
Review Article

Review on Hydrological and Environmental Challenges for Irrigation Agriculture Development in Ethiopia

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Abstract: Ethiopia is frequently faced with climate-related hazards, commonly drought and floods and its agricultural products decrease time to time. As 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, the governments of Ethiopia has followed the development of small-scale irrigation (SSI) schemes for the adaptation and mitigation strategy to increase productivity and to diversify the livelihood scenarios as an option. But, how much the country has 5.3 million hectares of irrigable potential land and the governments of Ethiopia followed the development of small-scale irrigation, still only 5 to 10% of this potential land is irrigated and produces less than 3% of the total food production of the country. So, this review was conducted in order to find out the factors that affect irrigation agriculture development in Ethiopia from different literatures to provide useful information to decision makers for the planning, managing and developing of positional irrigable land of the country for the alleviation of recurrent drought in the country. Different literature indicates that minimum development and small production of irrigation occur in Ethiopia due to different challenges like, inadequate awareness of irrigation water management, inadequate knowledge on improved and diversified irrigation agronomic practices and factors like environmental, social, economic and political. So, in the country for minimization of these challenges and factors, and to increase irrigation development, irrigation project should be developed based on integrated and grass root approach.

Keywords: Irrigation, Development, Agriculture, Factors and Ethiopia

1. Introduction

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 [1]. 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 [2].

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 [3]. Due to this millions of people have been left without food every year.

So, for this problem, to increase productivity and diversify the livelihood scenarios as an option, 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 [4, 5].

Even though, the governments of Ethiopia has followed the development of small-scale irrigation (SSI) schemes for the adaptation and mitigation strategy to increase productivity and to diversify the livelihood scenarios as an option, [5] and [6] also, believed that irrigation can increase security of crop production and income earning in the of country. In line with this, concurrently in many parts of the country; it uplifted the food security of many smallholder farmers. But, On the other way, according to [7], how much the country has 5.3 million

hectares of irrigable potential land and the governments of Ethiopia followed the development of small-scale irrigation, 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 [7].

Hence, for a long time in Ethiopia there has been a general misunderstanding about its irrigation potential and irrigation agriculture development. In the country factors that affect the development of irrigation agriculture are poorly assessed, hardly managed, under estimated and under controlled. So, the general objective of this review paper is to receive some information about factors that affect irrigation agriculture development in Ethiopia from different literatures to provide useful information to decision makers for the planning, managing and developing of positional irrigable land of the country for the alleviation of recurrent drought in the country.

2. Irrigation and Water Resource in Ethiopia

Although it needs further detailed investigation, according to [8], Ethiopia has about 124.4 billion cubic meter (BCM) river water, 70 BCM lake water, and 30 BCM groundwater resources. It has a potential to develop 3.8 million ha of irrigation and 45,000MW hydropower production. Irrigation development plays an essential role in stabilizing crop production by either supplementing or replacing the need for natural precipitation and makes agriculture more confidential [2].

2.1. Irrigation in Ethiopia

Irrigation history in Ethiopia do not have specified time and place. According to [9], in Ethiopia it is believed that irrigation practices were long been in use during ancient times with unspecified beginning period. Also According to [10], Ethiopia

has been started traditional irrigation practice since ancient time for the aim of subsistence food production and however, since 1950's modern irrigation system was introduced in Awash and Rift Valley basins for production of industrial crops. Currently, the government agricultural policy of Ethiopia paid high attention to develop small scale irrigation through water harvesting technology in different corners of the country to support local farmers to improve agricultural productivity, ensure food security and reduce poverty [11].

By considering the current population growth rate and food insecurity in Ethiopia, the Federal Government of Ethiopia [12], indicates that development of irrigation plays an important role in stimulating economic growth and rural development by increasing and stabilizing agricultural production and productivity of the country. For this, according to [7] the government of Ethiopia, donors and NGOs are investing in developing irrigation systems, especially on participatory small-scale irrigation schemes (PSSIS) and small-scale rainwater harvesting technology (SSRWHT). As a result of this, irrigation is developing rapidly in the country. However, its contribution to the national economy is insignificant when compared to rain-fed agriculture [10]. This clearly indicate, how much the irrigation sector is developing rapidly the expected output is minimum. This may occur due to different natural, social and political condition of the country.

Ethiopia has great irrigation potential, which is estimated as 5.3 million hectares of land of which 3.7million hectares can be developed using surface water sources and 1.6 million hectares using ground water and rain water management [13]. However, according to [7], how much the country has 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, irrigation sub-sector is not contributing its share based on the resources potential of the country to adapt climate change in the country.

Table 1. Summary of irrigation schemes category in Ethiopia.

Category	Command area (ha)	Infrastructure	Water management scheme
Small-scale	<200	Fixed or improved water control and diversion structures made of local materials.	Water users' association or irrigation cooperatives. Local water users' association
Medium-scale	200-3000	Fixed or improved water control and diversion structures.	Water users' association/ irrigation, cooperatives or state
Large-scale	>3000	Fixed or improved water control and diversion structures.	Mostly state enterprises

Source: Hagos et al. (2009) as cited by [9].

2.2. How to Develop Irrigation in Ethiopia

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 10,000 ha is classified as small while in Ghana the largest irrigation scheme is 300 ha. In Ethiopian, according to Bekele and Ayana (2011) as cited by [6] the most classification system is depends on command area of irrigation land and classified, into three types:

1. Small-scale irrigation systems (<200 hectares ha)
2. Medium-scale irrigation systems (200-3,000 ha)
3. Large-scale irrigation systems (>3,000 ha)

In Ethiopian according to [14] 46% of proposed irrigation developments are categorized in the small-scale irrigation category.

In addition to, the above irrigation schemes category in Table 1, according to [14] the irrigation development in Ethiopia is also classified based on the uses of a mix of the history of establishment, management system and the nature of the structures as follows:

1. Traditional schemes: These are small-scale irrigation

systems which usually use diversion weirs made from local material and needs annual maintenance. The canals are usually earthen and the schemes are managed by the community. Up to this time, this system is common in most parts of the country spatially after along rain season and they are use for both supplementary and complementary irrigations.

2. Modern schemes: These are small-scale irrigation systems with more permanent diversion weirs made from concrete that don't require annual maintenance. They are mostly community-managed and the primary and secondary channels are made of concrete. They are constructed by woreda, Zone or Region agricultural office.

3. Public: These are large-scale operations constructed and managed by the government. Sometimes these schemes support out-growers (smallholder farmers who have farms in the vicinity of the large scale schemes).

4. Private: These are privately owned systems in mechanized farms which need a highly intensive operation.

3. Challenges of Irrigation Development in Ethiopia

There are many challenges that retard the development of irrigation in Ethiopia. According to the [15] and [10] the main challenges for the development of irrigation in Ethiopia are listed in the following ways. These challenges can be explained as technical constraints and knowledge gaps and occurs in irrigation users mostly.

1. Inadequate awareness of irrigation water management: The aim of irrigation water management is to keep the water level in the root zone within a range where crop yield and quality are not damaged due to either inadequate or excess water [16]. Efficient and effective utilization of irrigation water has been major challenge in irrigation scheme of Ethiopia because most human powers do not have basic knowledge how to apply irrigation water. Since, efficient and adequate dosage of irrigation water advances crop production and raises water use efficiency for future purposes, now a days with changing climate long lasting irrigation water supply technique and effective water management approaches are most important taxes [17].
2. Inadequate knowledge on improved and diversified irrigation agronomic practices: Diversification increases systems' flexibility, previously neglected in development measures, such as per capita income and poverty. In some cases, the components of a typical development plan, such as infrastructure, social capital, technology and research, and the policy environment, might be similar to that of a diversification plan. Diversification strategies have to go a step further to generate flexible abilities among producers to quickly adjust to the opportunities created by the market and rational policies. However, in Ethiopia the reverse is true. According to [18], improper crop and varietal selection;

improper crop rotation cycle; inappropriate cropping pattern and cropping intensity; inappropriate crop calendar; inadequate availability of small hand tools and farm implements; poor land preparation and leveling; poor soil fertility management; poor irrigation scheduling/crop-water-requirement balance; inappropriate irrigation methods; and inadequate crop pest management practices these all are common in Ethiopia with related to irrigation agronomic practices.

3. Shortage of basic technical knowledge on irrigation pumps, drip irrigation system, sprinkler irrigations, surface and spate irrigation methods: In the country there is enough human power spatially related with these technical works. They always perform traditionally.
4. Scheme based approach rather than area/catchments based approach for the development of SSI Schemes:
5. Inadequate baseline data and information on the development of water resources: Even Ethiopia has many rivers and huge amount of water resource, many of these rivers do not have documented data for irrigation, water supply and other project development.
6. Lack of experience in design, construction and supervision of quality irrigation projects,
7. Low productivity of existing irrigation schemes,
8. Inadequate community involvement and consultation in scheme planning, construction and implementation of irrigation development,
9. Poor economic background of users for irrigation infrastructure development, to access irrigation technologies and agricultural inputs, where the price increment is not affordable to farmers.

4. Factor Affecting Irrigation Development in Ethiopia

In Ethiopia the government, the donors and the non-governmental organizations are investing to the development of irrigation systems from small to large scale irrigation schemes. As a result, irrigation is developing rapidly. However, it does not develop as expected and its contribution to the national economy is insignificant when compared to rain-fed agriculture [10].

The successes of irrigation development generally depend on the cooperation of larger range of government institutions and individuals, such as, for instance, the departments of irrigation, extension and rural works, banks and planning bodies. Unsurprisingly, development issues are interrelated and water resource developments by nature have interrelation with many factors. Consequently, irrigation developments are also determined by many factors for their success. According to B. N (1995) as stated by, [6], the performance of irrigation schemes depends on: cropping pattern, market accessibility, maintenance and spare parts, social and political, and land tenure policies and also some major factors like environmental, social, economical and political are negatively affect irrigation development in Ethiopia.

4.1. Environmental Factor

Salinity and Sodicity/alkalinity are the major problems that resulted in the valley due to irrigation practices in the enterprise. In some places high salinity and sodality/alkalinity levels coupled with poor drainage of the soils are at present resulting in quite a large area of productive lands being abandoned from cultivation [19].

In Ethiopia, the environmental impact that is usually associated with the establishment of the enterprise is the introduction and invasion of a thorny shrub by the name of *Prosopis juliflora* in the Middle Awash Valley. The development of large-scale irrigation projects in Rift valley in the absence of proper drainage systems for salinity control has also resulted in increasing severity and rapid expansion of soil salinity and sodicity problems leading to complete loss of land for crop cultivation in these areas [20].

The plant/weed covers most of the area near the enterprise, which was once barren land during dry seasons and possibly used for grazing purposes during wet seasons. Even if it has some benefits in reducing wind erosion and increasing the organic matter content of the soil, it created problems both to the enterprise and the surrounding inhabitants as it affects the canal network of the farms and cannot be used as animal feed.

4.2. Social and Climate-Related Factor

Increases in standing water associated with irrigation, especially when systems are poorly managed, can serve as a breeding-ground for disease vectors including *Anopheles* mosquitoes, contributing to increases in malaria and other disease. Similarly, dams constructed for irrigation slow water flow and may increase the prevalence of malaria or sleeping sickness. Irrigation with untreated wastewater can increase exposure of both producers and consumers to pathogens resulting in *schistosomiasis*, *diarrhea* or other ailments. Irrigation with chemically contaminated water, either natural as in arsenic or human induced has clear health implications. The availability of irrigation can encourage use of other agricultural inputs including fertilizer and pesticides, increasing exposure of both farmers and consumers.

4.3. Economic and Political Factor

Irrigation development is seen as one of the means to reduce poverty and promote economic growth. It influenced changes in agricultural productivity have been shown to impact overall growth through multiplier effects and can free human and financial capital for industry and services stabilize rural populations [21] and impact foreign exchange earnings and budgets via export taxes. Irrigation may also influence overall governance structures. While governance change may typically be a by-product of irrigation, it can also be an explicit objective. Similarly, electricity reform to support overall economic growth is complicated by the political economy of power subsidies and groundwater.

5. Conclusion

Even though, the governments of Ethiopia has followed the development of small-scale irrigation (SSI) schemes for the adaptation and mitigation strategy to increase productivity and to diversify the livelihood scenarios as an option, irrigation sub-sector is not contributing its share based on the resources potential of the country to adapt climate change in the country. This is occurred due to different challenges like, inadequate awareness of irrigation water management, inadequate knowledge on improved and diversified irrigation agronomic practices, shortage of basic technical knowledge on irrigation pumps, use of scheme based approach rather than area based approach for the development of SSI Schemes, inadequate baseline data and information on the development of water resources etc. In addition to these challenges, factors like environmental, social, economic and political are limit the development of irrigation in Ethiopia. So, in the country for the minimization of these challenges and factors and to increase irrigation development and the acceptance of the project by the users, irrigation project should be developed based on integrated and grass root approach.

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