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Review Article

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Agricultural Impact of Climate Change and Its Adaptation Strategies by Small-Scale Irrigation in Ethiopia: A Review

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Abstract

In Ethiopia agriculture accounts for about 45% of its GDP, creates 85% of employment and 65% of the total exports. Since, the country is one of the most vulnerable countries to climate variability and change its product is decreased time to time due to climate related hazards, commonly drought and floods. Due to this, in the country millions of people have been left without sustenance every year. For this problem, supplementary irrigation has been practiced by small holder farmers of Ethiopia for centuries to solve their livelihood challenges. At this time the government of Ethiopia also, paid high attention to develop the irrigation sector to fully it's potential by assessing and supporting local farmers to improve irrigation practices as well as the promotion of modern small scale irrigation practices to cope with climate changes adaptation and strategies. However, the irrigation sector is not developed based on the potential of the country. Form 5.3 million hectares of irrigable potential land still, only 5 to 10% of this potential land is irrigated and produces less than 3% of the total food production of the country. This shows that the irrigation sub-sector is not contributing its share based on the resources potential of the country to adapt climate change in the country. As a recommendation, since, adoption of small scale irrigation is a viable strategy to increase the agricultural production in general and food production in particular in the country to meet the growing food demands, the irrigation sector of the country should be developed based on its potential. For this any stakeholders, governments, experts, scholars, politicians along with the farmers should be participate in any irrigation development projects.

Keywords

Adaptation, Ethiopia, Climate change, Irrigation, Small-scale and Strategies

Introduction

Climate change refers to a change in the state of the climate that can be identified by changes that persists for an extended period, usually decades or longer [1]. The United Nations Framework Convention on Climate Change have argued that climate change may have a permanent negative impact on the natural resource base upon which agriculture thrives especially considering, that it is happening at a time of growing demand for basic human requirements such as food, fire and fuel [2]. Agriculture on the other hand is highly dependent on the climate change and human dependence on agricultural livelihoods, particularly the poor is high [3].

Africa is characterized by highly poor societies and depends on rain fed agriculture. In Africa, rain fed agriculture forms the backbone of most of the continent's economies and providing about 60% of all employment [4]. However, this rain fed agriculture is affected by a wide variety of climate systems in Africa which ranging from humid equatorial, through seasonally-arid tropical, to sub-tropical Mediterranean-type climates [5].

The rural poor in Sub-Saharan Africa (SSA) earn their livelihoods mostly from climate-sensitive rain fed agriculture. Their production is typically limited to a 3-6 months rainy season and crops grown are mainly cereal crops meant to sustain their livelihoods [6]. In Ethiopia, which is Sub-Saharan African country agriculture accounts for about 45% of the country's GDP, creates 85% of employment and 65% of the total exports. However, in the country the sector has remained in its rudimentary stage because of environmental degradation, small and fragmented landholding, unchecked population

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growth (2.4% per annum), high rate of urbanization (5%), limited access to new agricultural technologies, traditional methods of cultivation, high dependence on natural factors and unsatisfactory institutional support services [7,8].

In addition to the above listed factors, Ethiopia has been identified as one of the most vulnerable countries to climate variability and change, and is frequently faced with climate related hazards, commonly drought and floods and its agricultural products decrease time to time [9]. Due to this, millions of people have been left without sustenance every year. So, for this problem to increase productivity and to diversify the livelihood scenarios as an option, small-scale irrigation (SSI) schemes have been introduced in Ethiopian [10].

Small-scale irrigation is a type of irrigation and defined as irrigation on small plots, in which farmers have the controlling, influence and must be involved in the design process and decisions about boundaries [11]. In Ethiopia modern Small Scale Irrigation (SSI) practice and management was started during 1970, by constricting dams, diversion of streams and rivers from resource fund of the ministry of agriculture (federal or regional government) in the response to overcome droughts, which caused a wide spread of crop failures and consequently hunger and starvation [12].

Irrigation practices reduce the risk of crop failure that resulting from drought by devised their own adaptation strategies like production of different crops twice or three times within a year and increasing income of rural farm households. At this time government paid high attention to develop the irrigation sector to fully it's potential by assessing and supporting local farmers to improve irrigation practices as well as the promotion of modern small scale irrigation practices to cope with climate changes adaptation strategies [13].

As reported by UNDP (2004), climate change adaptation is a process by which strategies are applied to moderate and manage the consequences of climate changes in order to be enhanced, developed and implemented different mechanism in the climate change conditions. Adaptation to climate change involves changes in agricultural management practices in response to changes in climate conditions and often involves a combination of various individual responses at the farm-level [14].

So, the general objective of this review paper is to receive some information about agricultural impact of climate change and its adaptation strategies by small-scale irrigation in Ethiopia from different literatures in order to provide useful information to decision makers for the planning and management of climate change in the country by irrigation agriculture.

Climate Change in Ethiopia

Climate can be defined as the "expected weather" and when changes in the expected weather occur due to high GHG emissions we call these climate changes [15]. Ethiopia's contribution to GHG emissions is very low on a global scale. The emissions of greenhouse gases are predominantly from high-income countries while the negative effects of climate change are predominantly in low income countries like that of Ethiopia [16]. As a result of GHG emissions from developed country, the UNDP climate change country profile shows Ethiopia's mean annual temperature has increased by 1.3°C between 1960 and 2006, an average rate of 0.28°C per decade. The increase in temperature in Ethiopia has been mostly rapid in July, August and September at a rate of 0.32°C per decade. Daily temperature observations show significantly increasing trends in the frequency of hot days, and much larger increasing trends in the frequency of hot nights. The average number of 'hot' days per year in Ethiopia has increased by 73 (an additional 20% of days) between 1960 and 2003 [17].

Trend analysis of the annual rainfall show that there was a declining trend in the Northern half of the country and southern Ethiopie while there is an increasing trend in the central part of the country [18]. However, the overall trend in the entire country is more or less constant.

The study of National Metrological Agency (NMA) in the same year for 40 stations showed that there have been very warm and very cold years. Associated with rainfall and temperature change and variability, there were a recurrent drought and flood events in the country. There was also an observation of water level rise and dry up of lakes in some parts of the country depending on the general trend of the temperature and rainfall pattern of the regions [16].

Climate Chnge Impact in Ethiopia

Climate change and variability are a great environmental challenge facing humanity today [19]. However, with a high existence they would be the principal source of fluctuation in global food production, particularly in the semi-arid tropical countries of the developing world [20]. Also, in Africa, the negative impact from the climate change has been striking the agriculture sector which is mean source of food production [21].

Climate change is expected to intensify existing problems and create new combinations of risks, particularly in Africa [22]. It exacerbates existing risks such as water stress, the spread of infectious diseases, and food in security [23]. The negative impact from the climate change has been striking the agriculture sector in Africa. Ethiopia has been identified as one of the most vulnerable countries to climate variability and change, and is frequently faced with climate related hazards, commonly drought and floods [9]. This affects Ethiopia economy including, the country's health, education and industry sectors and public spending on productive investments [18]. In the country both farmers and pastoralists are highly dependent on the climate for their livelihoods; this is reflected in the remarkable way that gross domestic product (GDP) fluctuations follow rainfall [24].

In recent years, environment has become a key issue in Ethiopia. However, now a time Ethiopia is one of the African countries whose economy is largely dependent on agriculture and its economy is subjected to a direct impact of climate change. Because, large portion of lands in Ethiopia

are arid or semi-arid and inhabited by poor and vulnerable communities wholly dependent on rainfall. In addition, poor land management coupled with increasing climate extremes is affecting the livelihoods of these communities [25].

Ethiopia is highly vulnerable to drought due to climate change. Drought is the single most important climate related natural hazard impacting the country from time to time. Drought occurs anywhere in the world but its damage is severe in Ethiopia. For example as indicated by Gashaw *et al*. (2014), at the national level, World Bank suggests that climate change may reduce Ethiopia's GDP by 2-6% by 2015, and by up to 10% by 2045 as compared to a baseline scenario [9]. So, for Ethiopia, whose livelihood occupation of the nation is mainly based on subsistence agriculture that highly depended on rainfall, making an adjustment to adapt the changing situation is crucial [21]. By these problems and by considering the current population growth rate and food insecurity in the country MoWR (2002) and MoFED (2010) [26,27] indicates that development of small scale irrigation for stimulating economic growth and rural development by increasing and stabilizing agricultural production and productivity of the country.

Climate Change Aaptation in Ethiopia

Ethiopia, which is tropical country, having agriculture based economy; is highly vulnerable to the impacts of climate change and variability [9]. Due to this the country has been highly affected by drought and climate-related hazards, and millions of people have been left without sustenance every year. For this, according to Temesgen *et al*. (2014), making an adjustment to adapt the changing situation is crucial [21]. As a result of this, as indicated by Gashaw *et al*. (2014), at the higher level, the governments has signed and ratified all the Rio Conventions, namely, the United Nations Framework Convention on Climate Change and its Protocol, the Bio-diversity Convention and the Conventions to Combat Desertification. Following these, the government has initiated the Climate-Resilient Green Economy both to adapt and mitigate climate changes [9].

Even though, the governments of Ethiopia has followed the above adaptation and mitigation strategy at the higher level, to increase productivity and to diversify the livelihood scenarios of individual farmers, small-scale irrigation (SSI) schemes have been introduced as an option [10]. According to Meja, *et al*. in Ethiopia, it is believed that irrigation can increase security of crop production and income earning [28]. In line with this, concurrently in many parts of the country; irrigation uplifted the food security of many smallholder farmers. On the other way, according to [29] Mosissa and Bezabih (2017), how much the country has 5.3 million hectares of irrigable potential land, still only, 5 to 10% of this potential land is irrigated. This produces less than 3% of the total food production of the country [30]. This shows , irrigation sub-sector is not contributing its share based on the resources potential of the country to adapt climate change in the country [29].

Small-Scale Irrigation in Ethiopia

Irrigation practice across the world is vital to successful green revolution all year round to achieving sustainable development goals in food security, socio-economic and rural development [31]. Because, irrigation plays an essential role in stabilizing crop production by either supplementing or replacing the need for natural precipitation and it makes agriculture more confidential, stabilizes crop production by protecting against drought [32].

In Ethiopia, it is believed that irrigation practices were long been in use during ancient times with unspecified beginning period [33]. Also, according to Bekele *et al*. (2012), in Ethiopia, traditional irrigation was practiced before centuries and in the highlands of Ethiopia [34]. Irrigation practices have been also in use since ancient times for producing subsistence food crops [14,35,36]. Different authors such as, Awlachew, *et al*. (2007), Makombe, *et al*. (2007), Hagos, *et al*. (2009), and Bacha *et al*. (2011) stressed that supplementary irrigation has been practiced by smallholder farmers of Ethiopia for centuries to solve their livelihood challenges [14,34,35,37,38]. This is an indicator that, the people of Ethiopia have a long history of climate change adaptation by irrigation agriculture. Modern Small Scale Irrigation (SSI) practice and management was started since 1970 by the ministry of agriculture in the response to overcome droughts, which caused wide spread crop failures and consequently hunger and starvation [12,37].

Depending on the area irrigated, scale of operation and type of control or management irrigation is categorized as small-scale, medium and large-scale. However, the criteria for this category may vary from country to country. For example, in India the irrigation scheme of 10000 ha is classified as small while in Ghana the largest irrigation scheme is 300 ha. In Ethiopian according to Ministry of Water Resources (MoWR) (2002) and Bekele and Ayana (2011), irrigation development, small scale irrigation serves a command area of less than 200 ha [26,39]. So, form this division point of view small scale irrigation is irrigation that usually practiced on small plots where small farmers have the majority controlling influence, using a level of technologies which they can operate and maintain effectively. They are farmer-managed and farmers involved in the design process in specification, with decisions about boundaries, the layout of the canals, and the position of outlets and bridges. In Ethiopia they cover 46% of proposed irrigation developments in the country [40].

Conclusion

Agriculture is highly dependent on the climate change and human dependence on agricultural livelihoods particularly the poor is high. This is, common in Africa where rain fed agriculture is affected by a wide variety of climate systems. Ethiopia, which is Sub-Saharan African country, has been identified as one of the most vulnerable countries to climate variability and change, commonly drought and floods and its agricultural products decrease time to time. As a result of this, in the country millions of people have been left without sustenance every year. So, for this problem to increase productivity and diversify the livelihood scenarios

as an option, small-scale irrigation (SSI) schemes have been introduced in Ethiopian since 1970.

Irrigation practices reduce the risk of crop failure by resulting from drought by devised their own adaptation strategies like production of different crops twice or three times within a year and increasing income of rural farm-households. At this time, the government of Ethiopia paid high attention to develop the irrigation sector to fully it's potential by assessing and supporting local farmers to improve irrigation practices as well as the promotion of modern small scale irrigation practices to cope with climate changes adaptation strategies.

Adaptation is a process by which strategies are applied to moderate and manage the consequences of climate change by enhanced, developed and implemented the best mechanism. Adaptation to climate change involves changes in agricultural management practices in response to changes in climate conditions and often involves a combination of various individual responses at the farm-level. For this, in Ethiopia small-scale irrigation (SSI) schemes have been introduced and in many parts of the country; it uplifted the food security of many smallholder farmers. However, how much the country has 5.3 million hectares of irrigable potential land and long history of climate change adaptation by irrigation agriculture still only, 5 to 10% of this potential land is irrigated and produces less than 3% of the total food production of the country. This shows that, irrigation sub-sector is not contributing its share based on the resources potential of the country to adapt climate change in the country. As a recommendation, since, adoption of small scale irrigation is a viable strategy to increase the agricultural production in general and food production in particular in the country to meet the growing food demands, the irrigation sector of the country should be developed based on its potential. For this any stakeholders, governments, experts, scholars, politicians along with the farmers should be participate in any irrigation development projects.

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