Performance Evaluation of the Irrigation System in Lower Kabul River Basin, Afghanistan

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INTRODUCTION

Agriculture sector is the backbone of Afghanistan's economy which makes up around 22% of its GDP. Because of the complex terrain of the country, the arable land is only12% of the total area out of which 70% is solely occupied by wheat crop. Being a cereal deficit country, Afghanistan depends on food imports from neighboring countries to meet the growing population's food demand; the reason behind insufficient food production is the poor land and water productivity at the conventional farming system across the country.

As a physical water scarce country, the insufficient rainfall does not meet the local crops' water demand. The growing water scarcity problems in the region have not only limited the availability of water for existing agriculture but have also partly restricted the expansion of irrigated land area. Prior to any irrigation water management and development initiative taken, it is vital to evaluate the existing situation of the on-farm irrigation system of the Kabul River Basin (KRB). Through this study we assessed the irrigation performance by using irrigation application efficiency as the key indicator under the conventional irrigation system in the lower reaches of the KRB.

OBJECTIVE

To assess the performance evaluation of the Attawor irrigation scheme, located at Lower Kabul River Basin (KRB) of Afghanistan.

STUDY SITE

This study was carried out in Attawor Irrigation Scheme (AIS) which is located in the Nangarhar province of Afghanistan. The study area lies at the lower reaches of the Kabul River Basin (KRB) and constitute the North-western upstream of the Indus Basin.

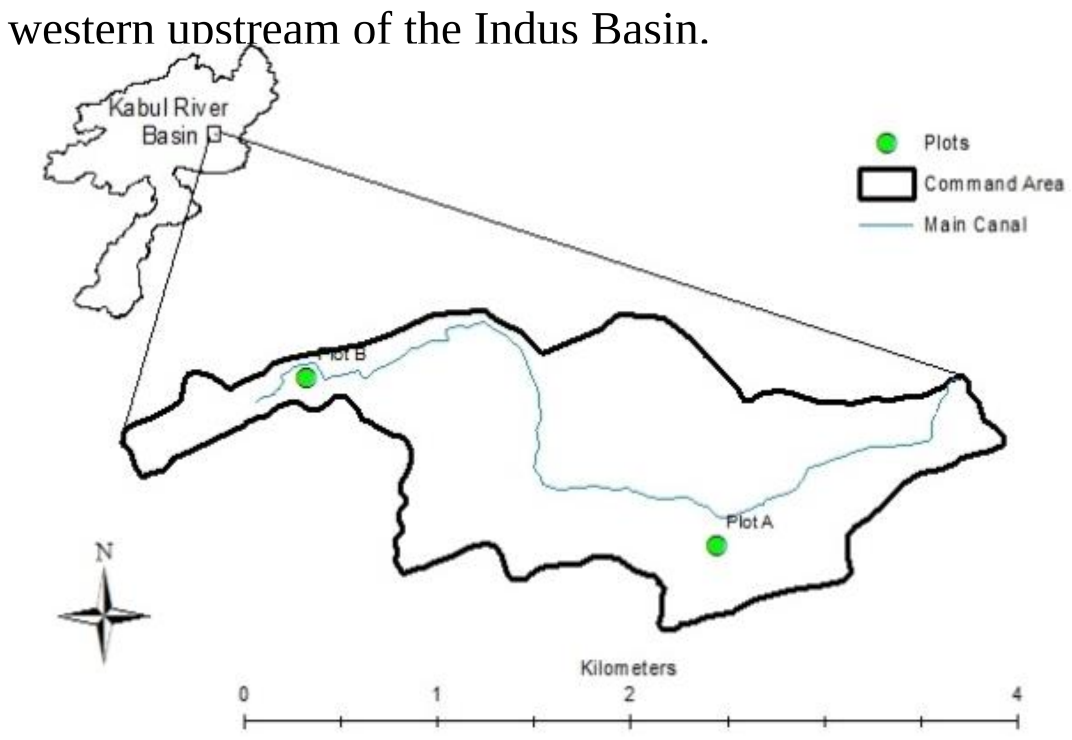


Figure 1: Location of the study area in the KRB

The Kabul River Basin consists of around 450,000 ha of irrigated area and hosts around one third of the country's total population. The KRB provides water for agricultural, industrial as well as municipal needs of its inhabitants. The area is characterized by hot summers and mild winters as the temperature rises up to 45 C^0 in summer and falls down to 2 C^0 in winter. The mean annual rainfall in the study region is about 150mm and agriculture is dependent upon irrigation completely or otherwise intermittently during rainy days.

Attawor irrigation scheme takes its supply from Kunar river and have a command area of 260 ha, out of which 200 ha is cultivated and the remaining 60 ha remain uncultivated.

Two experimental fields were selected for assessing the conventional irrigation practices along the canal. The two experimental fields hereinafter called Plot A(3,598 m^2) and Plot B (4,133 m^2) were selected in the head and tail of the canal respectively. Both Plots have a water source from Attawor irrigation scheme.

MATERIALS AND METHODS

Irrigation Application Efficiency

Irrigation application efficiency (AE) was used as the key indicator to assess the irrigation performance at field level. AE assessment gives an idea of how well, and how efficient the target irrigation depth is being achieved, and how it satisfies the required irrigation depth being in place at Attawor Irrigation scheme.

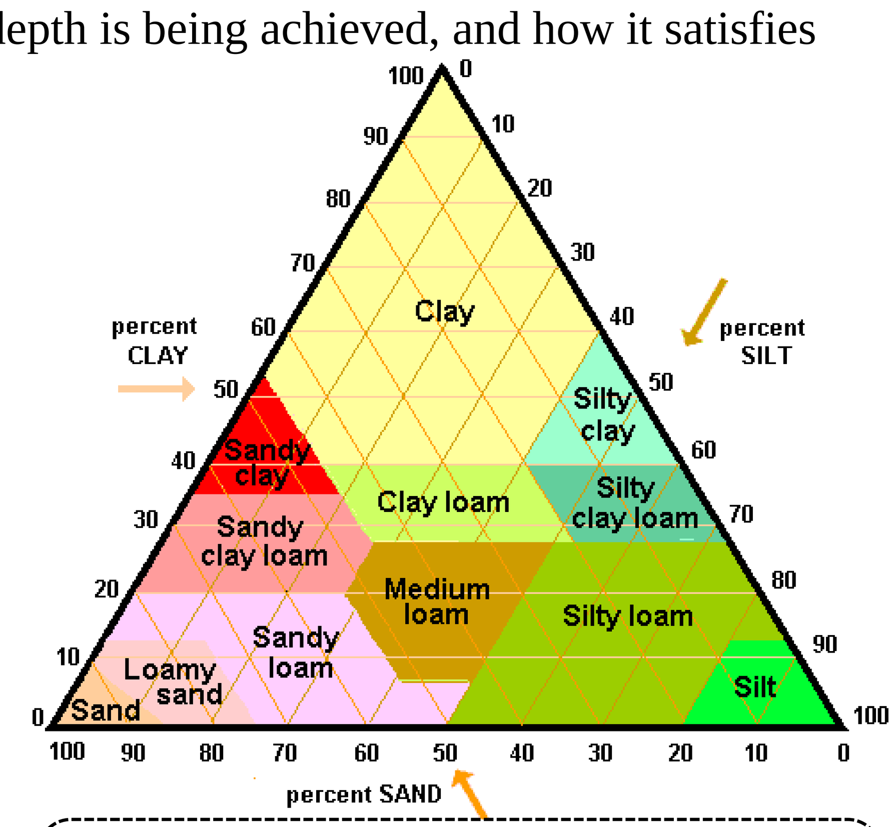
$$AE = \frac{Vs}{Vf}\ 100$$

In the above equation,
AE represents the application efficiency, while Vs is the amount of water stored in the root zone for crop use and Vf is the total application of water to the field.

Discharge Measurement

$$\boldsymbol{Q} = C_f \times H_u^{nf}$$

In the above equation,
Q is water discharge in cubic feet per second (CFS)
Cf is the free flow coefficient (4.33)
Hu is the upstream flume reading (ft)
nf is the free flow exponent (1.811)



USDA soil texture calculator was used to diagnose the soil types of both the experimental plots

Soil moisture content determination

$$\boldsymbol{\theta} = \frac{(\text{wt of wet soil} + \text{wt of can}) - (\text{wt of dry soil} + \text{wt of can})}{(\text{wt of dry soil} + \text{wt of can}) - (\text{wt of can})}$$

RESULTS

Soil Texture Analysis

Table 1: Soil texture analysis of Plot (A)

Soil Depth (cm)	sand	silt	clay	type of soil	Organic Matter (% weight)	Bulk Density g/cm³	Saturation (%volume)	Field Capacity (%Volume)	Wilting Point (% volume)
0-20	45%	24%	25%	Loam	6%	1.25	52.9	32.7	18.5
20-60	38%	29%	28%	clay Loam	5%	1.28	51.6	32.5	17.8
60-80	34%	30%	33%	clay Loam	3%	1.38	47.8	34.8	21
80-100	28%	30%	40%	Clay	2%	1.38	47.8	37.8	24.3
Average	36%	28%	32%	clay Loam	4%	1.3225	50.025	34.45	20.4

Table 2: Soil texture analysis of Plot (B)

Soil Depth (cm)	sand	silt	clay	type of soil	Organic Matter (% weight)	Bulk Density g/cm3	Saturation (%volume)	Field Capacity (%Volume)	Wilting Point (% volume)
0-20	47%	23%	23%	Loam	7%	1.18	55.4	32.8	18.1
20-60	35%	30%	30%	Clay Loam	5%	1.28	51.7	34.9	20.2
60-80	32%	30%	35%	clay Loam	3%	1.37	48.2	35.8	22
80-100	30%	25%	42%	clay	3%	1.36	48.7	38.7	25.7
Average	36%	27%	33%	clay Loam	5%	1.2975	51	35.55	21.5

Conventional Irrigation Schedule

Table 3: Conventional Irrigation Schedule at both plots

No of irrigation	Plot A			Plot B		
	Date	DAS	ΔS (mm)	Date	DAS	ΔS (mm)
1st Irrigation	1-Dec-16	22	148	5-Dec-16	26	78
2nd Irrigation	28-Dec-16	49	56	31-Dec-16	52	85
3rd Irrigation	25-Jan-17	77	79	22-Jan-17	74	62
4th Irrigation	22-Feb-17	105	83	18-Feb-17	101	66
5th Irrigation	22-Mar-17	133	87	15-Mar-17	126	75
6th Irrigation	17-Apr-17	159	89	14-Apr-17	156	106

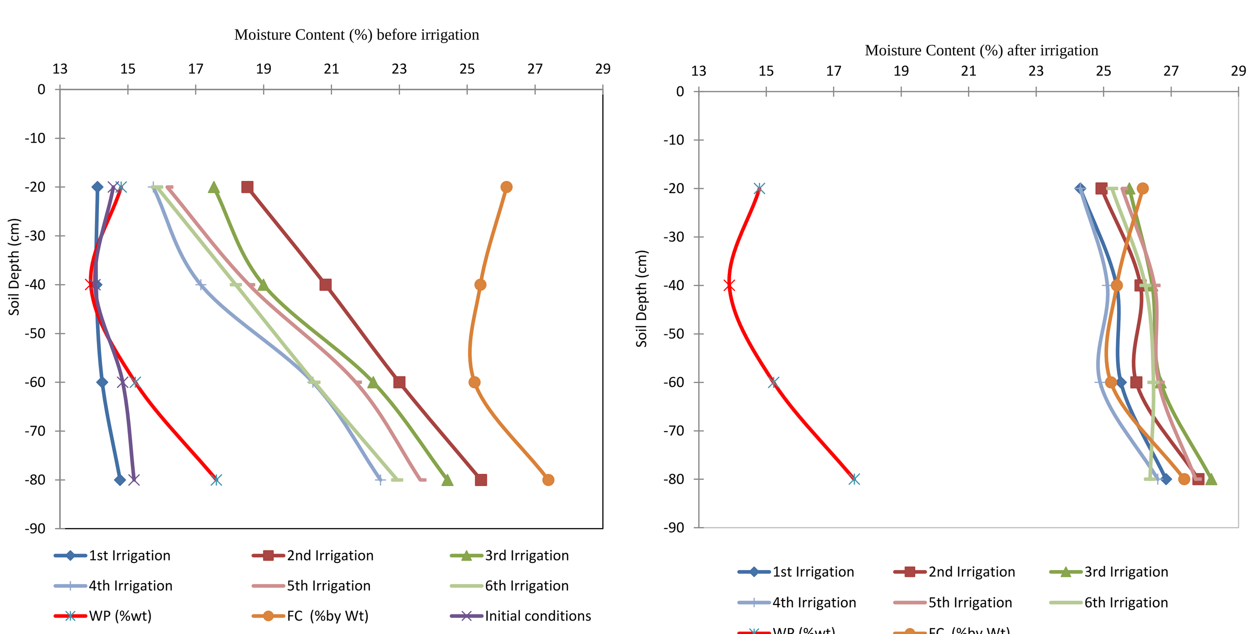


Figure 3:Siol moisture content before and after irrigation (Plot A)

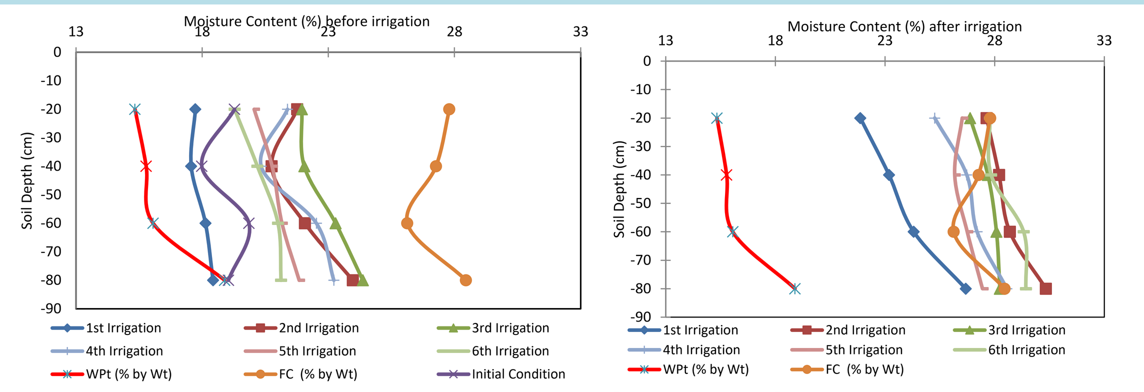


Figure 4:Siol moisture content before and after irrigation (Plot B)

Irrigation Application Efficiency

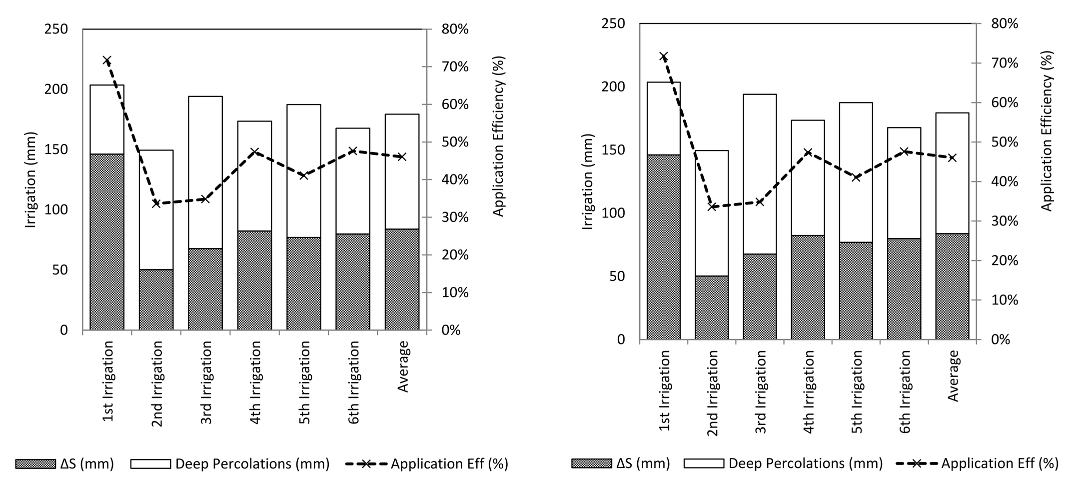


Figure 5:Application Efficiency at Plot (A) and Plot (B)

CONCLUSION

The conventional irrigation system in the research area is subjected to severe application losses; Moreover, the farmers know less about the timing and irrigation application is supply-based rather than demand-basis. The existing status of on-farm irrigation at the study area shows that there is great potential for water saving within the irrigation networks provided some technological interventions, infrastructural development and social awareness are made to reach the targeted food security status of the landlocked and war-hit country.

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