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**Reformulating Policies for Integrated Land and Water Use for Sustainable
Agricultural Development: A Case of Punjab state**

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1. Introduction

- Land and water are natural partners in agricultural development
- Their coordinated and sustainable use is essential for long-term optimization of economic as well as social welfare
- In Punjab, these aspects were overlooked while planning agricultural growth
- Consequently production pattern mismatched with the soil capabilities and water availability regimes which resulted into:
 - Decline in groundwater level
 - Depletion of soil health
 - Stagnant productivity and profitability
 - Increasing economic and social costs

2. Agricultural Profile of Punjab State of India

- Major agricultural state in India having 3 per cent of the total agricultural area and producing 13 to 15 per cent of the total foodgrains production of country
- Contribution to central pool of foodgrains for public distribution ranged from 50 to 60 per cent in different years
- Significant player in the food security of the country

3. Policies which prohibited the coordinated use of land and water

- No policy for land and water conservation
- Assured price and marketing of rice and wheat by state agencies
- Consistent increase in minimum support price of wheat and rice (table 1)
- Supply of fertilizer and electricity at subsidized rates
- Emphasis on R & D in rice and wheat only

4. Impacts of these policies

- Emergence of rice wheat monoculture due to higher profitability (table 2)
- Rice and wheat out-substituted soil enriching legume crops
- Free/subsidized (flat rate) electricity supply encouraged wasteful consumption of groundwater exceeding the sustainable supply (table 3)
- Ground water table declining at a fast pace (table 4 and 5)
- Soils became deficient in nutrients (table 6)
- Organic carbon level declined in the soils from 0.5 to 0.2 percent

5. Reformulation of policies

- Diversification of agriculture towards less water requiring and soil enriching crops
- Rethinking at the subsidies generating inefficiencies in resource use
- Reorientation of research programs
- Changing agronomic practices aiming at land and water conservation
- Institutional and legal regulation of land and water use
- Mapping soil and water resources using remote sensing techniques
- Checking depletion of soil health using organic and green manures (table 7)

Table 1: Trends in Minimum Support Prices of wheat and paddy

Years	Compound Growth Rates (%)	
1980-81 to 1990-91	5.98	4.93
1990-91 to 2000-01	9.28	10.43
1999-00 to 2004-05	2.45	1.70

Table 2: Shift in cropping pattern in Punjab, 1960-61 to 2003-04 (percent area)

Crop	1960-61	1970-71	1980-81	1990-91	1999-2000	2003-04
Rice	4.79	6.88	17.49	26.86	33.29	33.07
Maize	6.91	9.78	5.65	2.51	2.08	1.95
Cotton	9.46	6.99	9.59	9.34	6.07	5.72
Sugarcane	2.82	2.26	1.05	1.35	1.37	1.57
Wheat	29.58	40.48	41.58	43.63	43.18	43.57
Pulses	19.08	7.29	5.05	1.91	0.79	0.55
Oilseeds	3.91	5.19	3.52	1.38	1.26	1.08
Potato	0.19	0.29	0.59	0.31	0.97	0.83
Others	23.26	20.84	15.48	12.71	10.99	11.66
Total	100	100	100	100	100	100
Total Cropped Area (000 hectares)	4732	5678	6763	7502	7847	7905

Table 3: Irrigation water requirement and availability in Punjab state*(Million hectare meters per annum)*

Surface water availability at head works	1.80
Water losses during conveyance to fields	0.35
Surface water available for irrigation	1.45
Sustainable groundwater availability	1.68
Total water availability	3.13
Water requirement at current crop production pattern	4.37
Gap in availability and requirement	1.24
Over use of groundwater	1.24

Table 4: Average water table depth (m) in different regions of Punjab

District	Measured		Predicted	
Years	1993	2003	2013	2023
Foothill	17.6	18.5	19.4	20.3
Central	11.1	16.2	21.3	26.5
South-West	6.8	8.9	10.9	13.3

Table 5: Percent area under different water table depths in Central zone of Punjab

Water table depth (Meters)	Percent area					
	Years	1973	1990	2000	2002	2004
0-5		39	9	6	2	0
5-10		58	66	41	22	10
>10		3	25	53	76	90

Table 6: N, P, K Status of Punjab Soils, 1981 through 2002(*samples deficient in percent*)

Nutrient availability	Low		Medium		High	
	1981-90	1991-02	1981-90	1991-02	1981-90	1991-02
Years						
N(OC)	78	66	22	32	0	2
P	48	62	29	23	23	15
K	8	9	45	51	46	40

Table 7: Effect of application of organic manures on soil chemical properties

Characteristics	Organic manures				
	Control	Cowpea	Sesbania	Guar	Moong
Org. C(%)	0.38	0.45	0.46	0.45	0.43
Avail. N (kg.ha)	115	146	153	143	142
Avail. P(kg/ha)	39.7	48.2	44.8	47.5	49.0
Avail. K(kg.ha)	147	155	152	168	163
Zn (mg/kg)	1.00	1.95	1.86	1.96	1.94
Cu ..	0.41	0.57	0.51	0.60	0.51
Fe ..	9.29	11.58	11.79	11.82	11.99
Mn ..	14.87	19.85	19.61	20.05	19.34