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ON- FIELD WATER MANAGEMENT OF GOLDA SMALL SCALE IRRIGATION SCHEME: THE CASE OF ASSOSA, NORTH-WEST OF ETHIOPIA.

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***Abstract*: Miss management of available water for irrigation, both at system and farm level has led to a range of problems and further aggravated water availability and has reduced the benefits of irrigation investments. To solve irrigation water management problem; appropriate irrigation scheduling practices could lead to increased yields and greater profit for farmers, significant water savings, reduced environmental impacts of irrigation and improved sustainability of irrigated agriculture. This study was conducted for evaluating on-field water management of Golda small scale irrigation scheme which is found at Assosa, North- west of Ethiopia. In this study both secondary and primary data sources were used. Soil samples were collected for the determination of soil moisture, field capacity, and permanent wilting point, soil pH, organic matter content, total nitrogen and available phosphorous. Infiltration rate of the soil, crop water requirement, irrigation requirement and irrigation scheduling were determined. Application efficiency, storage efficiency and distribution uniformity of the system was evaluated. The organic matter content and available phosphorous of the soil were lowbut total nitrogen was high. Farmers were applying the same irrigation interval in each growth stage of the irrigated crop but crops are required different amount of water at different irrigation interval within each growth stage. The Application efficiency, storage efficiency and distribution uniformity were determined and the values were 51.6%, 91.6% and 80.76% respectively. Generally, irrigation users did not have sense of ownership for the scheme; poor irrigation water management was a problem as I have observed.**

***Keywords:* Assosa, Golda, irrigation scheme, water management, water requirement.**

I. INTRODUCTION

Irrigation water management is the act of timing and regulating irrigation water applications in a way that will satisfy the water requirement of the crop without the waste of water, soil, plant nutrients, or energy (United States of Bureau of Reclamation, 2005). It means applying water according to crop needs in amounts that can be held in the soil available to crops and at rates consistent with the intake characteristics of the soil and the erosion hazard of the site. Irrigation water shortages can result in lower economic yields, while excessive irrigation might result in non-beneficial water use. As a result, the farm level, which refers to when and how much to irrigate, plays a crucial role (Mekonnen et al.,2022).Management is a prime factor in the success of an irrigation system. Large quantities of water, and often large labor inputs, are required for irrigation. The irrigator can realize profits from investments in irrigation equipment only if water is used efficiently. The net results of proper irrigation water management typically: Prevent excessive use of water for irrigation purposes, Prevent irrigation induced erosion, Reduce labor, Minimize pumping costs, Maintain or improve quality of ground water and downstream surface water, Increase crop biomass yield and product quality.

Tools, aids, practices and programs to assist the irrigator in applying proper irrigation water management include: Applying the use of water budgets or balances to identify potential water application improvements, Applying the knowledge of soil characteristics for water release, allowable irrigation application rates, available water capacity, and water table depths; Applying the knowledge of crop characteristics for water use rates, growth characteristics, yield and quality, rooting depths, and allowable plant moisture stress levels; Water delivery schedule effects, Water flow measurement for on field water management, Irrigation scheduling techniques, Irrigation system evaluation techniques. Miss management of available water for irrigation, both at system and farm level has led to a range of problems and further aggravated water

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availability and has reduced the benefits of irrigation investments (FAO, 1996).Poor irrigation water management associated with water scarcity is the major reason for underperformance of most small-scale irrigation schemes in Ethiopia (Fissahaye et al., 2017).To solve irrigation water management problem; appropriate irrigation scheduling practices could lead to increased yields and greater profit for farmers, significant water savings, reduced environmental impacts of irrigation and improved sustainability of irrigated agriculture (Smith et al., 1996). Irrigation scheduling is an important irrigation management issues for maximizing production efficiency. The objective of this study was to evaluate on field irrigation water management of Golda small scale irrigation which is found at Assosa, north-west Ethiopia.

II. MATERIAL AND METHOD

2.1. Description of Golda small scale irrigation scheme

Golda small scale irrigation scheme is located at a distance of about 18km from Assosa to the west direction, the capital city of the region. Golda catchment lies between Latitude $9^0$50'25.77" and $9^0$56'58.2"N and Longitude $34^0$33'4.7"and $34^0$38'35.5"E. It has an area of about 53km^2. It is characterized by mountainous land in its southern boundary and the rest of the area up to the point of the diversion is flat land with smaller areas bordering the river having moderate to steep slopes. The Golda River descends to 160m in 10 kilometers with an average slope of 0.016m/m. Cultivation is limited to the areas adjacent to the river in Gambashire Kebele. Other areas between the foot of the mountains and the kebele are covered with grass and bamboo forests. The mountains are also covered with tree forests. No flow gauging station had been installed on the Golda river to-date to measure the flows.

Figure 2.1: Diversion weir of Golda small scale irrigation scheme

2.2. Data collection and analysis

In this study both secondary and primary sources was used. Soil samples using auger at 30 cm depth intervals from the surface up to maximum rooting depth of the crop (0-30, 30-60, 60-90 & 90-120cm) for the determination of BD, texture, FC, PWP, and soil moisture content, organic matter content, soil pH, total nitrogen and available phosphorus. Soil moisture before and after irrigation was determined by gravimetric estimation/oven dry method.

Figure2.2: soil moisture measurements after and before oven dry

Climatic data like minimum and maximum temperature, minimum and maximum rainfall, relative humidity, sunshine hours and wind speed at two meter height was collected from Assosa agricultural research center metrological station which were inputs for the determination of reference evapotranspiration. After determination of reference evapotranspiration and necessary input data for CROPWAT 8.0 model; the crop water requirement and irrigation water requirement were determined. Observations were made how farmers control and manage irrigation water during irrigation events.

Infiltration rate

An infiltration characteristic of the soil was determined using double ring inifiltro meter. The maximum infiltration rate was used for crop water requirement, irrigation water requirement and irrigation scheduling calculation in the CROP WAT 8.0 software.

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Figure2.3: Infiltration rate determination Golda small scale irrigation scheme

Organic matter content, total nitrogen and available phosphorus

Applying organic matter is one of the best methods in achieving and maintaining a fertile soil for this improves the cohesiveness of the soil, increases its water retention capacity and promotes a stable aggregate structure (Morgan,1986).Titration method was used. Sadras et al.(no date) suggested that nutrient availability, particularly nitrogen and phosphorus, are critical to high yield and water productivity. Total Nitrogen was determined by Kjeldhal method in the laboratory. Available phosphorus was determined by Olsen method which is sodium bicarbonate method.

Irrigation efficiencies

The common efficiency terms used for on-field irrigation system evaluation include application efficiency, storage efficiency, uniformity and adequacy; and recently complementary terms such as runoff ratio, deep percolation ratio, etc. are being applied (Jurriens et al., 2001).The primary on field water management indicators are application efficiency, storage efficiency and distribution uniformity (Michael, 1997). Even though, on-field water management could be evaluated in different indicators, I have used application efficiency, storage efficiency and distribution uniformity in this study.

III. RESULT AND DISCUSSION

Soil pH and nutrient contents

The soil pH, organic matter (OM), total nitrogen (N) and available phosphorus (P) in each canal reaches of the irrigation scheme were analyzed. For the interpretation of the result, Frank (1990) soil analytical data results interpretation range was used. Average OM at head and middle reaches of the canal were 0.27 and 0.16 which were very low and at tail reach of the canal was 2.54 which was low in the range of (<2) and (2-5) respectively. There for, the fertility status of the area should be improved by adding crop residues and compost which can be increase the organic matter content of the soil.

Average soil pH was 5.5 to 5.6 for the three canal reaches of the irrigation scheme which was medium acid in the range of (5.3-6). Average N at head and middle canal reaches were 2 and 1.2 which were very high and at tail reach 0.12 which was medium in the range of (>0.3) and (0.125-0.225) respectively. Average available Phosphorus at head and tail canal reaches were 3.45 and 3.15 which were very low and at middle 6.8 which was low in the range of (<5) and (5-8) respectively. This deficiency of P indicates that the area has a response for phosphorous fertilizer so that framers should be applying P fertilizer in the recommended rate.

Soil infiltration rate

In the study area, the basic infiltration rate was 0.72cm/hour which was attained after 150 minutes. Even though, the soil type of the study area was clay, the result was higher than the recommended value of FAO (2001), which is basic infiltration rate for clay soil is 0.1- 0.5cm/hour. The reason might be infiltration testing time, there was high temperature but this could not be the correct reason might be other factors. For the determination of crop water requirement using the CROPWAT 8.0 model, the maximum recommended value of the basic infiltration rate for clay soil, 0.5cm/hour was used.

Crop water and irrigation water requirements

Crop water and irrigation water requirements were calculated using CROPWAT 8.0 model. The total seasonal crop water requirement maize, onion, tomato, potato and pepper were 536.4, 621.6, 535.1, 600.3 and 555mm respectively. The total seasonal net irrigation requirements were 444.2, 577, 507, 484 and 454 for maize, onion, tomato, potato and pepper respectively. The variation of seasonal crop water and irrigation water requirements for the irrigated crops in the study area was shownin (Figure 3.1).

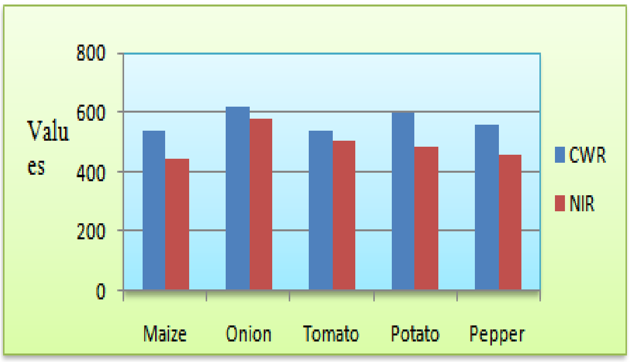

Figure 3.1: Variation of crop water and irrigation water requirement of the irrigation scheme

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Irrigation scheduling
The farmers practiced and calculated irrigation intervals were varied in some crops as indicated in (Table 3.1). Farmers were applying the same irrigation interval in each growth stage of the irrigated crop but crops are required different amount of water at different irrigation interval within each growth stage. But crops require different irrigation interval in each growth stage because requirement of water is depends on growth stage and other factors. As a result of applied the same irrigation interval throughout the growth stage, irrigated crop production would have declined.

Table 3.1: Farmers practiced and calculated irrigation intervals in the irrigation scheme

S. N o	Irrigate d crops	Farmers practiced irrigationintervals(d ays)	Calculated irrigationintervals(d ays) at peak period
1	Maize	7	9
2	Onion	3-4	4
3	Tomat o	3-4	4
4	Potato	3-4	5
5	Pepper	3-4	6

Figure3.2: water stressed and poor on field water management at onion irrigation field

Irrigated crop of the scheme
The total area irrigated of the scheme was only 51 ha but the scheme was designed for the total irrigable command area of 62ha.This was indicated that about 18% of the designed irrigable area was out of production. The type of crops which were cultivated by the irrigation scheme users were shown in (Table 3.2). Maize was the most dominant irrigated crop in the irrigation scheme which accounts about 36.27% from the total area coverage. Secondly 21.10% from the total irrigated area was covered by onion and Chat was covered a smallest irrigated area which was 1.96%. A bout 62.733% of the total irrigated area was covered by horticultural crops which was good, because it is advisable to cultivate horticultural crops by irrigation to be effective in productivity. As a result of out of 18% of the design command area out of production, there was no computation of irrigation rotation.

Table 3.2: Irrigated crops and their area coverage in the irrigation scheme

S. No	Irrigated crops	Area coverage (ha)	Percentage from the total area (%)
1	Maize	18.50	36.27
2	Onion	10.75	21.10
3	Tomato	6.00	11.76
4	Potato	4.50	8.82
5	Pepper	3.50	6.86
6	Cabbage	2.50	4.90
7	Carrot	2.25	4.41
8	Banana	2.00	3.92
9	Chat	1.00	1.96
Total		51	100

Application efficiency
The application efficiency is a measure of water application in the field. It also termed as farm efficiency as it takes into account water lost in application at the farm. Irrigation management can improve efficiency by 5-20% by applying the right depth of water in the right place at the right time. The average application of efficiency was 51.6%. Irrigation users were applying excess amount of water to their fields without considering the water requirement of the crop. From the result as I have seen, the distances of the irrigation field from water source never limit the users to apply excess amount of water.

Storage Efficiency
The adequacy of an irrigation event is expressed in terms of water requirement (storage efficiency). Storage efficiency has the advantage to know the applied irrigation water is satisfied the moisture deficit of the crop root zone. It is the most directly related to the crop yield since it will reflect the degree of soil moisture stress. Usually, under- irrigation in high probability rain fall areas is a good practice to conserve water but the degree of under-irrigation is a difficult

question to answer at the farm level (Walker, 1987). The storage efficiency was 91.6% which means around 8.4 % of the water was lost due to different resean.

Distribution uniformity

The distribution efficiency shows how the applied irrigation water was evenly distributed to the crop. It was 80.76% which means this much of water was distributed evenly.

IV. CONCLUSION

Supporting by irrigation experts; the scheme requires proper irrigation water management like irrigation scheduling: applying the required amount of water at the right time that could increase application efficiency. The organic matter content and available phosphorous deficiency should be improved by mulching with crop residues, using compost and applying the recommended phosphorous fertilizer that could increase on field water management performance of the scheme. The Irrigation scheme's users should produce more than once per year to get high production that could increase gross return of the investment. Generally, in Golda small scale irrigation scheme irrigation users did not have sense of ownership for the scheme; poor irrigation water management was a problem as I have observed.

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