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Devised Mathematical Technique for Flexible Gated Pipe Alignment in the Case of Furrow Irrigation in Ethiopia

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Abstract

This study was aimed at analytically examine the convectional layout of Felix Gated Pipe in irrigation field and come up with new approach that enhance approach to optimize economical affordability and durability. With conventional method Flexi Gated Pipe was installed in field stay in the field until harvesting time. Flexi Gated Pipe can irrigate left and right in the in the reach of 100 m, therefore if Flexi Gated Pipe 100 m length was considered in conventional method it irrigate only 2 ha through the crop growing season. With new practice that was introduced, the same 100 m long flexi-gated pipe can irrigate at least 20 ha in 10 days (including five days of idle time) by implement aided rotation within the estate. Metehara sugar Estate in Ethiopia which is about ten thousand hectares, 50000 meters of Flexi Gated Pipe will be required 35,000,000 ETB. A total of 10,500,000 ETB can be saved from one sugar estate. Therefore, 75% of the initial investment costs will be reduced with minimum input of labour and implement cost.

Keywords: Flex gated pipe; Surface irrigation; Convection approach; New technique

Introduction

Background

Surface irrigation is the mostly used irrigation method due to its low capital, maintenance costs and low energy requirements [1]. Furrow irrigation is a method of applying water at a given rate into shallow evenly spaced Canals [2]. In furrow irrigation, the field divided into sectors furrows in which irrigation water is applied. The furrows are filled to the desired depth of water and this water is retained until it infiltrates into the soil both vertically and horizontally.

The flexible gated pipe (hydroflume) is defined as a closed conduct with a circular cross section with water flows through it. The flows result from pressure difference between inlet and outlet and they affected by fluid properties and the flow rate.

Blocked ended furrows of different lengths (dominantly 100 m and few 200 m furrows) are being irrigated using gated pipe distribution system at Metehara sugar estate. Basically two types of gated pipe are available at Metehara: one-way and two-way with length varying depending on the widths of fields. The gated pipes are made of 16" plastic pipe with evenly spaced outlets at 1.45 m spacing. Non-sliding gates on the outlets are used. During operation 40 outlets are opened simultaneously however no measurement to ensure inflow rate of 200 l/sec at inlet or to satisfy the required hydraulic head are done.

The flexible gated pipe furrow irrigation system consists of relatively large diameter pipes of about 0.41 m (16 inches), with gates usually equipped on one side and corresponding to the furrow spacing. The hydroflume is made of VU and thermally protected low density polyethylene of 700 micron wall thickness for maximum service life time in hot and tropical condition. It is flexible so that no alluvial clings to its wall. The Flexible gated pipes as an improvement in furrow irrigation, in which the conventional head ditch and siphon are replaced by an above ground pipe. Flexible gated pipe was introduced to allow more uniform irrigation. Uniformity of flow is determined by setting the gates precisely to deliver equal flow into furrows the rate of discharge in each furrow was less than with siphon tubes that induced erosion, and less leaching potential.

There are several potential performance gaps that can occur with irrigation systems [3]. The first is a technological performance gap. This is when the infrastructure of an irrigation system lacks the capacity to deliver a given hydraulic performance standard. The normal solution to technology performance gaps is to change the type, design or condition of physical infrastructure.

Using water saving technologies such as sprinklers, center pivot, hydro-flume is one thing but, it's dependence on foreign currency for initial investment and spare parts cost on the other hand is terriblesome. Therefore development and evaluation of mathematical technique is a medication to reduce foreign currency and technological dependence. Introduction of this method will therefore, intended as it will reduce initial investment on hydro flume to cover specific area by more than 70% at least and increase its service life time duration because it enables moving and storing at a safe area during idle time.

Methods

Description of the study area

Metahara Sugar Factory is located 200 km from Addis Ababa in the southeast direction. It is situated at 80 53' N latitude and 390 52' E longitudes at an altitude of 950 (m.a.s.l). The area has a semi-arid climatic condition. Most of soils of the area are Haplic Cambisols and a few are Hypersalic or Haplic Solonchaks [4]. The long term climatic condition of the area has a minimum and maximum temperature of 17.36°C and 32.97°C, respectively with the annual rainfall is 533 mm. Whereas; the average relative humidity, sunshine hour and wind speed of the area is 77.44%, 8:46:00, 4.12 km/hr, respectively.

Infield layout

A single flexible gated pipe control-reel device should not be taken afar but should move forward and/or laterally within a fixed range which should depend on irrigation depth and irrigation interval. The

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hydro-flume length will be determined based on actual field scenario. Existing irrigation plan is determinant in the design of the layout of the field and length of gated flexi pipe (Figure 1).

Results and Discussion

The mathematical analysis that demonstrates how to significantly reduce the investment required to cover specific length of feeder ditch through rotating flexible gated pipe were taken from the diagram showing infield irrigation hydraulic structures (Figure 2).

Figure 1: Flexible gated hydroflume in the irrigation field.

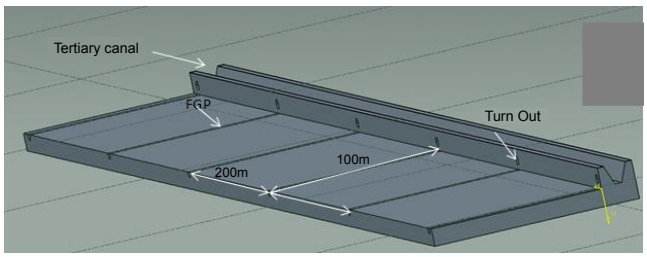

Figure 2: Diagrammed presentation of tertiary canal, turn out, hydro-fume.

The following points are considered during analysis of expected economic benefit:

Length of gated pipe=100 m; estimated cost 28,000 ETB (100 m flexible gated pipe); Cut off time=60 min for irrigation water advancement.

Number of furrows in hectare=100/1.45 (distance between furrow center)=69; and discharge=5 l/s,

Irrigation interval=12 days, and irrigation time in a day=8 hrs.

Time to irrigate two hectares (both sides of the flexi-gated pipes)=3.45 hrs+considering downtime=4 hrs.

It is therefore in a day 4 hectares will be irrigated on both sides. But, to minimize wear and obsolesce on the flexi gated pipe, working days for the device are limited to only five days. Therefore, device will irrigate 20 hectares within five days.

With existing irrigation practice at Metahara (10,000 hectares), it is required about 50000 meters of flexi-gated pipe which costs about=50,000 × 280 ETB=14,000,000 ETB per sugar estate. With new practice that will be introduced, 100 m long flexi-gated pipe can irrigate at least 20 ha in 10 days (including five days of idle time) by rotating FGP after irrigating a given hectares. So to irrigate 10000 hectares, 50000 meters will be required (12500 × 280 ETB=3,5000,000 ETB). A total of 10,500,000 ETB can be saved from one sugar estate. Therefore, 75% of the initial investment costs will be reduced.

Recommendation

By replacing Feeder ditch with flexi gated pipe in field irrigation water application can be improved by 10% [5] and with minimum cost for labour, initial investment on FGP can be reduced by 75%. Therefore, I recommend that using FGP by rotating like sprinkler is appropriate measure for surface Irrigation. Moreover, it is good if further research could be initiated to aid the rotation of hydro-flume (FGP) by simple machine (hand tool).

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