms of answer for the institutions are answer the big farms in the region owned by the commercials those are dealing with commercial crops and have good irrigation on their farms mainly from Afgoi district as they cannot reach the other districts or villages in the region due to security reasons; while the interview farmers from different places in the region, some of them have not irrigation in their farms instead they deal with cereal crops and some cash crops.

3. Any drought resistant crops do the farmers use?

Forty percent of respondents mentioned that the famers in Lower Shebelle apply drought resistant crops from local varieties; seeds came from Turkey and the Middle East; while 60 percent had mentioned that farmers do not use any drought resistance seeds.

4. What source/type of irrigation is used on the farms in the region?

All the respondents use Shebelle river irrigation.

5. How would you describe the agricultural production in Lower Shebelle region?

Table 8: Agric-production in Lower Shebelle

Institution	% respondents
Higher	10%
Normal	10%
Low	70%
Very Low	10%
Total	100%

Source: (primary source 2019)

Most of the respondents which are 80% on the above table nine replied that agricultural production in Lower Shebelle region was low.

6. How do farmers deal with drought?

The stakeholders replied to this question that farmers in Lower Shebelle deal with drought in terms of weeding, earth uproots, cover crops, uprooting, mixed cropping system, intercropping and early cropping techniques.

7. What can you tell about the rainfall over the past 5 years in Lower Shebelle?

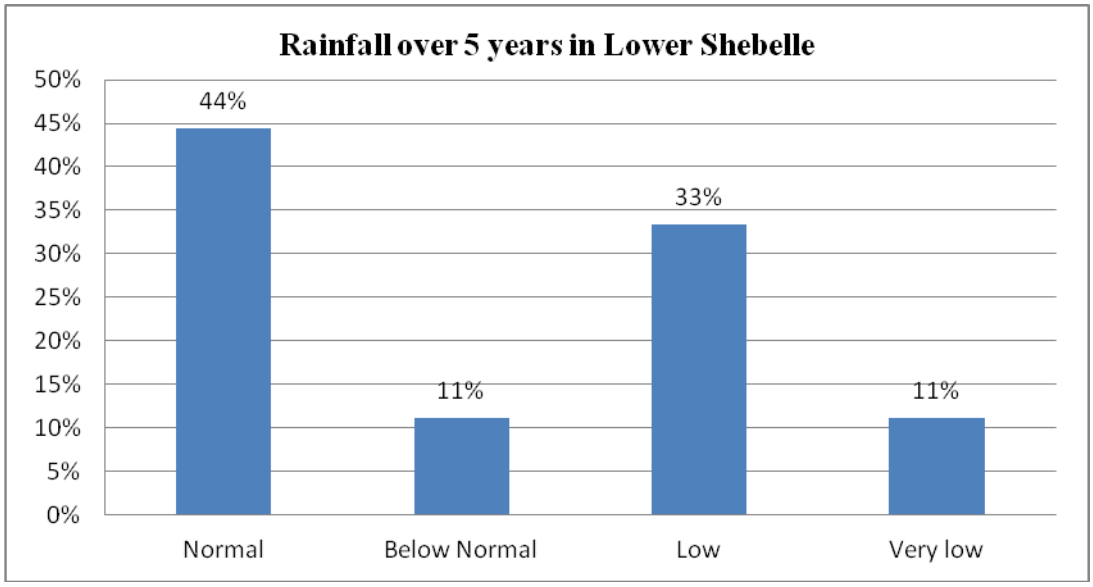

Figure 16: rainfall over the past 5 years from respondents,

Source: (primary source 2019)

Mostly respondents agreed that rainfall in Lower Shebelle was normal, while some others indicated low.

8. Droughts affected?

Respondents of this question mentioned that drought affected seriously in Lower Shebelle region in terms of crop failure that caused that farmers to abandon their farms and join IDPs camps in the cities.

9. What major drought-related problems have been experienced in the lower Shebelle in the past 5 years?

The respondents showed in their answers that low agricultural production, money loss, crop inflation, lack of production, river dried up, soil erosion mainly wind erosion, migration and resources related conflicts among farmers and livestock owners.

10. What role do you play in addressing impacts of drought in the region?

The question concerns the roles that institutions are addressing to the impacts of drought in the region. Most of the respondents' highlighted that the farmers need to get training for climate smart agriculture, distribution drought tolerance crops, changing crop cultivation patterns, improving local varieties though plant breeding technique as well as indicated that the farmers need early warning for drought preparation in term of raising awareness and advocacy, and proper water managements and installation for drip irrigation.

11. What, if anything, has helped farmers to deal with drought?

The respondents answered the above question providing farmers in awareness for capacity building for the farmers and adaptation strategies and they helped farmers to adapt with drought and doing resilience adaptation on current drought problems.

12. Are things better or worse than before regarding drought?

This figure 17 below about institutional perception indicates whether the situation in the region is getting better or worse.

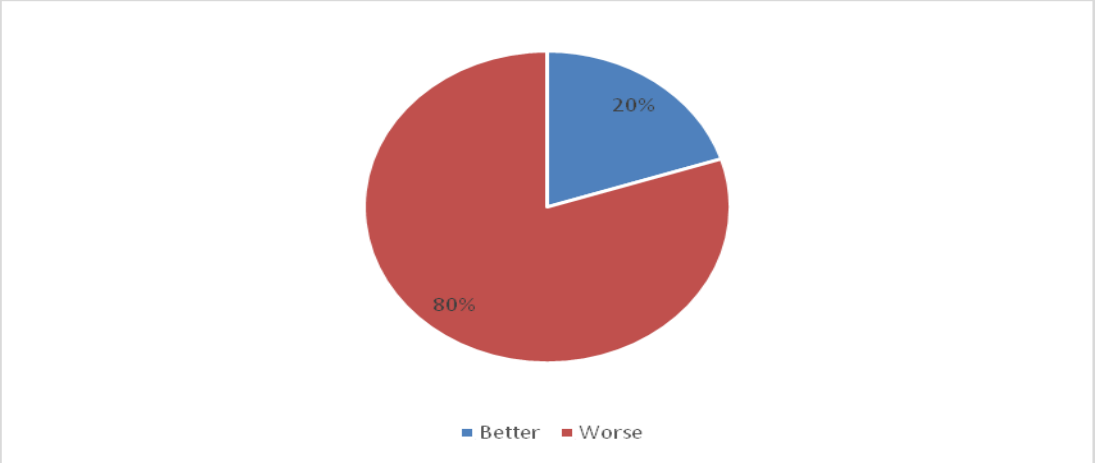

Figure 17: Better or Worse

Source: (primary source 2019)

The above pie chart shows that 80% of respondents mentioned the situation is worse than before.

13. Who do you work with the most to deal with drought?

Table 9: Drought collaboration

Institutions	**Drought Collaboration**
NGO	NGOs, IGOs, Farmers, Ministry of agriculture and irrigation
Graduate student	Farmers, Cooperatives, NGOs
University Student	NGOs, Farmers & Cooperatives
Extension officer	NGOs, Ministry of agriculture and Irrigation
NGO	Ministry of Agriculture and Irrigation, Farmers
NGO	Farmers, Cooperatives
NGO	Farmers, Cooperatives
Local scholar	FAO
Local scholar	NGOs
NGO	Ministry of Agriculture and Irrigation, Farmers

Source: (primary source 2019).

The table above shows who institutions and other actors have collaboration during drought period in Lower Shebelle regions because the region is very crucial for agricultural production in the whole of the country and it is closer to the capital city of the country where much population is habited.

14. How do you work with them?

Table 10: Collaboration strategies

Institutions	**Collaboration strategies**
NGO	Info sharing, expertise, support
NGO	Info sharing, support
NGO	Early warning information
NGO	Early warning information sharing & support
NGO	Support
Graduate student	Info sharing
University Student	Info sharing and expertise
Extension officer	Info sharing, expertise
Local scholar	Info sharing
Local scholar	Info Sharing, expertise

Source: (primary source 2019).

The above table shows how the institutions contribute their knowledge to the Lower Shebelle farmers; it expresses what kind of collaboration they have with the farmers.

15. What information, if any, is the most useful in dealing with drought?

Table 11: Drought dealing

Institutions	**Info dealing with drought**
NGO	Water wells, conservation technologies
NGO	-
NGO	Sharing information
NGO	Sharing information

NGO	Early planting crops & proper irrigation
Graduate student	-
University Student	Sharing information
Extension officer	Sharing information
Local scholar	Drought prevention, early warning systems and copy mechanism
Local scholar	-

Source: (primary source 2019).

The above table indicates information that the institutions deal with farmers during drought period.

16. Are you able to access that information?

In this question above all the respondents replied that they access information except one respondent showed that he/she does not access information and that respondent is graduate student.

17. What do you think can solve the challenges presented by drought?

The above question was asked to the institutions their idea about how drought can be solved, and this paragraph below collected their suggestions:

Most of the institutions replied; training for the farmers, early seed sowing, availability of drought resistance seeds, improved agric-technology, improving for local varieties, climate adaptation strategies, early warning for drought, support farmers before they displace, drilling wells, improved water management and repairing water canals in the region, improving proper irrigation and preventing water runoff improving water infiltration in the soil.

CHAPTER FIVE -

CONCLUSION AND RECOMMENDATIONS

This chapter will focus on the conclusion and recommendations of the study. First, it will be addressed the objective in the study stated. Second, the conclusion and the lastly, the researcher will come with recommendation and further study.

To explore farmers' perceptions on how the accelerated climate change is affecting agricultural production on Lower Shebelle

The first objective of the study was to determine farmer's perception on how the accelerated climate change is affecting agricultural production on Lower Shebelle. The study reveals that the most of respondents replied that agricultural production in Lower Shebelle is low.

To identify farmers' and local actors' approaches to building drought resilience in the face of seasonal climatic variations

The second objective of the study was to identify farmers' and local actors' approaches to building drought resilience in the face of seasonal climatic variations. The study shows the suggestions given for the respondents in their solution proposal is to get early warning before the drought starts, proper water harvesting technique, building water catchments and repairing water canals in the region, drilling wells in the farms, water harvesting technique, proper irrigation and also suggested in terms of farming; training for farmers; early planting for seeds, cultivating drought resistance varieties, improving local varieties, to stop deforestations and strong government that can keep the security of the region.

To examine factors influencing farmers' capacity to develop and maintain drought resilience to mitigate climatic risks

The third objective of the study was to examine factors influencing farmers' capacity to develop and maintain drought resilience to mitigate climatic risks. The data analysis provided

for the farmers, local actors and institutions reveals that awareness raising; the government, international organizations like FAO and the local people have to help the capacity of the farmers and the necessary infrastructure in the region like building canals. Introduction of climate change related agricultural practices and creation of income generation sources for drought affected farmers and families in the region and to encourage for going back their farming before the abandon on the farms and join to the refugee camps as internally displaced people (IDPs).

Conclusions

The findings of the study show that most of the respondents revealed that there is a drought problem in the region which affected the whole of the region in terms of crop failure that resulted in farmers leaving their farms and joining IDPs in the cities.

Some of them highlighted that there is prolonged dryness due to the rain shortage that exacerbated the situation of the crop growth and its productivity.

Some of them enlightened that precipitation rain in the region was below normal. The expected rain was not achieved to receive over the past 5 years in lower Shebelle and this exacerbated the crop production into lowering and sometimes lack of rain causes dryness for the river and creates conflict between farmers and livestock owners.

In addition to this, since the questions asked to the farmers and institutions were quite similar, it seems that they are providing different answers that indicate stakeholders of this study are not aware at each other but this study did not cover the whole region as many districts/villages controlled by Al-Shabab terrorists linked to Al-Qaida where the interviewers cannot reach it.

One local scholar suggested income generation needed for the families affected by the drought and other local scholar suggested that well structured governments in peace condition in the region.

Recommendations

I recommend that NGOs, IGOs, local scholars, local actor's ministry of agriculture and irrigation should not stop working and offering training to the farmers of the region. Before they provide training and the programs need to be organized.

Non-governmental organization (NGOs) and Intergovernmental organization (IGOs)

I. Help farmers to build their capacity by giving trainings and education for drought resilience which will enable them to carry out their work successfully.
II. Provide support to farmers in their locations before they leave their farms.
III. Provide appropriate crops which fits in the drought environment.
IV. Drill water wells, application of soil and moisture conservation technologies and repairing irrigation canals in the region.
V. To improve technologies innovative technology in crop cultivation.
VI. Capacity building for farmers, extension officer and local scholars.

Trained farmers, cooperatives and local scholars

I. Should encourage, collaborate and create local awareness with farmers so as to provide early warning and to carry out their work in effective drought resilience manner.
II. Extend their skills and education trained to other local farmers who did not get chance for the training.
III. Should collaborate with each other and work with skilled stakeholders.
IV. Provide modern post harvest technology and proper food storage to the farmers.

The Government and ministry of agriculture and irrigation

I. To bring peace and stability in Lower Shebelle region.

II. Allocate a budget to construct irrigation canals for water development to capture water running to the Indian oceans and minimize floods in the region.

III. Build Meteorology data collector in the region.

IV. Encourage farmers and subsidize agricultural inputs.

V. Provide stable financial and rigid agricultural policy and to find investment from abroad or local business organizations to the farming projects.

VI. To find international markets where agricultural products can be sold in the future.

VII. Build institution research centers

VIII. Since the country has no ministry of environment, forestry and climate change, the government must build this institution and work with the ministry of agriculture and irrigation.

IX. Introduce an integrated drought resilience system as a solution to combat drought, accelerated climate change in the region.

X. To stop deforestation and encourage a forestation program.

XI. Strengthen collaboration among stakeholders and the government for effective monitoring of drought in the region.

Trade Unions and Religious Groups Should

These two institutions are not involved in the study but can take part building drought resilience in agriculture in the region in response of the accelerated climate change and their role can be:

I. Invest farmers and to encourage the farmers to remain the farms before they convert into IDPs
II. Give subsidy to farmers when they face financial difficulties.
III. Since the country is Muslim, religious groups should advocate for the farmers and the government the importance of farming in the region.

Suggestions for further Studies

I. Assessing challenges facing rain fed agriculture areas in Lower Shebelle region**.**
II. The sample of this study is very small, it would be better to be broader and to evaluate the difference between drought resistance cultivars and non-drought resistance cultivars grown in the whole of Lower Shebelle region.

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APPENDIX ONE: QUESTIONNAIRES

Introduction

Dear Respondent

My name is Abdulkadir Kasim Farah. I am a Central European University (CEU) student researching "**Building Drought Resilience in Lower Shebelle Agriculture: Somalia in response to accelerated Climate Change"**. You have been chosen to participate in this study and your contribution is very important. Please be assured that the data you provide will be used for academic purposes and your name is not provided in this thesis.

Please also keep in mind that your response is very important and can help in the future to build drought resilience for agriculture in response to the impacts of climate change in the region. The answers that you provide will be kept strictly confidentially. You will be notified about the result of the study if you wish so. Answering and the filling out of the questionnaire might take up to 15-20 minutes. If you have any questions related to the survey or a question not clear to you please feel free to contact me on this email: farah_abdulkadir@student.ceu.edu.

SECTION A: Questionnaires for farmers and local actors in lower Shebelle region: Somalia

1. Farm location……
2. What type of crops do you currently cultivate?

   ……

   ……

   ……

   ……

   a. Any drought resistant crops? If so, please specify where the seeds come from?

      ……

      ……

      ……

      ……

3. Do you use irrigation? Yes ☐ No ☐

   a. If yes, what source/type of irrigation do you use on your farm?

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   b. How would you describe the agricultural production on your farm?

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4. What can you tell about the rainfall over the past 5 years in lower Shebelle?

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5. What major drought-related problems have you experienced in the lower Shebelle in the past 5 years? Please describe them.

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6. Have droughts affected:

   a. Your farm? If so, how?

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……..

   b. The region? If so, how?

……

……

c. Agricultural production? If so how?

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…….

7. How do you deal with droughts on your farm? What do you do? (e.g., mitigation, prevention, etc.)

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…….

8. Are things better or worse than before?

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9. Who do you work with the most to deal with drought? Please tick (✔) the applicable answer and specify the name of others

NGOs	Ministry of Agriculture and Irrigation	IGOs	Farmers	Cooperatives	Others, specify

10. How do you work with them? Please tick (✔) the applicable answer and specify the name of others

Information-Sharing	Expertise	Support	Grand	Other,

				specify

a. What kind of assistance do they provide? Is it helpful or not? If so, how?

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b. Has there been more or less assistance over time?

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11. What information, if any, is the most useful in dealing with drought?

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……..

12. Are you able to access that information? Yes ☐ No ☐

If not, what is needed?

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13. What do you think can solve the challenges presented by drought?

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Introduction

Institutional Questionnaires

Dear Respondent

My name is Abdulkadir Kasim Farah. I am a Central European University (CEU) student researching "**Building Drought Resilience in Lower Shebelle Agriculture: Somalia in response to accelerated Climate Change"**. You have been chosen to participate in this study because you have experience and knowledge in this field that are very important in this study and will help to tackle serious problems in the region. Please be assured that the data you provide will be used for academic purposes and your name is not provided in this thesis.

Please also keep in mind that your response is very important and can help in the future to be built drought resilience for agriculture in response to the impacts of climate change in the region. The answers that you provide will be kept strictly confidentially. You will be notified about the result of the study if you wish so. Answering of the questionnaire might take up to 15-20 minutes. If you have any questions related to the survey or a question not clear to you please feel free to contact me on this email: farah_abdulkadir@student.ceu.edu.

1. **Occupation**

Extension Officer	NGO worker	Graduate student	University student	Local scholar	Other, specify

Section C: Building drought resilience and mitigating climate risk

2. What type of crops do the farmers in Lower Shebelle currently cultivate?

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3. Any drought resistant crops do the farmers use? If so, please specify where the seeds come from?

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4. What source/type of irrigation is used on the farms in the region?

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5. How would you describe the agricultural production in Lower Shebelle region?

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6. How do farmers deal with drought?

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7. What can you tell me about the rainfall over the past 5 years in Lower Shebelle?

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8. Have droughts affected?

   a. Specific farms, in particular? If so how?

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b. The region? If so, how?

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c. Agricultural production? If so how?

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9. What major drought-related problems have been experienced in the lower Shebelle in the past 5 years? Please describe them.

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10. What role do you play in addressing impacts of drought in the region?

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11. What, if anything, has helped farmers to deal with drought (e.g., awareness raising, support, etc)

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……..

12. Are things better or worse than before regarding drought?

……

13. Who do you work with the most to deal with drought? Please tick (✔) the applicable answer and specify the name of others

NGOs	Ministry of Agriculture and Irrigation	IGOs	Farmers	Cooperatives	Others, specify

14. How do you work with them? Please tick (✔) the applicable answer and specify the name of others

Information-Sharing	Expertise	Support	Grand	Other, specify

15. What information, if any, is the most useful in dealing with drought?

……

……

16. Are you able to access that information? Yes ☐ No ☐

If not, what is needed?

……

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……

17. What do you think can solve the challenges presented by drought?

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Thank you for answering this questionnaire

APPENDIX TWO: MONTHLY RAINFALL IN LOWER SHEBELLE FROM 2014/2018 IN (MM)

Year	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mach
2014	11.0	49.2	6.9	37.6	0.0	20.8	93.3	132.5	0.0	0.0	0.0	0.0
2015	97.3	20.1	0.0	13.0	21.2	6.4	97.5	80.8	0.0	0.0	0.0	0.0
2016	29.5	56.9	87.6	0.0	28.5	0.0	0.0	82.8	19.0	0.0	0.0	0.0
2017	44.6	19.5	0.0	11.5	12.5	18	37.5	88.3	0.0	0.0	0.0	0.0
2018	197.6	115.5	77.5	0.0	7.2	0.0	19.7	0.0	0.0	0.0	0.0	0.0

Source: (SATG ABIC CENTER AFGOI, 2019)

APPENDIX THREE: PERSONAL BIOGRAPHY

Abdulkadir Kasim Farah is the 3rd of 12 children born to Kasim Farah Dhiblawe and the oldest son of Fadumo Hussein Isak. He was born on 25th of November 1983 in Baidoa southwest Somalia, 223 Km from Mogadishu the capital city of the country. After the broke out of the Somali civil war in 1991, his family fled from Baidoa to Mogadishu, where he spent much of his life.

At the beginning of his early age in Mogadishu. He enrolled in **Towfiq Primary** school in 1993- 2000, where he completed his primary and intermediate school.

Between 2000-2003, he graduated **Al-mathal Secondary School** in Mogadishu and thereafter was recruited as a chemistry teacher in 2006 till 2009.

In September 2009, he joined **AMOUD UNIVERSITY** faculty of agriculture and Environmental Sciences and completed in 2013, his research was on "**Weed Management and the Success of Crop Productivity in Soybean System in Borama district Somaliland"**.

In 2013, he worked with rural community Concern (**RCC**) in partnership with Germany Agro-action (**GAA**) as an intern student for Soil and Water Conservation in north Somalia (Somaliland), later he joined as independent consultant with Development Alternatives Incorporated (**DAI**) in partnership with **USAID** to introduce new varieties of vegetables and cereal crops in Awdal region Somalia.

Between 2013 to 2014, he worked as a Senior Monitoring, Evaluation and Training Officer for Somali Agriculture Technical group (**SATG**) in partnership with **USAID** in Lower Shebelle (Afgoi, Awdhegle stations) and Mogadishu office.

In September 2016, he joined **ZENT ISTVÁN UNIVERSITY** in Hungary and completed in 2018 obtained M.Sc. in Agricultural Engineering, his research was "**Increasing Nutrient Supply of Soil with Organic and Inorganic Fertilizers on maize".**

He studied advanced English from Central European University (**CEU**) in Budapest and obtained advanced English certificate in 2016-2017. He also obtained Hungarian as foreigner language certificate from Than Károly School in Budapest-Hungary 2016-2017.

He is linguistically oriented and does speak several languages including; Somali (Native), English (Advanced), Arabic (Intermediate), Hungarian (Intermediate) and Finish (Primary).