International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
(A Peer Reviewed, Referred, Indexed and Open Access Journal)
DOI: 10.22192/ijarbs Coden: IJARQG (USA) Volume 9, Issue 7 -2022

Review Article

DOI: http://dx.doi.org/10.22192/ijarbs.2022.09.07.021

Review on Development and Status of Drip Irrigation in Ethiopia

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Abstract

This study reviewed general information on drip irrigation development and status in Ethiopia. Drip irrigation delivered water uniformly to each plant through a closed pipe system and improve yield more than other methods of irrigation and has high water productivity. Low-head drip irrigation technologies include gravity drip irrigation and bucket and drum kits. Cost of drip irrigation, clogging of drip emitters and skill gap of farmers on water management are the most serious problems associated with drip irrigation. Different researches on drip irrigation were conducted in different locations of Ethiopian (Arba Minch,Tigray Regional State, Amhara's lowland region and Ethiopia's Mid-Rift Valley).Drip irrigation increase crop production, conserve water and improve crop quality. And it is economical for smallholder farmers if it is well managed. This paper argues that in areas where there is irrigation water scarcity, especially for vegetable crops drip irrigation is the best irrigation type. Any concerned organization like policy makers, irrigation administrators, and development practitioners should promote the growth of drip irrigation financially and technically.

Keywords: Drip irrigation, review, status, Ethiopia.

1. Introduction

Water scarcity, which is brought on by inadequate use, low storage, yearly and inter - annual fluctuations in precipitation and high evaporation demand, limits crop productivity. Additionally, competition between diverse industries deprives agriculture of a significant amount of water each year [3]. The cultivation of high-value vegetable crops and fruits utilizing drip irrigation, which can save water and prevent crop failure, is thus becoming increasingly popular as a complement to this risky rain-fed staple food production[24].

Drip irrigation, as defined by [25], is an irrigation technique in which small amounts of water are applied directly to the root zone of plants using a system of plastic pipes, valves, emitters, or drippers, and auxiliary equipment. Drip irrigation is familiarized primarily to save water and increase the water use efficiency in agriculture [9].

Small-scale farmers may be able to boost their agricultural production by using water more effectively using low-cost drip irrigation technologies.

Increased crop productivity, water savings, a decrease in labor-intensive hand-irrigating of crops, and modular systems that may accommodate different plot sizes are all advantages of drip irrigation. Drip irrigation maximize water application by minimize frequency of irrigation depending on water holding capacity of the soil.

Drip irrigation systems are therefore being taken into account as a potential option in the planning of irrigation in various parts of the world. Drip irrigation can conserve water, increase crop production, and enhance crop quality. To this purpose, numerous regions of the nation have implemented modern drip irrigation technology in an effort to increase irrigation efficiency [16].This review is therefore important for understanding on drip irrigation development and status in Ethiopia.

2. General review on drip irrigation Drip irrigation

Water is delivered to residential landscapes using a range of low-pressure, low-volume irrigation techniques, such as dripping, spraying, and streams.

By using a plastic pipe with outlets, drip irrigation entails giving water to the soil extremely close to the plants at very low flow rates (0.5 - 10 lt/hr).The drip irrigation technique's fundamental idea is to keep a moist bulb of soil in which plant roots can absorb water. The soil is only moist in the area immediately surrounding the plant.

The parameters of the soil (texture and hydraulic conductivity) and the drip emitter's discharge rate affect the volume and form of the moist bulb that is irrigated by each drip emitter. To keep the soil water content in the bulb close to field capacity, applications are often made frequently (every one to three days) [22].

This is possible because a closed pipe system allows for uniform water delivery to all plants. Drip irrigation can thereby considerably improve the amount of land that can be fully irrigated with a given amount of water by replacing traditional surface irrigation[15].

Drip irrigation increased output higher than other irrigation techniques, according to many research [13].The study discovered average water savings of 55%, labor savings of 58 %, and a reduction in spending on pesticides and fertilizers of 16% when compared with flood irrigation systems [19].In comparison to basin, furrow, and sprinkler irrigation methods, drip irrigation produced the highest mean potential dry yield of pepper with 1.58 t ha-^{1}[12].

2.1.1. Affordable or Low-cost drip irrigation systems for smallholders

Standard commercial drip systems are simply not appropriate or affordable for most smallholders. Some of the reasons are: (1) they cost from $1,500 to $2,500 per hectare or $0.15 to $0.25/m^2; (2) eliminating dripper clogging is expensive and (3) complicated water filtration systems are required, thus a 2-hectare system is about the smallest practical size and (4) the required operating pressure head at the pump is typically between 20 m and 30 m to reduce losses in the filter and pipe distribution network and provide sufficient pressure for the drippers; [15]. Recent studies show that by using reasonable priced of drip irrigation systems, small farmers can change from producing for their own needs to producing goods with higher market value.Hence, they double their income and greatly enhance house food security [20].

2.1.2. Types of low head drip systems

Drip kit' is the name that was coined by Chapin who has developed and promoted, low cost, and efficient drip irrigation [7].To come up with

affordable drip systems for small-scale farmers low cost drip kits were designed to operate at pressure as low as 0.5- 2.0m water head unlike the standard conventional drip system are operated at pressures as high as 20-30m water head. Thus, it has been possible to use small reservoirs such as oil drums or buckets as header water tanks, which are supported above ground so that pressure falls within specified range. Also, due to low head pressure light perforated flexible piping and inexpensive fittings are used and this makes it easy to repair any possible leaks. Low-head drip irrigation technologies include gravity drip irrigation and bucket and drum kits [18].

2.1.2.1. Gravity drip irrigation

The type of irrigation blends in with the network of existing ditches, canals, and farms that are irrigated by gravity. Furthermore, a very low pressure is used. Due to the very low pressure of operation, these systems are sensitive to ground elevation differences and these require special drip laterals [11].

2.1.2.2.Bucket system

Two drip lines that are each 15 to 30 meters long and a 20-liter bucket for retaining water make up the bucket system. To prevent any debris from clogging the drip nozzles, each drip line is joined to a filter. The bottom of the bucket is raised between 0.5 and 1 meter above the planting surface and supported by a bucket stand [14].

A single bucket system can irrigate 100–200 plants at a spacing of 30 cm using just 2–4 buckets of water per day. Plants can be as many as the bed will allow for crops like onions or carrots. Currently, a bucket system cost roughly $15 USD. Typically, a market-oriented farmer can recoup this investment within the first harvest year [14]. [10]With his case study in India concluded that it was economical to use bucket kits for vegetable production.

2.1.2.3. Drum kits

The drum system combines a number of bucket systems but has been updated to draw water from a 100- to 200-liter drum rather than a 20-liter bucket. It consists of lateral lines to which the drip lines are attached (15–30 m in length), a drum or a small tank that serves as the water storage and is raised 0.5–1 m above the ground. This system allows for the connection of five to ten bucket kit equivalents. Pipes with a diameter of 2.5 cm constructed of PVC, steel, or polyethylene make up the lateral line. Each pair of drip lines has a connecting tee [21]. From 500–1000 plants planted with a spacing of 30 cm between each row may be watered with a drum system, which is equivalent to five bucket systems. Depending on the crop and location, a system like this needs between 100 and 200 liters of water each day.

It costs a total of US$ 85. For instance, cabbage grown by this system gave yield with a gross return of US$ 250 [14]. A farmer can grow vegetables thanks to the effective water utilization made possible by drip irrigation [4].

2.2.Drip Irrigation Developments and Current Statusin Ethiopia.

2.2.1. Drip Irrigation Developments

According to [5], large irrigation systems are typically incompatible with the majority of smallholder farming systems in Africa. This is because ineffective farmer support services like extension and credit frequently change the established patterns of land tenure and settlement, which has the effect of upsetting or undermining the established economic institutions.

Additionally, due to the low amounts of water gathered and stored relative to crop water requirements, improvements to surface irrigation may not be sufficient. Drip irrigation is therefore being taken into account as one of the options in the development of irrigation in Tigray Regional

State. A device that can conserve water, boost crop yield, and enhance crop quality is drip irrigation.In various regions of the Tigray Regional State, attempts have been made to increase irrigation efficiency through modern technologies. As a result, the Norwegian Development Fund (DF) launched the Triangular Project to collaborate with water sector development groups in Tigray, Ethiopia, and India to increase irrigation efficiency [16].A familiar drip irrigation system was transferred as part of this initiative from Gujarat, India, to Tigray, Ethiopia, and it has since expanded throughout the region. The family drip irrigation (FDI) kits needed for drip irrigation are now even being produced in a plant in Tigray.

As a result, in recent years, both governmental and non-governmental organizations have been giving the family drip irrigation beneficiaries technical and financial support.

In this regard, selected household heads were given a motorized or pressurized treadle pump, a 400-liter tin water tanker, and a set of family drip kits to develop a 500-square-meter area.

Additionally, agricultural inputs including fertilizer, fruit seedlings, and vegetable seeds are offered. All inputs are provided on a credit basis with a five-year repayment period. Based on consumer demand, the crops chosen for cultivation.

Poor scheme management, an imperfect market, lack of funding, lack of technical expertise, lack of knowledge about the use of irrigation, negative environmental and social impacts, and institutional issues are the main obstacles to the success of irrigation development.

According to Mulatu Kassa and Tesfa Gebrie Andualem [17],even if the potential and actual irrigated area is not precisely investigated, the estimated irrigable land of Ethiopia varies between 1.5 and 4.3 million hectares, in average about 3.5 million hectares. However, about 10-12% of the total irrigable potentials are currently under production using traditional and modern irrigation schemes. The total land under irrigation now is estimated to be in the range between 160,000 - 200,000 hectares which is less than 5% of the country's irrigable land.

2.2.2. Application of drip irrigation

According to [8].Applications are made more frequently with drip irrigation water, which creates a highly beneficial high moisture level in the soil where plants can thrive. In order to only soak a portion of the soil where the roots grow, water is administered near to the plants. According to [23], drip irrigation scheduling is usually based on frequent replacement of the water consumed by the crop to maintain essentially steady level of moisture content in the root zone.

2.2.3. Different research on drip irrigation in different areas of Ethiopian.

Low on-farm water management techniques, and thus poor performance, are a common feature of smallholder irrigation schemes in Ethiopia [6].Poor resource allocation that prevents timely and optimal water supply as well as plant water uptake is the root cause of poor on-farm water management. To put it another way, inefficient irrigation scheduling, uneven on-farm water distribution, insufficient irrigation duration, etc. are some of the variables that contribute to ineffective on-farm water management. Farmers' poor understanding of on-farm water management, especially on how much and when to irrigate (since they tend to over-irrigate as long as water is available), leads to water shortages and conflicts in other areas of the schemes. This also implies that the performance of a scheme is directly impacted by on-farm water management costs.

Onion yield and water use efficiency are increased in Amhara's lowland region when it is drip-irrigated with mulch [26]. Both irrigation level and mulching rate had a significant impact on the total marketable onion.

Experiences from Arba Minch demonstrate that a single, inexpensive drip irrigation system may provide a household with fresh vegetables for domestic consumption for an initial expenditure of 60 to 70$[26].

Temporal distribution trend of family drip irrigation system(FDI)at zonal Level of the Tigray Regional State, Northern Ethiopia, show that the distribution of FDI kits has shown increasing trend both across the years and zones. However, the findings of the site assessments revealed that the availability of FDI kits varied throughout all Zones of the region at a particular time and location. The greatest FDI kit distribution was recorded in the year 2008, according to an analysis of the distribution records for the previous five years (2004–2008). The well-established plant that manufactures the drip irrigation system's necessary equipment could make a significant contribution to maximizing the temporal and unique distribution trends of the technology.

At the zonal level of the Tigray Regional State in northern Ethiopia, there is a spatial distribution tendency of the FDI system. However, only 1442 of the 2615 provided FDI Kits were operational (installed) across the entire region (i.e. 55 %). There is significant spatial variance within the region, ranging from 20% in the Southern Zone to 84 % in the Southeast Zone. Factors controlling adoption of FDI system are, age group and adoption status, education level and FDI adoption status, access to water source type and FDI adoption status, gender and FDI adoption status[2].

Ethiopia's Mid-Rift Valley, Adami Tulu Jido Kombolcha District, evaluation of Low Cost Drip Irrigation Technology through Tomato Production revealed that low cost drip irrigation system has demonstrated superior performance on tomato production and other yield-related parameters as compared to conventional furrow irrigation system. Drip irrigation had substantially greater water use efficiency since it utilized far less water than surface irrigation systems did [1].

Knowing the system's spatial and temporal distribution was crucial to comprehending the adoption and diffusion status across the region. For this, the Tigray Regional Bureau of Agriculture and Rural Development (BoARD), the Tigray Bureau of Water Resource Development (BoWRD), and the Relief Society of Tigray (REST), local development organizations operating in irrigation development in the region, provided a list of family drip irrigation kits distributed over the period of 2004–2008.

Additionally, the data gathered from the three Bureaus was arranged according to spatial and temporal sequences. In order to establish the operational state of the given FDI kits, they were also recognized as installed and uninstalled. While three-stage sampling approaches were used to gather data for the analysis of FDI acceptance status and rate.

As a result, 120 household heads were randomly chosen from three sites. Each site had 40 randomly chosen respondent farmers, including FDI technology users and non-users.Micro tubes and emitters in blind hose with a 16 mm diameter are used to deliver water to the crops.
In order to maintain moist soil surrounding the plant without wasting water, crops are planted adjacent to the holes. To maintain a high level of soil moisture and meet the crop water requirement, irrigation with a low-cost drip system should be administered more frequently (daily or every other day). As a result, the interval between bucket filling depends on the crop water requirement. WP = BY/Wa, where BY is beneficial yield (kg ha^{-1}) and Wa is total irrigation applied water, was calculated by dividing beneficial fruit yield by total applied irrigation water (m^3 ha^{-1}).

2.2.4. Cost of development of drip irrigation

When compared to surface irrigation systems, inexpensive drip irrigation systems saved more than 25.9% of the water. The study's findings suggest that the most beneficial and profitable

option for tomato production was low-cost drip irrigation. Before being widely distributed to users, this technology needs to be evaluated in farmer circumstances to yield better results [1]. The most significant issue with drip irrigation is emitter clogging and the cost of traditional drip irrigation systems. Because they cannot see how much water is being utilized, farmers that employ drip irrigation confront another problem with water management.

3. Summary and Conclusion

✓ Low on-farm water management techniques, and thus poor performance, are a common feature of smallholder irrigation schemes in Ethiopia.
✓ The primary obstacles to the adoption and advancement of drip irrigation were: flawed design, a lack of knowledge regarding the use of contemporary irrigation technology, poor water and land management, inefficient input utilization, insufficient management capacity, a lack of information and databases, and a lack of post-harvest technology and management.
✓ Extension services should be boosted in the nation in order to increase understanding of drip irrigation technology usage and administration, as well as monitoring and implementation techniques.
✓ Economic feasibility analyzes of the drip irrigation system should be prioritized widely.
✓ Drip irrigation is simple to design and install, and it lessens disease issues brought on by excessive wetness on some plants. It is the method of irrigation that is most effective.
✓ Any organization that is concerned should promote the growth of drip irrigation financially and technically.
✓ Arid area in Ethiopia will receive more water thanks to increased drip irrigation, which will increase crop yields and the potential to cultivate cash crops. It will also enable smaller farmers to start turning their farms into sustainable enterprises.
✓ The primary benefit of drip irrigation is that it is the most effective method of feeding crops with nutrients and water.
✓ In drip irrigation each plant receives the precise amount of water and nutrients it requires at the precise time for optimum growth by being delivered straight to the root zone of the plants.

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	Website: www.ijarbs.com
Quick Response Code	Subject: Agriculture
DOI:10.22192/ijarbs.2022.09.07.021	

How to cite this article:
Demeke Tamane Mitku. (2022). Review on Development and Status of Drip Irrigation in Ethiopia. Int. J. Adv. Res. Biol. Sci. 9(7): 212-219.
DOI: http://dx.doi.org/10.22192/ijarbs.2022.09.07.021