Enhancing Water Use Efficiency in Agriculture

New Delhi, 16 th March, 2017

Jain Irrigation Systems Ltd.

Corporate Philosophy

Mission

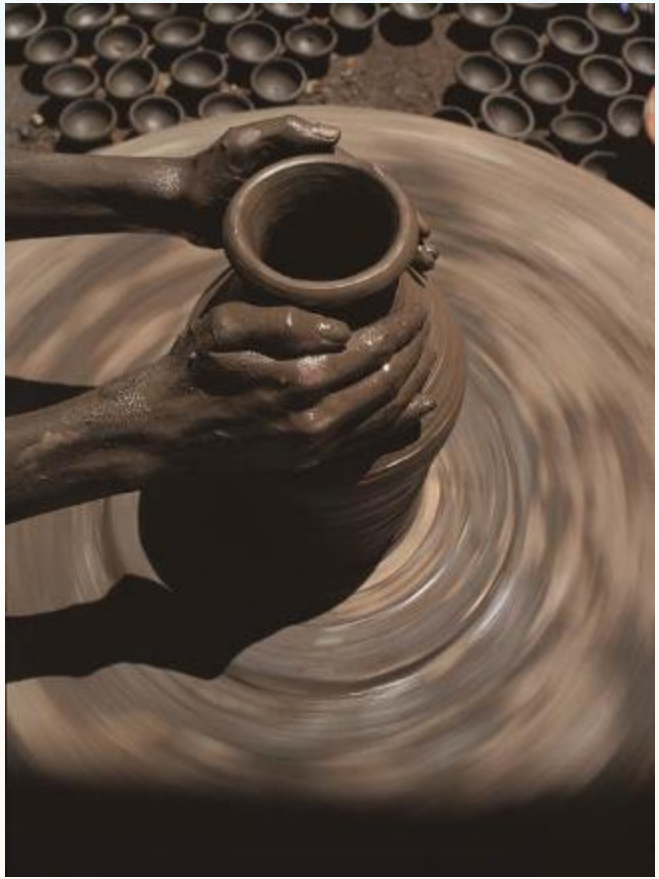
Leave this world better than you found it.

Work Culture

Work is life; life is work.

Intensely Committed to

An Integrated approach for improving complete Agri Value Chain through sustainable and affordable technological interventions.



Jain Irrigation Systems Ltd.

Corporate Vitals

Enterprise Life	50 years completed.	
Turnover 2013-14	US$ 1 Billion	
Manufacturing Plants	India – 12 in 5 states.	Abroad – 15 in 4 continents
Permanent Manpower	India – 9,200.	Abroad – 1,100
Dealer Network	India – 2,711.	Abroad – 901

"Invested capital of about US$1 Billion has enabled the enterprise to be the largest & most integrated private sector Agricultural Institution in India."

Jain Irrigation Systems Ltd.

Corporate Product Range

Hi-Tech Agri Inputs

- Micro Irrigation Systems:
  Green, Poly & Shade Houses,
  Solar Agri Pumping Systems,
  Tissue Culture of Banana & Pomo
- Integrated Irrigation Solutions

Green Energy

- Solar Water Heating, Home Lighting & Off Grid Systems.
- Solar Photovoltaic Power Generation.
- Bio Gas Power Generation.
  (Agri & Fruit Plant Waste)

Food Processing

- **Pulp, Concentrates, IQF:** Mango, Guava, Banana, Pomegranate and Tomato.
- **Dehydration:**
  Onion and Garlic.

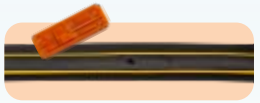
Polymer Processing

- Plastic Piping Systems .
  (mostly used in Agriculture)
- Plastic Sheets.
  (wood substitute)

Product Range

Inline Drip System



Online Drippers and Spray heads

Jain Filtration System

Jain Fertigation System

Jain Rainport/ Micro Sprinklers

Jain PVC/PE Pipes & Fittings

Automation System

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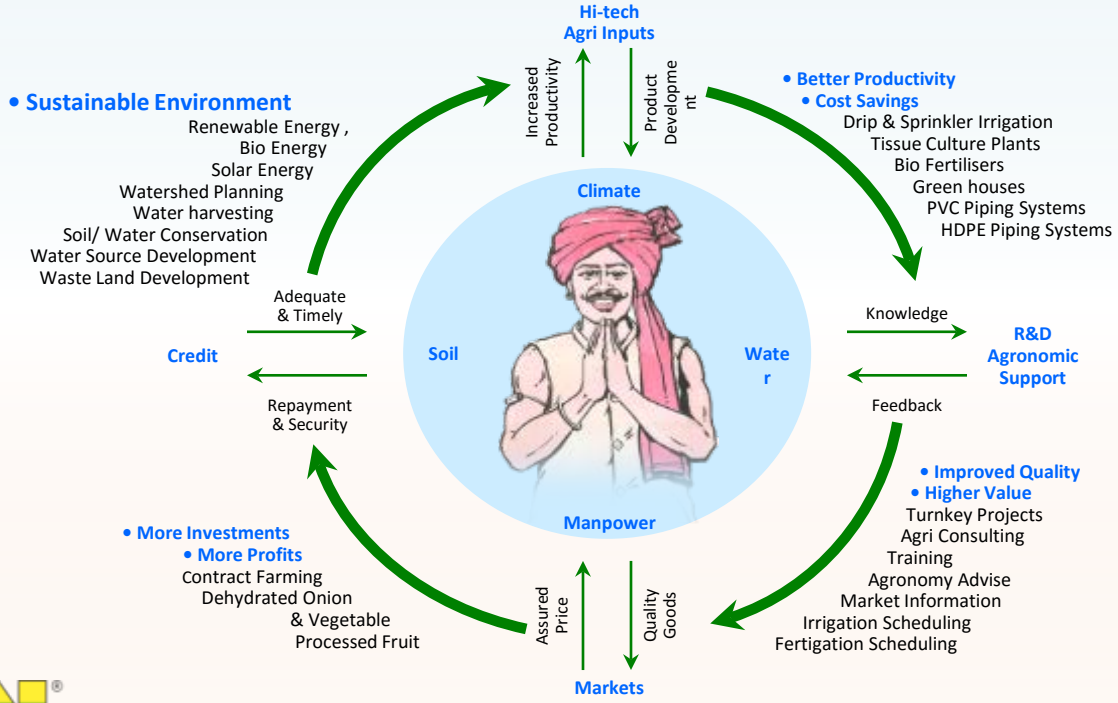
Jain Integrated Model

The Jain Self Sustaining Agri Cycle



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Resources Distribution

Resource	World	India	% to world
Population, Million	6710	1270	18.9
Land, 000' Km2	149000	3288	2.2
Water, BCM	48632	2085	4.3

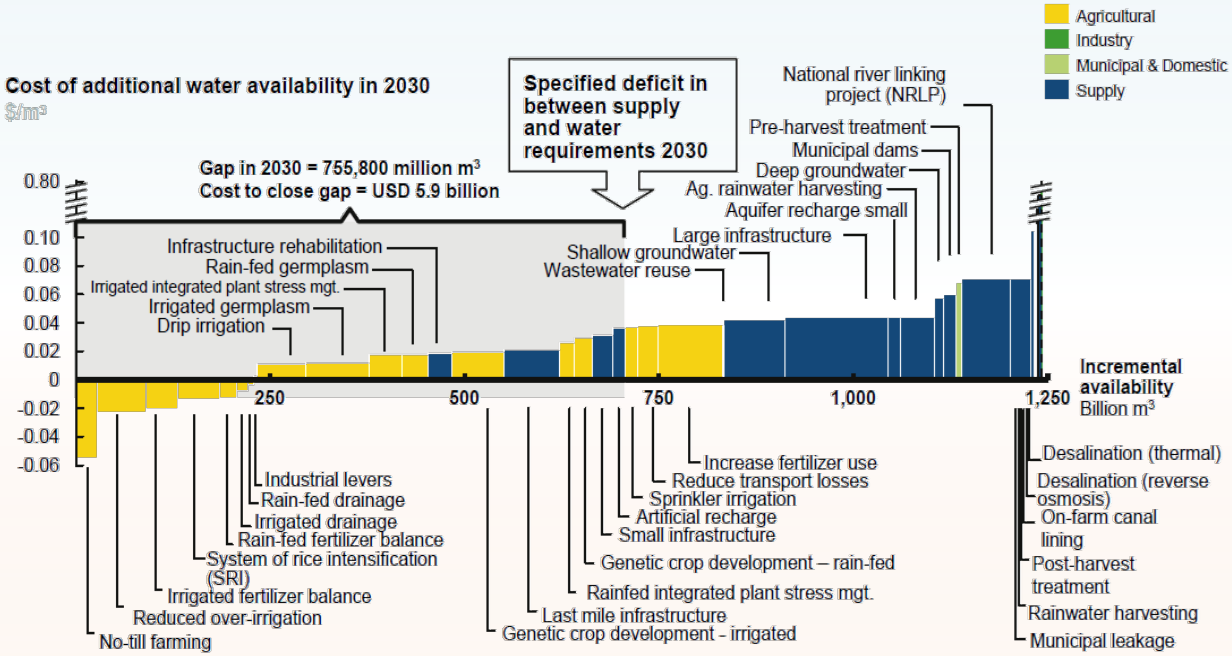
Source : GoI

Water Demand and Availability in India

Particulars	Water Demand in km³ or BCM		
Year	2010	2025	2050
Water Demand from all Sectors	710	843	1180
Irrigation	557	611	807
Drinking water	43	62	111
Industry	37	67	81
Energy	19	33	70
Others	54	70	111
Availability of Utilisable Water	1123	1123	1123
Excess / Short Fall	**413**	**280**	**-57**

Source : Ministry of Water Resources, GOI, New Delhi

India - Water Availability cost curve



Source : 2030 Water Resources Group

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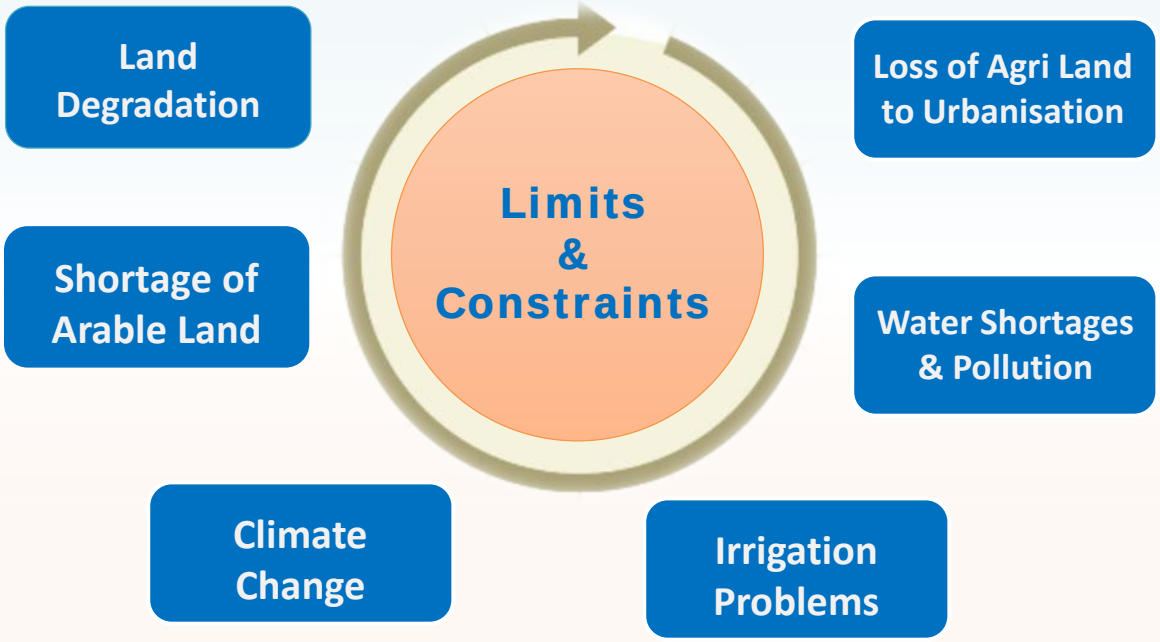
Limits & Constraints - Food Production



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Irrigation Potential in India

Sr. No.	Particulars	India (Area,000 ha)
1	Ultimate Irrigation Potential	139894
2	Irrigation Potential Created by 2007 end	123263
3	Irrigation Potential Utilized by 2007 end	91086
4	Percentage Utilization	73.9

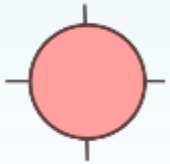
Source : Central Board of Irrigation & Power

Source-wise Net Irrigated Area in India

S.No	Source of Irrigation	Net Irrigated Area, Million ha	%
1	Canals	15.989	29
2	Tanks	2.524	5
3	Wells	33.227	61
4	Other Sources	2.892	5
	Total	54.632	100

Source : CWC (2003-4)

Productivity under Wells and Canals



Sr No	State	Canals, MT /Ha	Wells, MT/Ha	Difference,%
1	Punjab	3.24	5.45	68
2	Tamilnadu	2.60	6.53	151
3	Andhra Pradesh	3.42	5.68	66
4	Haryana	3.20	5.70	78
5	Madhya Pradesh	2.00	2.80	40
6	Karnataka	3.50	4.20	20

Drawbacks in Conventional Irrigation Method

First Three Days After Irrigation

During first three days of irrigation soil pores are saturated with water. In this condition, total air in the soil is replaced by water & field capacity level is not maintained in the soil. Though sufficient nutrients are avaiable in the soil, the excess water condition suffocates the roots of the plant & water absorption by roots is totally ceased. As the plant is under suffocation the growth is hampered.

Middle Three Days

During next three days, due to evaoration & percolation losses, the excess soil moisture is reduced & soil comes to field capacity level wherein air, moisture & nutrients are available at optimum level.

Plant growth takes place only during this phase.

Last Two Days

In last two days, the moisture level in the soil goes below the root zone hence, plant is under stress condition in this period.

Even though air and nutrients are sufficiently available in the root zone they can not be taken easily by plant as the plant is under stress and hence growth restricted.

Conclusion: It is very clear from the above phenomonon that for the plant growth, optimum moisture level available is only for about three days out of 8 days' cycle. Rest of the time plant is either under stress or suffocation condition, hence gorwth is restricted thereby yield is reduced.

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Drawbacks - Supply Based System

- Method of Water Application : Flood
- Huge Water Losses
- Poor Water Use Efficiency up to 40%
- Unreliable and Inadequate Supply
- Low Value Crops
- Poor Recoveries
- Unviable Projects

Advantages - Demand Based System

- Method of Water Application : Drip/Sprinkler
- Huge Water Savings
- High Water Use Efficiency
- Reliable Water Supply
- Greater Flexibility
- High Value Cash Crops
- Better Recoveries
- Viable Projects

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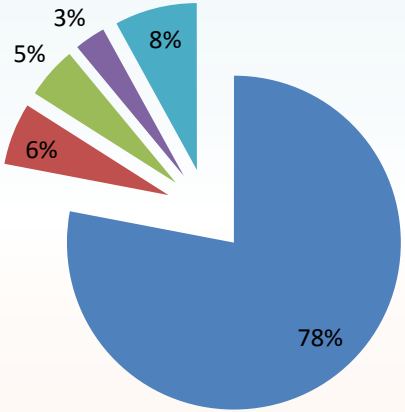
Water Uses in India

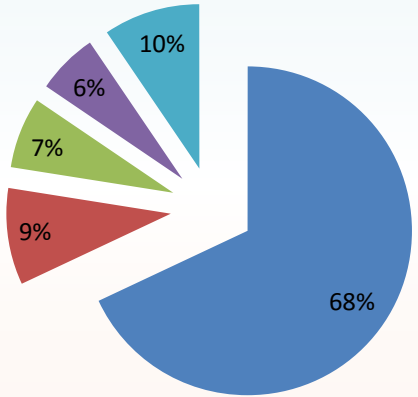
Year 2010



Use	Year 2010	Year 2050
Irrigation	78%	68%
Domestic	6%	9.5
Industries	5%	7%
Power Development	3%	6%
Other Uses (Environmental etc)	8%	9.50%
Total	100%	100%

Source : GoI

Year 2050



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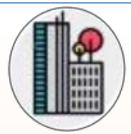
Efficiencies of Different Sectors

- Irrigation
  - Surface Water — 30-65%
  - Ground Water — 65-75%

- Urban Water Supply — 50-60%

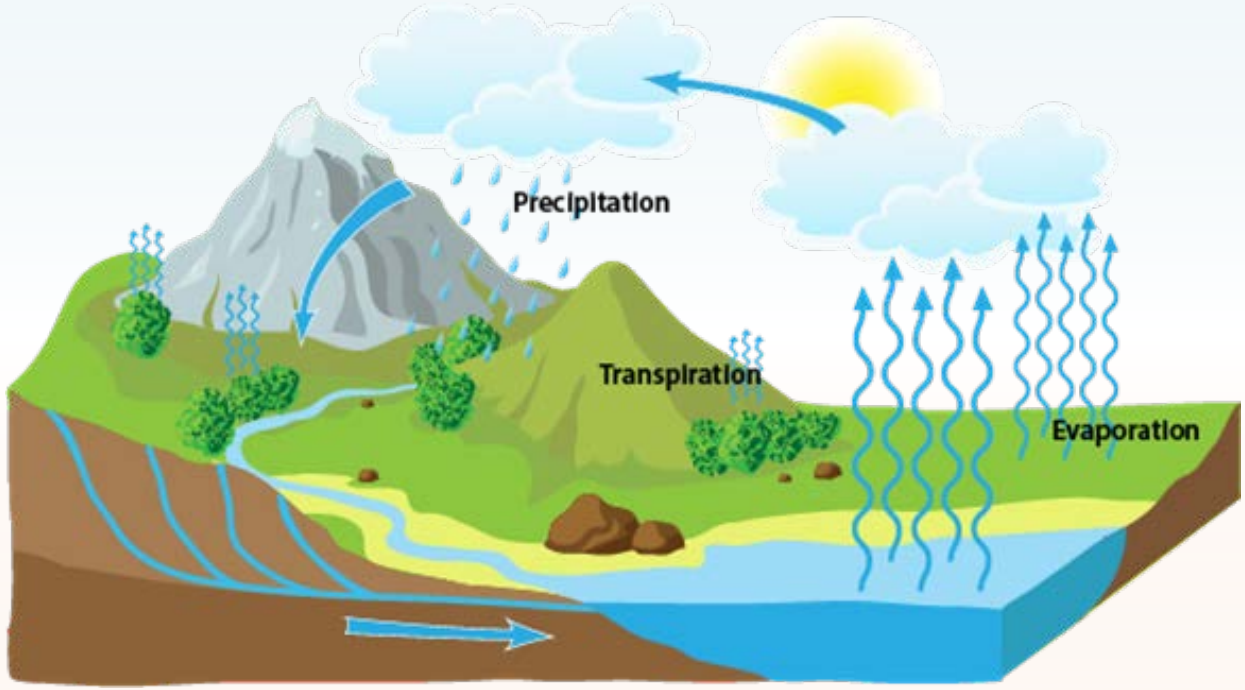


- Rural Water Supply — 60-70%

- Industrial Use — 80%

Source : GoI

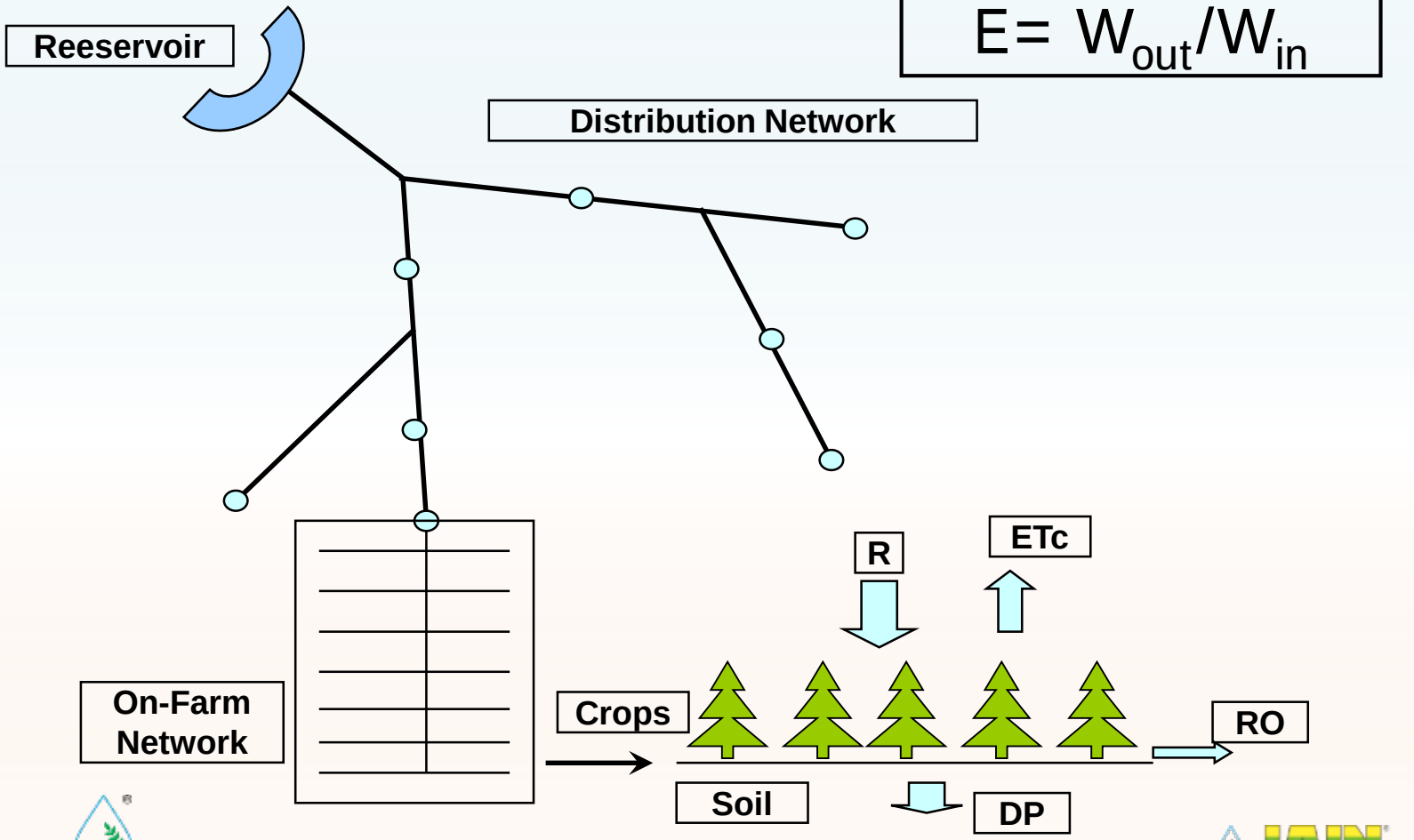
Evapo-transpiration Concepts



Efficiency- Concepts

- Efficiency = Relative Output /Given Input
- Conveyance Efficiency = Water Delivered to Farm/ Water taken from source
- Field Application Efficiency= Water Consumed by crops/Water Delivered to farm
- Water Use Efficiency = Total Biomass produced (above ground dry matter) / Volume of water consumed by crops

$$E = W_{out}/W_{in}$$



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Water from Reservoir to Root Zone Chain of Efficiency Steps: (From T. HSIAO, 2006)




$$\frac{W_{root\ zone}}{W_{reservoir\ in}}$$

Storage efficiency	Conveyance efficiency	Farm efficiency	Application efficiency	Overall efficiency

Sample calculation:

0.90 x 0.85 x 0.72 x 0.75 = 0.413

- Although the efficiency of each step is at least reasonable good but the overall efficiency is low

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FROM RESOURCE TO ROOT

From Resource to Root ™

Legend

- Conveyance Efficiency
- Field Application Efficiency
- Overall Project Efficiency for Soecific Model
- JIIS Jain Integrated Irrigation Solution

Note :

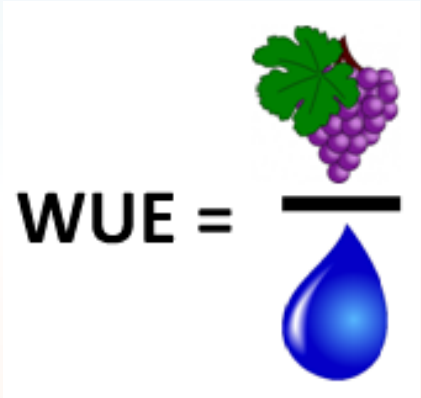
1) The field application efficiency assumed for different irrigation method is Drip 90%, Sprinkler 75% & Flow 60%.
2) For PVC/ PE piped network, conveyance efficiency is assumed to be 99%.
3) If the water conveyance is through only open canals and on farm application through flow, then the maximum achievable efficiency of **Model-5** would be only 34%.
4) In case open canal are partially converted into piped network the overall efficiencies **Model- 2 to 4** would be between 39% to 77% depending on the on-field irrigation method chosen.
5) If the pipes are chosen for water conveyance & Drip Irrigation is chosen as on-farm irrigation system, the overall irrigation efficiency will be the highest at 89%, hence this model - **Jain Integrated Irrigation Solution "From Resource to Root" is highly recommended.**

	99 % JIIS	86 % Main Canal	76 % Distributary Canal	66 % Minor Canal	56 % Water Courses
Drip	89 %	77 %	68%	59%	50%
Sprinkler	74%	64%	56%	49%	42%
Flow	59%	51%	45%	39%	34%
	Model - 1	Model - 2	Model - 3	Model - 4	Model - 5

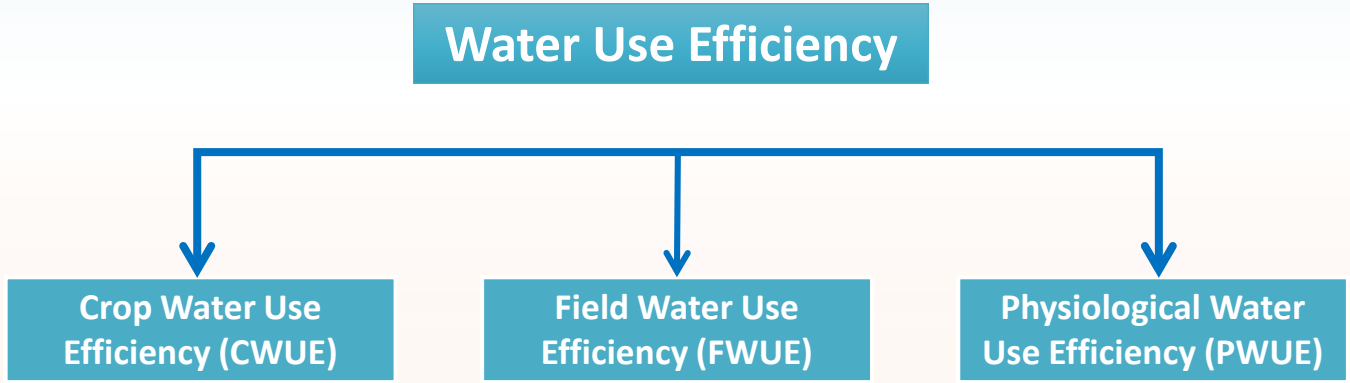
Source : FAO, WB, Others and Jain Irrigation internal study

Water Use Efficiency OR Water Productivity

- Fag= P/U,
- U= R + D + Ep + Es + Tw + Tc
  - R= Volume of water lost by runoff from field
  - D= Deep Percolation
  - Ep= Evaporation loss during conveyance and field application
  - Es = Evaporation from soil surface
  - Tw= Volume transpired by weeds
  - Tc= Volume transpired by plants



Water utilized by the crop is evaluated in terms of Water Use Efficiency



CWUE, FWUE & PWUE

- CWUE is the ratio of crop yield (Y) to the amount of water used by the crop for evapotranspiration (ET).

$$\text{CWUE} = \frac{Y}{ET} \ldots\ldots\ldots\ldots$$

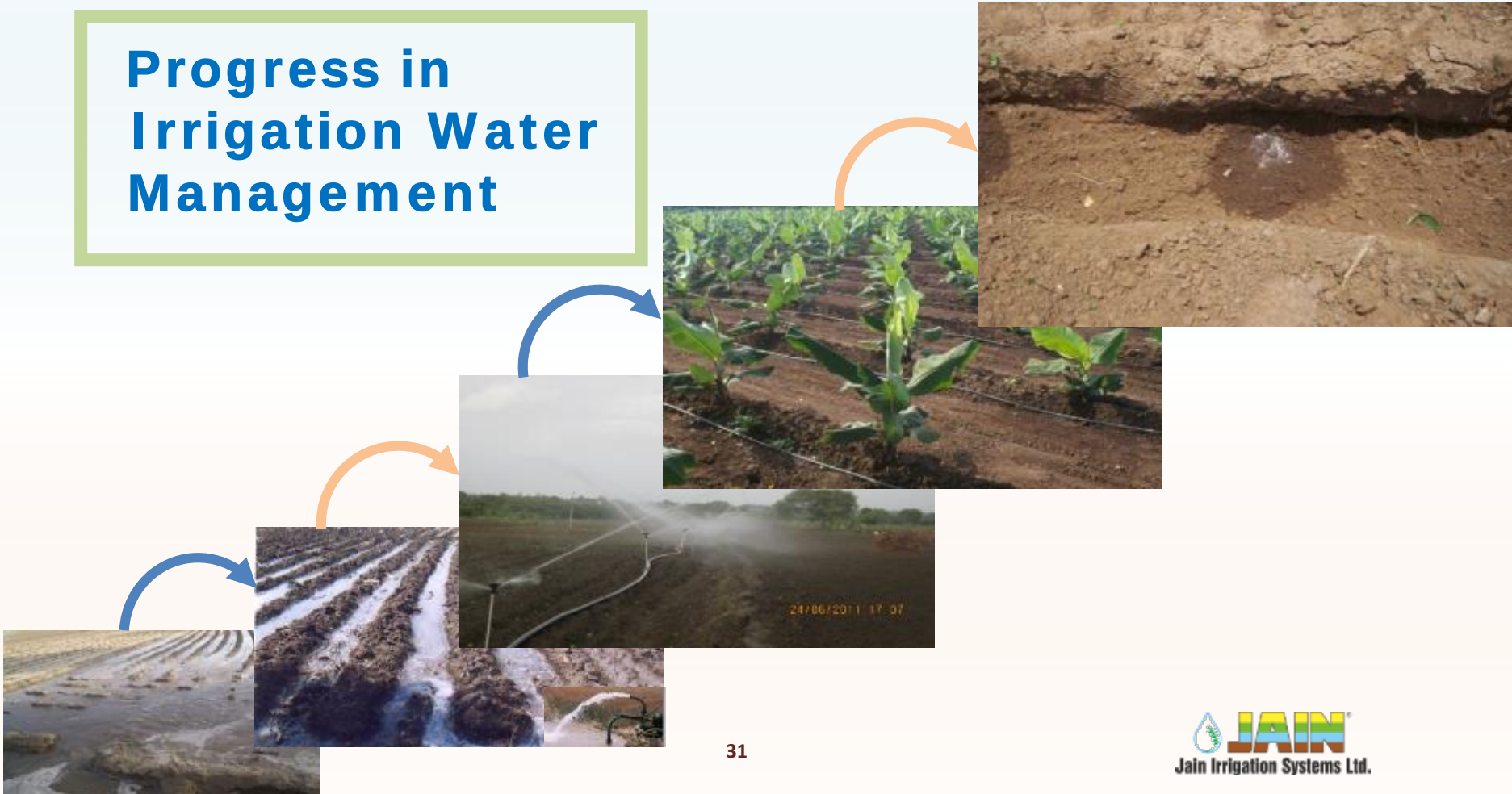
- FWUE is the ratio of crop yield (Y) to the total amount of water used in the field (WR).

$$\text{FWUE} = \frac{Y}{WR} \ldots\ldots\ldots\ldots$$

- PWUE is the ratio of rate of photosynthesis to rate of transpiration.

$$\text{PWUE} = \frac{Rate\ of\ Photosynthesis}{Rate\ of\ Transpiration} \ldots$$

Progress in Irrigation Water Management



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Water Use Efficiency- Vegetables

Water Saving and Productivity Gains under Drip Method of Irrigation : India									
Crop's Name	Water consumption (mm/ha)		Yield (tonne/ha)		Water Saving over FIM	Yield Increase over FIM	Water use Efficiency (yield/ha)/(mm/ha)		%Diff.
	FIM	DIM	FIM	DIM	(%)	(%)	FIM	DIM	
Ash gourd	840	740	11	12	12	12	0.013	0.016	23
Bottle gourd	840	740	38	56	12	47	0.045	0.075	67
Brinjal	900	420	28	32	53	14	0.031	0.076	145
Beet root	857	177	5	5	79	7	0.005	0.028	460
Sweet Potato	631	252	4	6	61	40	0.007	0.023	229
Potato	200	200	24	34	nil	46	0.118	0.172	46
Lady's finger	535	86	10	11	84	13	0.019	0.132	595
Onion	602	451	9	12	25	31	0.015	0.027	80
Radish	464	108	1	1	77	13	0.002	0.011	450
Tomato	498	107	6	9	79	43	0.012	0.083	592
Chillies	1097	417	4	6	62	44	0.004	0.015	275
Ridge gourd	420	172	17	20	59	17	0.041	0.116	183
Cabbage	660	267	20	20	60	2	0.03	0.075	150
Cauliflower	389	255	8	12	34	39	0.021	0.045	114
Vegetable (Avg)	638.1	313.7	13	17	54	26	0.0	0.1	243

Water Use Efficiency - Fruits and cash crops

Water Saving and Productivity Gains under Drip Method of Irrigation : India									
Crop's Name	Water consumption (mm/ha)		Yield (tonne/ha)		Water Saving over FIM	Yield Increase over FIM	Water use Efficiency (yield/ha)/ (mm/ha)		%Diff.
	FIM	DIM	FIM	DIM	(%)	(%)	FIM	DIM	
Papaya	2285	734	13	23	68	77	0.006	0.031	417
Banana	1760	970	58	88	45	52	0.033	0.090	173
Grapes	532	278	26	33	48	23	0.05	0.117	134
Lemon	42	8	2	3	81	35	0.045	0.315	600
Watermelon	800	800	29	88	nil	179	0.037	0.110	197
Mosambi*	1660	640	100	150	61	50	0.06	0.234	290
Pomegranate*	1440	785	55	109	45	98	0.038	0.139	266
Fruit Crops (Avg)	1217.0	602.1	40	70	58	73	0.0	0.1	297
Sugarcane	2150	940	128	170	65	33	0.06	0.181	202
Cotton	856	302	3	3	60	25	0.003	0.011	267
Coconut	-	-	-	-	60	12	-	-	
Groundnut	500	300	2	3	40	66	0.003	0.009	200
Other Crops (Avg)	1169	514	44	59	56	34	0	0	223
*** - Yield in 1000 numbers**									

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Water Use Efficiency - Food Grains

Farm Research Data on Sprinkler Irrigation in Comparison to Convetional Surface Irrigation									
Sr	Crops	Location	Yeild (q/ha)		Irrigation water(cm)		Water use Efficiency (q/ha/cm)		% Diff
			FIM	SIM	FIM	SIM	FIM	SIM	
1	Wheat	Rahuri	32.41	36.29	35.00	20.25	0.93	1.79	92
		Udaipur	26.61	33.02	33.02	14.52	0.81	2.27	180
		Hissar	44.80	48.70	33.94	32.68	1.32	1.49	13
2	Bajara	Rahuri	6.97	8.33	17.78	7.82	0.39	1.07	174
3	Jowar	Rahuri	4.92	6.62	25.40	11.27	0.19	0.59	211
4	Sorghum (k)	Rahuri	44.12	54.97	18.00	12.00	2.45	4.58	87
5	Maize(k)	Udaipur	15.62	18.10	12.80	9.00	1.22	2.01	65
6	Barley	Bikaner	24.09	28.15	17.78	7.82	1.35	3.59	166
		Hissar	35.10	34.80	23.87	21.88	1.47	1.59	8
7	Gram	Hissar	6.55	9.91	17.78	7.82	0.37	1.27	243
Foodgrains (Avg.)			**24.12**	**27.89**	**23.54**	**14.51**	**1.05**	**2.03**	**124**

Water Use Efficiency - Oilseeds

Farm Research Data on Sprinkler Irrigation in Comparison to Convetional Surface Irrigation									
Sr.	Crops	Location	Yeild (q/ha)		Irrigation water (cm)		Water use Efficiency (q/ha/cm)		% Diff
			FIM	SIM	FIM	SIM	FIM	SIM	
8	Oilseeds	Dhelhi	8.33	9.34	60.00	30.00	0.14	0.31	121
9	Groundnut (s)	Rahuri	23.24	28.98	90.00	62.00	0.26	0.47	81
		Junagarh	13.00	16.00	91.00	65.00	0.14	0.25	79
		Dharwad	33.96	39.86	76.30	63.60	0.45	0.63	40
		Punjab	5.50	11.90	68.60	50.20	0.08	0.24	200
		Navsari	31.00	30.00	56.00	44.00	0.55	0.68	24
		Rahuri(k)	18.31	22.15	21.00	14.00	0.87	1.58	82
10	sunflower	Rahuri	16.02	19.19	30.00	20.00	0.53	0.96	81
Oilseeds (Avg.)			**18.67**	**22.18**	**61.61**	**43.60**	**0.38**	**0.64**	**88**
11	Chillies(k)	Pune	17.41	21.52	36.00	24.00	0.48	0.89	85
		Rahuri	17.15	20.91	39.00	26.00	0.44	0.80	82
12	Garlic	Rahuri	69.99	73.99	84.00	60.00	0.83	1.23	48
13	Onion(s)	Rahuri	334.90	412.70	78.00	52.00	4.29	7.94	85
14	Cotton	Navsari	6.99	7.04	40.64	29.65	0.17	0.24	41
		Punjab	10.00	15.00	91.10	58.60	0.12	0.26	117
15	Sugarcane	Rahuri	792.10	866.30	245.00	188.00	3.23	4.61	43
		Dharwad	55.70	48.00	51.40	43.50	1.08	1.10	2
Others (Avg.)			**163.03**	**183.18**	**83.14**	**60.22**	**1.33**	**2.13**	**63**

Advantages of Drip Irrigation for different crops

Crop	Yield (MT/ha)			
	Conventional	Drip	% Yield increase	Water Savings (%)
Banana	57.5	87.5	**52**	45
Grapes	26.4	32.5	**23**	48
Sweet Lime	100	150.0	**50**	61
Pomegranate	56.0	109.0	**98**	45
Tomato	32.0	48.0	**50**	31
Water Melon	24.0	45.0	**88**	36
Chilies	4.2	6.1	**44**	63
Sugarcane	128.0	170	**33**	56
Average	53.51	81.01	**54.75**	48.12

Source: Report of Task Force on Micro Irrigation, 2003

What does it means?

Crop	Yield (MT/ha)				
	Conventional	Drip	% Yield increase	Water Savings (%)	Increase in water use efficiency (%)
Banana	57.5	87.5	**52**	45	176
Grapes	26.4	32.5	**23**	48	136
Sweet Lime	100	150.0	**50**	61	289
Pomegranate	56.0	109.0	**98**	45	167
Tomato	32.0	48.0	**50**	31	119
Water Melon	24.0	45.0	**88**	36	196
Chilies	4.2	6.1	**44**	63	291
Sugarcane	128.0	170	**33**	56	204

Source: Report of Task Force on Micro Irrigation, 2003

Food security

Water security

Energy Security

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Measures to Improve WUE in Irrigation Sector

- Irrigation Sector Reforms and PIM
- Adoption of scientific Water Management Practices
- Take holistic approach & adopt integrated solutions
- Use of MIS(Management Information Systems and DSS (Decision Support System)
- Piped conveyance & distribution
- On Farm Micro Irrigation Systems
- R and D Efforts.

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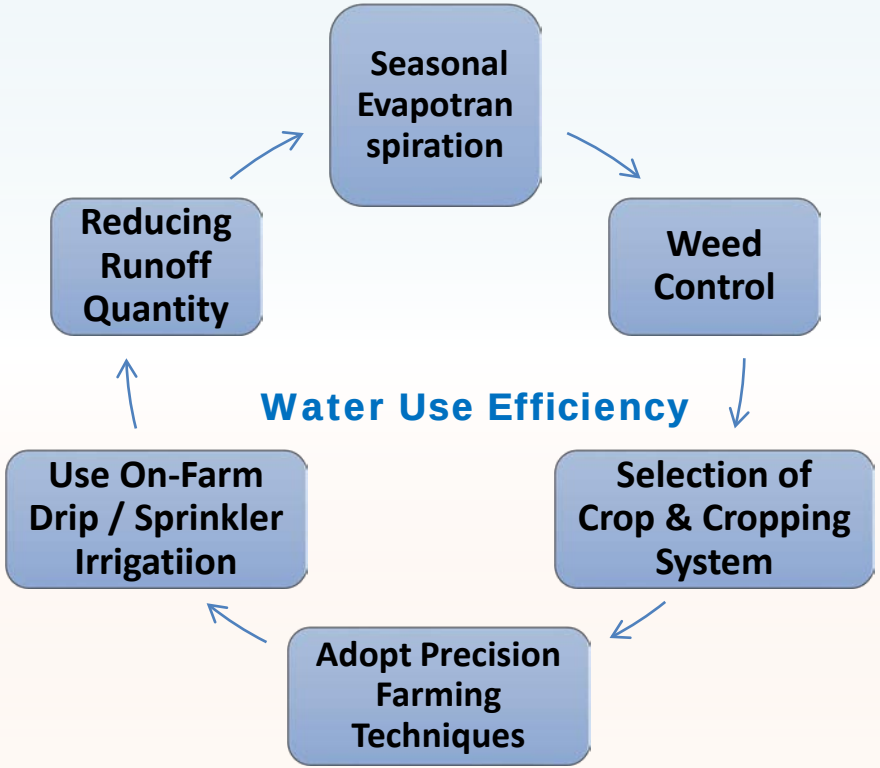
Strategies to Improve Water Use Efficiency



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COMMUNITY LIFT CUM DRIP IRRIGATION MODEL EXECUTED BY JISL AT

SAMPATRAO SAHAKARI PANI PURWATHA SANSTHA, RAYGAON KADEPUR, SANGLI)

More Crop Per Drop

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JIIS SAMPATRAO SAHAKARI P.P.S. PROJECT

Location	Sampatrao Deshmukh Sahkari Pani Purvatha Sanstha Ltd., Raigaon, Tal: Kadegaon, Dist: Sangli.
Area to Be Irrigated	2009 Acre (813.36ha)
No. of Beneficiaries	1255
Water Source	Hingangaon Talav (0.42TMC Water from Tembhu Project)
Total Value of the Contract to Jain Irrigation	2746.44 Lakhs (Rs. 137,000 Per Acre)
Total Value of the Project	3640.00 Lakhs (Rs. 181,000 Per Acre)

Salient Features of the Project

Crop	Sugarcane	
Drip System	SubSurface Drip System	
Total Irrigated Area	2009	Acre
Beneficiaries	1255	Farmers
Water required for 2009 Acre	0.42	TMC
Rising Main Pipe Dia.- HDPE	900	mm
Rising Main Length	4.13	Km
HP at Jack well (275 HP x 4 Nos)	1100	HP
HDPE/PVC Pipe Distribution Network	185	km
HP at Main Delivery Chamber (For Distribution + Drip	750	HP
Suggested Inline Lateral Spacing	6	Feet
Suggested Inline Lateral Dripper Discharge	4	LPH
Suggested Inline Dripper Spacing	50	cm
Available Electricity	16	Hrs
Application Rate of the Drip System	4.37	mm/hr
Peak Water requirement	6.00	mm/day
Operating Time	1.37	Hr
Possible No. Of Sections per day	12	Nos

Salient Features of the Project

Total 4 Zones (Branches)		**Avg. 500 acre**	
Zone – I (Branch – I Area) – Total 10 Blocks		563	Acre
Zone – II (Branch – II Area) – Total 8 Blocks		372	Acre
Zone – III (Branch – III Area) – Total 10 Blocks		427	Acre
Zone – IV (Branch – IV Area) – Total 15 Blocks		647	Acre
Average Block Area (Total 43 Blocks)		47	Acre
Average Sectional Area (Total 12 Sections)		3.90	Acre
I) AT RESERVOIR LEVEL :			
V. T. PUMPS OF 275 HP 4 NOS	SUB TOTAL	1100	HP
II) CENTRIFUGAL PUMPS AT DELIVERY CHAMBER LEVEL			
1) FOR ZONE - 1 : 50 HP 3 NOS			
2) FOR ZONE - 2 : 40 HP 3 NOS			
3) FOR ZONE - 3 : 40 HP 3 NOS			
4) FOR ZONE - 4 : 120 HP 3 NOS			
	SUB TOTAL	750	HP
OVERALL TOTAL		**1850**	**HP**

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Sugarcane First Harvest - Average Yield 60 Tonne /acre

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Cost-Benefit Comparison JIIS V/s Canal Irrigation

JIIS Project Example - SDSPPS Cane Agro Project- Maharashtra

Sr.	Parameter	Traditional Canal System	Jain Integrated Irrigation Sloution System (Piping Network + on Farm Drip Irrigation)
1	Project Area, Acre	2009	2009
2	Project Cost , Rs. Crore	27.51	36.4
3	Project Cost, Rs./Acre	1,36,817	1,81,042
4	Irrigation Efficiency ●	34%	89%
5	Water Required, Mm^3	17.97	11.91
6	Anticipated Crop Yield as Per Project Cropping pattern, MT	60317	120635
7	Water Use Efficiency, Kg/m^3 ▲	3.36	10.13
8	Expected Net Income, Rs Crore	5.02	15.87
9	Net Income, Rs./Acre	24,980	78,938
10	Value Creation Efficiency, Rs/m^3 ★	2.79	13.32

$$● = \frac{\text{Irrigation efficiency}}{\text{Water utilised}} \qquad ▲ = \frac{\text{Water use efficiency}}{\text{Crop Yield}} \qquad ★ = \frac{\text{Value Creation Efficiency}}{\text{Crop Income}}$$

$$\text{Water supplied} \qquad \text{Water Supplied} \qquad \text{Water Supplied}$$

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References

- FAO Manual
- Guidelines for improving Water Use Efficiency in Irrigation, Domestic and Industrial sector, by CWC, New Delhi
- Ministry of Water Resources, Government of India
- Narayanmurthy's research papers
- Das, Anup., Mudra, G, C., Patel, D, P., 2009. Technological Options for Improving Nutrient and Water Use Efficiency
- Strategies to Improve Water Use Efficiency, 2016. http://extension.psu.edu/plants/crops/news/2016/07/strategies-to-improve-water-use-efficiency , accessed on 5th Oct, 2016

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better than you found it.”

- Bhavarlal H. Jain

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