

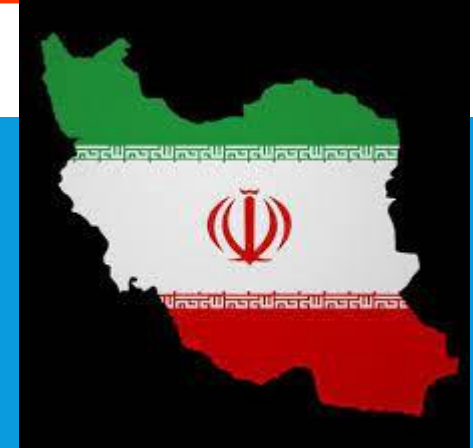
Comparison of subsurface drip irrigation and sprinkler irrigation for alfalfa in a semi-arid region of Iran.

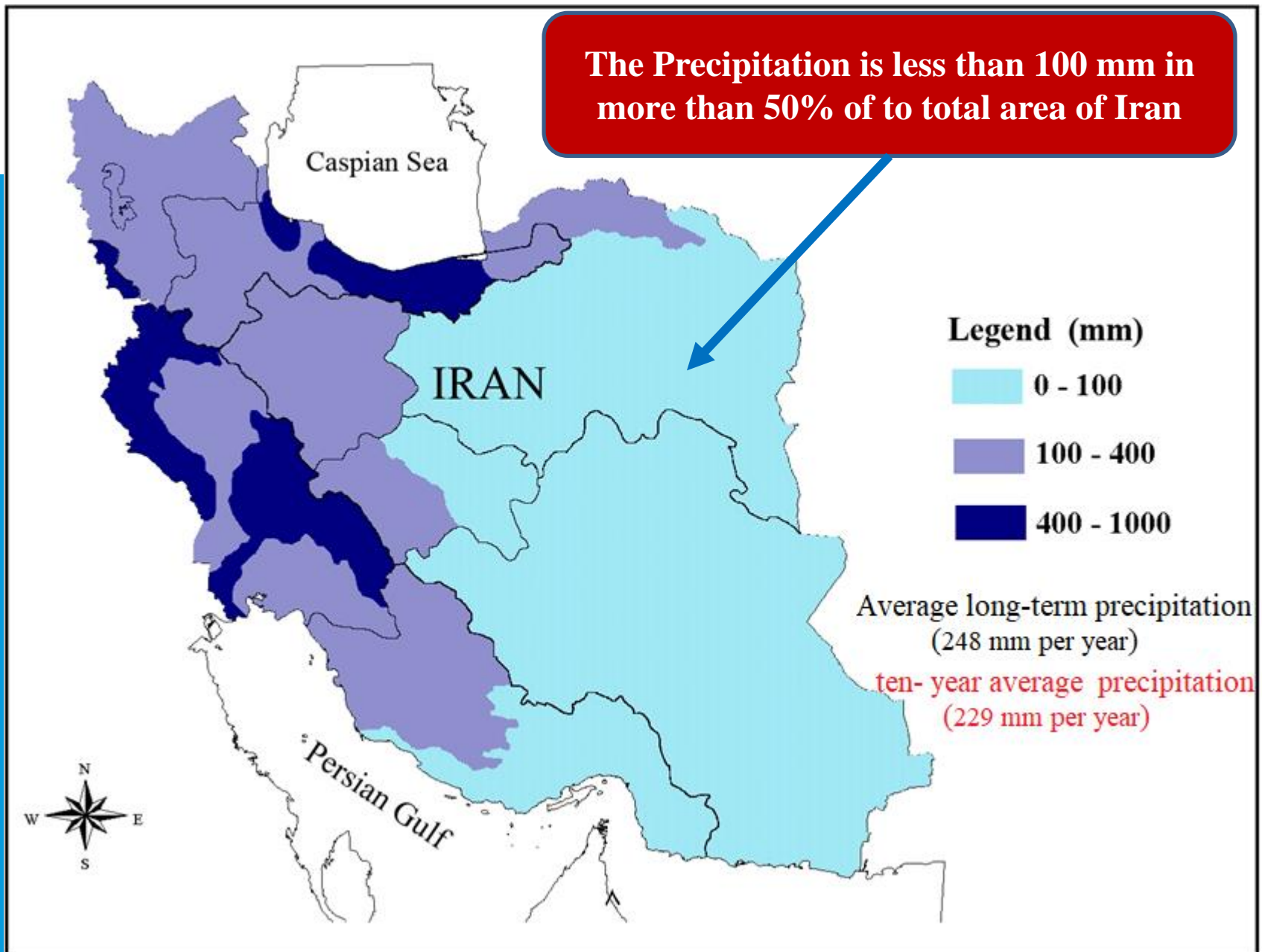
A.Ghadami Firouzabadi



IRAN

- **Climate:** Arid & semi-arid
- **Area:** 165 Mha (*18th in the world*)
- **Average long- term precipitation:** 248 mm/yr
- **average ten-year Precipitation :** 229 mm
- **Irrigated Area:** 8.7 million ha





Precipitation volume, renewable water and consumed water in agriculture

The volume of precipitation

- 334 BCM

Renewable water

- 106 BCM

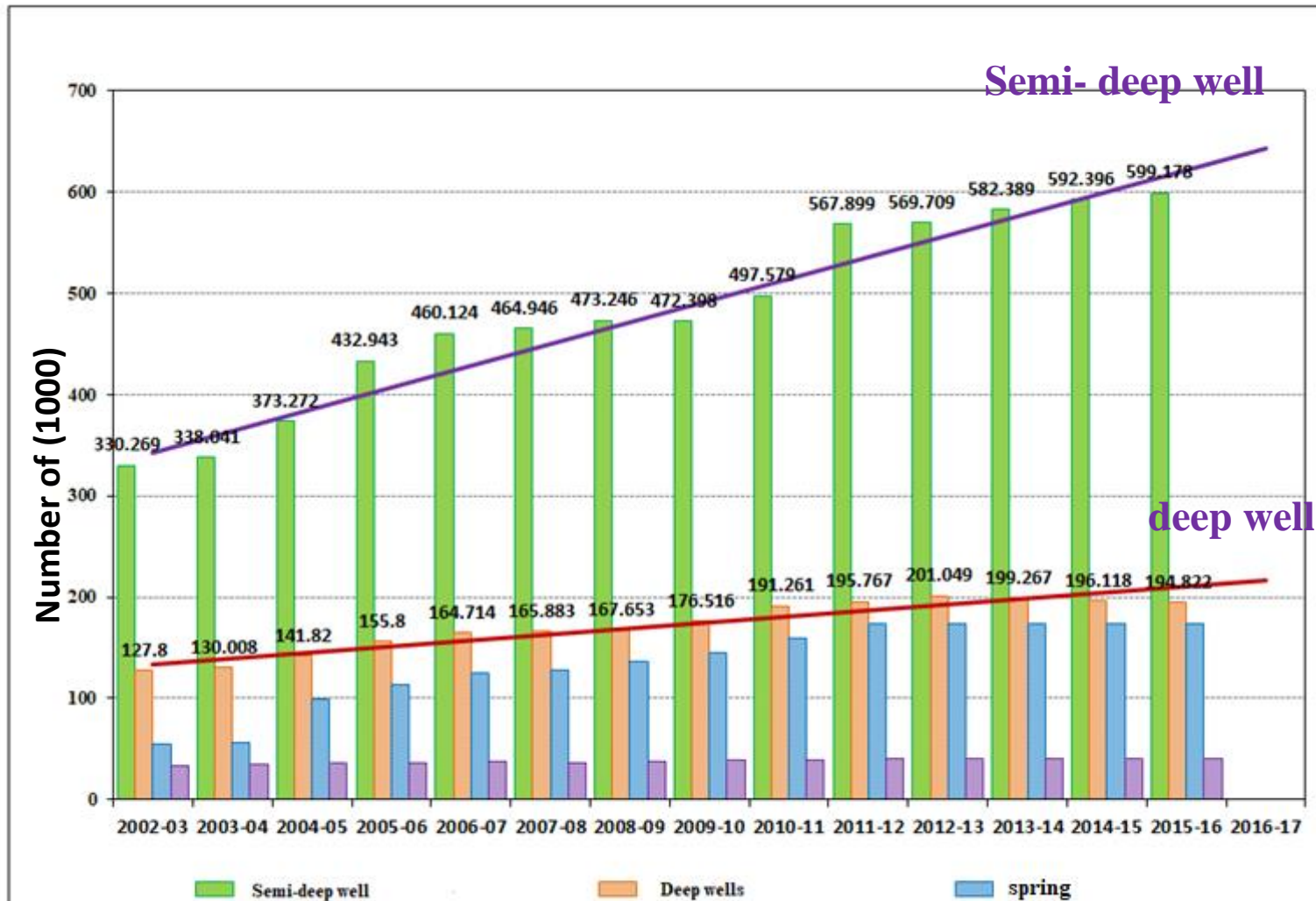
Consumed Water in agriculture

- 75 BCM

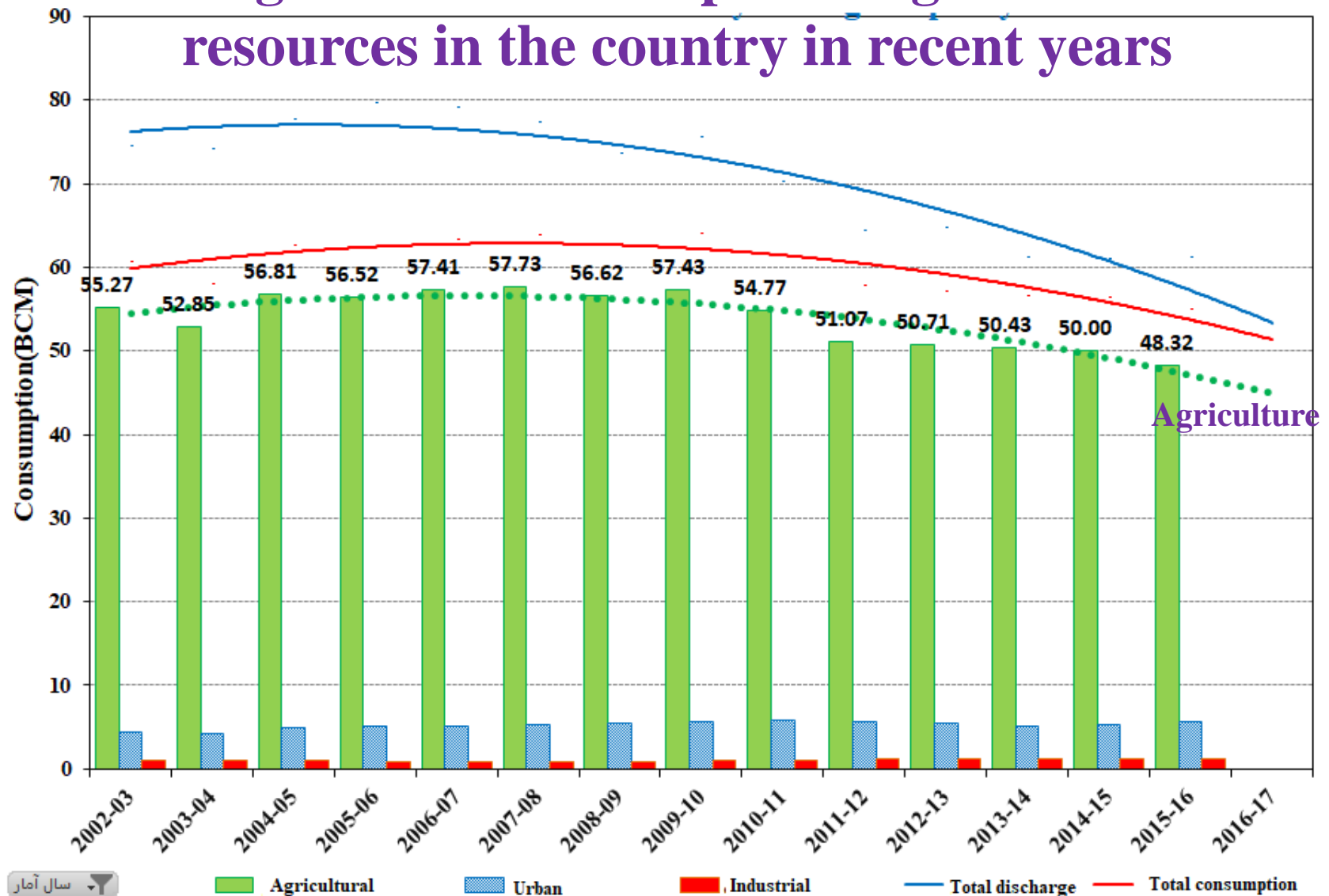
Percentage of water consumption in agriculture (surface and groundwater resources)

water source	Percentage of use in agriculture	Percentage of invested credit
Groundwater	65.5	3 – 4 %
Surface water	34.5	96 – 97 %

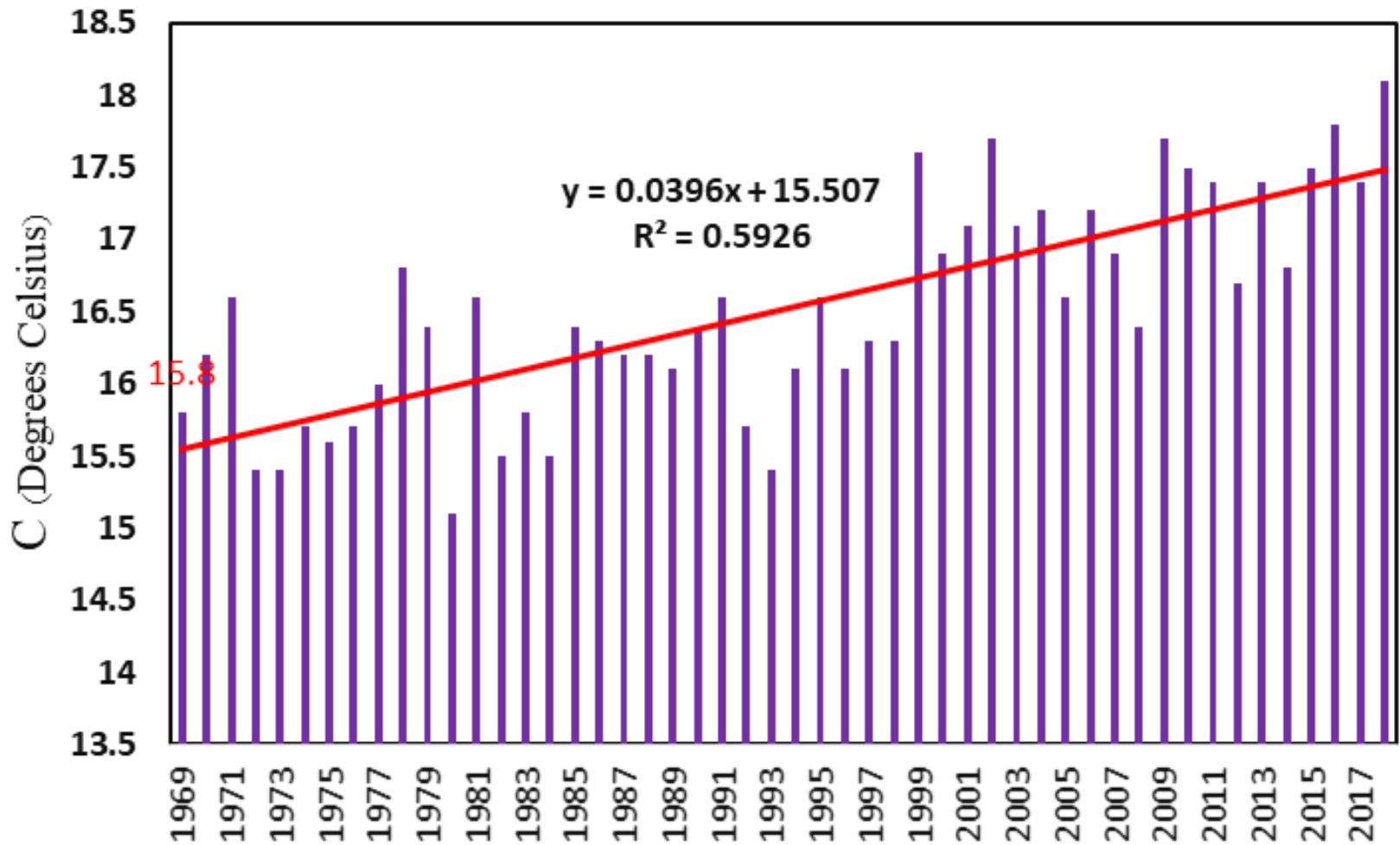
The trend of changes in the number of wells



Changes in the consumption of groundwater resources in the country in recent years



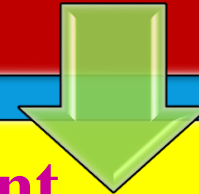
The trend of temperature changes in the country in a period of 50 years



Iran's population growth



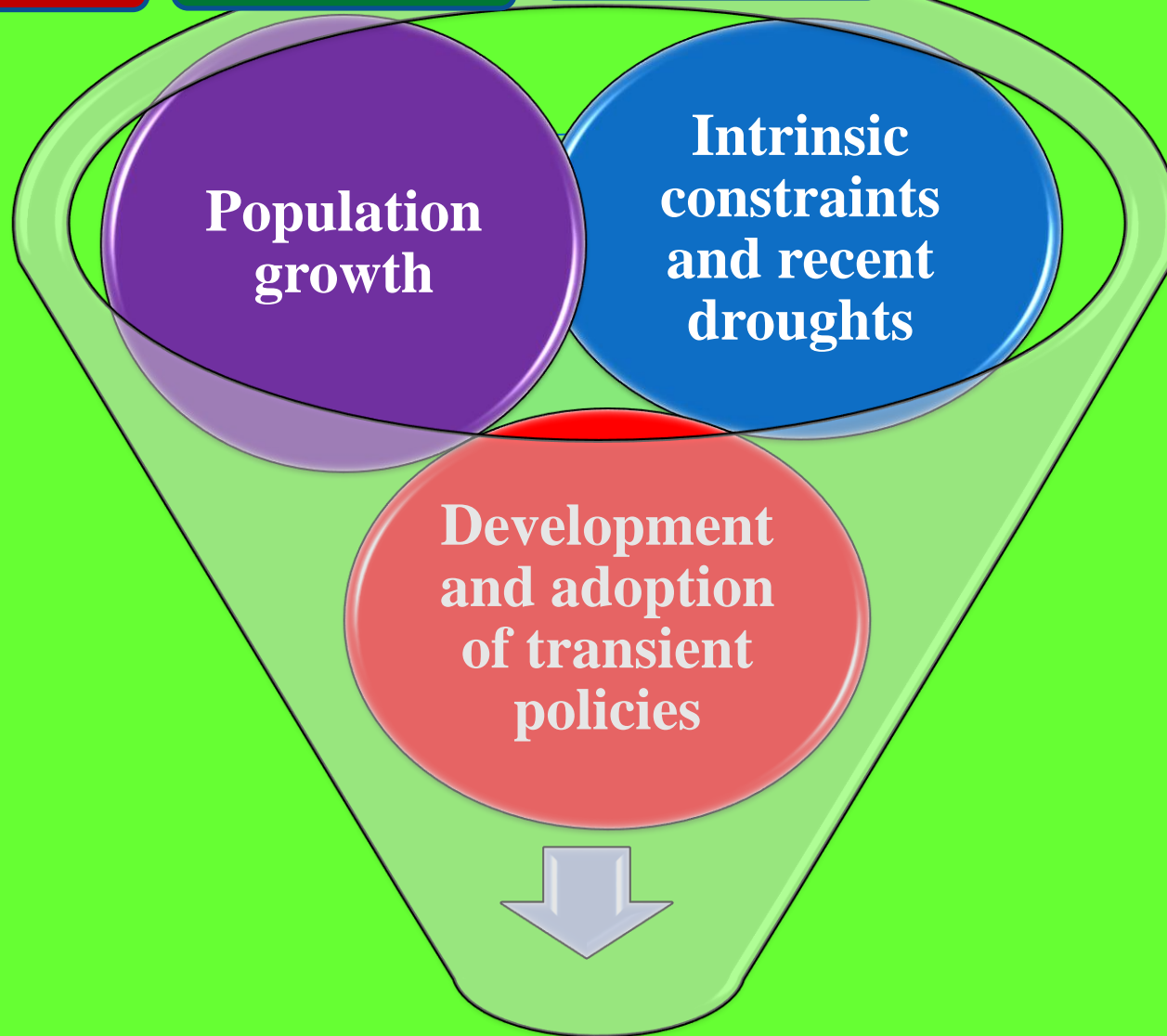
Population in 2051 (95.3million)



Increasing the needs of different sectors, increasing water consumption in urban, rural and industrial sectors

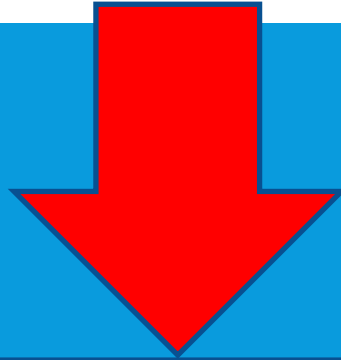


Need 130 billion cubic meters of renewable water sources



**exacerbated the water crisis and Necessity of
increasing water productivity**

One of the ways to increase water efficiency



Use of modern irrigation systems



Subsurface drip irrigation capabilities

- Reduction of **evaporation** from soil surface, **surface runoff** and **deep percolation** as a result of increasing **water use efficiency**.
- Possibility of **using effluent** in a **subsurface way**: **Reduction of pathogens**, and not transmitting the disease to **humans and animals**.
- **Relatively accurate control** of **water and nutrients** and **increase the uniform distribution** of these elements in the field

Subsurface drip irrigation capabilities

- Increase **the growth, yield and quality of some products** such as alfalfa.
- Reducing the **severity of diseases and fungi** due to reduced moisture content of the plant canopy
- Increase the efficiency **of fertilizer and pesticide use**
- **Low impact of weather restrictions** such as strong winds, **freezing temperatures**, etc. on this system

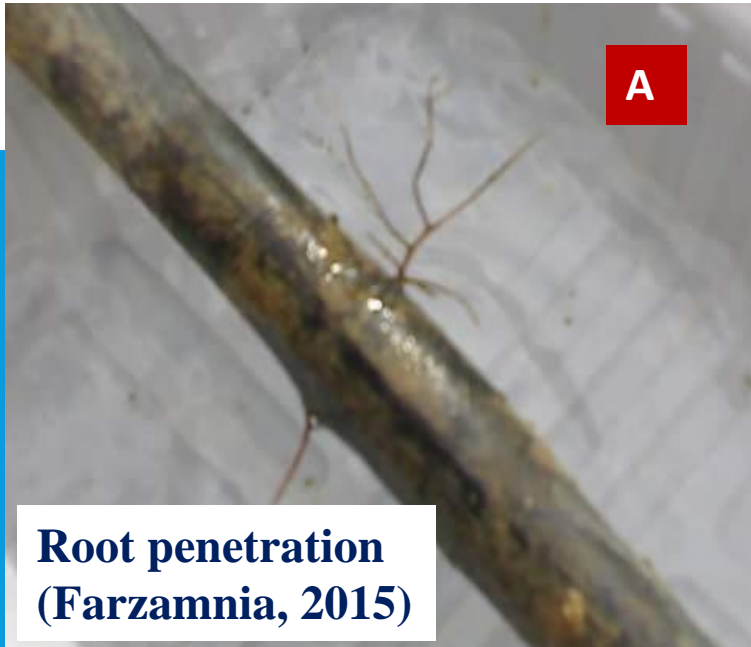
Subsurface drip irrigation capabilities

- **Less pressure** is required than a sprinkler system, so energy costs are lower.
- **Compared to sprinkler irrigation systems**, most components of the system are plastic **and are less prone to wear and tear**.
- **It has** many capabilities **for** different sizes and shapes **of the farm**.
- **There is** no need to collect and reinstall **the system at harvest time and plant another crop**

Challenges of subsurface irrigation

- **Accumulation of solutes in the surface layer of soil**
- **Drippers clogging (physical, chemical, biological)**
- **The high cost of the system**
- **Impossibility of visual inspection of dripper discharge**
- **Environmental issues due to the use of toxins**

Problems of using the subsurface drip irrigation system



**Root penetration
(Farzamnia, 2015)**



**Root accumulation
(Akbari, 2015)**



**Wetting of the soil surface
due to improper
installation depth**



**Accumulation of salt
on the surface of the soil**

Experimental site

Research location: Ekbatan station of Agriculture and Natural Resources Research and Education Center of Hamedan, located in the west of Iran.

geographical coordinates: 34° 52' 47.6" N and 48° 32' 1.6" E

Farm area: 1.44 ha

Years of research :2019- 2021

Mean annual temperature: 9.6 °C

annual precipitation :314 mm.

Elevation: 1730 m

region's climate: semi-arid

Image of the research site



Soil and Irrigation water properties

Soil texture :loam

Soil EC: 0.6 ds/m

pH: 7.3

Type of water source : well

Wilcox classification: C3S1

Chemical properties of irrigation water.

Year	EC (<u>dS m⁻¹</u>)	pH	CO3 ²⁻	CO ₃ H ⁻	CL ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	SAR
			<u>(<u>meq l⁻¹</u>)</u>							
2019	0.820	6.3	0.0	5.6	1.32	1.55	3.2	4	1.27	0.62
2020	0.780	7.3	0.0	6.6	1.8	1.7	4.2	3.0	2.6	1.3
2021	0.78	7.5	0.0	6.1	1.6	2.4	4.5	3.0	2.6	1.3

Notes: EC: Electrical conductivity; CO_3^{2-} : Carbonate; CO_3H^- : Bicarbonate; CL^- : Chlorine; SO_4^{2-} : Sulfate; Ca^{2+} : Calcium; Mg^{2+} : Magnesium; Na^+ : Sodium; SAR: Sodium Absorption Ratio.

Treatments

included :

- **A1: subsurface drip irrigation without Trifluralin injection** (PC. AS (Anti Siphone))
- **A2: subsurface irrigation with Trifluralin injection at 4 lit/ha** (PC. AS (Anti Siphone))
- **A3: subsurface irrigation with Trifluralin injection at 6 lit/ha** (PC. AS (Anti Siphone))
- **A4: Subsurface irrigation without Trifluralin injection** (PC . ND (Non Drain))
- **S: a classic fixed sprinkler treatment (control)**

The initial stages of implementing the Irrigation system



Tools used to install subsurface drip irrigation pipes



Details of subsurface drip

Depth of pipes placement : 40 cm

The distance between the laterals : 50 cm

Distance between drippers: 40 cm.

Diameter of pipes: 16 mm

Q(lit/hour): 1.6 lit/hour

Crop planting

Planting date: 17 May 2019

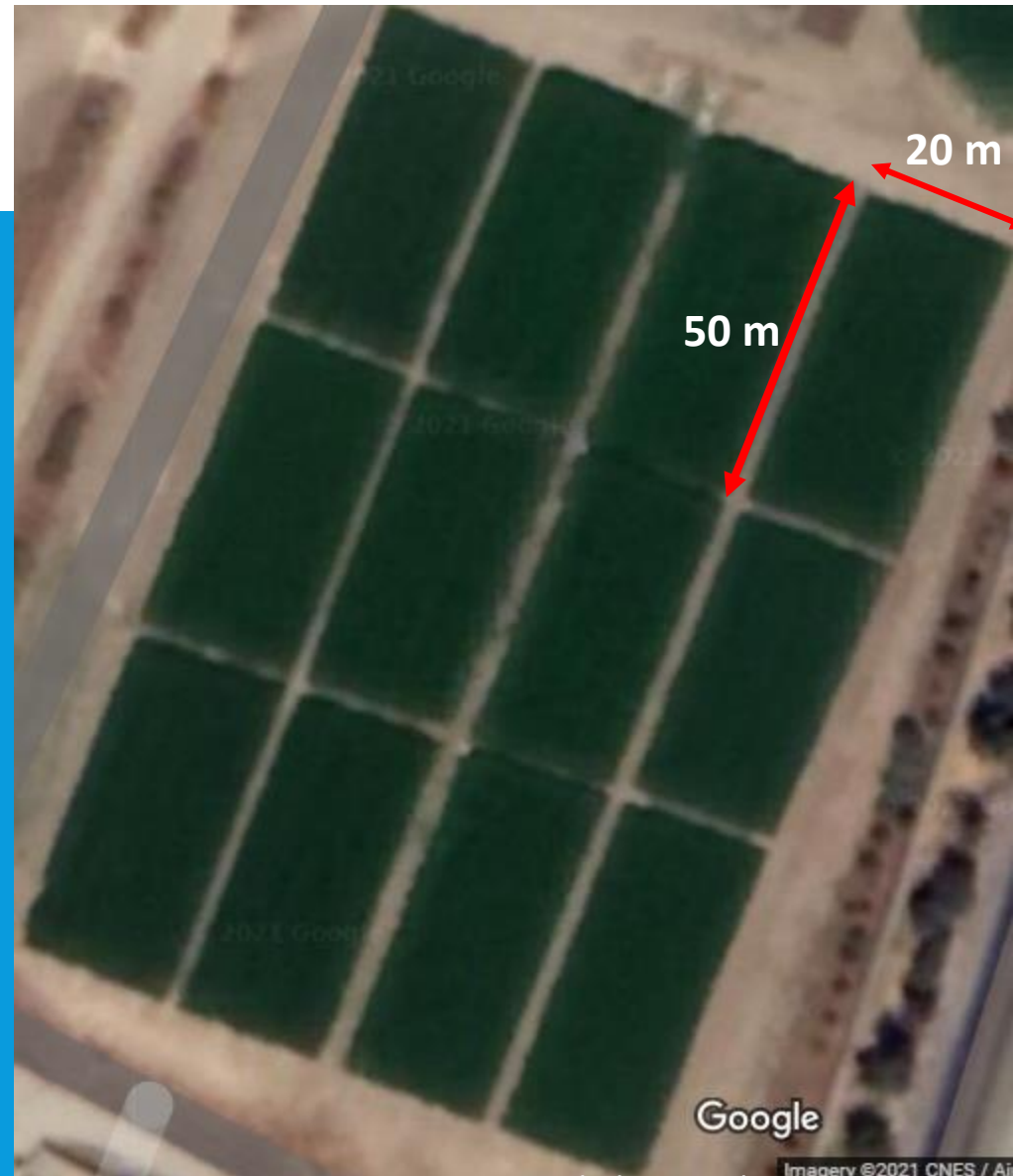
crop was planted :by alfalfa machine

Seed consumption per hectare:50 kg/ha

**Germination and emergence took place
one week after planting.**



- The length and width of each plot were 50 and 20 meters, respectively.
- In Trifluralin injection: in three stages (mid-April, mid-July and mid-October)



Water requirement & Leaching requirements

Water requirement and Leaching requirements were calculated using the following formulas

$$T_c = ET_c * (P_s + 0.15(1 - P_s))$$

$$ET_c = K_c * ET_0$$

Sprinkler Irrigation

$$LR = 100 * \frac{EC_{iw}}{5 * EC_e - EC_{iw}}$$

Trickle Irrigation

$$LR = 100 * \frac{EC_{iw}}{2 * EC_{e\ max}}$$

View of the alfalfa farm



In this photo, you see a view of a alfalfa farm(subsurface Irrigation)
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Evaluation of subsurface drip irrigation system



In every year, At the end of the growing season, Uniformity of dripper flow rate was calculated by measuring the flow rate at the beginning, one third, two thirds and the end of the laterals.

Introduction

Methods

Results and
discussion

conclusion

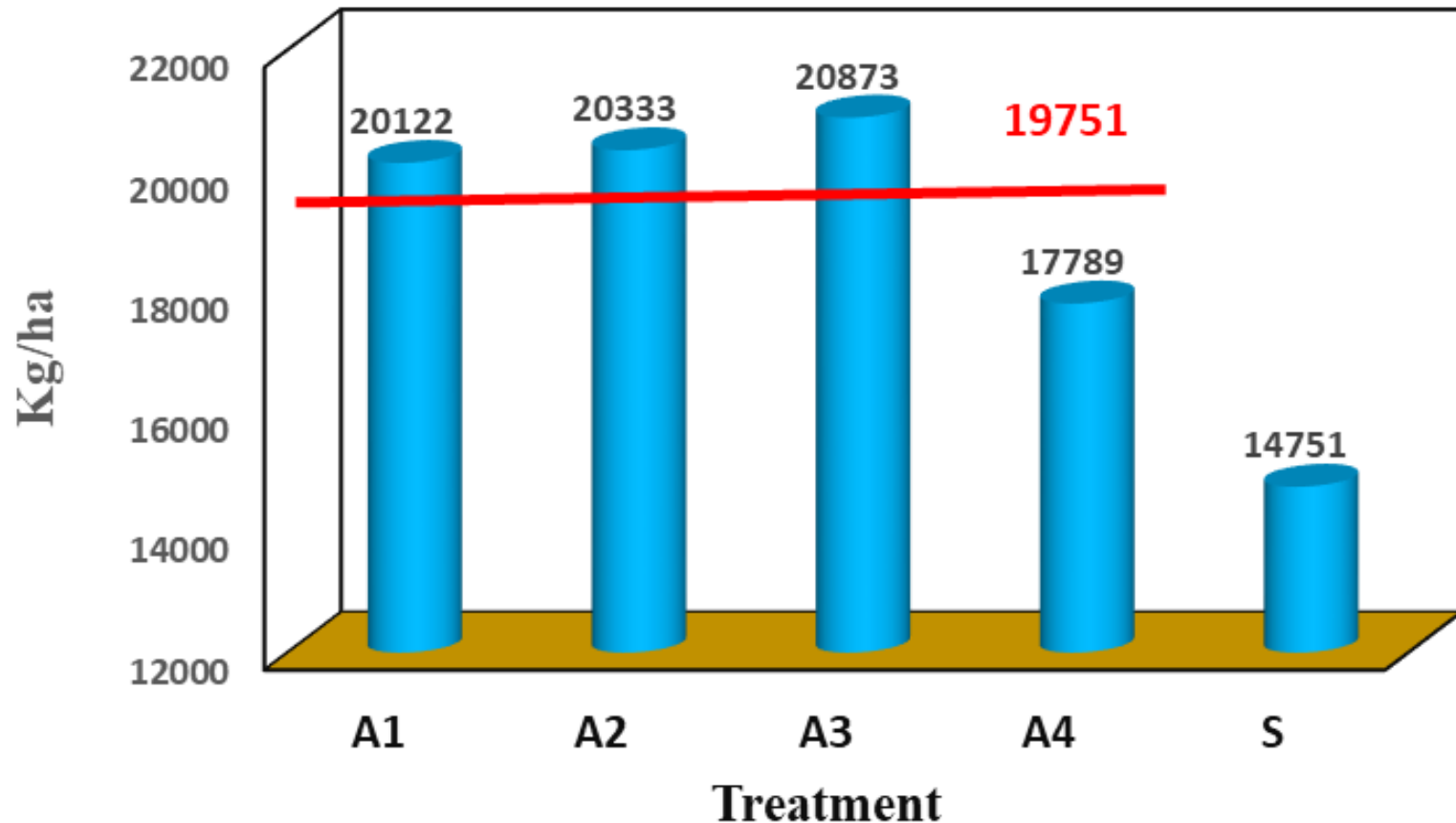
Measuring the flow rate of droppers



Washing the soil around pipes and drippers

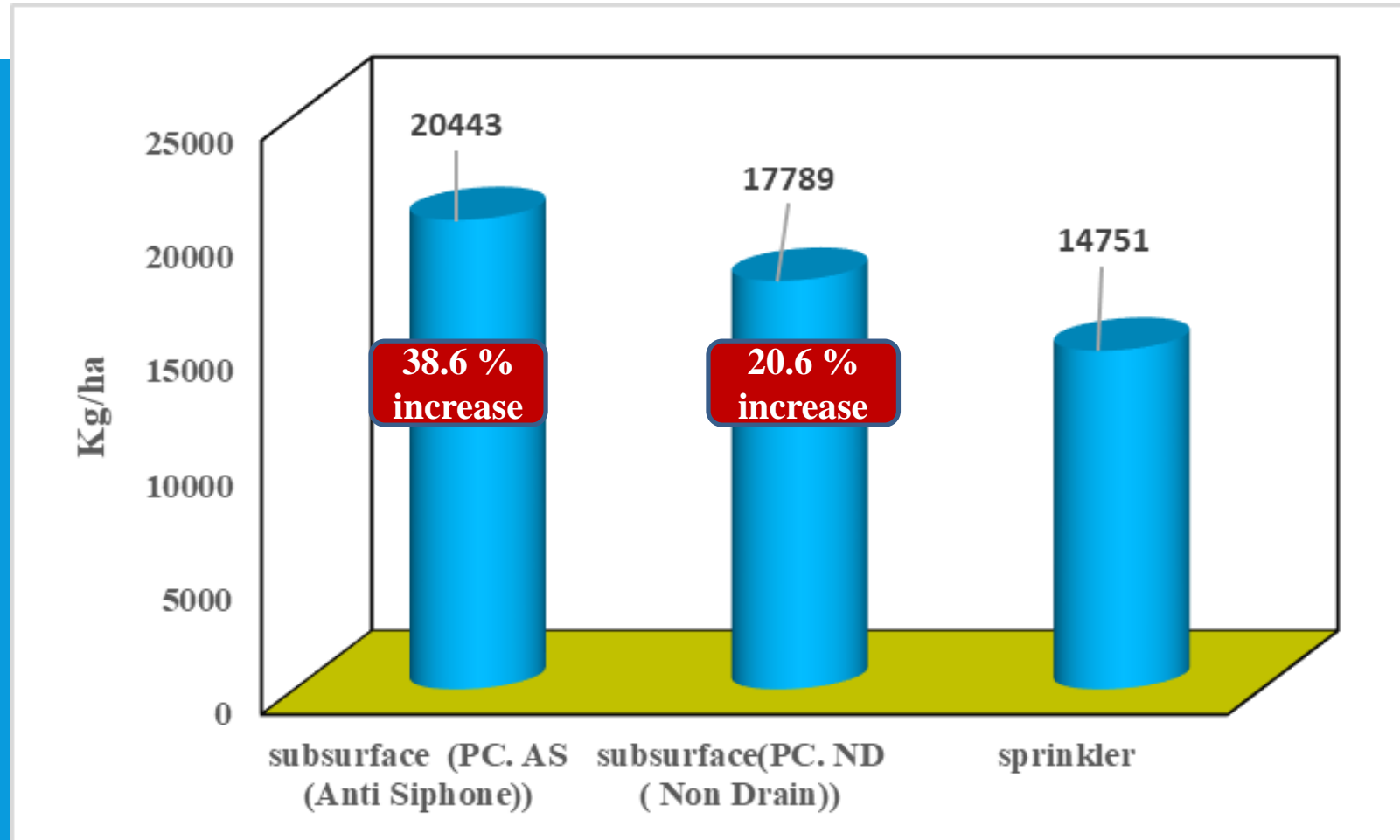


Comparison of yield in different treatments

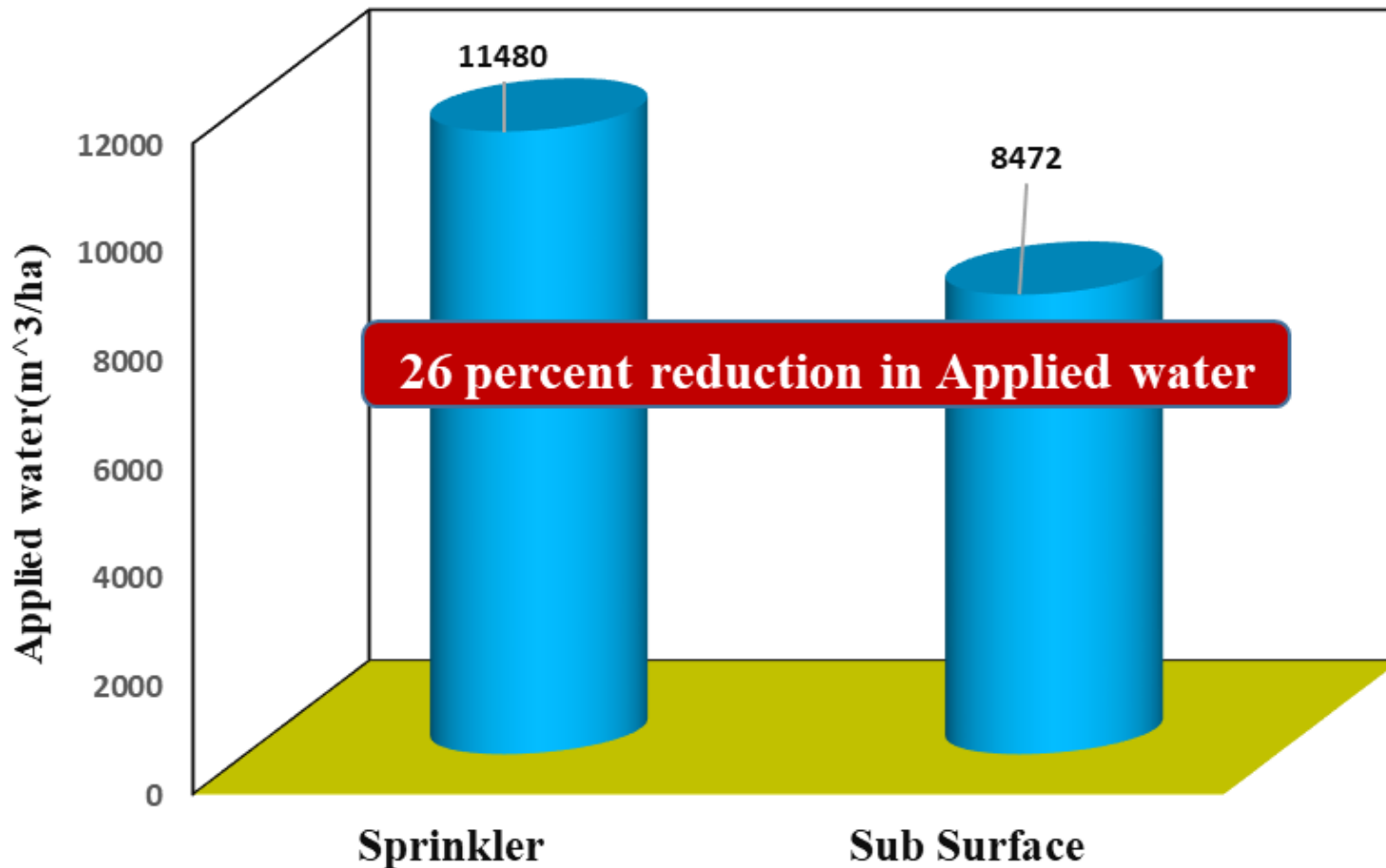


subsurface drip irrigation has increased the yield of the crop **by 33.9%** compared to the sprinkler irrigation method

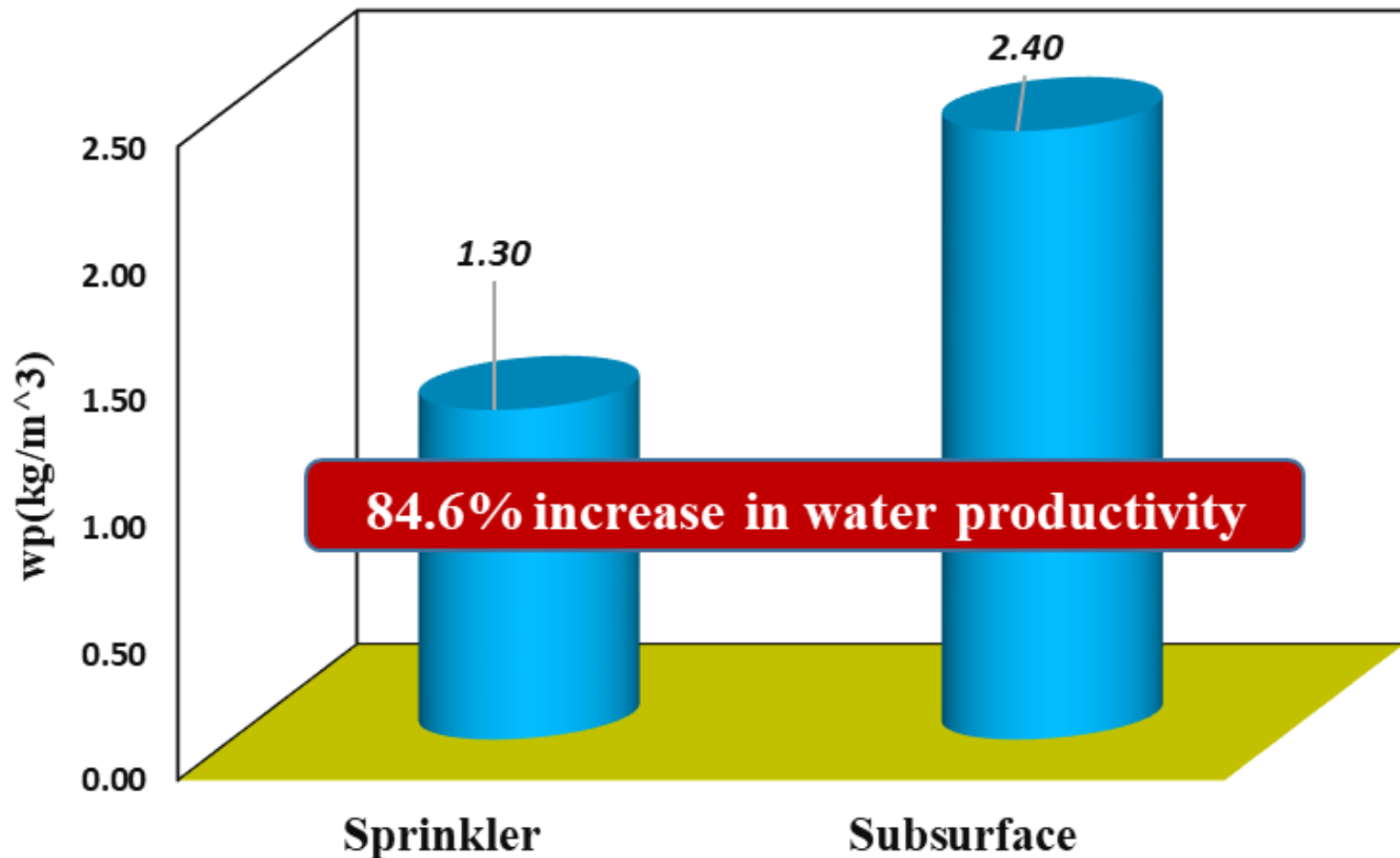
Comparison of crop yield in subsurface and sprinkler irrigation



Comparison of Applied water in two irrigation systems (sprinkler and subsurface)



Comparison of water productivity in two irrigation systems (sprinkler and subsurface)



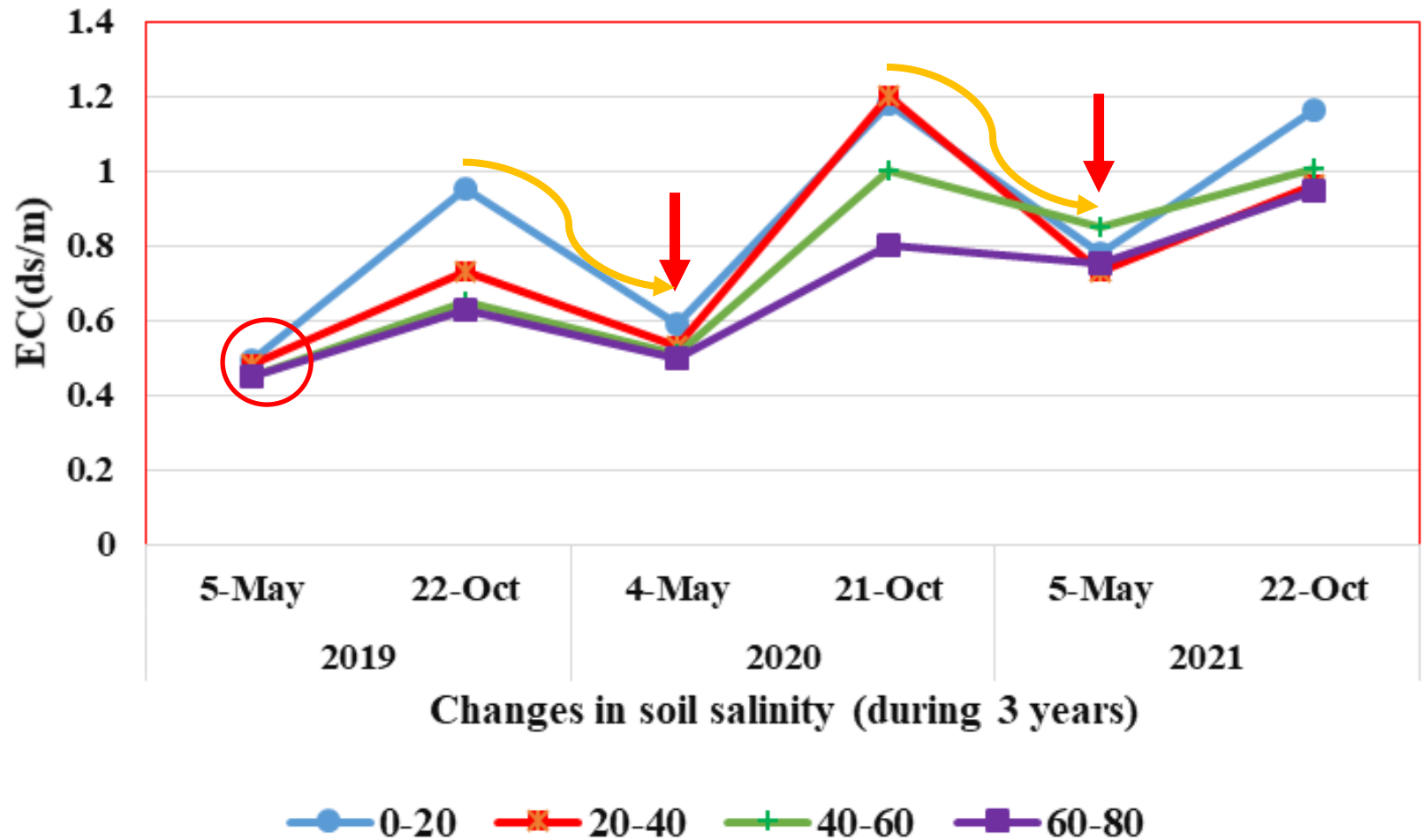
View of root movement around water pipes



View of root movement around water pipes



Salinity changes in different soil depths



Coefficient of variation of emitters flow rate and variation of flow rate

Treatments	CV%		qvar	
	The beginning of the cultivation season	End of the third year	The beginning of the cultivation season	(End of the third year)
A1: Witout Trifluralin	6.2	10.8	13	19.5
A2:With Trifluralin (4lit/hr)	6.2	10.5	13	19.2
A3:With Trifluralin (6lit/hr)	6.2	9.9	13	19.75
A4: NOn Drain	5.1	11.1	11.18	20

Economic Analysis

Increase in final benefit due to change of irrigation method from sprinkler to subsurface (Dollars per hectare)


A: (Based on the cost of water extraction)

Amount of final profit increase at different discount rates					Description
%24	%20	%18	%15	%12	
-768.0	-526.0	-406.5	-211.6	-49.2	Subsurface (PC. AS)
-1175.3	-933.3	-813.8	-618.9	-456.5	Subsurface (PC. Nd)

Economic Analysis

Increase in final profit due to change of irrigation method from sprinkler to subsurface (Dollars per hectare)

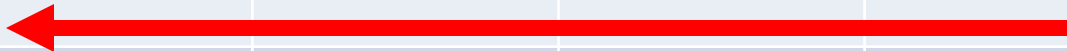
B: Based on the actual price of water

Amount of final profit increase at different discount rates					Description
%24	%20	%18	%15	%12	
					Subsurface (PC. AS)
-417.6	-175.6	-56.1	<u>138.8</u>	<u>301.2</u>	
-824.9	-582.9	-463.4	-268.5	<u>106.1</u>	Subsurface (PC. Nd)

Amount of benefit-to-cost ratio due to change of irrigation method from sprinkler to subsurface

Based on the actual price of water

Benefit-cost ratio at different discount rates					Description
%24	%20	%18	%15	%12	
0.75	0.88	0.96	<u>1.13</u>	<u>1.32</u>	Subsurface (PC. AS)
0.5	0.59	0.64	0.76	0.89	Subsurface (PC. Nd)



Subsurface drip irrigation compared to sprinkler irrigation:

- **increased crop yield by 33.9%**
- **reduced water consumption by 26**
- **increased water productivity by 84.6%**

- **If the installation depth of the drip irrigation pipe is not suitable, Possibility of salt accumulation on the soil surface or moisture reaching the soil surface**
- **In case of accumulation of salt on the soil surface, Soil leaching should be done every 2 to 3 years.**

- Despite the high efficiency of the subsurface irrigation system, but due to the high cost of initial investment, its **development and acceptance by farmers is limited**
- **The results of economic analysis showed** that provided that the real price of water is considered, the ratio of benefit to cost and annual benefit decreases by increasing the discount rate, so that the benefit is negative at a rate of more than 15%.
- The discount rate is a **function of inflation and bank interest rates**. Therefore, considering that the real discount rate is the same level as the bank interest rate, **government subsidies and support** are required to expand these systems.

**Necessary factors for the development
of this system(**economically**)**



real price of water

**Pay cheap and
subsidized credits**



Thank you for your attention

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