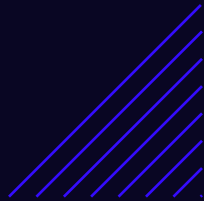


# **Impact of Modern Agricultural Techniques on Sustainability of Groundwater and Enhancing Field Crops Production in Dhamar**

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## Introduction

Yemen water scarcity form a major constrain that obstacle realizing of national strategic development plans' goals. Its water resources limitation threaten the future of the coming generations. Annual per capita of water share decreased to record ( $115\text{m}^3/\text{year}$ ) which consider as one of the lowest per capita at international level where the average per capita is estimated of ( $1200\text{m}^3/\text{year}$ ) (IWMI 2007).

The gap between annual water resources (2.5BCM) and annual water consumption (3.4BCM) is estimated of (0.9BCM) which considered as annual groundwater depletion, as a negative consequence, groundwater table level declines rapidly in many basins.

Irrigated agriculture consumes more than 80% of annual groundwater abstracted

Because most of irrigated areas still depend on traditional methods of low efficiency (35%), Yemen governmental water sectors as Ministry of Agriculture and Irrigation (MAI) and Ministry of Water and Environment (MWE) make great efforts to reduce groundwater consumption for agricultural sectors. As example, National Irrigation Program (NIP-MAI) targeted to cover total areas of (1250) hectares by subsidized drip irrigation systems in Amran, Dhamar and Sana'a.

Table (1): Distribution of targeted areas to be covered in the three critical basins

Basin	Improved Conveyance Irrigation System	Modern Irrigation Systems
Sana'a	3,640	495
Dhamar	3,114	380
Amran	3,417	375
<b>Total</b>	<b>10,171</b>	<b>1,250</b>

Table (2): Distribution of areas that had been realized in the three critical basins, 2012

Basin	Improved Conveyance Irrigation System	Modern Irrigation Systems
Sana'a	1,211	109
Dhamar	734	1.4
Amran	848	3
<b>Total</b>	<b>2,793</b>	<b>113.4</b>

Table (3): Areas, yields and average crop production for tomatoes and potatoes in Dhamar

Crop	Tomatoes	Potatoes
Total Area (hectare)	2776	7992
Total Yield (ton)	35314	91313
Average crop yield (ton/hectare)	12.72118	11.42555

## **Research Objectives**

**Main research objective is to assess impact of applying modern agricultural techniques on: decrease groundwater abstraction and increase crop yield.**

**In addition, research sub- are:**

**1 - Predict the amount of irrigation water that could be conserved when applying modern agricultural techniques for cultivation of tomatoes and potatoes and crops Effect on sustainability of groundwater declining rate at level of Dhamar aquifer.**

**2 -Supporting water governmental sectors' efforts on monitoring importance of applying modern agricultural techniques by using results**

**3- objectives of this research to rise agricultural community awareness and mobilization towards adopting of modern agricultural techniques to realize increasing in crop yield with less irrigation water requirement in manner that help in sustain their groundwater resources.**

## Location Background

Dhamar province, lies 100 km south of Sana'a, where Jahran area as appear in situated near the central of Dhamar Governorate.

The total monthly rainfall for the Dhamar area in 2010 The average annual rainfall for 2010 is (395 mm) for Dhamar.. In 2006 the amount of rain is estimated to be (448 mm). The difference between both years is quite large (12%).

Jahran basin consider as the biggest basin in Dhamar governorate with an area of 195km<sup>2</sup> (19500ha) and depth of ground water between 400-1000m .

Jahran basin represents 45% of the global area of Dhamar basin. It contain about 70% of total capacity of Dhamar groundwater aquifer storage from which the annual groundwater abstraction is estimated of (181.38 mcm) with annual groundwater recharge of (86mcm) which mean that the deficit is equal to (113.38mcm) annually, which be compensated from Dhamar aquifer strategic reserves of groundwater (NIP 2009

## Research Approach

The approach of this research is built upon calculating the amount of groundwater that could be saved by using modern irrigation techniques such as improved conveyance irrigation system, drip irrigation system, greenhouse, and mulching techniques. Comparing the obtained results with the traditional furrow irrigation system mostly used in Dhamar depending on its average irrigation water requirement and average crop yield per hectare



The most two important crops in Dhamar tomatoes and potatoes were determined to be cultivated under experimental treatments as following and showing in table (5):

Table (5): Experimental treatments information

Crop	Ag. Technique	Start date	end date	season Duration	Area
				Month	m2
Tomatoes	DG	1-Jun	27-Dec	7	378
	DP	1-Jun	14-Aug	2.5	2860
Potatoes	DI	6-Jan	9-Aug	3	1200
	SI	1-Jun	24-Aug	3	2400

## Results and Discussions

**Table (6): Irrigation water use and crop production results for cultivation of tomatoes under DG and DP treatments**

Treatment	Area (m <sup>2</sup> )	Season duration (month)	IWU (m <sup>3</sup> )	Production (ton)
DG	378	7	221.518	10.08126
DP	2860	2.5	631.8	6.864

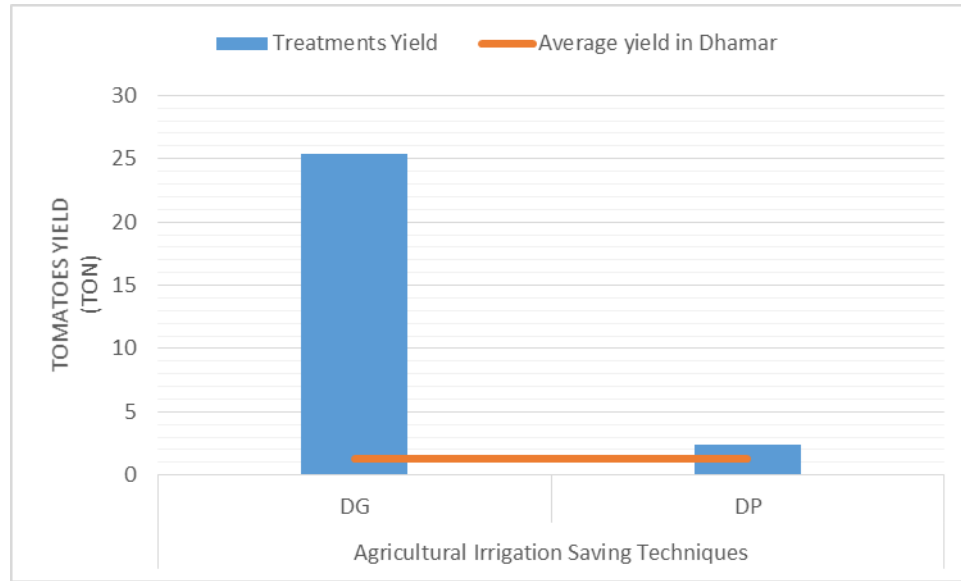
**Table (7): Irrigation water use and crop production results for cultivation of tomatoes under DG and DP treatments**

Treatment	Area (m <sup>2</sup> )	Season duration (month)	IWU (m <sup>3</sup> )	Production (ton)
DI	1200	3	599.4	3.6
SI	2400	3	2332.8	6

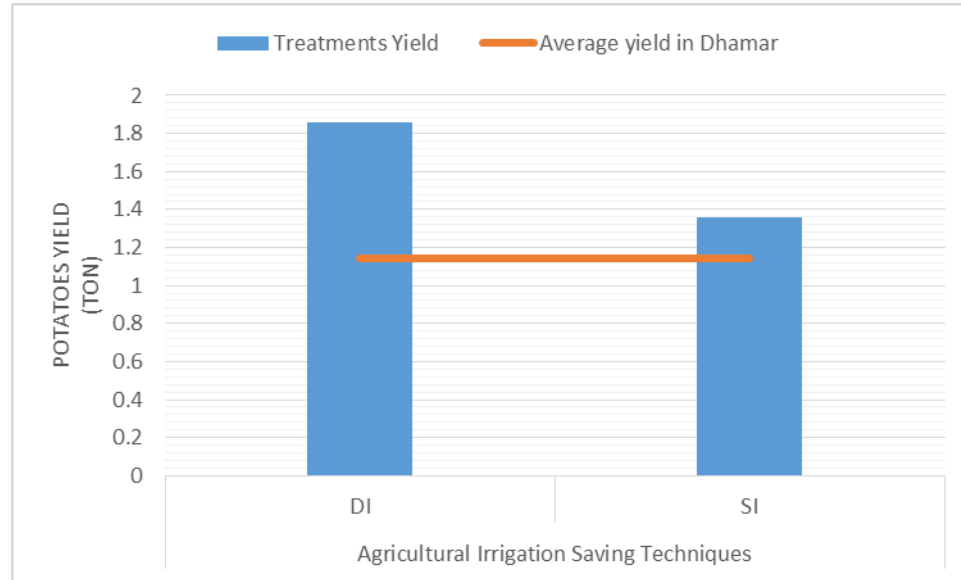
**Impact of applying modern agriculture techniques on crop yield**

Table (8): Tomatoes and potatoes yield under agricultural techniques vs average yield in Dhamar

Crop	IT	Yt		Yav		Y increasing	
		ton/area	kg/m2	ton/hect	kg/m2	k/m2	times
Tomatoes	DG	10.0812 6	26.67	12.721186	1.2721186	25.397884	19.965033
	DP	6.864	2.4			1.1278814	0.8866176
Potatoes	DI	3.6	3	11.425555	1.1425555	1.8574449	1.6256941
	SI	6	2.5			1.3574445	1.1880788



**Fig (3): Impact of agricultural irrigation saving techniques on tomatoes yield comparing with average yield in Dhamar per m2**



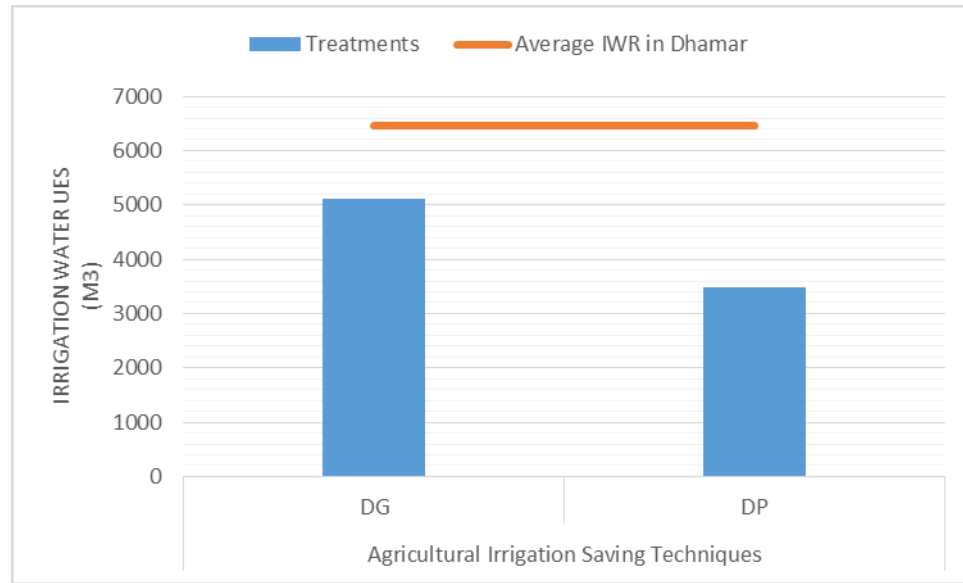
**(4): Impact of agricultural irrigation saving techniques on potatoes yield comparing with average yield in Dhamar per m<sup>2</sup>**

## **Impact of applying modern agricultural techniques on reducing irrigation water requirements**

Determine the effect of each treatment on saving of irrigation water requirement will be based on estimating the equivalent value of irrigation water required to produce the same quantity of the crop resulting from each treatment as part of the average irrigation water required to irrigate one hectare, depending on the average crop yield per hectare in Jahran.

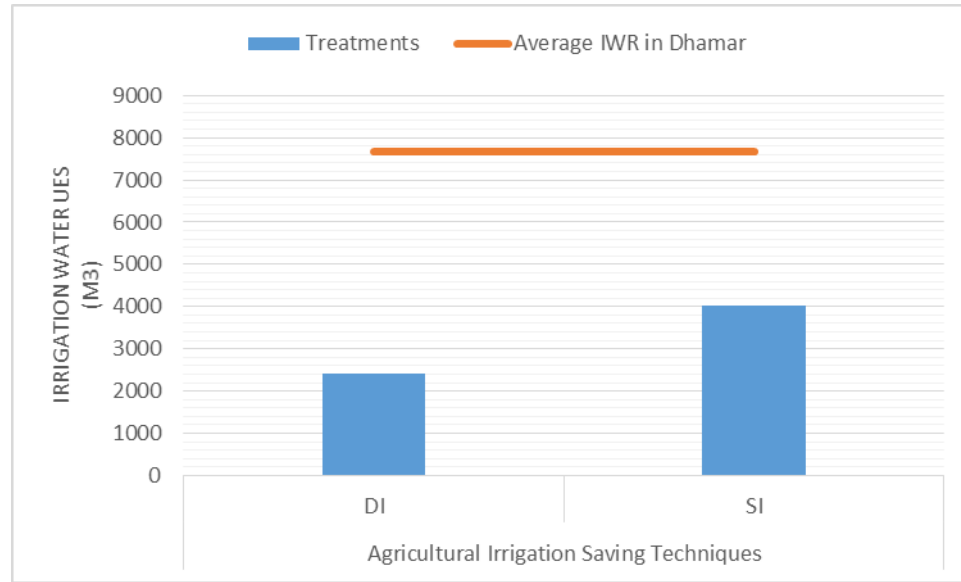
Table (9): Equivalent IWR for different agricultural techniques comparing with average IWR in Dhamar

Crop	IT	Yav	Yact	Ae	IWUa	IWUe	IWUt	IWS	IWSp
		ton/area	ton/area	m <sup>2</sup>	m <sup>3</sup> /hectare	m <sup>3</sup> /Ae	m <sup>3</sup> /At	m <sup>3</sup>	%
Tomatoes	DG	12.728	10.08126	7924.7827	6455	5115.442	221.518	4893.929	95.667
	DP		6.864	5395.7252		3482.940	631.8	2851.141	81.860
Potatoes	DI	11.425	3.6	3150.8328	7662	2414.169	599.4	1814.768	75.171
	SI		6	5251.3888		4023.614	2332.8	1690.814	42.022



**Fig (5): Impact of agricultural techniques on saving IW for tomatoes production comparing with average IWR in Dhamar**



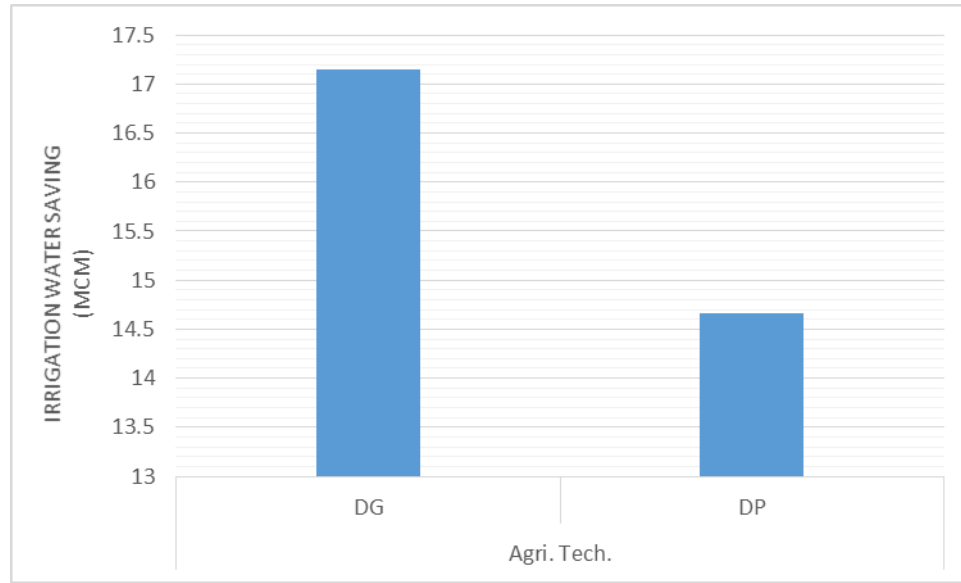


**Fig (6): Impact of agricultural techniques on saving IW for potatoes production comparing with average IWR in Dhamar**

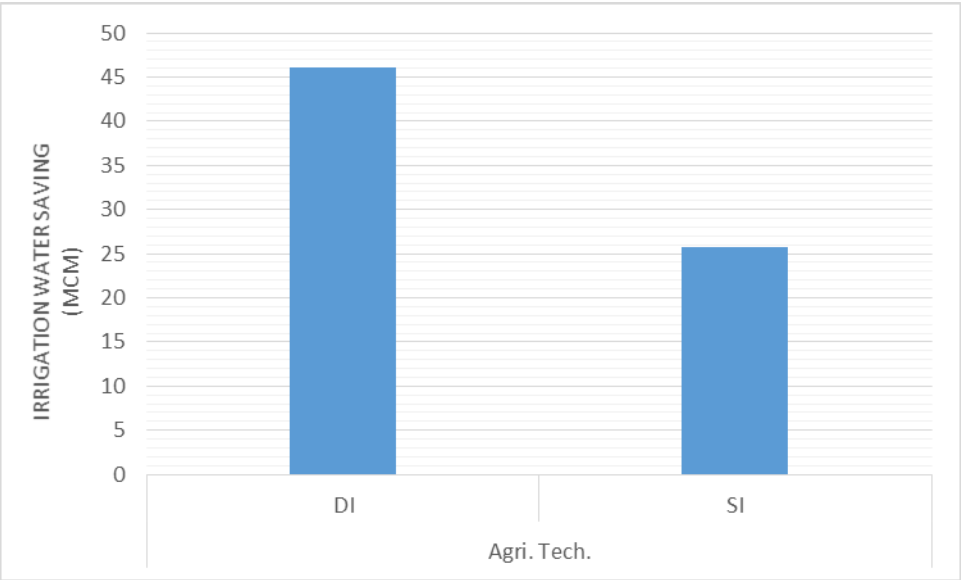
## Impact of applying modern agricultural techniques on Dhamar groundwater aquifer

Table (10): Saving in groundwater abstracted from applying different agricultural techniques to produce same annual yield of tomatoes and potatoes in Dhamar

Crop	IT	TA	IWUav	T IWUh	IWSt	T IWS
		hectare	m3/hect	m3	%	m3
Tomatoes	DG	2776	6455	17919080	95.66963	17143117
	DP				81.86016	14668587
Potatoes	DI	7992	7662	61234704	75.17157	46031090
	SI				42.02227	25732210



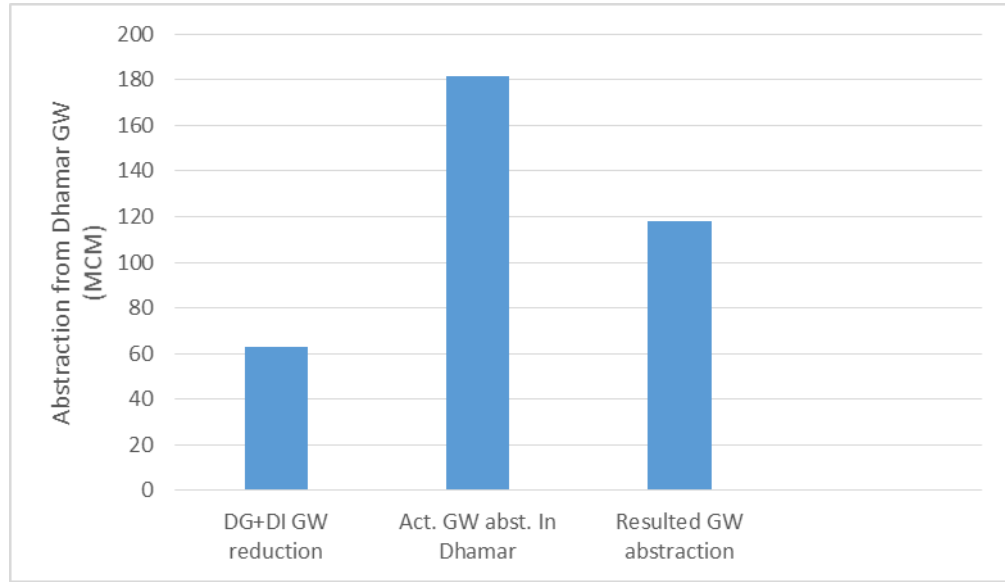
**Fig (7): Impact of agricultural techniques on saving IW used at level of total tomatoes areas in Dhamar**



**Fig (8): Impact of agricultural techniques on saving IW used at level of total potatoes areas in Dhamar**

Table (11): Reduction in annual groundwater abstraction (mcm) when applying both DG and DI techniques to produce both crops annual yield in Dhamar

Ensemble reduction in GW abstraction from depending on DG+DI	Actual GW abstraction In Dhamar	Annual GW abstraction after applying DG+DI
63.17420631	181.38	118.2058



**Fig (9): Estimating of the reduction in GW abstraction when applying DG+DI for tomatoes and potatoes to produce actual both yield in Dhamar**

**Thank You**