



Effect of Subsurface Drip Irrigation System on Date Palm Production and Water Productivity

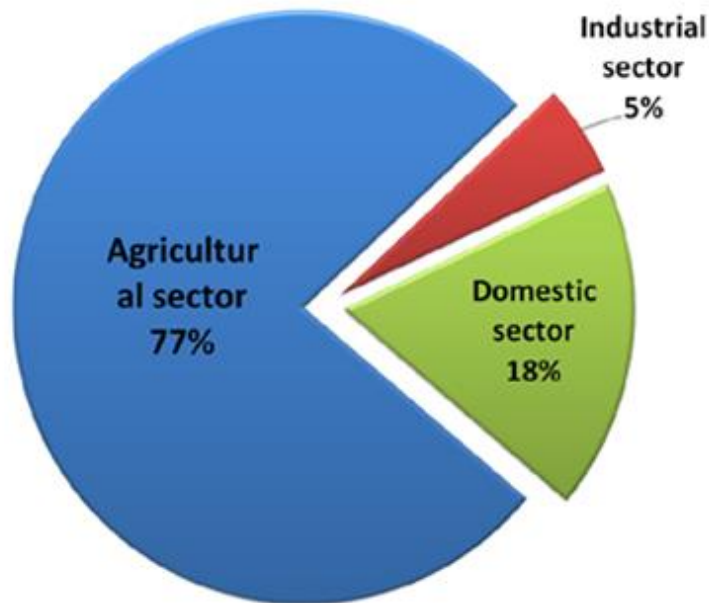
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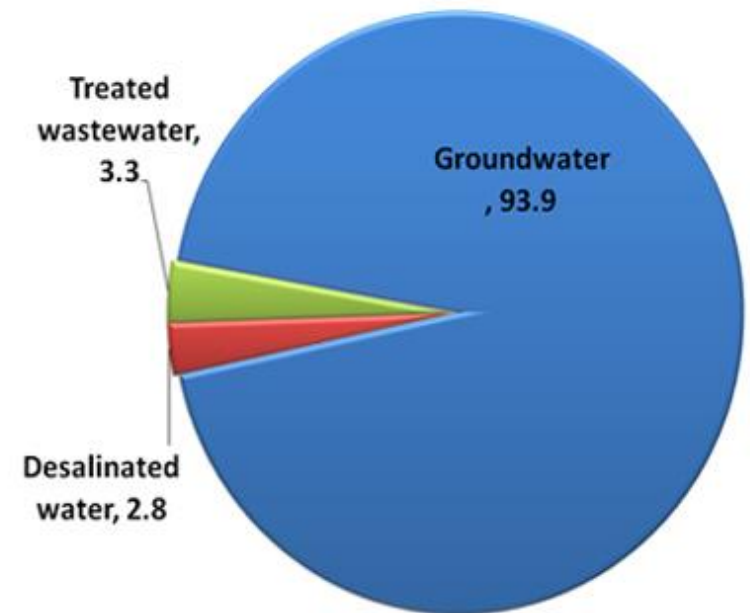


Agriculture and Groundwater Resources

- Agriculture is the largest user of water resources



Water use by sector in GCC



Water source for agriculture in GCC

(Unified Water Sector Strategy for GCC, 2014)





High water consumption in Agriculture

Justifiable reasons

- Harsh climate/ aridity
- Investing water in food production

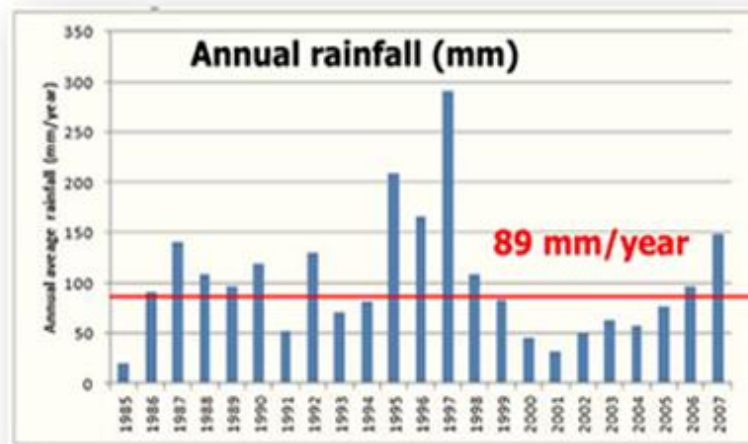
Unjustified reasons

- Expansion of agricultural lands in limited water resources areas
- Inefficient methods of water application
- Growing crops of high water requirements

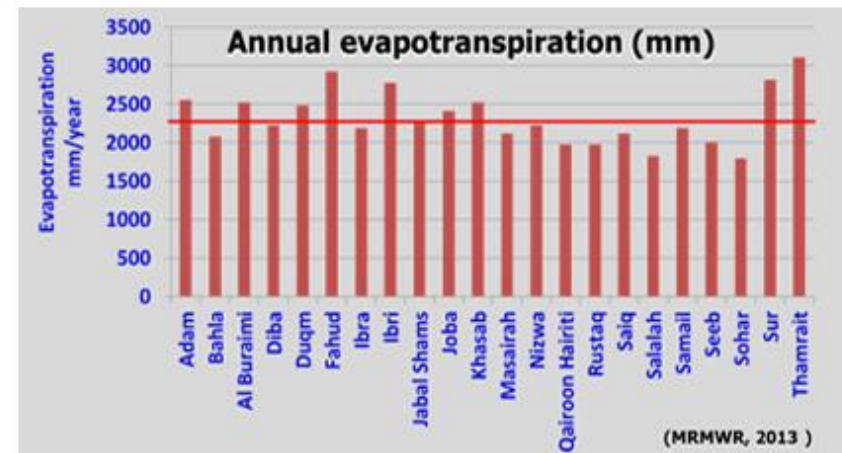


Climatic Condition in Oman

- * Low and erratic rainfall
- * High temperature
- * High evapotranspiration rate



(MRMWR, 2013)

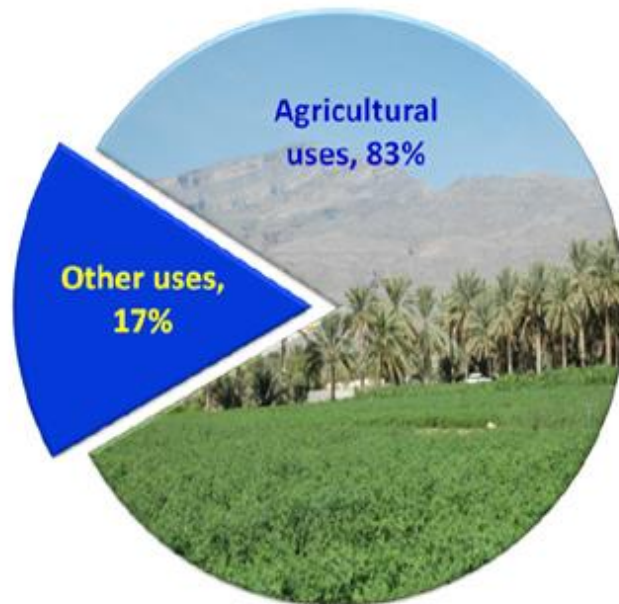


(MRMWR, 2013)

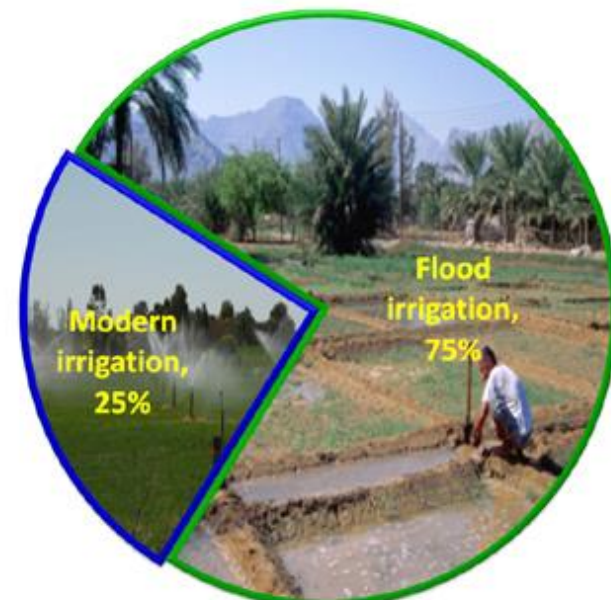


- Arid climate (low rainfall, high evapotranspiration)
- Very limited fresh water resources

(Water must be used more efficiently in agriculture)



Agricultural water use in Oman



Flood and modern irrigation application

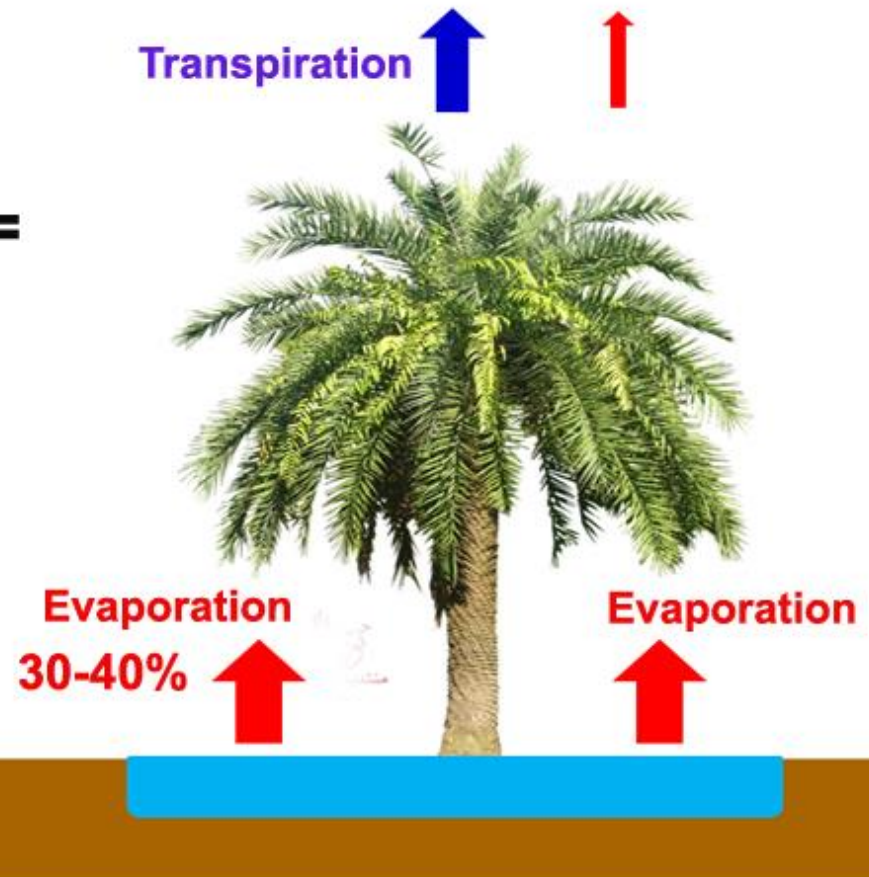




Irrigation and Crop Water Consumption

Water consumption (Evapotranspiration) =
ET
Transpiration + Evaporation

$$WP = \frac{\text{Production}}{ET}$$





Subsurface Irrigation

Subsurface irrigation:

- * Application of irrigation water directly to the root zone
- * High water and nutrients use efficiency



- **Studies indicated that subsurface drip irrigation (SDI) leads to a greater yield and making significant water saving rather than surface irrigation**





Case Study: Subsurface Drip Irrigation System for Date Palms Trees





Date Palms in Oman

- * Total number of date palms in Oman:
7.5 Million trees
- * Covering **30%** of the total cultivated lands.
- * Annual water consumption of a date palm:
55 cubic meter/tree/year
- * Total water consumption of all date palm cultivations :
300-400 million cubic meter/year





Irrigation of Date Palms

- * **Flood irrigation method : 88% of cultivated area Has an efficiency between 40-60%**
- * **Bubbler irrigation system : 12% of cultivated area Has an efficiency about 75-80%**



Experiment Location, Al-Kamil, Al Sharqiya





Irrigation Treatments:

- T 1 : 100 % ETc **Bubbler**
- T 2 : 60% ETc **Subsurface**
- T 3 : 40% ETc **Subsurface**
- T 4 : 20 % ETc **Subsurface**





Climatic Data in Al-Kamil, Al Sharqiya

Month	Max Temp °C	Min Temp °C	R. Humidity %	Wind m/s	Sunshine hours	Radiation MJ/m ² /day	ET _o mm/day
January	24.6	13.9	65	1.1	8.8	16.9	2.82
February	30.7	15.1	58	1.3	9.5	19.9	3.97
March	29.7	18.6	64	1.3	9.1	21.6	4.36
April	34.2	20.9	57	1.5	9.4	23.6	5.45
May	40.3	24.2	47	1.7	10.6	25.9	6.99
June	42.1	26.2	54	1.8	11.7	27.5	7.64
July	41.4	25.7	53	1.8	10.3	25.3	7.23
August	41.0	24.6	58	1.8	10.3	25	6.93
September	40.4	23.8	55	1.8	9.8	23	6.48
October	36.7	22.3	57	2.1	9.8	20.8	5.76
November	29.9	19.3	67	2.3	8.9	17.4	4.13
December	26.9	16.3	69	2.1	8.3	15.7	3.32





Irrigation Scheduling

Month	ET _o mm	Kc	ET _c mm	Irrigated area m ²	Total Water applied liter
January	2.82	0.9	2.5	38	96
February	3.97	0.9	3.6	38	136
March	4.36	0.9	3.9	38	149
April	5.45	0.9	4.9	38	186
May	6.99	0.9	6.3	38	239
June	7.64	0.9	6.9	38	261
July	7.23	0.9	6.5	38	247
August	6.93	0.9	6.2	38	237
September	6.48	0.9	5.8	38	222
October	5.76	0.9	5.2	38	197
November	4.13	0.9	3.7	38	141
December	3.32	0.9	3.0	38	114





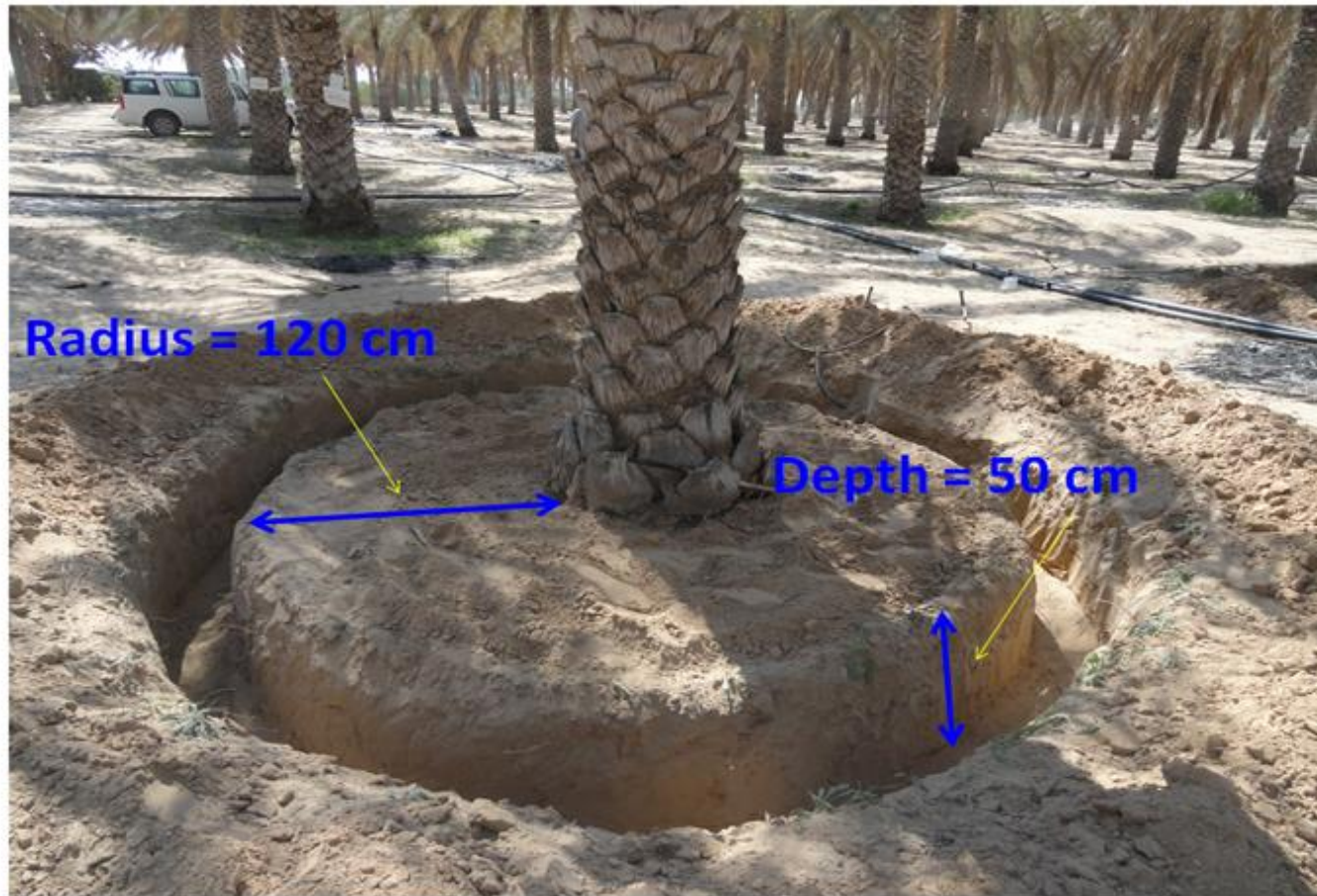
Soil Chemical and Physical Properties

Location	depth cm	E.Ce dS/m	pH	Ca meq/l	Mg meq/l	P ppm	K ppm	CaCo3 %
1	30-0	0.9	8.0	2.1	4.0	15.3	60.0	29.4
	60-30	1.1	7.9	2.5	4.9	22.2	50.0	
	90-60	0.8	8.0	2.3	2.6	15.9	30.0	
2	30-0	1.4	7.0	4.6	5.5	28.8	90.0	38.0
	60-30	1.6	8.0	6.4	6.9	12.5	70.0	
	90-60	1.3	7.9	4.3	6.1	23.0	80.0	
3	30-0	1.0	7.9	4.2	2.7	39.9	50.0	34.8
	60-30	1.0	7.8	4.1	2.9	32.5	70.0	
	90-60	1.1	7.8	4.4	3.2	14.3	70.0	
Location	depth cm	Gravel %	C.Sand %	F.Sand %	Silt %	Clay %	Texture	
1	30-0	1.2	1.0	88.2	3.6	7.2	sand	
2	30-0	0.0	3.2	52.0	20.6	24.2	SCL	
3	30-0	0.9	1.3	69.9	10.6	18.2	Sandyloam	





Subsurface Drip System Installation





Subsurface Drip System Installation





Bubbler irrigation system



Subsurface drip irrigation





Soil Moisture Content Monitoring





Production and WP of Date Palm

Production:

- Fruits were harvested as fresh dates
- Water Productivity :

$$WP = \frac{\text{Production (Kg)}}{\text{Water Applied (m}^3\text{)}}$$

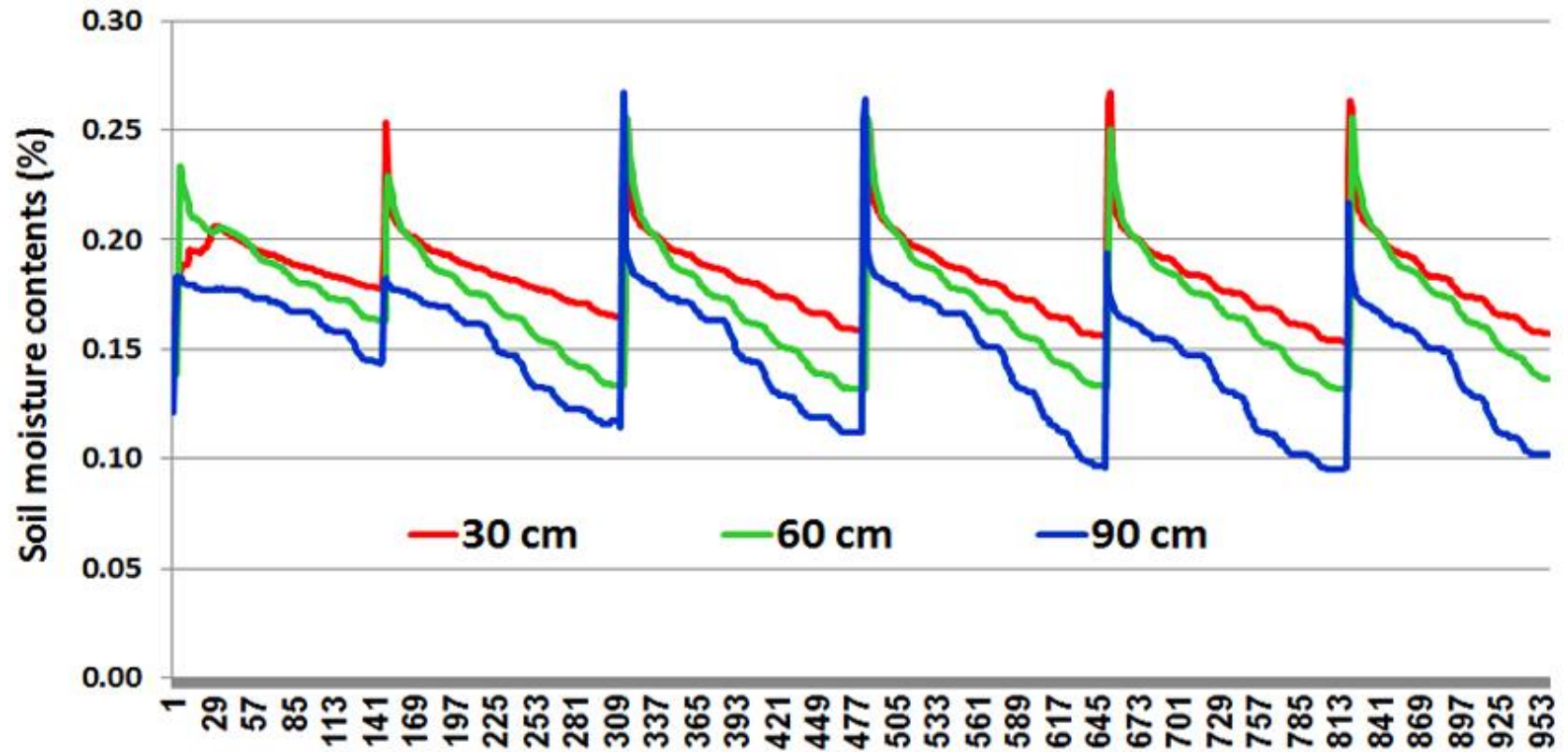




Results

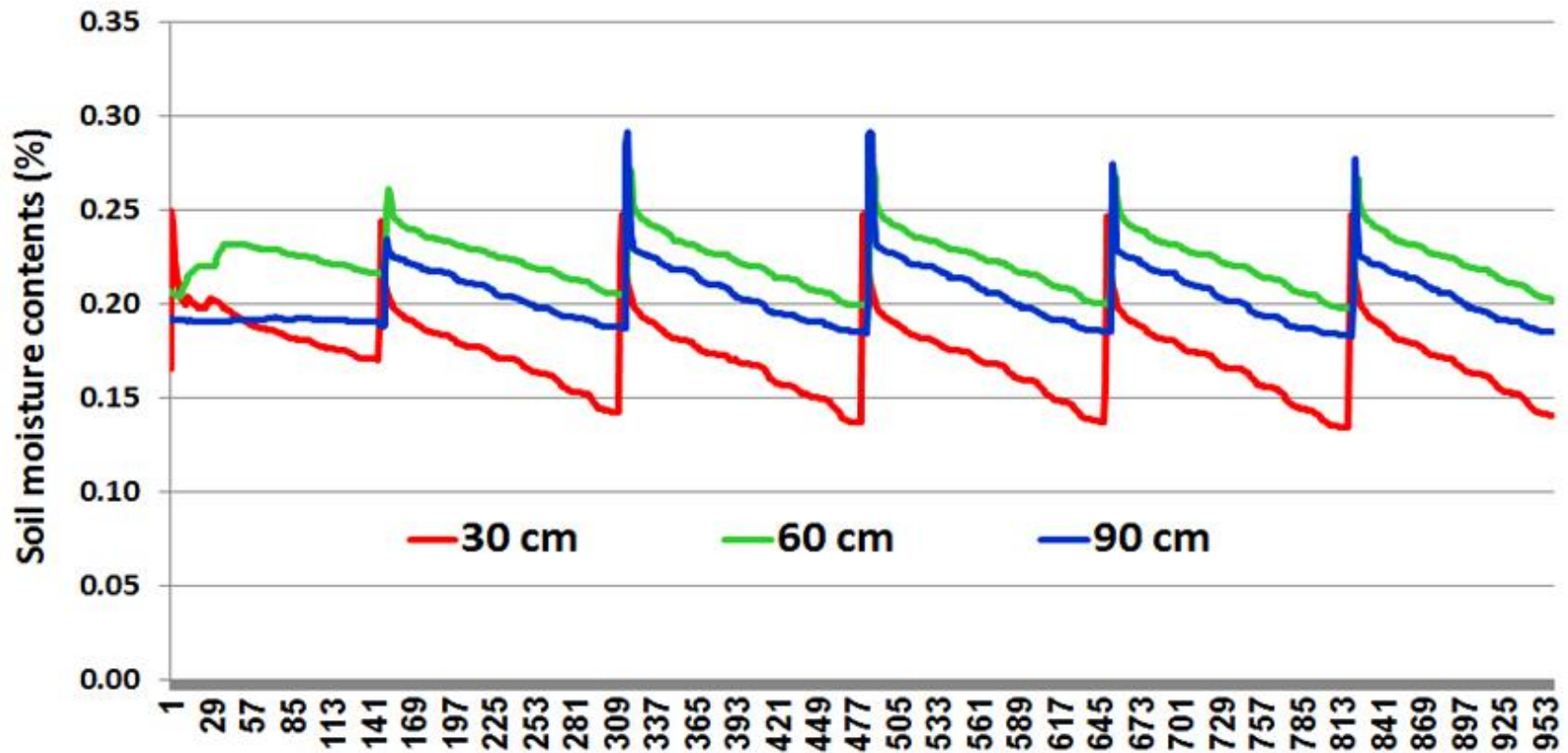


Soil Moisture Content Under Bubbler Irrigation



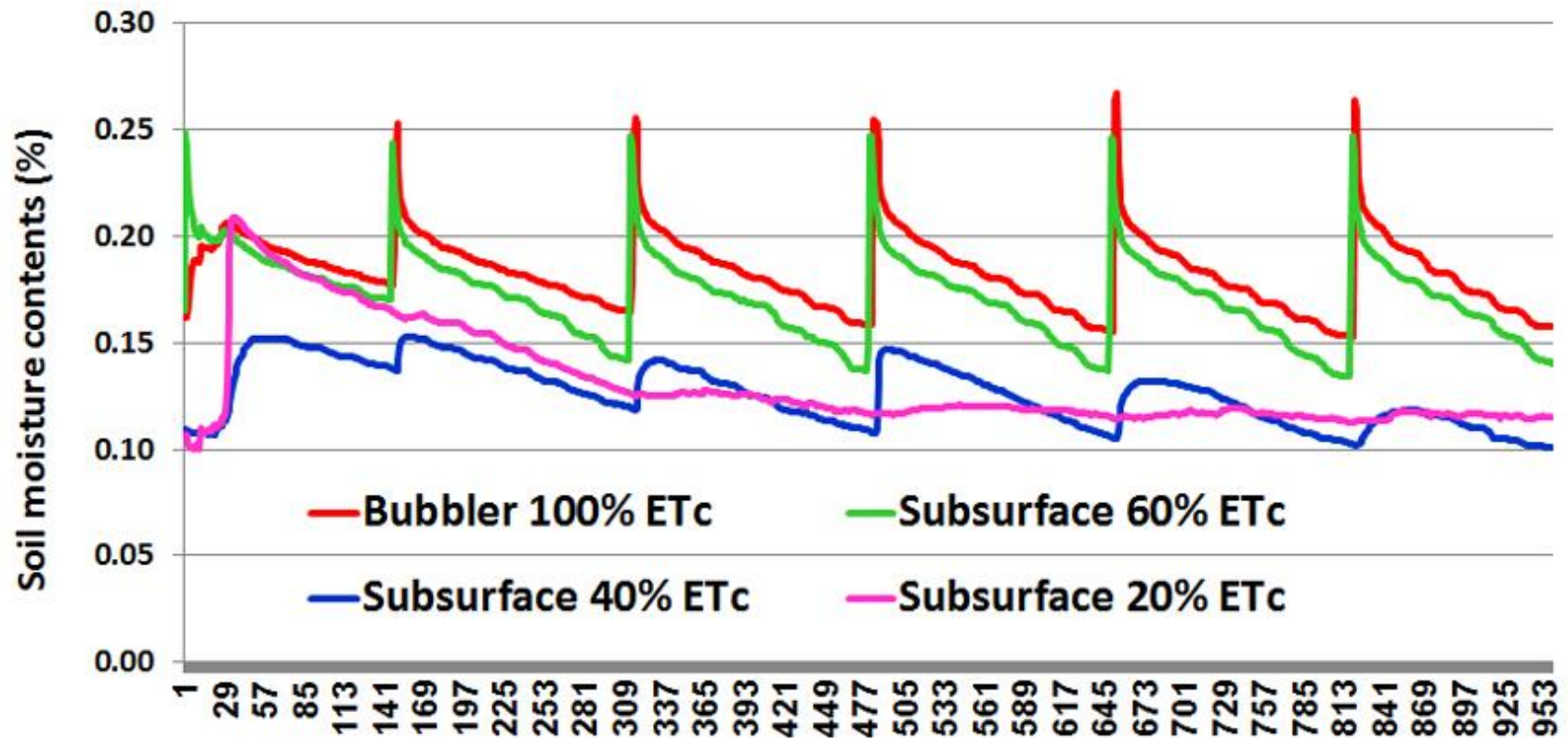


Soil Moisture Content Under Subsurface Drip Irrigation

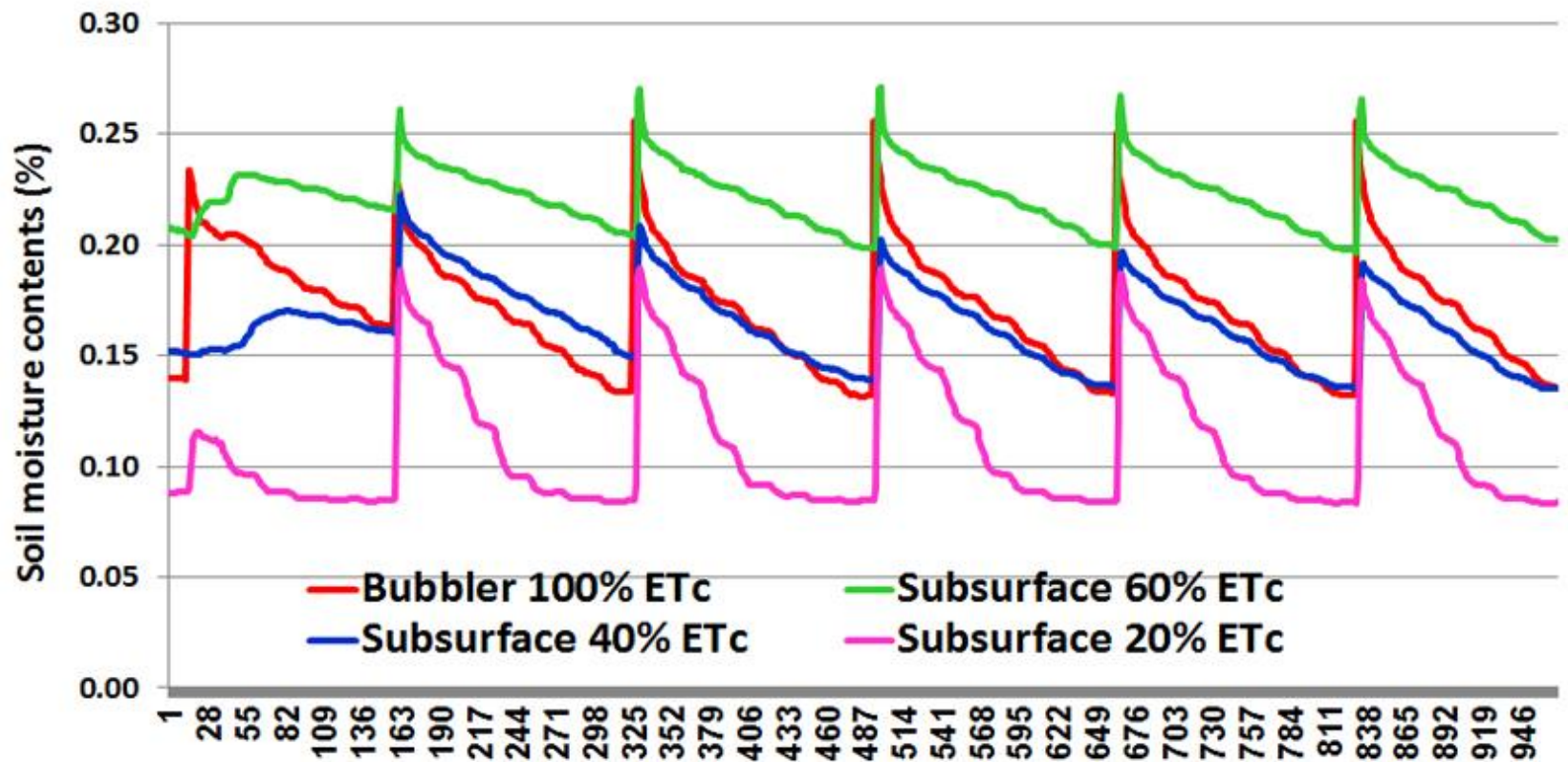




Soil Moisture Content Under Different Irrigation Levels at Depth 30 cm

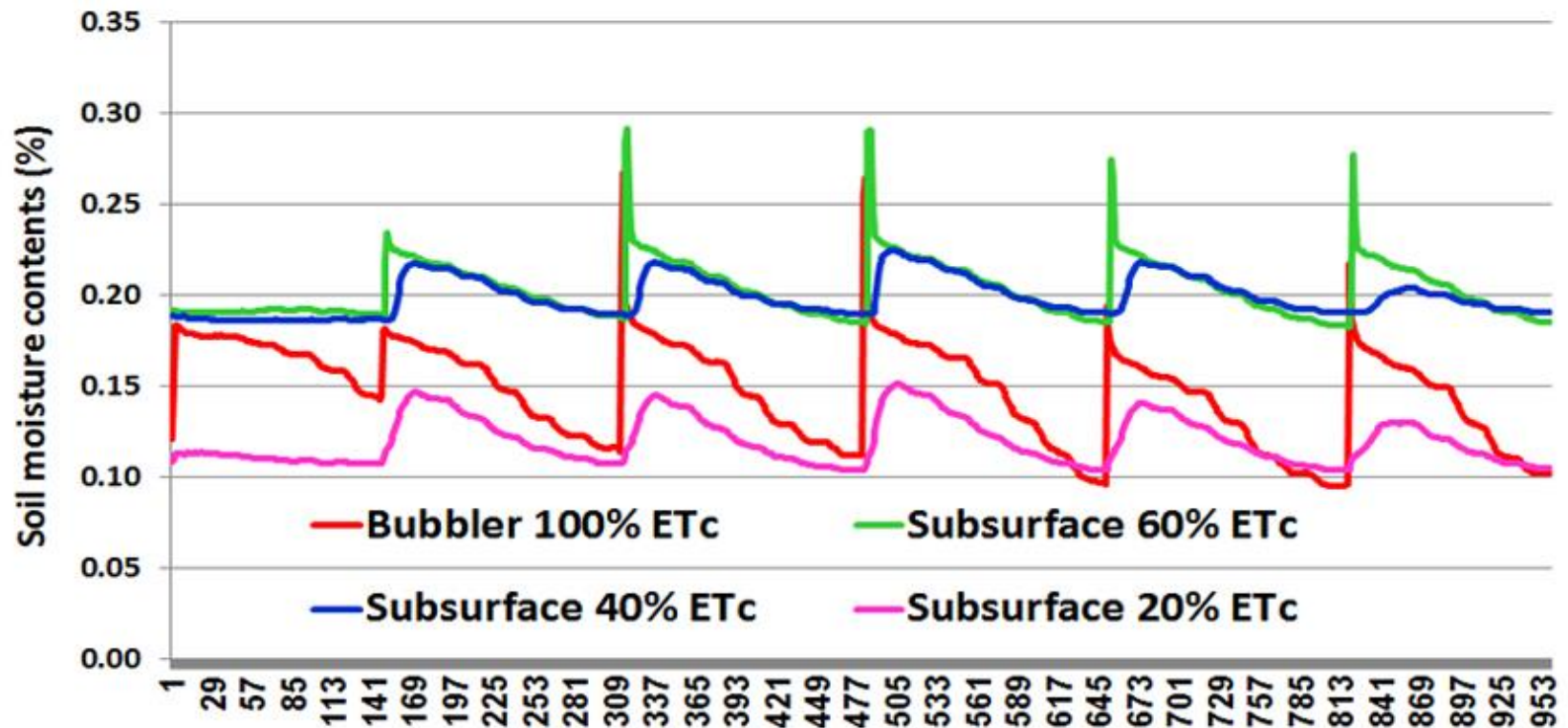


Soil Moisture Content Under Different Irrigation Levels at Depth 60 cm



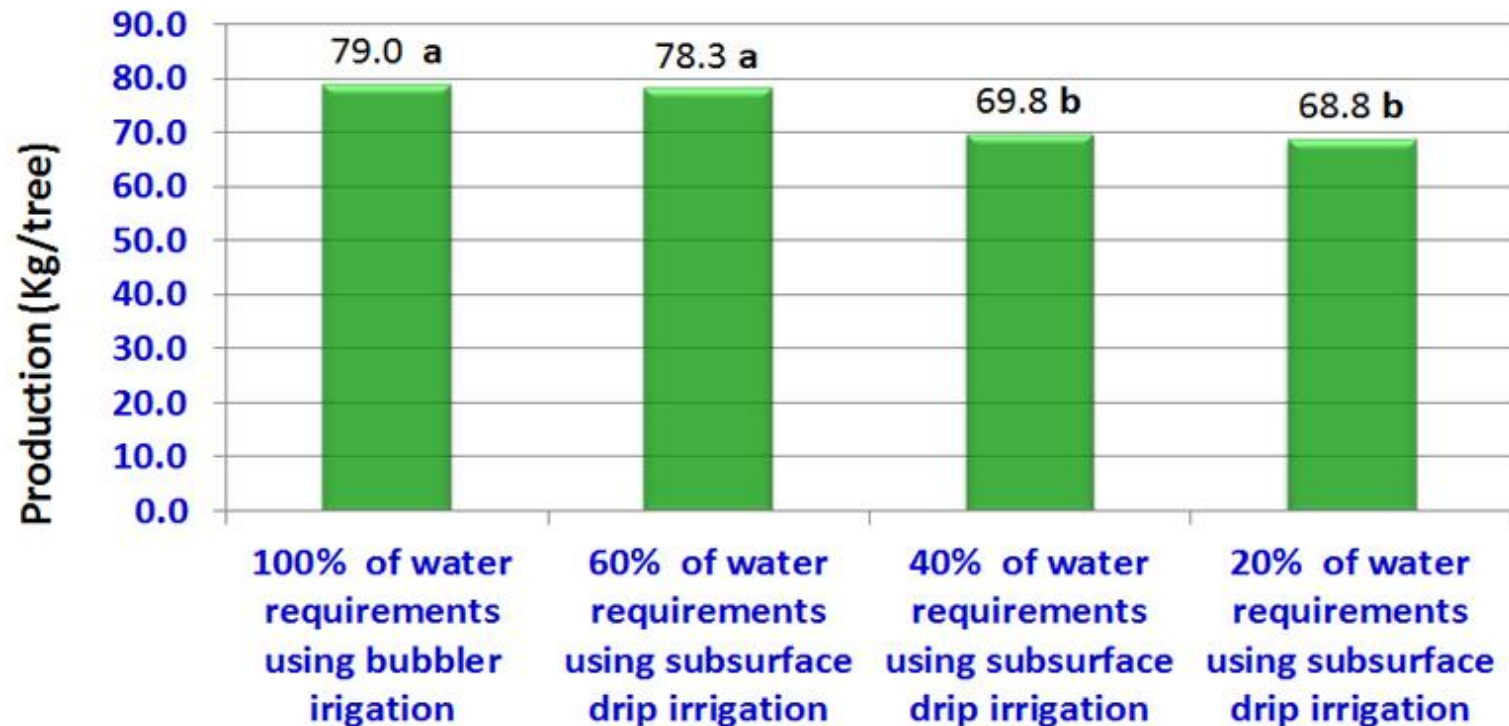


Soil Moisture Content Under Different Irrigation Levels at Depth 90 cm





Production of Date Palm (Kg/tree)

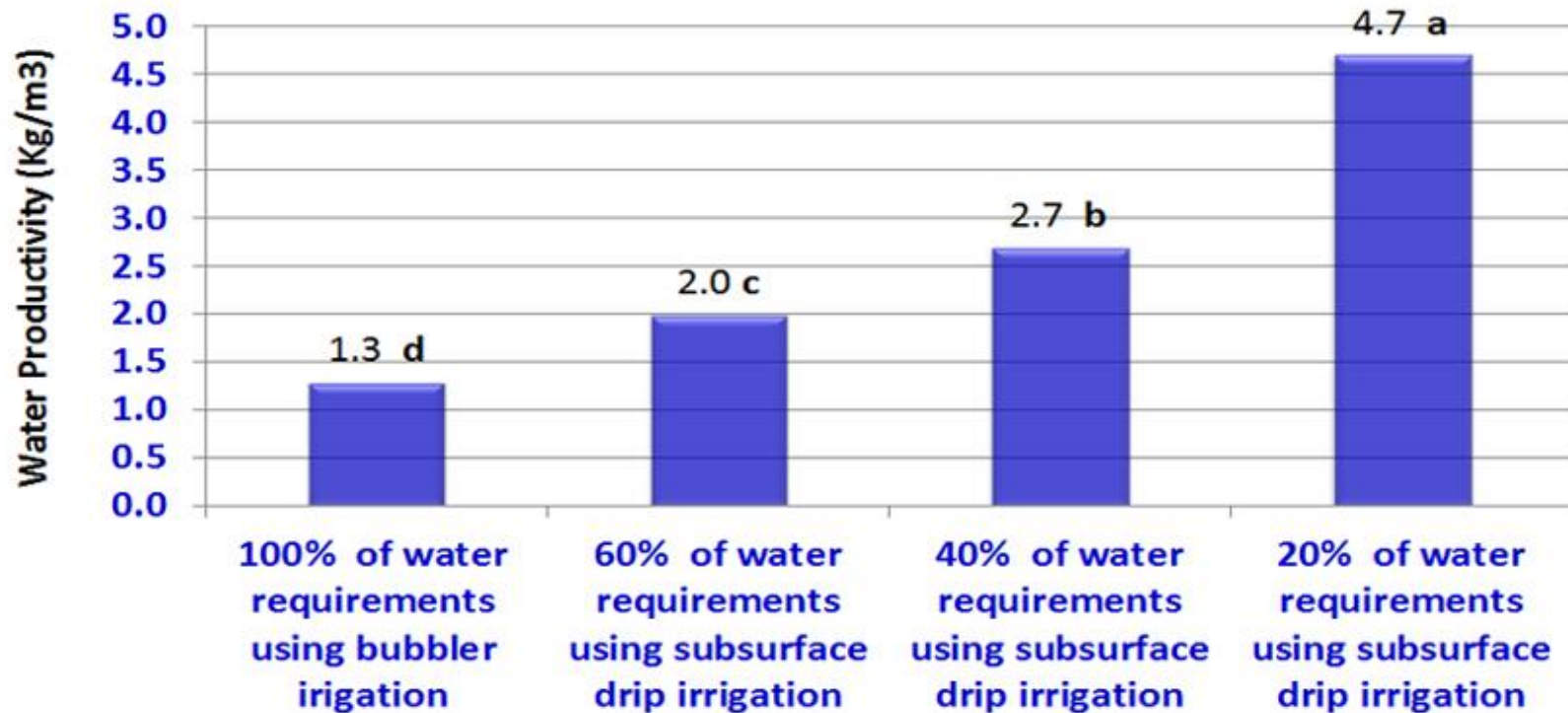


LSD = 8.4, values with different superscript letters indicate significantly at P=0.05





Water Productivity (Kg/m³)



LSD = 0.45, values with different superscript letters indicate significantly at P=0.05





Irrigation system and installation costs

The cost of subsurface drip irrigation depends on the number of drips around each tree. In order to have same water flow as a bubbler (240 liter/hour), we need to put 60 drippers around the tree

2 bubblers (480 liter/hour) = 120 drippers (480 liter/hour)

Irrigation system	Cost (OMR/hectare)		
	Equipments	Installation	Total
Bubbler irrigation	1570	393	1963
Subsurface drip	2011	603	2614





Summary and Conclusion

- **Application of subsurface drip irrigation save up to 40% of irrigation water**
- **Reducing water quantity under subsurface drip irrigation increase WP with a little reduction in yield**
- **Huge oppertunity to save water in agriculture through efficient water application methods**





Thank **Y**ou!

