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Review on the Cause and Effects of Recurrent Drought on Ethiopian Agriculture Productivity

Sena Amsalu

Department of Agricultural economics, Raya University, Ethiopia
senaamsalu9@gmail.com

Abstract**—** *Drought occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another. Ethiopia characteristically sees three seasons of varying amounts of rainfall. The central western regions getting a sufficient amount of rain during the rainy season, but the rest of the country, especially towards the horn being very dry for most time of the year. This also leads that some parts of regions of Ethiopia severely affected by recurrent drought. Recurrent drought caused by deforestation, high population growth, land degradation and soil erosion which intern affect agriculture include crop losses, lower yields in both crop and livestock production, increased livestock deaths and generally it may bring economic, environmental, and social impacts. Different efforts are made by policy maker and government to reduce or mitigate the impact of drought but still the impact is there thus this review show the gap.*

Keywords**— drought; deforestation; land degradation; yield; impact; productivity.**

I. INTRODUCTION

1.1 Background of the study

Now a day, most African countries are dealing with a number of socio-economic and environmental challenges including poverty, resource degradation, rapid population growth, and low agricultural productivity. Particularly, deal with continent which is regularly affected by severe and often multiyear of drought. However, all areas within Africa are not equally vulnerable to drought. The sub-Saharan part of the region is considered to be the most drought-prone. This region is relatively drier, receiving much lower rainfall compared with the rest of the region (Sara, 2009).

Ethiopia is one of the sub-Sahara African countries highly prone to hazards. The main environmental hazard in the country include land degradation, soil erosion, deforestation, loss of biodiversity, desertification, recurrent drought, flood and water and air pollution. Since large part of the country is dry, sub-humid, semi-arid, and arid, they are prone to desertification, drought, famine, flood, malaria, land degradation, livestock disease, insect pests, earthquakes. Especially, recurrent drought, famine and, flood are the main problems that affect millions of people in the country almost every year (NAPA, 2007).Recently drought has remained the leading cause of disaster and human suffering in Ethiopia. The magnitude, frequency and the effects of the droughts have increased since mid-70s. The severity and persistence of the latest droughts has produced a wide range of impacts across the country.

Though agriculture was taken as a core sector to solve the current challenges and to bring future sustainability to the continent, the sector is recently challenged by climatic shocks such as prolonged drought, late coming and early stop of rainfall before and after crop maturity. Agricultural production has been severely affected and there has been a significant reduction in livestock populations that are the mainstay of subsistence. Large population movements due to drought have aggravated and compounded these miseries for communities, often with disproportionate impacts across the country (McCarthy, 2001; Collier et al., 2008; Ngaira, 2007; Adger et al., 2003).

1.2 Objectives

- ✓ To review the main causes for drought and its feature on agriculture productivity
- ✓ To show the impact of recurrent drought on agriculture productivity in Ethiopia

II. LITERATURE REVIEW

2.1 Concept and Definitions of Drought

Drought occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another and its definition varies from region to region and may depend upon the dominating perception, and the task for

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which it is defined. It originates from a deficiency of precipitation over an extended period of time, usually a season or more. It should generally be defined relative to some long-term average condition in a particular area, a condition often perceived as "normal". It is also related to the timing (i.e., principal season of occurrence, delays in the start of the rainy season, occurrence of rains in relation to principal crop growth stages) and the effectiveness (i.e., rainfall intensity, number of rainfall events) of the rains. Other climatic factors such as high temperature, high wind, and low relative humidity are often associated with it in many regions of the world and can significantly aggravate its severity (Sara 2010).

Drought is a temporary deviation; it differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate (Sara, 2009). Based on a disciplinary perspective, can be found in, where droughts are related to precipitation (meteorological), stream flow (hydrological), soil moisture (agricultural) or any combination of the three (Dracup*et al*., 1980).

Metrological drought

According to Dracup*et al.* (1980), Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period. It is based on solely on departures of rainfall from expected amounts. So, the definition of meteorological drought must be considered as region specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region.

Agricultural drought

Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapo-transpiration, soil water deficits, and so forth. It happens after meteorological drought but before hydrological drought. A good definition of agricultural drought should be able to account for the variable susceptibility of crops during different stages of crop development, from emergence to maturity. Deficient to topsoil moisture at planting may hinder germination, leading to low plant populations per hectares and reduction of final yields. However, if topsoil moisture is sufficient at this early stage, it may not affect final yield (Verdin J., 2007 & Sara, 2009).

Hydrological drought

Hydrological drought is associated with the effects of periods of precipitation on surface or subsurface water supply (i.e., stream flow, reservoir and lake levels, and ground water). The frequency and severity of hydrological drought is often defined on a watershed or river basin scale (wilhite and Glantz 1985).

2.2 Ethiopia's Climate Characteristics and Economy

Geographically, Ethiopia can be subdivided into five agro ecological zones, based on moisture and land use: 1) drought-prone highlands with insufficient rainfall; 2) rainfall-sufficient highlands dominated by enset-based farming; 3) rainfall-sufficient highland areas mainly planted with cereal-based crops; 4) generally dry, pastoral lowland areas (bordering on Eritrea); and 5) humid lowland areas further inland that primarily support crop farming. We expect that climate change will lead to adaptive shifts in cultivation patterns in all five regions (World Bank, 2008).

A combination of varied rainfall and temperature patterns are mostly responsible for Ethiopia's classification in Africa's tropical zone and the country's assorted topography. A year in Ethiopia characteristically sees three seasons of varying amounts of rainfall. These seasons include: "kremt"(Summer), the main rainy season running from June- September; "bega"(Winter), the dry season running from October-January; and "belg"(Autumn), the small rains season running from February-May. The average rainfall ranges from about 2000 millimeters in the Southwest regions to about 100 millimeters in the Northeastern Lowlands. The average mean of rainfall is 113 millimeters from 1951-1995(Morgan 2012).

According to Adenew (2006), Over 80 percent of the population of the country derives its livelihood from agriculture. Of the 4.3 million hectares of potentially irrigable agricultural land, less than 10 percent is currently farmed. Smallholder farmers dominate the sector, generating about 90 percent of agricultural output.

According to Alemu*et al*., (2011), Agriculture in Ethiopia, is heavily dependent on rain. Its geographical location and topography, plus a low adaptive capacity, make the country highly vulnerable to the adverse impacts of climate change. Poverty in Ethiopia is a chronic problem and about two-thirds of its 72 million people live on less than $2 a day (World Bank 2008). It is one of the most food-insecure countries in the world, a situation compounded by droughts and famine that cycle in and out.

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About half of all rural households in the country experienced at least one major drought from 1999 to 2004. With agriculture highly dependent on rainfall variability and amount, weather in general rules the lives and well-being of many rural Ethiopians. The weather determines whether they will have enough to eat, be able to provide basic necessities, and be able to earn a living. Indeed, farmers' dependence on rainfall and its erratic patterns have largely contributed to the food shortages and crises with which they constantly battle (Dercon 2009).

2.3 The Cause and Effects of Recurrent Drought

According to Tagel*et al.* (2013),the high dependency of the peasant farmers on rainfall associated with the shortfall and erratic nature of the rainfall during the last three decades have resulted in widespread drought and famine. Moreover, the rising population pressure and clearing of forests to satisfy its basic demands such as food and energy made the soil susceptible to wind and water erosion which in turn bring drought.

Ethiopia has a long history of drought, which greatly contributed to land degradation. In addition to this, the combined effects of deforestation, overgrazing, expansion of cropland and unsustainable use of natural resources has contributed to land degradation (Deschee*et al*, 2011).

There is growing concern that much of Sub-Saharan Africa's natural resource base and ecological environment are deteriorating mainly due to high loss of vegetative cover resulting from deforestation and conversion of savanna to cropland (UNECA, 1993). Among the contributory factors in the deterioration of the environmental conditions in the African continent, Drought is one of the utmost important disasters associated with climate variability, which cause instability in food production.

Some of the reasons for the fragility of Ethiopian agriculture were climate change and her dependence on rain-fed agriculture. In the country there are two distinct growing seasons, and in recent years, due to climate change, that has changed. Right now, the short rains have become delayed and shorter, and the long rains equally have become unpredictable (Catholic Relief Services report 2011).

According to Tsegaye (2012), recurrent drought shocks, causing severe harvest failure and loss of livestock, have adverse impacts on immediate consumption as well as long-lasting effects (poverty persistence) on household livelihoods. The drought years were associated with a very low food grain production. Crop failure due to the severe drought the warming temperatures and rainfall changes could diminish the availability of water for crops and shorten the growing season. The warming of a few degrees, decrease in rainfall and increase in frequency of extreme weathers, drought, will have an immediate and direct effect on the agricultural sector.

By the year 2011, Global Facility for Disaster Reduction and Recovery reported that, drought impacts include pasture shortages, overgrazing, land degradation, decreased water availability, and livestock diseases. All of these impacts lead to decreased livestock productivity, crop failure in agro-pastoral areas, food insecurity, and increased conflicts over scarce resources. Droughts not only bring loss of life, famine, and hardship to today's inhabitants (during the 2006 droughts, 25-60% of livestock were killed in some areas), but they also threaten the country's future, as children aged five or less are 36 and 50% (respectively) more likely to be malnourished if they were born during a drought.

Drought has caused famine in parts of Somalia and killed tens of thousands of people in recent months. And also bring an impacts on agriculture include crop losses, lower yields in both crop and livestock production, increased livestock deaths, increases in insect infestation and plant and animal diseases, damage to fish habitat, forest and range fires, land degradation and soil erosion. Its impacts on human health include increased risk of food and water shortages, increased risk of malnutrition and higher risk of water- and food-borne diseases (Emergency Ministerial – Level Meeting 2011).

According to National Drought Mitigation Center (2015), drought affects all parts of our environment and our communities and they grouped the impact as "economic," "environmental," and "social" impacts. All of these impacts must be considered in planning for and responding to drought conditions.

Economic Impacts

Economic impacts are those impacts of drought that cost people or money. Some examples of economic impacts include, farmers may lose money if a drought destroys their crops, if a farmer's water supply is too low the farmer may have to spend more money on irrigation or to drill new wells, ranchers may have to spend more money on feed and water for their animals, businesses that depend on farming, like companies that make tractors and food may lose business when drought damages crops or livestock, people who work in the timber industry may be affected when wildfires destroy stands of timber, power companies that normally rely on hydroelectric power (electricity that's

created from the energy of running water) may have to spend more money on other fuel sources, and if drought dries up too much of the water supply The power companies' customers would also have to pay more (NDMC 2015).

Environmental Impacts

Drought also affects the environment in many different ways. Plants and animals depend on water, just like people. When a drought occurs, their food supply can shrink and their habitat can be damaged. Sometimes the damage is only temporary and their habitat and food supply return to normal when the drought is over. But sometimes drought's impact on the environment can last a long time, maybe forever. Examples of environmental impacts include: Losses or destruction of fish and wildlife habitat, lack of food and drinking water for wild animals, increase in disease in wild animals, because of reduced food and water supplies, migration of wildlife, increased stress on endangered species or even extinction, lower water levels in reservoirs, lakes, and ponds, loss of wetlands, more wildfires, wind and water erosion of soils as well as poor soil quality (NDMC 2015).

Social Impacts

Social impacts of drought are ways that drought affects people's health and safety. Social impacts include public safety, health, conflicts between people when there isn't enough water to go around, and changes in lifestyle. Examples of social impacts include: Anxiety or depression about economic losses caused by drought, health problems related to low water flows and poor water quality, health problems related to dust, loss of human life, threat to public safety from an increased number of forest and range fires, reduced incomes, people may have to move from farms into cities, or from one city to another, and also fewer recreational activities become common (ibid)

2.4. Effort to Overcome Drought in Ethiopia

Ethiopia is experiencing the effects of climate change. Besides the direct effects such as an increase in average temperature or a change in rainfall patterns, climate change also presents the necessity and opportunity to switch to a new, sustainable development model. Therefore the Government of Ethiopia initiated the Climate-Resilient Green Economy (CRGE) to protect the country from the adverse effects of climate change and to build a green economy that will help realize its ambition of reaching middle-income status before 2025(Green economy strategy 2011).

The country Development Cooperation Strategy between the year 2011 – 2015 states that, response to the drought has been good, with the government of Ethiopia. As a result of the drought in 2011, plans to build the DRM (Disaster Risk Management) work further, particularly in pastoralist areas, are being linked to the already strong support incorporated in the Feed the Future plan.

Integrated and sustainable development and utilization of water resources by creating interconnection among different sectors and users, ensuring fair and equitable utilization of the resources taking into consideration the demand and benefit of the future generation, contribute to fast and sustainable social and economic development of the nation through sound development strategies, mitigating the impacts of runoff, drought and other natural hazards stand amongst the priorities of Ethiopian water resources management policies(MoFED,2010).

UNICEF (2015), continue to support the Government of Ethiopia to build disaster risk management capacity in regions affected by food insecurity and has prepositioned emergency life-saving supplies in Addis Ababa as well as three regional hubs to address the humanitarian needs of 125,000 people in a timely manner. Some of these supplies are being used to initiate an immediate response in drought affected areas.

Report from agriculture and social protection in Ethiopia (2009), develop integrated drought risk management plan. The plan is to apply coordinated financial instruments tailored to different levels of risk that farmers face, thereby enabling the government and donor agencies to respond to livelihood stress and emergencies as effectively and efficiently as possible – that is, to save lives and livelihoods at the lowest cost possible (WFP, 2007).

According to Amdissa*et.al*, (2004) recently, the government has promoted "livelihoods packages" that aim to support secondary sources of income (such as beekeeping) by smallholder households, as a way of supplementing and diversifying household incomes against drought and other production shocks.

Study conducted by Thomas, (2015) found that climate variability with unexpected droughts and floods causes serious production losses and worsens food security, especially in Ethiopia. As a result he brought different adaptation option and promotes new maize and wheat varieties to be accompanied by policy interventions such as credit and fertilizer subsidy and the result shows that the

effectiveness of available adaptation options is quite different across the heterogeneous smallholder population in Ethiopia. As a result, he suggest that policy assessments based on average farm households may mislead policymakers to adhere to interventions which are beneficial on average albeit ineffective in addressing the particular needs of poor and food insecure farmers.

Ethiopia country programming framework (2010-2050), expressed four strategic objectives including achieving a sustainable increases agriculture productivity, and production, accelerating agriculture commercialization and agro-industrial development, reducing degradation and improving productivity of NR(natural resource),and achieving universal food security and protecting vulnerable HH from natural disasters(USAID 2011).

2.5 Empirical Evidence

A study conducted by Assefa, (2011) in East Gojjam of Ethiopia, found that there is an expansion of farmlands to the rangelands and cultivation of the steep and very steep slopes. This is because of large population pressure in the area characterized by low socio economic condition and have low adaptive capacity if climatic hazards occurred and also the result show that all patterns of climatic element trends are on the position of increasing or very increasing except the amount and duration of rainfall become on the trend of decreasing and very decreasing position. This demonstrated that there is a disturbance and a change in amount, duration, intensity, and variability of rainfall together with an increase pattern of drought. Moreover, increased drought and flood frequency, rainfall comes early or lately, dry up of water bodies, shortening of plants growing period become the common phenomena.

The study conducted by Amsalu *et.al,* (2017) found that economy-wide and regional effects of climate change induced productivity and labor supply shocks in agriculture in Ethiopia. The effects on national GDP may add up to -8% with uneven regional effects ranging from -10% in agrarian regions (e.g. Amhara) to +2.5% in urbanized regions (e.g. Addis Ababa). Nevertheless, given the role of agriculture in the current economic structure of the country and the potency of biophysical impacts of climate change, adaptation in the sector is indispensable. Otherwise, climate change may hamper economic progress of the country, and make rural livelihood unpredictable.

According to Kassa*et.al*, (2012) found that in the country land productivity declined in the last 20 years. The reduction was related to changes in rainfall. The rainfall was extremely unpredictable and erratic with a coefficient of variation ranging from 18 percent in the midlands to 42 percent in the lowlands. Livestock holding size and crop yield showed a positive correlation with rainfall amount. However, the number of pack animals significantly increased regardless of the decreased rainfall amount. This increase was due to farmers' shift to off-farm activities.

Climate change has turned to be a major economic threat in many developing countries. It severely affects poor households in a given country and low-income countries in general. Climate change induced productivity and labor supply in agriculture in Ethiopia and this brought falling in agricultural output but increasing prices for agricultural commodities. The net effect is declining real consumption by households. Therefore, climate change and its likely impacts shall be accounted along with proactive measures in national economic plans of the country (Amsalu, 2016)

Study conducted by Defferew, (2011) on the impact of drought on livelihoods, in North Shoa, Ethiopia, reveal that drought increases from time to time in the zone even if there is variation between and among years and it challenges the livelihood of the whole region. To cope up with the impacts, societies use savings, migration, credits, selling own assets (who own asset) and on-farm and off-farm diversification as strategy. The coping mechanisms provided by institutions is very weak and at its early stage in the zone. And the coping mechanisms available in the zone are not equally important and practiced and are insufficient to cope with drought impacts. Though all households in the zone are vulnerable to the disaster, the problem is more acute on the poor, women, large size family, and children, old and disabled. Vulnerability is further aggravated by the decline in the fertility of land, landlessness, unemployment, unavailability and inability of most farmers to afford agricultural inputs, fertilizer and selected variety of crop.

Study in Borana pastoralist area by Gezu, (2008) found that the drought in 2007/8 was said to have started with the comparative failure of the "belg" rains in March to May 2007. Between April 2007 and July 2008, the cattle populations were declined from 2880 to 1297, being a 45.03% reduction of which 44.06% was due to death reason. The drought-affected pastoralists have had to sell around 13% of their herd in order to buy feed and veterinary medicines for the remaining and day-to-day necessities for their family. Furthermore, calf mortality in this area was estimated to 69.2% (505/730) of the claves existed at onset of the drought. Milk yield – in the study herds, initially

59.9% (266/377) of the cows fed by CARE either returned to milk production, or began milk production following the birth of calves while in feeding centers, however, as death of calf always leads to a virtual cessation of milk, reportedly only 113 were producing milk at time of the study.

According to Sara, (2010) study in Tigray region of Ethiopia revealed that recurrent cycle of drought has an impact on crop production, women health and education. Furthermore, with a rapid population growth about 2.8% per annum prevailing in the region, this pressure on the limited natural resource for increased agricultural production has been mounting, causing encroachment in marginal areas. Rapid population growth, an increasing livestock population, overstocking and restlessness cutting down of trees have all exposed the environment to great risk during times of drought. It is observed that there are encouraging activities carried out by the government to address cause and impacts of drought. It is also founded that government intervention are effective solution in mitigating the root cause of drought in the study region.

III. CONCLUSION

Drought can define as the deficiency of precipitation over an extended period of time and it is related to precipitation (meteorological), stream flow (hydrological), soil moisture (agricultural) or any combination of the three. Ethiopia characteristically sees three rainy seasons with varying amounts of rainfall. Most of the region of Ethiopia severely affected by recurrent drought which is caused by different reasons including deforestation, high population growth, land degradation and soil erosion. These factors mostly aggravate the situation and this in return affect countries agriculture production and productivities in a bad way. Even though, the countries develop different mitigation and cop up strategies but still the effect is there especially some part of the region including Borena, Somalia. Thus there is a need to address the root causes and need to shift rain fed agriculture in to irrigated agriculture.

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