

Resource Conservation Technologies in Reclaimed Alkali Soils



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Declining ground water levels and deteriorating quality of soil in the Indo-Gangetic plains is emerging a serious concern for agricultural sustainability in the near future. Depletion of groundwater in areas irrigated by tube wells and associated water quality concerns have brought about heightened awareness of the need for the judicious use of rain, surface and ground water resources. The pressures on natural resources are immense. Soils are depleting in their fertility as a result of continuous and intensive cropping. The organic carbon levels in Punjab soils have decreased from 0.5% (1950-60) to about 0.25% at present. Tillage costs are rising, which accentuates the already serious labour shortages during peak periods of land preparation and harvest. For these and other reasons, the long-term sustainability of these systems is now a subject of attention. Further, increased cost of cultivation and declining productivity is compelling the farmers to quit the farming.

There is a general consensus that quality of natural resources base needs to be improved for enhanced productivity, sustainability and profit. Also, it is believed that future productivity growth would come through efficient management of inputs (water, nutrients and energy) and better risk management strategies. Targeted resource conserving technologies offer newer opportunities for better livelihood for the resource poor, small and marginal farmers of the region.

Though rice-wheat systems are critical in Indo-Gangetic plains, yet valuable information has remained underutilized by the farmers. Improved tillage, residue management and crop establishment practices show real potential for improving the productivity and profitability of rice-wheat systems. Reduced and zero tillage can improve yields, increase input-use-efficiency, reduced the intensity of machinery use and lower the production costs. Therefore, efficient soil and water management practices such as, tillage, irrigation and nutrients have to be fine-tuned according to the crop establishment requirements in a particular transect. Keeping the above facts in view, a long-term experiment is started at CSSRI to address some of the problems faced by the farmers in managing the natural resources for increasing the rice-wheat productivity.

OBJECTIVES

Immediate Objectives

- To study the effect of resource conservation options on water, nutrient, energy-use-efficiency and crop productivity
- To monitor the changes in physical, chemical and biological properties of soil as influenced by different resource conservation options
- To work out salt, water, nutrient, energy and gas fluxes in selected treatments to monitor impacts of conservation agricultural practices in moderating climatic variations
- To monitor changes in plant growth, yield and economics in different treatments

Long-term Objectives

- To evaluate different resource conservation options for the sustainability of rice-wheat cropping system
- To recommend the most profitable, eco-friendly and resource upgrading technology to the farmers of the region
- To provide input for making suitable policy for the management of natural resources for rice-wheat cultivation in Indo-Gangetic Plains

TREATMENTS

- T₁ Conventional rice transplanting / Conventional wheat sowing
- T₂ Conventional rice transplanting after wheat residue incorporation/wheat sowing after rice residue incorporation
- T₃ Direct seeded rice/ wheat in reduced tillage
- T₄ Direct seeded rice after wheat residue incorporation/ wheat in reduced tillage after rice residue incorporation
- T₅ Direct seeded rice/ wheat in zero tillage
- T₆ Direct seeded rice in zero tillage with wheat residue/ wheat in zero tillage with rice residue
- T₇ Rice transplanting on raised beds/wheat sowing on permanent beds



T₈ Rice transplanting in unpuddle condition/wheat sowing on fresh beds

T₉ Direct seeded rice + sesbania/wheat sowing in zero tillage

T₁₀ Conventional rice transplanting after sesbania green-manuring/wheat sowing in zero tillage.

Experimental Design: Strip plot; Replication : 4

Crop Rotation: Basmati Rice (CSR-30)-Wheat (PBW-343)

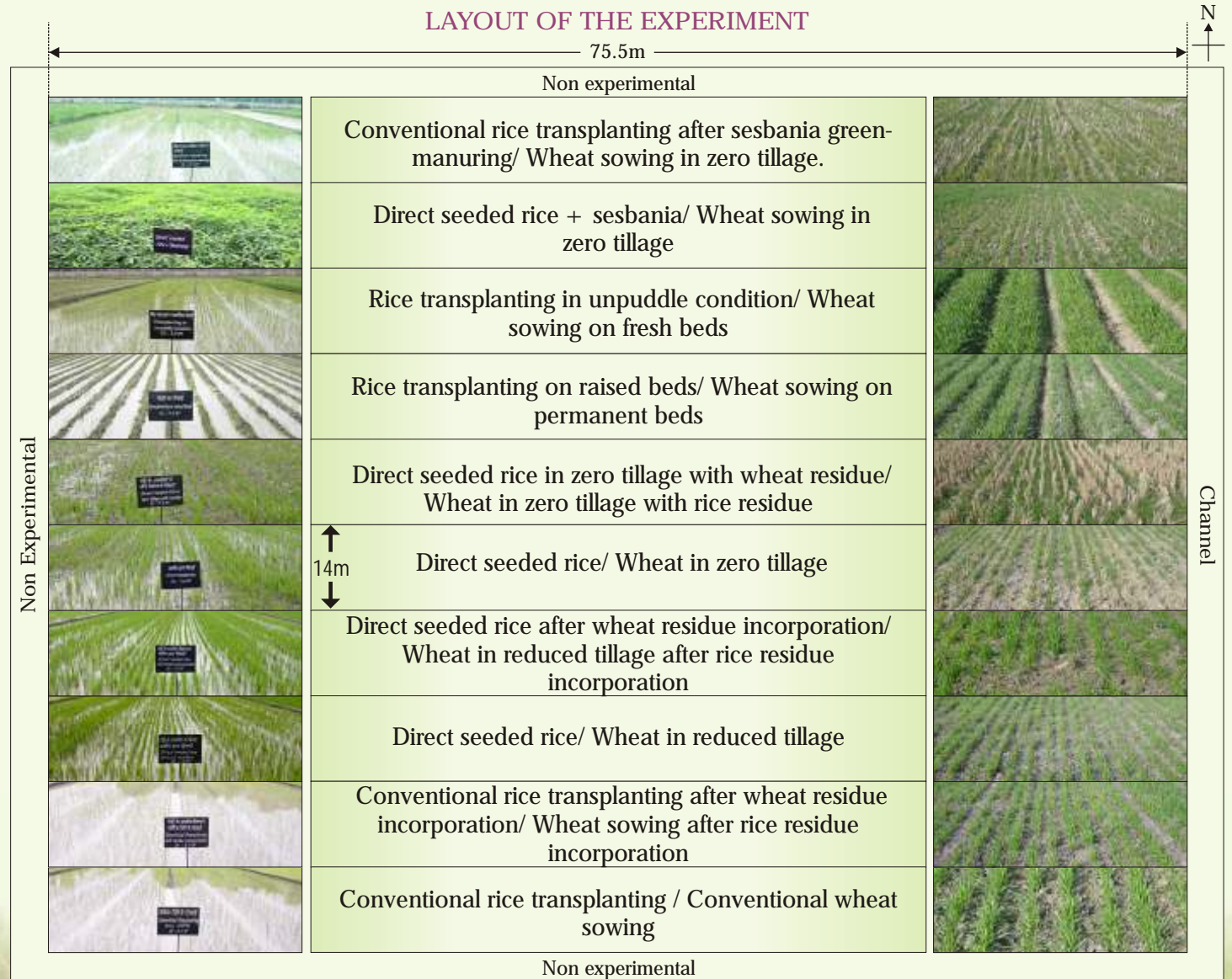
Observations to be recorded

- Water productivity and water application efficiency
- Soil permeability (Infiltration rate/ Saturated

hydraulic conductivity)

- Soil bulk density
- Soil dispersion
- Soil organic carbon
- ODR/Redox potential
- Nutrient status of soil (N, P, K, Ca, Mg, S, Zn, Mn, Fe and Cu)
- Crop yield and yield attributing parameters
- Microbial biomass
- Salt, gas and energy fluxes
- Benefit : Cost ratio

LAYOUT OF THE EXPERIMENT



PRELIMINARY RESULTS

Two seasons results of this experiment are presented in the following paragraphs.

In *kharif* 2006, the maximum yield of basmati rice (CSR-30) was recorded with unpuddled transplanted rice (4.00 t ha^{-1}) followed by conventional puddled transplanted rice (3.69 t ha^{-1}). Direct seeded rice (DSR) with sesbania co-culture as a *brown manuring* yielded (3.65 t ha^{-1}) compared to DSR (3.24 t ha^{-1}). Water productivity was highest in DSR at transplanting time followed by DSR+ Sesbania (Table-1). The maximum water saving was recorded in DSR at transplanting time (49.2%) followed by DSR+ Sesbania (43.65%), DSR (39.68%) and raised bed transplanted rice (24.60%).



Transplanted Rice



Direct Seeded Rice

Table 1. Effect of different crop establishment techniques on yield and water productivity of Basmati rice (CSR-30), *Kharif* 2006

Crop establishment techniques	Grain yield (t ha^{-1})	Water applied (m)	Irrigation water productivity (kg m^{-3})	Rainfall (m)	Gross water productivity (kg m^{-3})	Water saving (%)
Conventional transplanting	3.69	1.26	0.29	0.20	0.25	-
Unpuddled transplanting	4.00	1.25	0.32	0.20	0.27	-
Raised bed transplanting	2.95	0.95	0.31	0.20	0.26	24.60
Direct seeded rice (DSR)	3.24	0.76	0.42	0.23	0.32	39.68
DSR + Sesbania	3.65	0.71	0.51	0.23	0.38	43.65
DSR at transplanting time	2.91	0.64	0.45	0.23	0.43	49.20
CD at 5%	0.32	-	-	-	-	-

Highlight of the *kharif* season (2006)

Direct seeded rice with sesbania co-culture as a *brown manuring* yielded at par, compared to conventional transplanting and saved 43.6% water





Direct Seeded Rice + Sesbania

In *rabi* 2006-07, the maximum yield of wheat was recorded in zero tillage sowing where *Sesbania* was grown as a *brown manuring* during the *kharif* season (4.62 t ha^{-1}) followed by zero tillage without residue (4.35 t ha^{-1}). Conventional sowing with and without residue incorporation yielded 4.01 and 4.06 t ha^{-1} , respectively, whereas sowing on permanent and fresh beds recorded 3.81 and 4.11 t ha^{-1} yield (Table 2). Weed population of *P. minor* was less in zero tillage than in conventional tillage, whereas broad leaf weed population increased in zero tillage. Water productivity in zero tillage was higher (1.94 – 2.07 kg m^{-3}) as compared to conventional tillage (1.72 kg m^{-3}), whereas water productivity in sowing on permanent and fresh beds was 1.81 and 1.85 kg m^{-3} , respectively.

Table 2. Effect of different tillage practices on straw and grain yield of wheat in rice-wheat cropping system (*rabi*, 2006-07)

Tillage practices	Straw yield (t ha^{-1})	Grain yield (t ha^{-1})	WP (kg m^{-3})
Conventional sowing without residue	5.60	4.06	1.72
Conventional sowing with residue incorporation	5.52	4.01	1.71
Sowing in reduced tillage without residue	5.86	4.06	1.73
Sowing in reduced tillage with residue incorporation	5.78	4.06	1.72
Sowing in zero tillage without residue	6.18	4.35	1.94
Sowing in zero tillage with residue	6.28	4.33	1.93
Sowing on permanent beds	5.31	3.81	1.81
Sowing on fresh beds	5.76	4.11	1.85
Sowing in zero tillage (<i>Sesbania</i> in rice)	6.54	4.62	2.07
CD at 5%	0.40	0.30	--

Highlight of the *rabi* season (2006-07)

Green manuring in rice followed by zero tillage in wheat seems to be a promising option for sustained and economic yield





Conventional Wheat Sowing



Wheat Sowing in Zero Tillage

CROP DIVERSIFICATION

A permanent experiment has been established at the Central Soil Salinity Research Institute Farm, Karnal to evaluate the rice crop diversification opportunities in rice-wheat cropping system. Important *kharif* and *rabi* crops are grown continuously under zero tillage and conventional practices. The permanent layout of this experiment is as under:

Conventional Tillage (CT)	P A T H W A Y	Zero Tillage (ZT)
Barley / Pigeonpea UPSA 120		Barley / Pigeonpea UPSA 120
Oat / Sorghum (Hybrid Jumbo)		Oat / Sorghum (Hybrid Jumbo)
Wheat PBW 343 / Pigeonpea ICPL 88039		Wheat PBW 343 / Pigeonpea ICPL 88039
Mustard CS 54 / Moong Asha		Mustard CS 54 / Moong Asha
Mustard CS 52 / Moong SML 668		Mustard CS 52 / Moong SML 668
Wheat PBW 502 / Soybean SL 525		Wheat PBW 502 / Soybean SL 525
Gram HK 1 / Clusterbean Nav Bahar		Gram HK 1 / Clusterbean Nav Bahar
Gram HC 1 / Pearl Millet Hybrid		Gram HC 1 / Pearl Millet Hybrid

Area: Conventional tillage = 0.15 ha each; Zero tillage = 0.20 ha each



Soybean in Zero Tillage



Pigeon pea in Zero Tillage





Oat in Zero Tillage

Preliminary results revealed that most crops performed better in zero tillage (Table 3) .

Table: 3 Effect of different tillage options on yields of different crops (q/ha)

Crops	Conventional Tillage (CT)	Zero Tillage (ZT)
Pigeonpea	5.86*	11.29*
Soybean	5.62	6.59
Clusterbean	8.56	9.96
Barley	25.67	27.50
Wheat (PBW 343)	40.60	43.50
Mustard (CS 54)	9.20	11.50
Mustard (CS 52)	11.40	10.85
Oat	20.33	28.67

* Varieties are different: CT pigeonpea-ICPL-88039, ZT pigeonpea- UPAS-120





Published by : Director, CSSRI, Karnal-132001, Haryana

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Designed & Printed at : Azad Offset Printers (P) Ltd. 144-Press Site,
I.A.-1, Chandigarh Tel. : 0172- 2652349, 2651316, 2654411,5001805