Climate Change: Strategies of Adaptation and Mitigation in Rainfed Agriculture in Relation to Water Management in Andhra Pradesh

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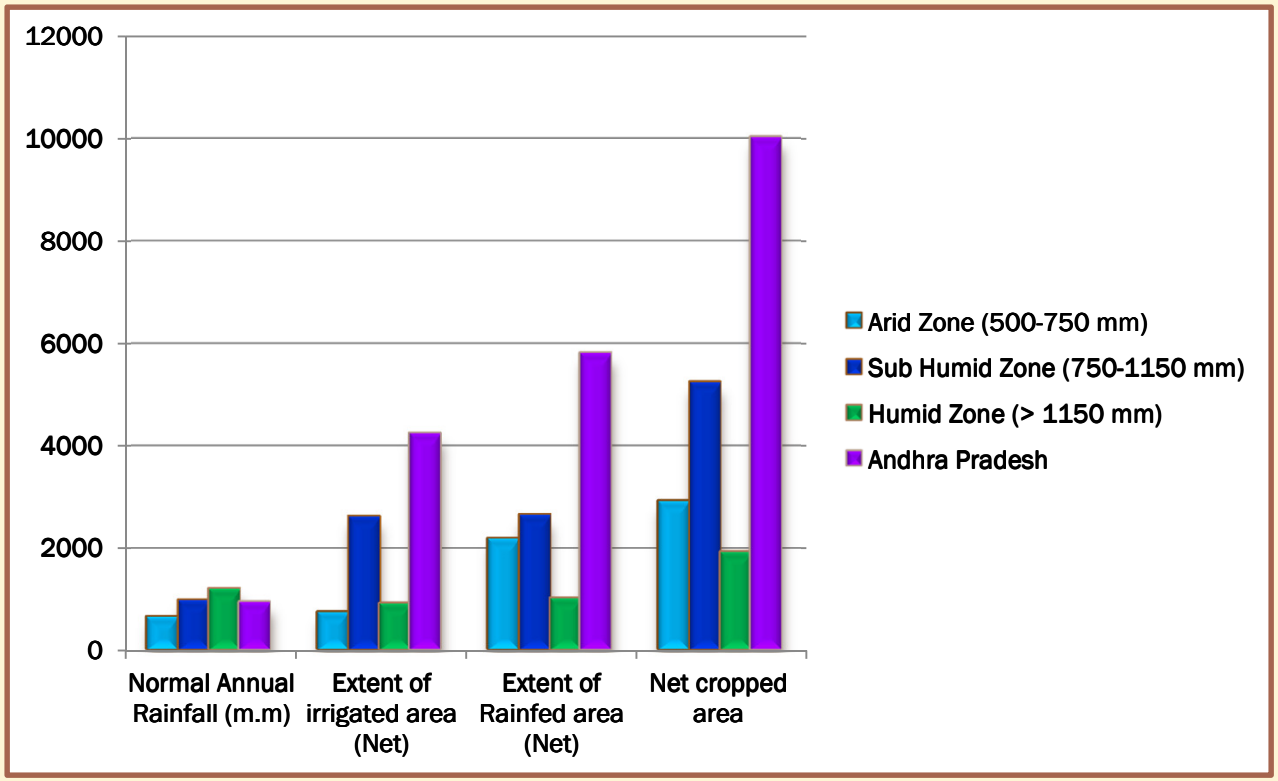
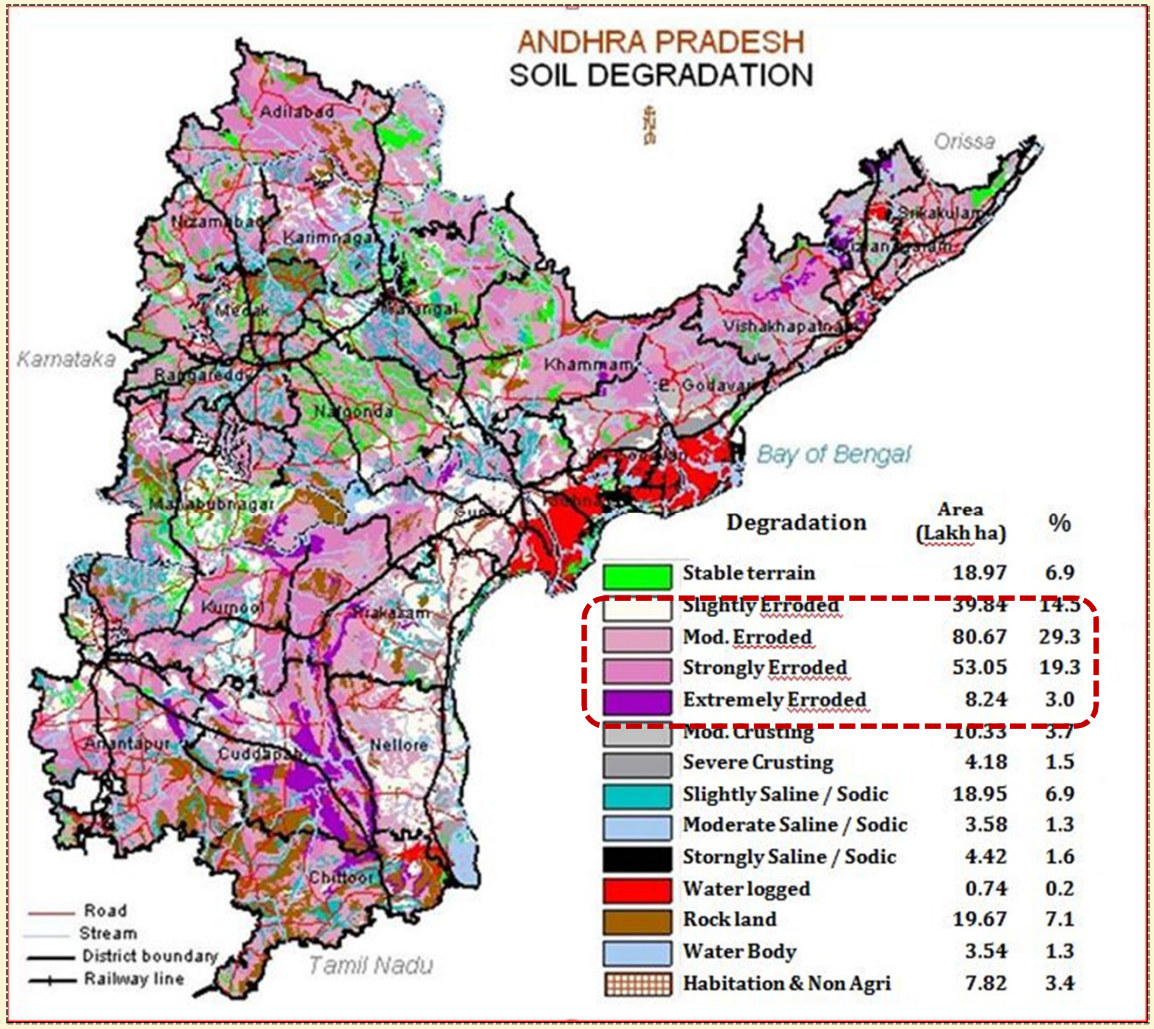
PHYSICAL STATISTICS OF ANDHRA PRADESH (2010-11)

- The total geographical area : 275.04 Lakh Ha.
- Gross Area Sown : 145.12 Lakh Ha
- Net area sown:112.88 Lakh Ha
- Rainfed Area : 57.77 Lakh Ha
- The Area irrigated under canals :14.45 lakh ha
- The Area irrigated by Tubewells & Dugwells : 22.83 lakh ha
- The Area irrigated by other source :1.53 lakh ha
- Number of Pumpsets : 29 lakhs

Distribution of Rainfed areas (1000ha) under different Rainfall Zones in Andhra Pradesh





Degradation	Area (Lakh ha)	%
Stable	18.97	6.9
Erroded	181.80	66.1
Crusted	14.51	5.2
Saline / Sodic	26.95	9.8
Others	23.95	8.6
Non Agri	7.82	3.4

Adaptation and Mitigation strategies in Rainfed areas

Adaptation

- Rainwater Harvesting(In-situ & Ex-Situ)
- Ground Water Recharge
- Drought Resistant crop Varieties
- Enhancing Water Productivity through Efficient Irrigation systems

Mitigation

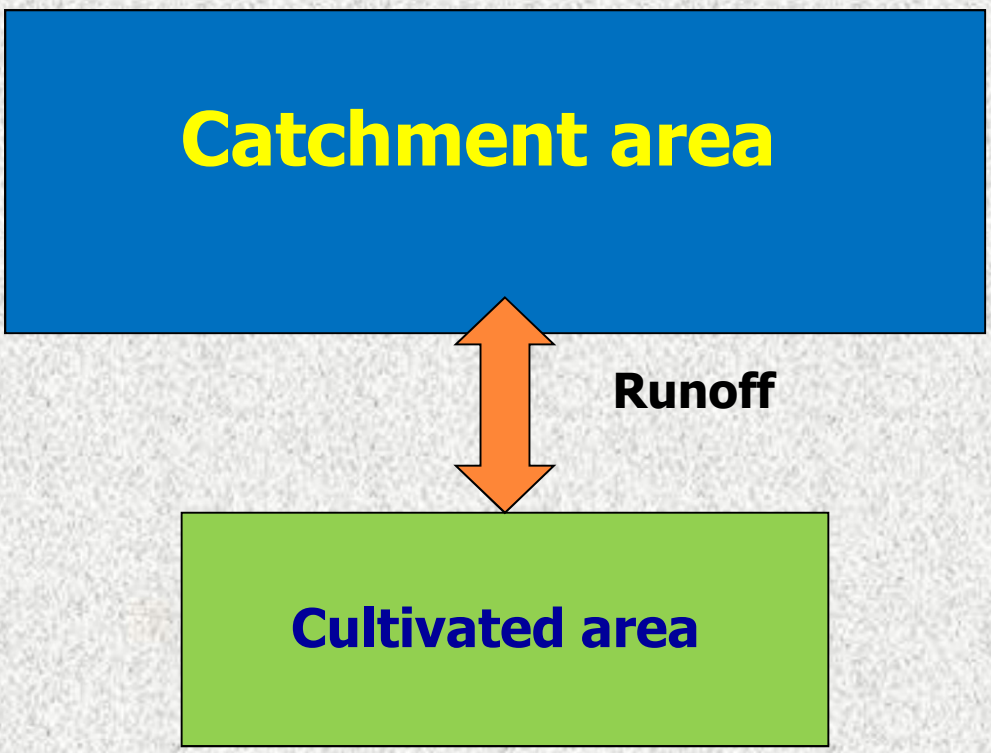
- Conservation Agriculture
  - Mulching
  - Low/Minimum Tillage
  - Carbon Sequestration

Estimated potential volume of rainwater storage for small-scale water harvesting structures

Rainfall zone (mm)	Geographical area (million ha)	Rainwater availability (million ha m)	Harvestable runoff (million ha m)
<500	52.07	15.6	0.78
500-750	40-26	25.2	1.51
750-1000	65-86	57.6	4.03
1000-2500	137.24	205.9	14.61
>2500	32.57	95.7	3.26
Total	328.0	400.0	24.19

(Source: Katyal, 1997)

BASIC MODEL OF WHS



Present:

Community based

Future:

Individual land holdings

In-situ conservation of rain water:

- Contour cultivation
- Tillage Practices- Deep
- Tied ridging
- Conservation furrows
- Broad bed and furrows
- Vertical mulching
- Compartmental bunding

Conservation furrows + deep tillage in sunflower. Yield benefit 25% over farmers practice

Ridges and furrows system in cotton. Additional yield of 500 kg/ha over farmers practice

***In situ* moisture conservation minimized drought effects across production systems : 270 on farm trials in 18 target districts**

Pigeonpea in ridge and furrow system recorded 13% yield increase over flat sowing at Mirzapur, UP, India

POTENTIAL OF RAIN WATER HARVESTING AND RECYCLING AS ON ADAPTATION STRATEGY TO CLIMATE VARIABILITY/CHANGE IN RAINFED CROPS

Rainfall- Runoff events during Kharif,2009

Date	Rainfall, mm	Runoff, mm	Per cent runoff to rainfall
8/06/2009	34.4	0.67	1.95
13/06/2009	14.4	0.17	1.18
20/06/2009	9.0	0.16	1.78
23/08/2009	17.4	0.88	5.06
26/08/2009	48.4	1.90	3.93
31/08/2009	96.4	10.16	10.54
29/09/2009	30.0	0.65	2.17
30/09/2009	55.0	4.32	7.85
01/10/2009	29.0	0.73	2.52
9/10/2009	50.0	0.98	1.96
19/11/2009	25.0	2.59	10.36

Rainfall- Runoff events during Kharif,2010

Date	Rainfall, mm	Runoff, mm	Per cent runoff to rainfall
11/06/2010	70.2	3.42	4.87
13/06/2010	62.0	6.37	10.27
06/07/2010	75.4	6.36	8.40
10/09/2010	29.0	0.45	1.55

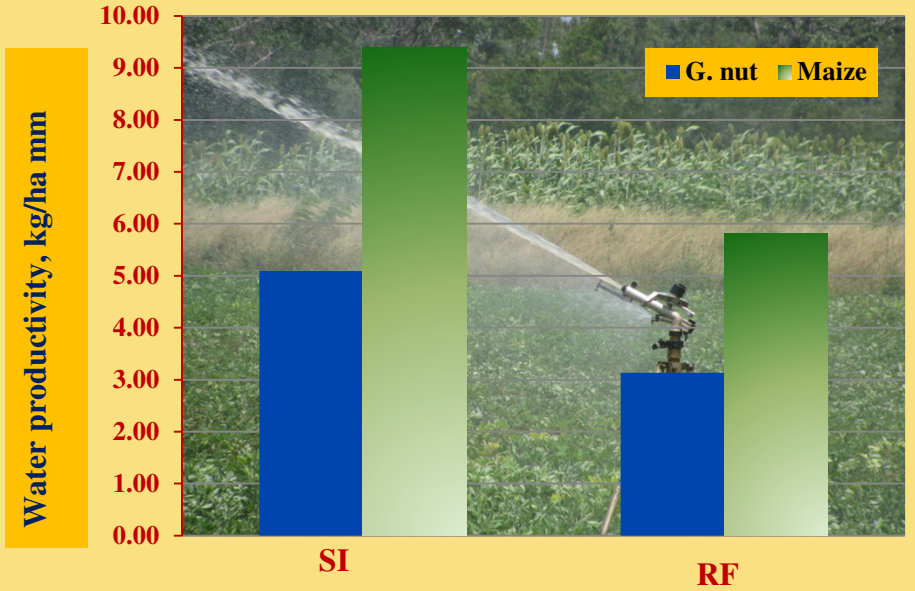
Rainwater productivity:

- Adaption of a suitable pumping system
- Selection of suitable water application system based on water quality in storage structures

Average yields(kg/ha) of G.Nut & Okra and Shelling (%) and oil content (%) in G.nut in different treatments

Treatments	G.Nut Yield, kg/ha			G.Nut Shelling, %			G.Nut Oil, %		Okra Yield, kg/ha		
	2008	2009	2010	2008	2009	2010	2009	2010	2008	2009	2010
SI (TS)	1105	1783	3340	60	63	69	41	47	2610	3200	4095
SI (NTS)	844	1595	2853	54	56	66	46	47	2367	2663	3391
RF (TS)	633	917	3360	55	56	69	46	47	1490	1525	3941
RF (NTS)	500	845	2940	48	50	66	48	46	897	965	3008
CD (5%)	190.2	70.59	601.69	2.93	2.53	4.48	12.26	4.10	442	78.0	593.24
SE	77.72	28.85	173.87	1.20	1.04	1.293	3.54	1.185	180.50	31.86	171.43

- A net work of 6 farm ponds having catchment area from 2 to 14.5 ha at GRF
- Capacity of farm pond ranges from 250 to 1750 m^3
- Lined with HDPE(500 microns) and Silpaulin (300 gsm) plastic sheet
- Spray gun with 3 hp diesel monoblock pumpset (Discharge:270 lpm at 200 kPa)



SI: Supplemental Irrigation; RF: Rainfed

Salient Observations:

❖ Seasonal rainfall of 350 mm was recorded(50 % deficit to normal)during 2011 with two rainfall events producing runoff of 1500 m^3 in 6 farm ponds

❖Experiments conducted in groundnut (1.2 acres)and maize (1 acre) with 3 irrigations in groundnut and two irrigations in maize increased the water productivity by 67% over the rainfed in sandy loam and sandy clay loam soils

Crops	Rainfall during growing period, mm	Water applied as supplemental irrigation, mm	Total water used, mm	Crop productivity, kg/ha	
				SI	RF
Ground nut(ICGV9114)	318.6	63.0	391.6	1942	1000
Maize(DHM117)	319.8	59.0	378.8	3561	1862

WATER USE PARTICULARS OF RAINFED CROPS UNDER DIFFERENT FARM PONDS AND THEIR WATER PRODUCTIVITY (2012)

Crops	Area Irrigated (Acres)	Season	Contributing Farm Ponds	Amount of water used, m^3	Yield q/ha	Water productivity (q/ha mm)
Groundnut	1.0	*Kharif*	R3-1&2	300	8.8	0.16
Maize	1.0	*Kharif*	R1	500	47.5	1.07
Carrot	0.77	*Rabi*	L6	417	6.0	0.06
Redgram	2.10	*Rabi*	R5	483	1.8	0.02
Green Gram	2.87	*Summer*	R5, L6	675	7.2	0.07


Green Gram


Maize


Groundnut


Carrot


Red Gram

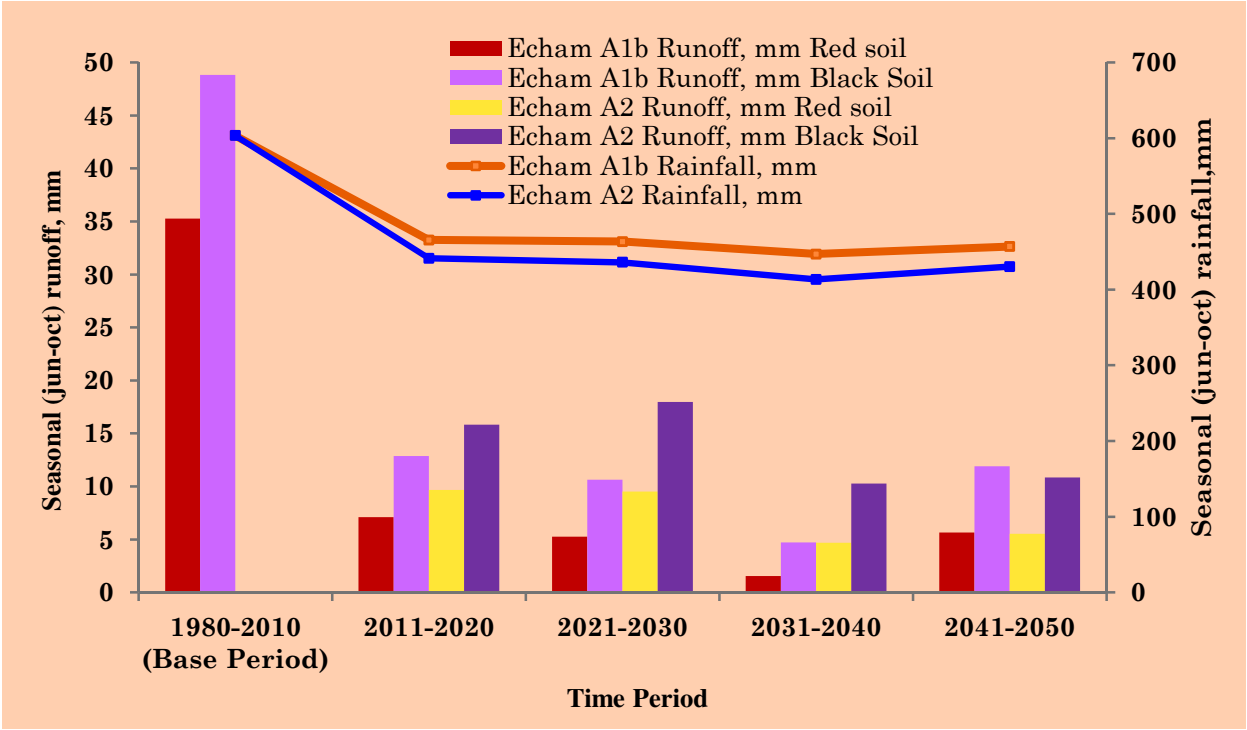
Efficient water application systems for improving productivity is crucial to agriculture

Recharging Ground water through Bore wells from outlet of the farm pond

Demonstration of different micro irrigation systems in Sapota

Micro water harvesting: half moon bunds in Mango across the slope

SEASONAL RAINFALL & RUNOFF (JUNE-OCTOBER) IN DIFFERENT CLIMATE CHANGE SCENARIOS FOR SOUTHERN TELANGANA



Assessment of Rain Water Productivity Through Aqua crop Model

Experimental Details

Study area	:	**Gunegal Research Farm, CRIDA Hyderabad**
Design	:	**Split Plot Design**
Maize variety	:	**Monsanto, Dekalb 900 M.Gold**
Total Plot size	:	**4050m^2**
Each Plot size	:	**15 x 4.5 m^2**
Total Plots	:	**20**
Main Treatments:	:	**5 irrigation Treatments (I1, I2, I3, I4 and Rainfed) – Main plots**
	:	**2 Management Practices – Sub plots Mulching @ 5 t/ha, Non mulching Fertilizer doses (Normal 90kg N, 45kg P, 45kg K and 125% of Normal)**
Replications	:	**3**
Season	:	**Kharif , June 21 to October 15, 2012**

AquaCrop Model

Environment

- Climate
- Crop
- Manag-ement
- Soil

Simulation

- Period
- Initial Conditions

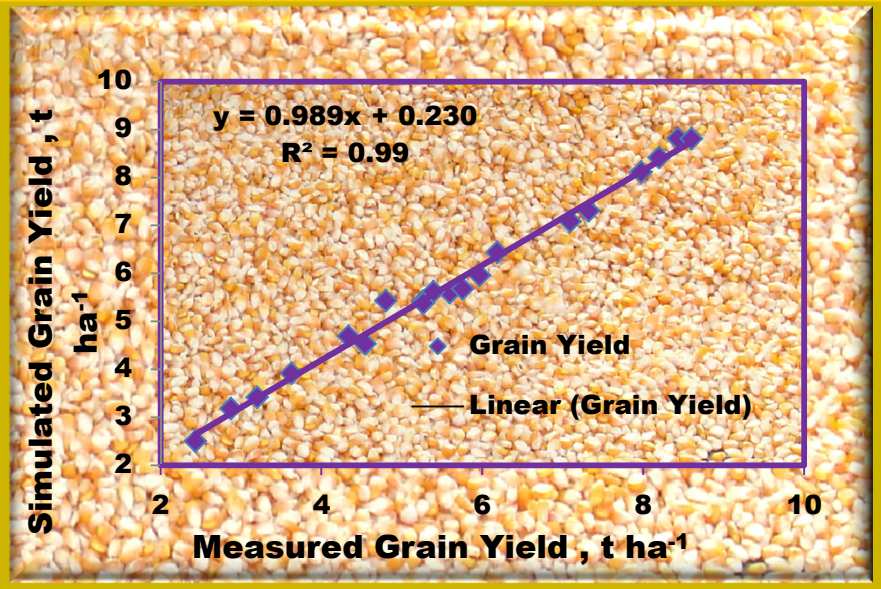
Project

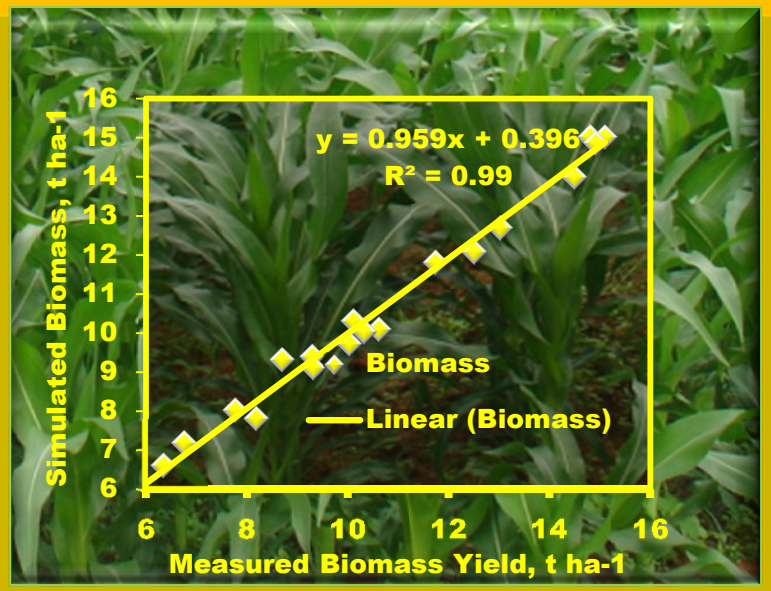
- Run

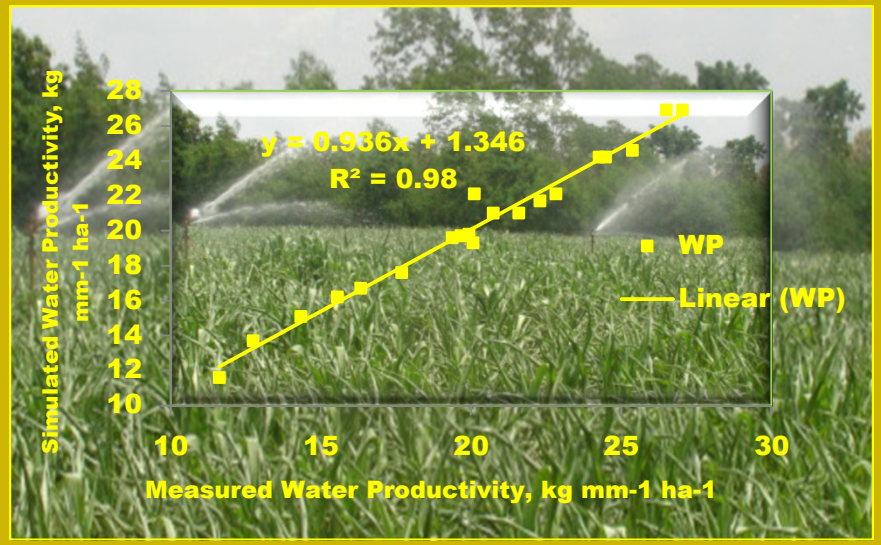
OBSERVED AND CALIBRATED INPUT DATA FOR AQUACROP MODEL

Base temp	8	^{0}C
cut off temp	32	^{0}C
Canopy growth coefficient (CGC)	15.5	%/day
Canopy decline coefficient (CDC) at senescence	4.2	%/day
Maximum basal crop coefficient (Kcb)	1.05	
Time from sowing to emergence	6	days
Time from sowing to start flowering	51	days
Time from sowing to start senescence		
Rainfed	68	days
20mm	71	days
30, 40,50 mm	75	days
WP	31	g/m^2
Time from sowing to maturity	117	days
Length of the flowering stage	10	days
stomatal closure		
Upper	0.69	unit less
Shape factor	6	unit less
Early canopy senescence		
upper	0.69	unit less
shape factor	2.7	unit less
canopy expansion		
upper	0.14	unit less
lower	0.72	unit less
shape factor	2.9	unit less

Model Performance statistics of the AquaCrop during Calibration

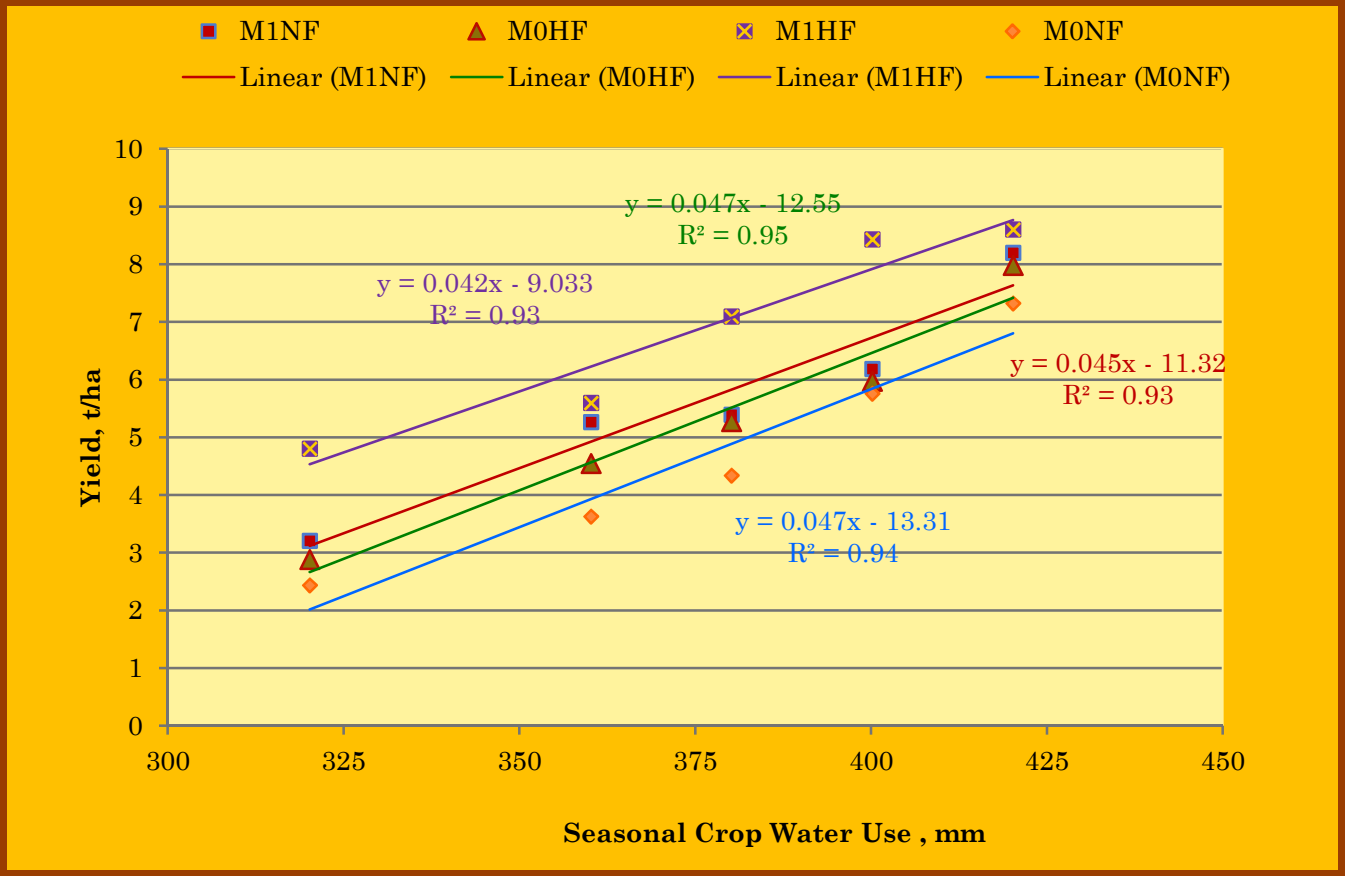






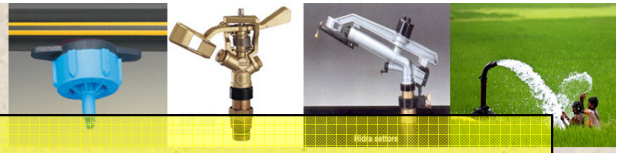
Performance Statistics	Biomass, t ha^{-1}	Yield, t ha^{-1}	WP, kg ha^{-1} mm^{-1}
E	0.99	0.98	0.98
RMSE	0.16	0.21	0.08
MAE	0.52	0.43	0.70
D-index	0.95	0.94	0.93

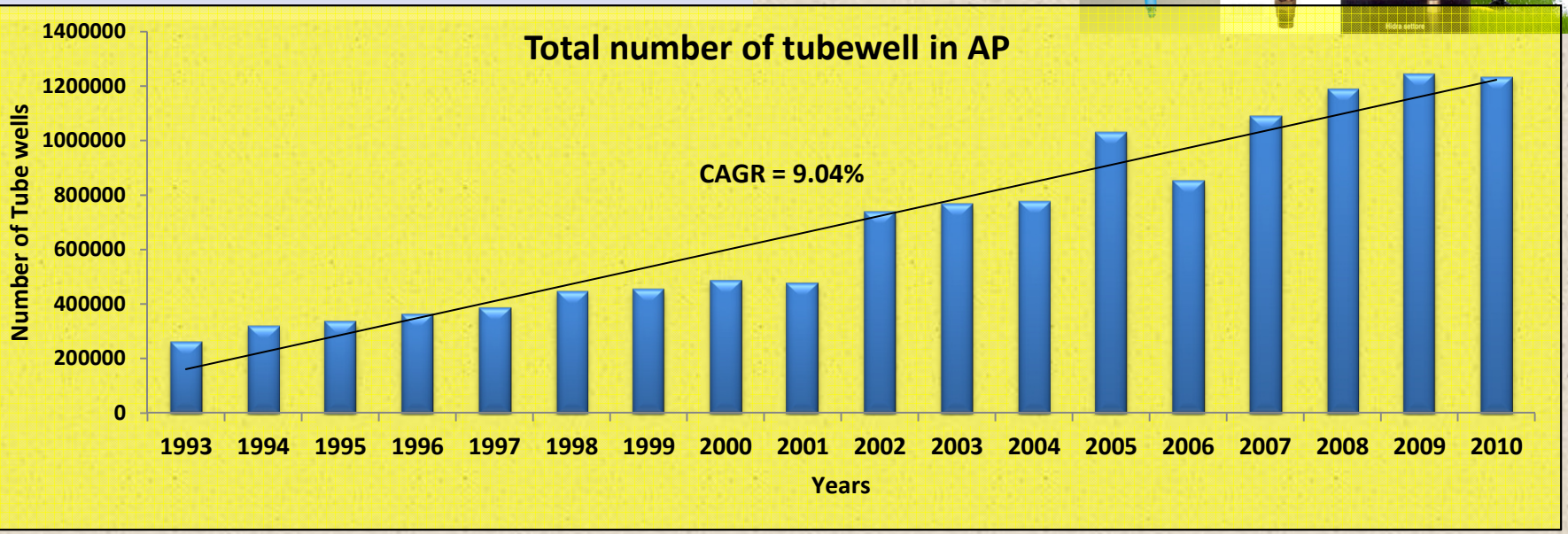
Crop Water Production Functions for Maize



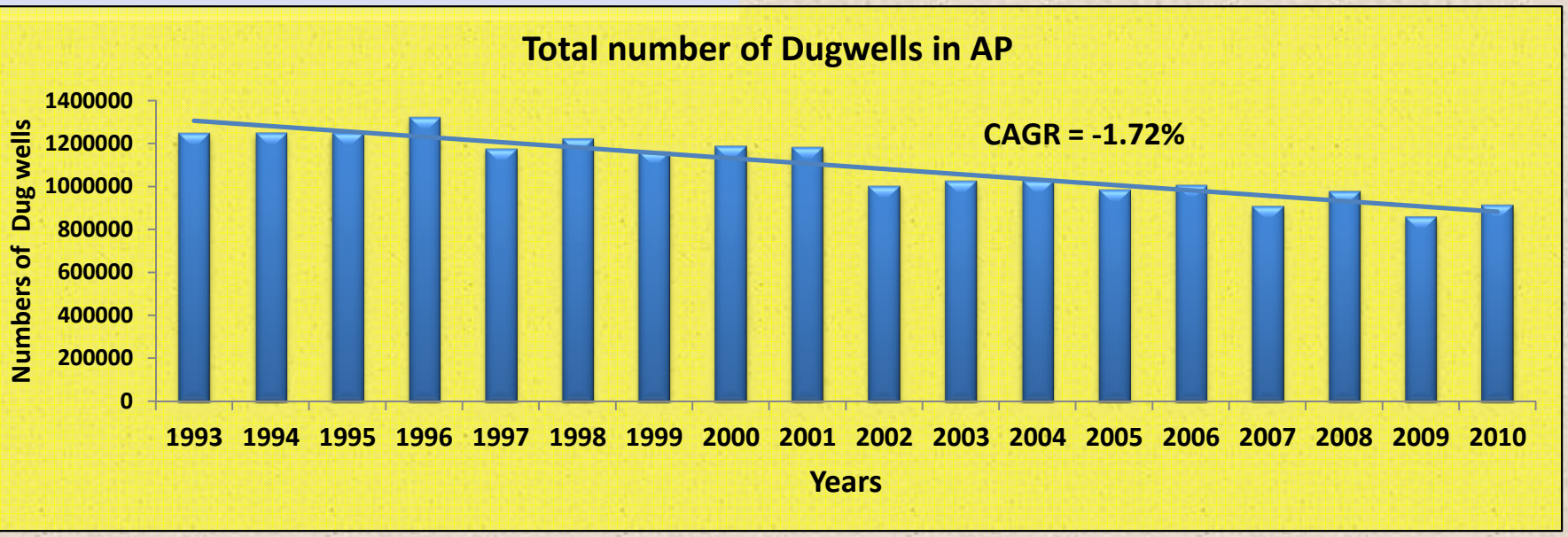
Water, Energy and Co_2 Nexus under wells in Andhra Pradesh

Tubewells in AP (from 1993-2010)





Dugwells in AP (from 1993-2010)



PUMPS DISTRIBUTION POWER WISE IN ANDHRA PRADESH

Sl. no	Pump (Hp)	Working of Pumps (%)
1	3	19.85
2	5	52.81
3	7.5	9.55
4	10	9.61
5	>10	8.18

In Andhra Pradesh majority of pumpsets are 5Hp rated. However, on an average 5Hp rating was taken for calculation of Co2 emission.

SYSTEMS AND PUMPSET EFFICIENCIES FOR DIFFERENT IRRIGATION PRACTICES

Sl. No.	Irrigation System	Efficiency (%)		
		Application	Pump set	Overall
1	Surface Irrigation	60	50	30
2	Raingun Irrigation	70	50	35
3	Sprinkler Irrigation	75	50	37.50
4	Drip Irrigation	90	50	45

C-CONTENT AND CO_2 EMISSION RATE FROM DIFFERENT COALS

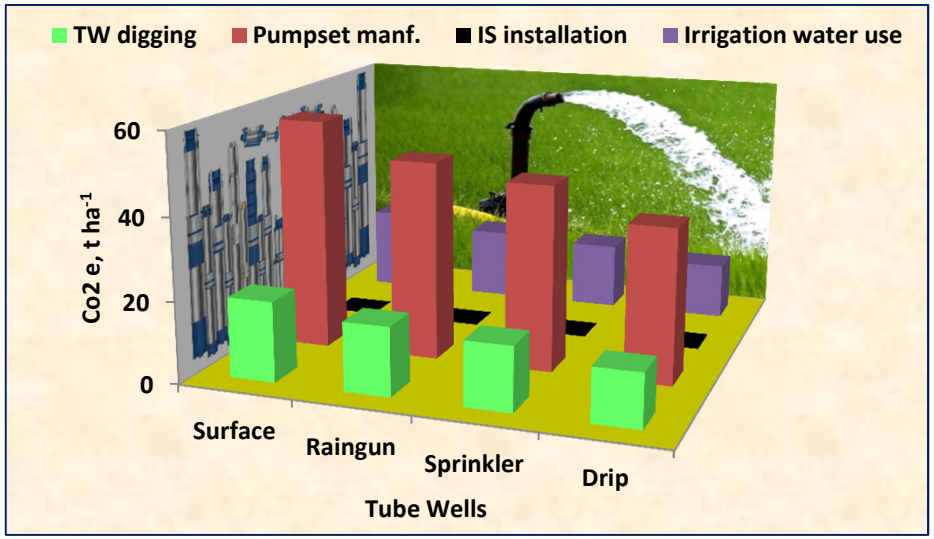
Sl. No.	Coal	Co2 Emission (Kg/kg of coal)	C-Content (%)
1	Anthracite	3.49	98
2	Bituminous	2.89	65-92
3	**Sub-Bituminous**	**2.38**	**45-65**
4	Lignite	1.46	25-45

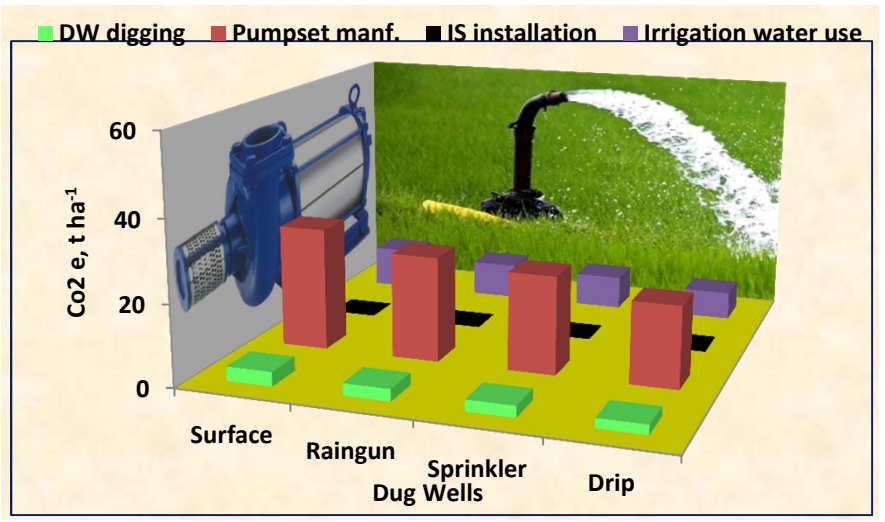
In this study **sub-bituminous** coal is selected which contains the Co2 emission rate **2.38 kg/kg of coal** burning with **45-65 %** of C-Content and it is most widely used in India and in Andhra Pradesh for producing the electricity in thermal power plants.
The coal required to produce 1 kW-hr energy or electricity is 0.5 kg.

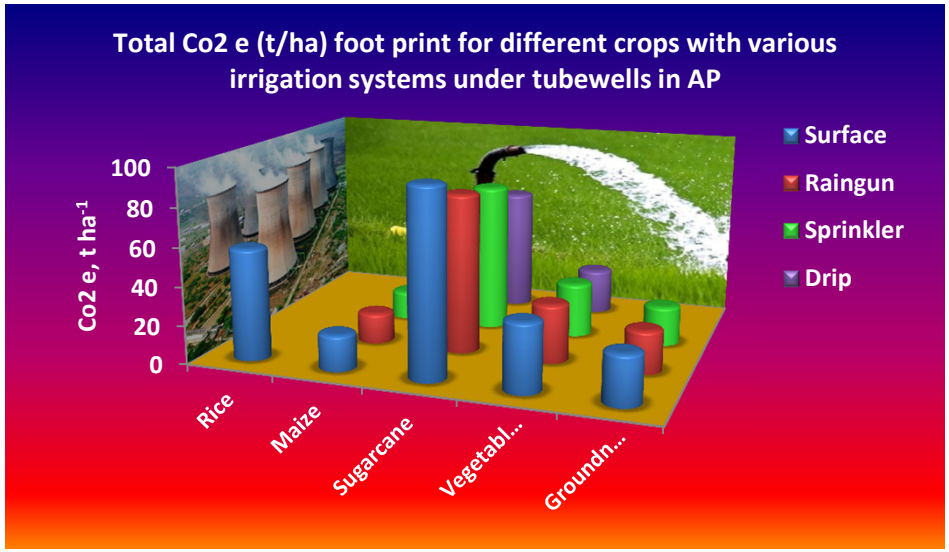
Note: R2 is the increase in pumpset efficiency by 5% after replacing the GI pipes with PVC pipes, fittings and low friction foot valve.

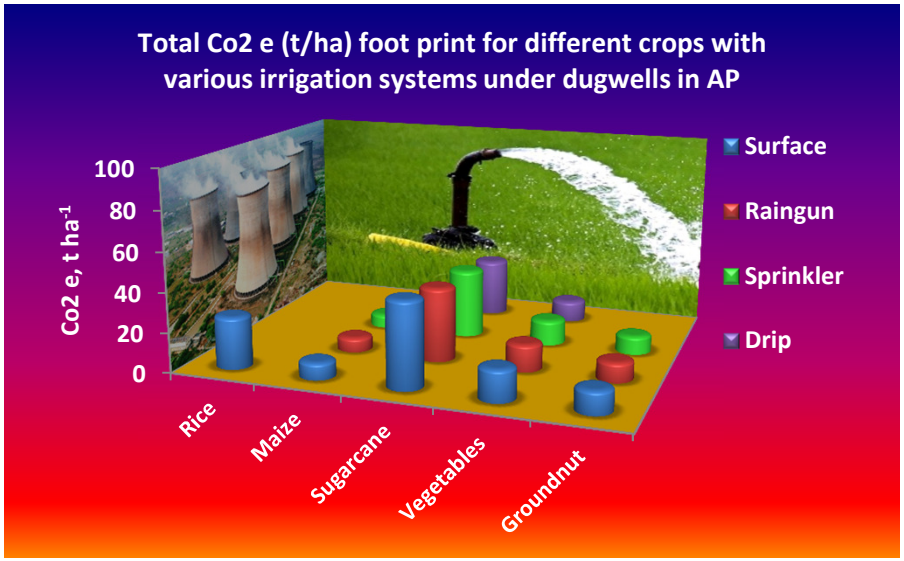
Development of Co2 foot print for well irrigation in Andra Pradesh for 5 major crops



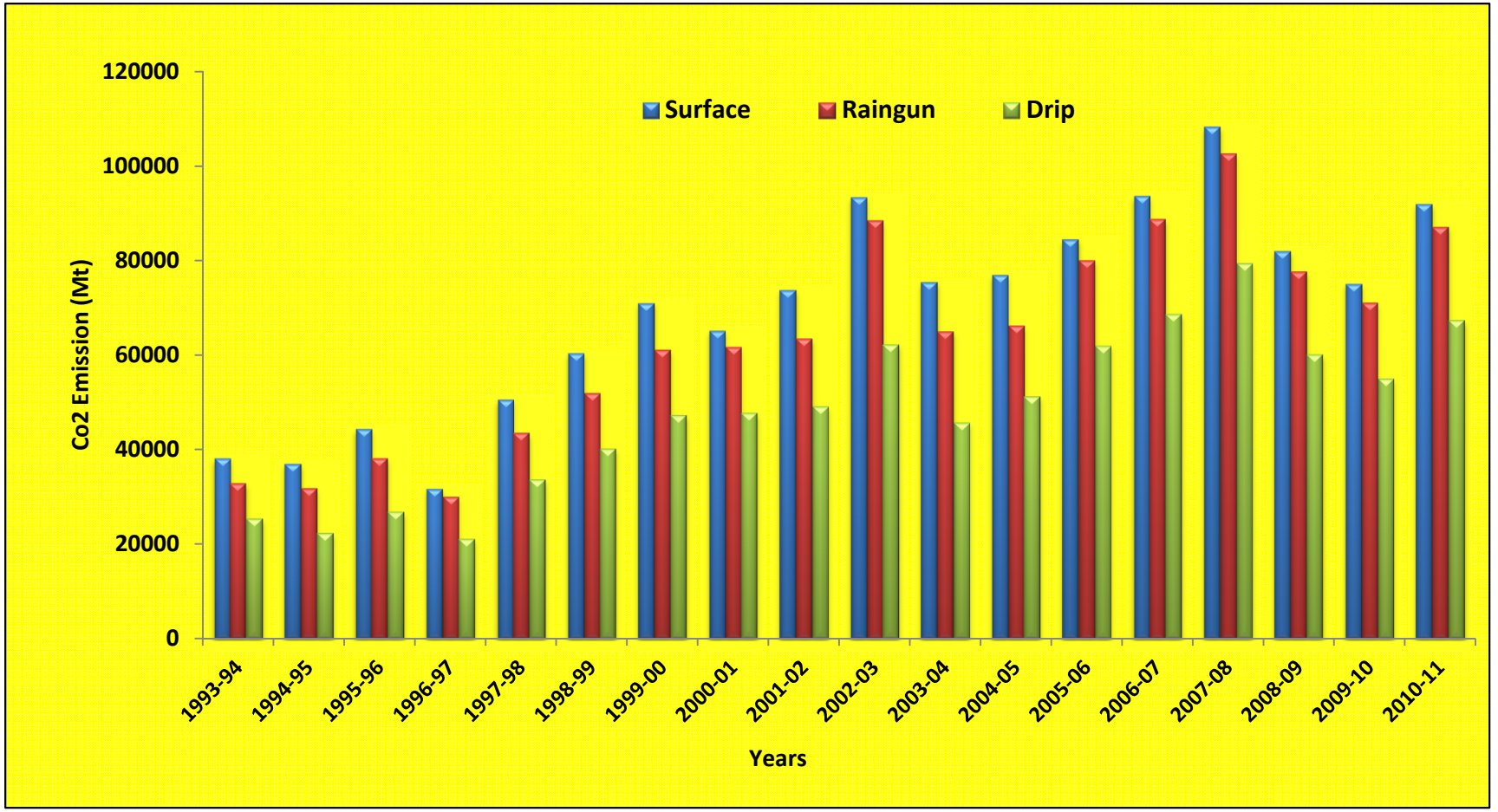


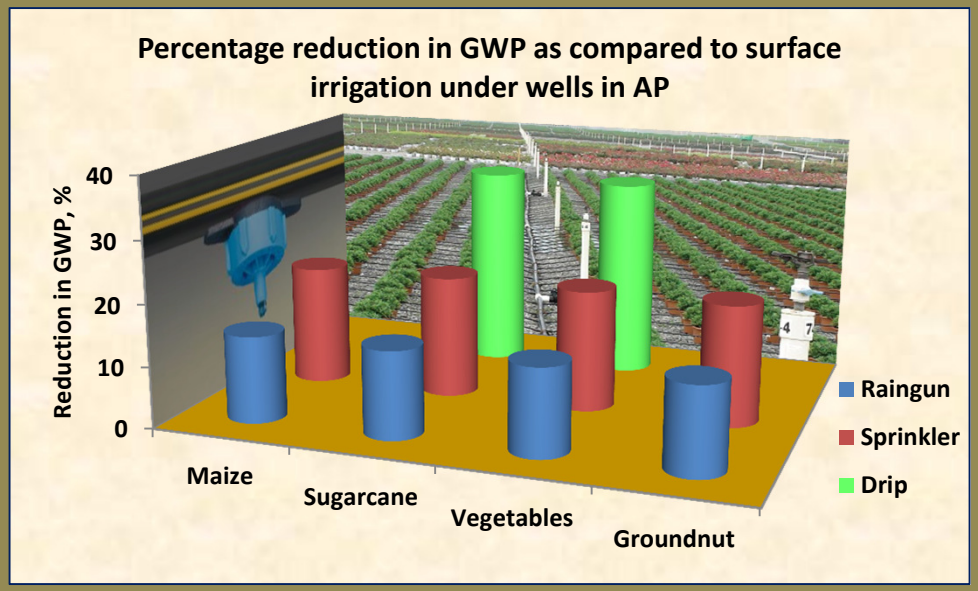






CO_2 EMISSION FOR SUGARCANE UNDER DIFFERENT IRRIGATION SYSTEMS IN AP





Findings:

➢Out of the components considered, the contribution to Co2 emission by pump industry is maximum.

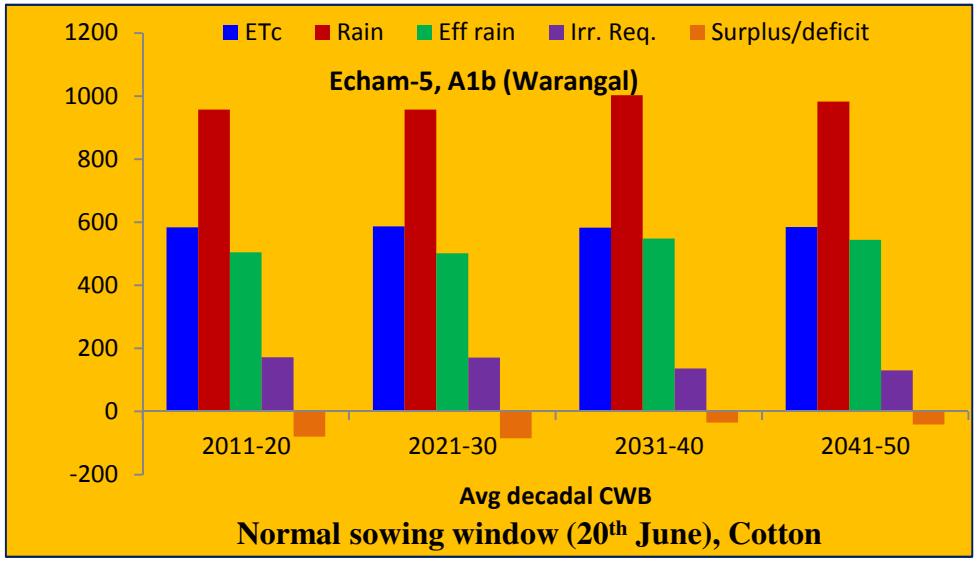
➢Drip irrigation has the advantage in maximum reduction of global warming potential as mitigation strategy as compared surface irrigation systems under wells.

Impact of climate change on crop water balance in Telangana region (Maize and Cotton)

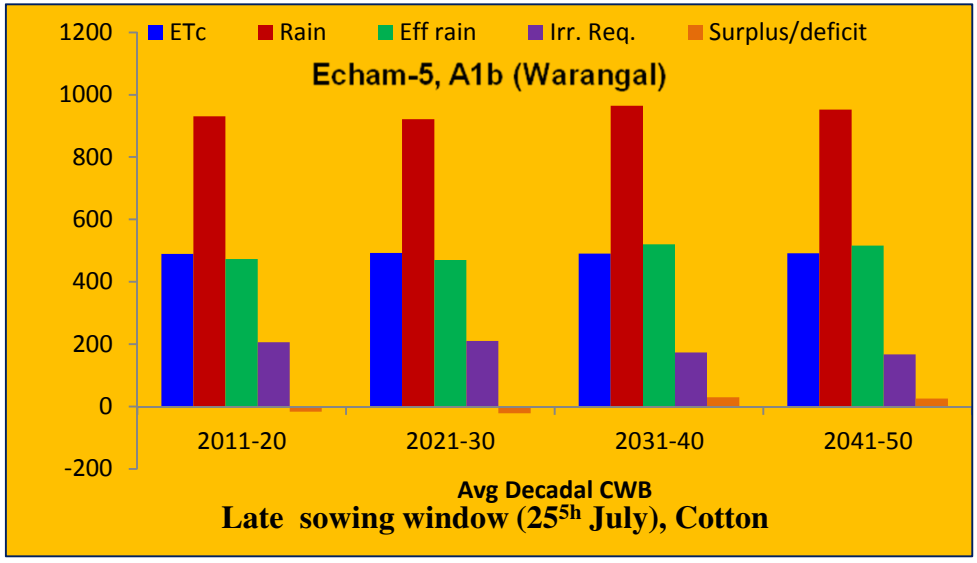
CROPWAT model was used for calculating crop water balance components of rainfed maize and cotton in 9 districts of Telangana region for different CC scenorios of A1b and A2 of ECHAM5 and CSIRO.

Findings:

1. **The CC scenarios predicted the shift in the rainfall pattern, reduction in crop ET, increased effective rainfall because of fall in the temperatures.**
2. **Accordingly, the deficits have been reduced in late sowing as compared to normal sowing of cotton and maize crops.**

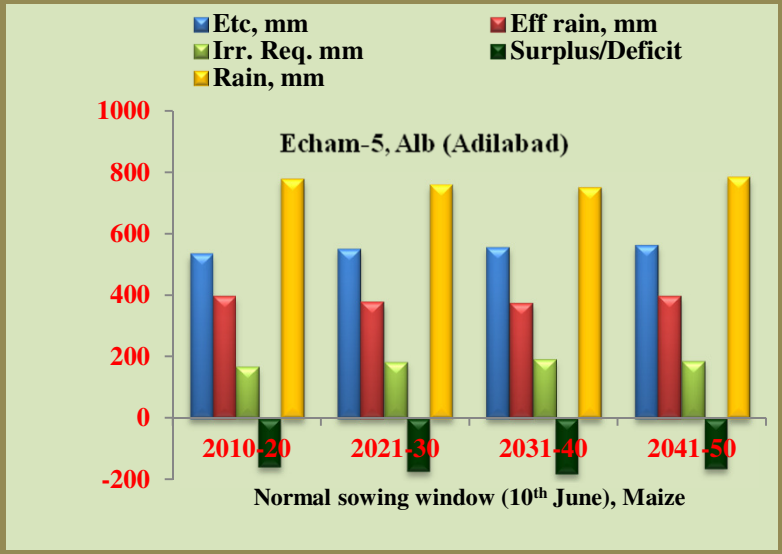


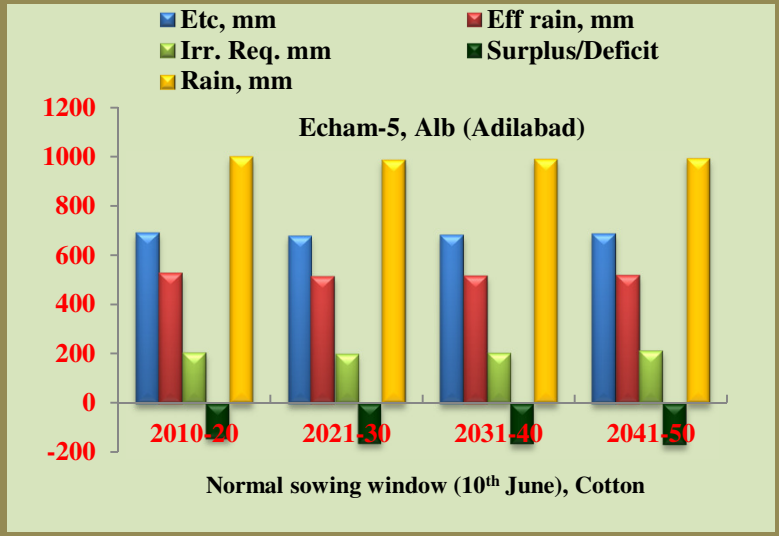
Normal sowing window (20th June), Cotton

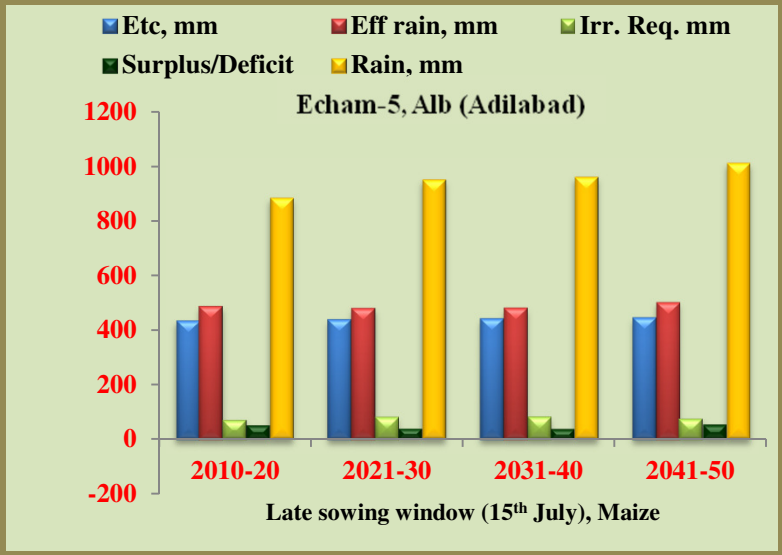


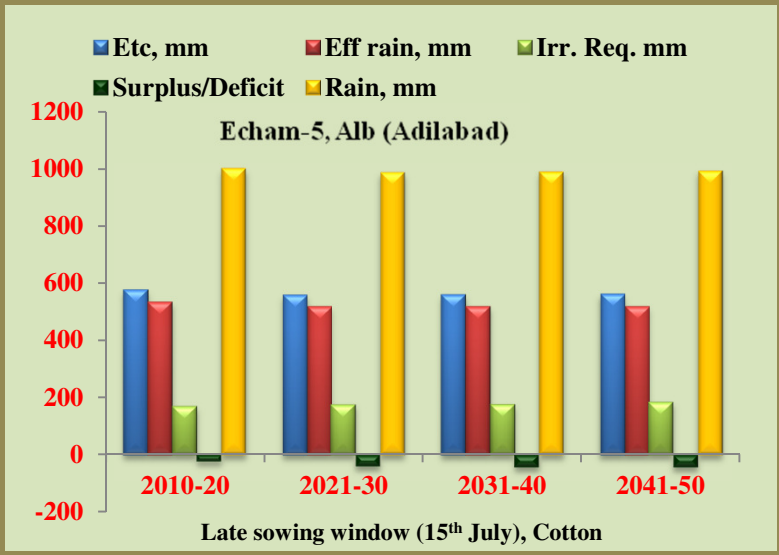
Late sowing window (25^{5h} July), Cotton

Decadal Crop Water Balance for Maize and Cotton in High Rainfall District









Drought resistant Crop varieties in Andhra Pradesh

Crop	Varieties/ Hybrids
Oil seeds	
Ground nut	Abhaya, Navayani , ICGV-9114,
Castor	PCH-111 , Kranti, Jyothi, Haritha, Kiran
Sunflower	Private Hybrid
Pulses	
Redgram	PRG-158, LRG-50,
Greengram	LGG-460
Blackgram	LBG-623, T-9
Horsegram	CRIDA-18R, CRHG-4
Chickpea	KAK-2
Soyabean	MACH-58, PK-472
Sorghum	CSV-23, CSH-16,25
Bajra	ICMV-122
FT Millet	Sri lakshmi, Narasimharaya
Cotton	BT

Sailent findings/Recommendations:

- Rain water harvesting systems through farm ponds has good potential of adaptation to climate risk in both kharif and rabi rainfed crops. This system has advantage of conservation of both soil, water and nutrients and promotes local water availability for agricultural operations. It can be made for multiple enterprise integrating agriculture, horticulture, fish, poultry etc.

- Aqua crop has been found effective with reliable results for assessing the rain water productivity in rainfed areas.

- The AquaCrop model was calibrated for maize under different supplemental irrigation and crop management practices. The maximum basal crop coefficient for maize varies from 0.75 to 1.05 and water productivity of 31 gm^{-2}

- AquaCrop model predicted well with the measured values in case of grain yield, biomass, WP, crop canopy and soil water content. The model efficiency varied from 0.98 to 0.99 for grain yield, biomass and water productivity.

- Under well irrigation, CO2 foot print was found minimum with drip irrigation system as compared to other surface, raingun and sprinkler.

- The crop water balance for both maize and cotton with Echam-5 & CSIRO models climate data indicated the reduction in the deficits because of shift in rainfall, reduced Crop ET in case of late sowing of the crops for Telanagana region.

- While introducing the new technologies as a strategy to mitigate the climate change, both investments and incentives for the farmer must be considered for protecting the future agri environment


THANK U...