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Economic Evaluation of Farmers' Irrigation Practice: The Case of the Holeta River, Upper Awash Basin, Ethiopia

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Abstract

In the Holeta river watershed, inefficient irrigation practices contribute to a significant waste of the amount of water required to cultivate crops. It appears that managing water resources at the farmer's home level by adopting economically efficient irrigation systems is the key to achieving sustained irrigated agriculture production. The purpose of this study was to evaluate the irrigation types used in the Holeta river watershed and to recommend economically viable irrigation methods. According to these reviews, the gravity-fed drip irrigation system outperformed traditional surface irrigation systems in terms of cost. Therefore, adopting a small-scale gravity-fed drip irrigation system at the household level is an efficient and economically feasible system, in terms of getting a high yield and saving water.

Keywords: Gravity-fed • Drip irrigation • Surface irrigation

Introduction

When compared to traditional flood irrigation approaches, drip irrigation technology can save up to 80% of the necessary irrigation water volume for local food crop production ("Methodology- for-Water-Quantification-in-Drip-Irrigation-Practices," n.d.). In Ethiopia, smallholder farmers are characterized by inadequate on-farm management techniques and, as a result, poor performance [1]. Excessive and insufficient resource allocations that enable optimum and timely water supply and plant water uptake promote poor on-farm water management. To put it another way, improper irrigation schedule, non-uniform on-farm water distribution, and incorrect irrigation duration are all factors that contribute to poor water management.

In Ethiopia, the average farm area per household is 0.5 ha, with irrigated land per household ranging from 0.25 to 0.5 ha. With limited landholdings, meeting rising population food demands requires either expanding arable land or boosting crop yields every year through irrigation [2]. Farmers can better withstand the effects of climate change by improving agricultural water management and irrigation while also boosting productivity per unit area of land and volume. The applicability of various irrigation methods, such as surface, sprinkler, and drip irrigation, is influenced by natural conditions, crop type, and technology, past irrigation experience, required labor inputs, pricing, and benefits.

Ethiopia is one of the second most populated countries in Africa [3]. It covers around 1.13 million km^2 of land. Of this area of land, around 0.7 percent is water bodies [4] based on the Ethiopian Central Statistical Agency [5] the total population in Ethiopia is estimated at around 94 million people, approximately 85% of which live in rural areas. Traditional irrigation schemes in Ethiopia are constructed by farmers on their own internal initiative. At country level, around 572 000 farmers are involved with an estimated area of 138 000 ha [6]. A modern irrigation system was introduced in the 1950's in the Rift Valley basin to cultivate industrial crops.Those medium irrigation projects are constructed and held by the government. The Holeta River encounters a problem with water shortages during the period of dry season [7]. The majority of farmers living along the Holeta River are traditional irrigation users. They used the river for traditional irrigation activities. Because of population increment in the study area, there is a computation between water users and that leads to conflict. Poor water management systems and using traditional surface irrigation systems contribute to wastage of water and reduce irrigation efficiency [7]. Therefore, in order to improve irrigation water use efficiency, it needs to improve the efficiency of the different types of irrigation and analyze the economic feasibility of adopting them by smallholder farmers. Water loss is one of the severe problems in the Holeta river catchment due to farmers' agricultural activity using less efficient traditional surface irrigation methods and uncontrolled water use. These surface irrigation activities lead to loss of water by seepage and evaporation. Therefore, this review study aims to assess the types of irrigation methods implemented along the Holeta river upper awash basin and to propose an efficient, economically feasible small-scale irrigation method for individual farmers.

Materials and Methods

Area description

The study area is located around 45km from the capital city of Addis Ababa, which is located in the upper part of the Awash River basin and lies at an altitude of (2069 – 3378) meters above sea level. The annual rainfall is between 818 – 1226 mm and the temperature ranges from 6oc to 23oc [8].

Methods

Different types of irrigation methods applied in the Holeta River; upper awash basin was identified based on the secondary source of data from different literature reviews. Source of data: Price of treadle pump from (http://www.ide-ethiopia.com/pressure-treadle-pump/) (accessed November 2016). The average onion production in Ethiopia from the production year 2014 is around 10.4762 tons/ha https://www.statsethiopia.gov.et/our-survey-reports/ (accessed, November 2016). Doing cost-benefit analysis of the different types of irrigation systems, such as small-scale gravity- fed drip irrigation and surface irrigation systems, by calculating the net present benefit from the production of onions for each type of irrigation system (Net present value = benefit – cost).

Assumption

Installing a small-scale gravity fed drip irrigation system for each individual household farmer. The assumption is that you put the water storage tank at 1.5m high and fill it once a day. The capacity of the storage tank is estimated depending on the water demand of the irrigated crop for one day. Then irrigate the cultivated land from the storage tank by gravity through the drip network

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pipe lines. And the other assumption, depending on different literature review, is that water is saved by 45% and yield increased by 20% by using a small-scale gravity fed drip irrigation system. The average life time of a storage tank is 15 years. By assuming the production cost of onions for both gravity-fed drip and traditional surface irrigation systems is equal, the benefit getting from the yield has been the same throughout the 5-year period.

Results and Discussions

The irrigation systems implemented along the Holeta River are traditional surface irrigation systems by smallholder farmers and drip irrigation methods by private companies. One of the main advantages of drip irrigation is to minimize water loss and improve water productivity for agriculture. The outputs of different studies in the world, including Ethiopia, have shown that drip irrigation has a principal impact on improving the yield and water use efficiency of crops. It has the potential to use scarce water resources more efficiently to produce crops as water can be delivered precisely to the root zones rather than irrigating the entire field surface as with other methods [8]. According to INCID (1994), the efficiency of drip irrigation is estimated at about 90%, whereas the surface irrigation method is around 35-40 percent. The study conducted by [9] showed that the yield of crops produced by drip irrigation is twice as much as by furrow irrigation. Drip irrigation can save around 56.4% of water and increase yield by 22% as compared to surface irrigation methods [8][10]. Obtained higher fresh onion yields, irrigation water use efficiency and economic returns with a drip irrigation system compared to furrow irrigation systems [11].

From the above review, wastage of water is very high in surface irrigation systems. Therefore, implementing the traditional surface irrigation method is not recommended in the Holeta catchment. So, we need to have another option. For example, small-scale gravity-fed drip irrigation.

According to FAO (1986), the water demand for onions per growing season is 350-550 mm by taking 400 mm for Ethiopian conditions and calculating the water use for 0.2 hectares of irrigated land, which is equivalent to 800 m3 per 0.2ha. To calculate the required size of the storage tank that needs to be installed for a gravity-fed small-scale drip irrigation system. Assuming the safety factor of 1%, which is equal to (0.01*800 m3/0.2ha) +800 m3/0.2ha =808 m3 for the whole growing period. To get the required size of storage tank for one day, divide the total water demand of onions by the growing period and multiply by 1 day, we get (909m3/170days * 1day) = 4.7m3=5 m3 = 5000 liters. The current selling price of a 5000-liter water storage tank is around US $600. The current selling price of a treadle pump in Ethiopia is around US $100. The price of a full set of plastic pipes for 0.2ha is around US $200. Also, for installation and transport costs, it accounted for US $300.

Cost benefit analysis

Cost benefit analysis evaluates and compares all the costs and benefits of the environmental, social, and economic. Positive and negative impacts of the adaptation approaches are expressed in monetary terms based on general information. Crop production costs include operating costs, fixed costs, and the consumption of water. The benefits are sales revenue, water and labor savings from the irrigation systems. The cost and benefits of crop farming consist of the following components.

Costs- Economic cost: investment cost, operating cost, Environmental cost: water loss [12] [13].

Benefits- Economic benefits: revenue, additional yield, Environmental benefit: water saving, Social benefits: labor saving. The current unit price of onions is around USD0.7/kg. The yield of onions per 0.2 hectare is around 2.1 tons.

When using gravity fed drip irrigation methods, we can save 360 m3 of water from 0.2 hectares of irrigated land during the growing period of onions. But the above cost-benefit analysis is done without considering the benefit gained from water saving.

As the above analysis (Table 1) indicates, even if the initial investment of small-scale gravity fed drip irrigation is high, in five cropping seasons we can have a net benefit of US $1570 more than traditional surface irrigation systems. Therefore, adopting a small-scale gravity-fed drip irrigation system at the household level is an efficient and economically feasible system, in terms of getting a high yield and saving water.

Conclusion

Implementing small scale gravity fed drip irrigation systems at the household level plays a crucial role in saving water and increasing yield. Farmers who have cultivated land near the river would have more opportunities to adopt the system. However, the initial investment of a gravity-fed drip irrigation system is high compared to traditional surface irrigation methods, but it has great long- term net return benefits from the production of several crops. The government should provide loans for farmers with lower interest rates to encourage them to adopt the systems.

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Table 1. Total cost benefit analysis of small-scale gravity fed drip irrigation and traditional surface irrigation systems for the production of onions for a 5-year period.

Types of Irrigation System	Cost of Tank, Pipes & Pump US$	Installing Operation & Maintenance Cost US$	Total Cost US$	Benefit from Yield US$/Cropping Season	Benefit From Yield Within 5 Years US$	Benefit From Price of Tank & Pump After 5 Years US$	Total Benefit US$	Net benefit US$
Traditional Surface Irrigation	-	400	400	1470	7350	-	7350	6950
Small Scale Gravity Fed Drip Irrigation	900	300	1200	1764	8820	900	9720	8520

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