Political Economy of Groundwater in Punjab

R S Sidhu

Punjab Agricultural University

Ludhiana

Background

- Punjab is a Classic Success Story of Green Revolution in India

  -Substantial increase in production of wheat and rice

- Factors responsible
  - Expansion in irrigated area
  - High yielding seeds
  - Higher use of chemical fertilizers
- Supported by
  - Agricultural price and marketing policy
  - Institutional agricultural credit
  - Rural electrification, rural roads and rural markets

- Outcomes

  -Positive impacts on income, poverty and food security

  -Emerging issues: Natural resources depletion especially groundwater, fall in diversification, indebtedness
- Strategies for sustainability of groundwater resources

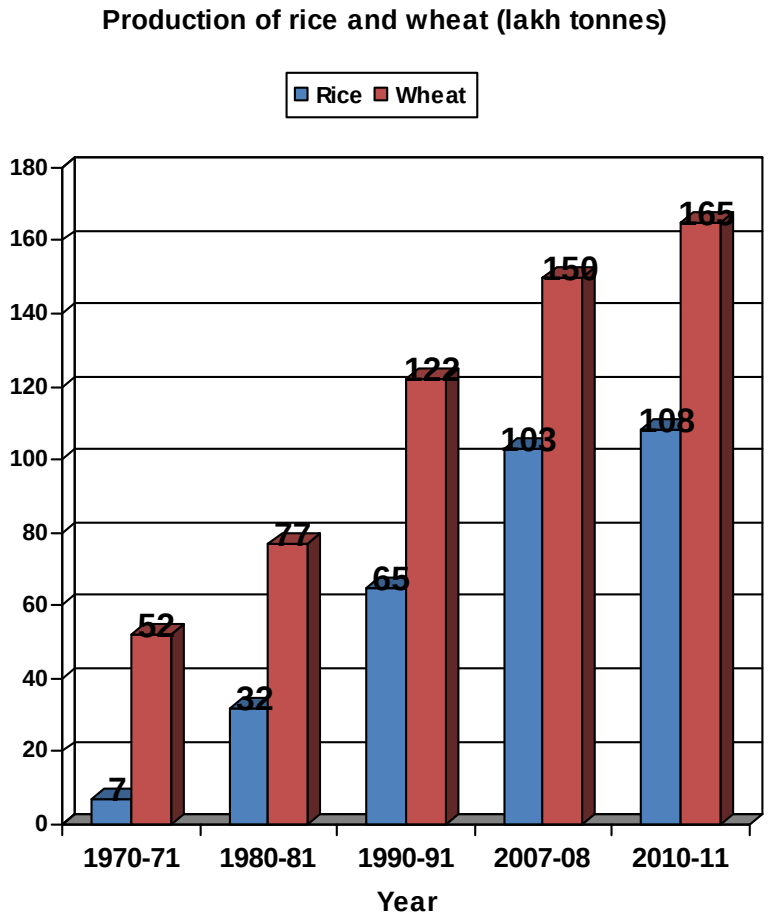
Basic Agricultural Characteristics of the Punjab State

Intensively cultivated area with dominance of rice-wheat crop pattern, double cropped, irrigated and high use of chemical fertilizers and pesticides

- Geographical area: 5.03 m ha
- Net sown area: 4.2 m ha
- Gross Cropped area:7.9 m ha
- Cropping intensity: 190%
- Irrigated area: 98%

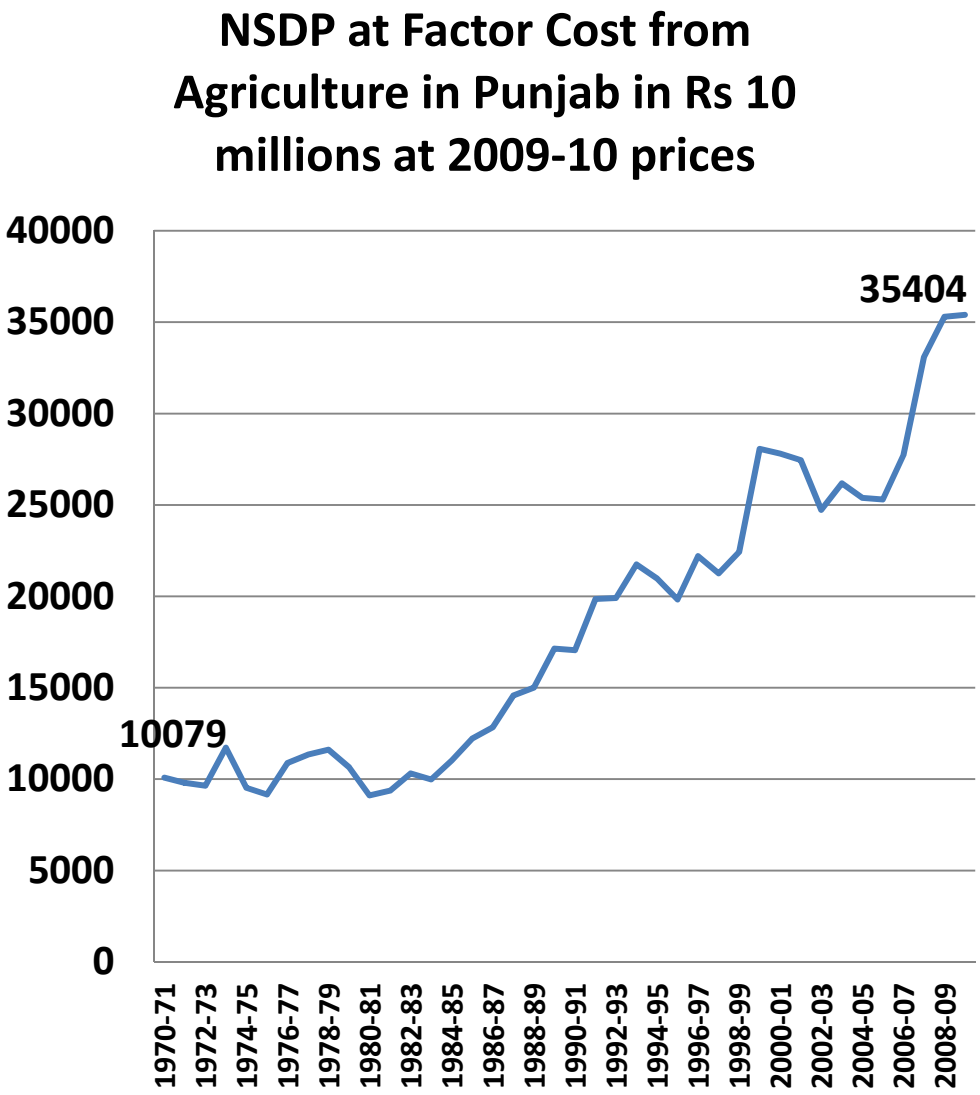
  -Through surface water: 26%

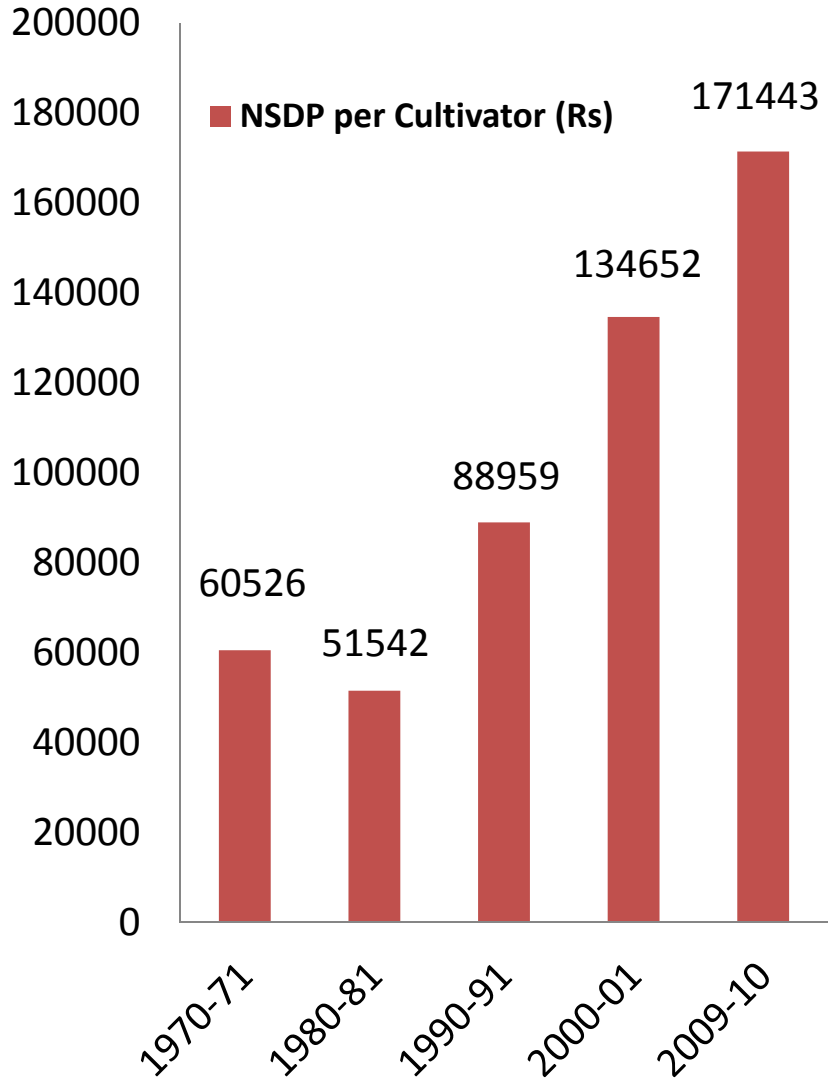
  -Through groundwater:74%
- N+P+K use: 243 kg/ crop ha
- Area under rice-wheat rotation: 77% of cropped area
- Productivity/annum of rice+ wheat: 9.2 t/ha (2011-12)



Source: Official Statistics, Govt. of Punjab

Impact on Farmers' Economy





Effects of Intensive Agriculture

- **Stagnation/slow growth in yield**
  - **Already achieved very high levels of yield**
  - **Higher use of inputs to maintain current yield**
- **Cropping intensity**
  - **Burning of crop residue**
- **Fertilizer use**
  - **From FYM to N, P, K, Zn, S, Fe, Mn**
  - **Overuse of N**
- **Water**
  - **Depletion of ground water**
- **Overuse/Misuse of pesticides, electricity and tractors**

Productivity (t/ha)	Wheat	Rice
Punjab	4.7	6.0
India	2.9	3.2
World	3.0	4.3
World Highest	7.9 UK (1.8 m ha)	10.0 Egypt (0.75 m ha)

CENTRAL PUNJAB

Year	% area under different water table depths		
	> 10m	> 15m	> 20m
1980	5.7	0.6	0.4
1990	26.7	2.9	0.4
2000	53.2	14.1	0.1
2005	85.4	42.1	14.5
2010	91.6	75.1	50.5

DEPLETION OF GROUND WATER

CENTRAL PUNJAB

	Ground water depleted	
Period	(km^3 / year)	Bhakra Dams/year
1980s	0.85	0.12
1990s	1.27	0.18
2000s	4.23	0.61
5 yrs to 2005	4.54	0.66
5 yrs to 2010	3.92	0.57

Note: Total area of the zone is about 25000 km^2

(Bhakra dam live storage capacity= 6.91km^3)

Annual flow: 3.5 to 4 equivalents of Bhakra live capacity

Soil porosity of Central Punjab is about 0.2

Number of *blocks* in different categories

Category	2000	2005	2010
Over-exploited (Dark)	73	103	110
Critical	11	5	3
Semi Critical	16	4	2
Safe	38	25	23

In Central Punjab, 96% out of 78 blocks are over-exploited

Water Demand, Availability and Deficit

Particular	Extent
Irrigation Water Demand	4.45 million ha-m
Surface Water Availability	1.43 million ha-m
Annual Replenishable Recharge	1.61 million ha-m
Total Irrigation Water Availability	3.04 million ha-m
Irrigation Water Demand Deficit	1.41 million ha-m

Groundwater behavior in Southwest Punjab

Year	Water table depth (mts)	Rate of change (cm/year)
1975	10.613	
1990	6.814	+14.3
2000	5.736	+13.2
2005	7.138	-29.2

- Factors responsible

- Increased canal water supply

Year	% share in canal irrigation
1990-91	62.1
1999-00	66.4
2005-06	75.7
2010-11	70.9

-Increase in rice area

1990-91: 425 thousand ha

2010-11: 827 thousand ha

Factors responsible

Year	Cropped area	Number of pumpsets	Electricity operated pumpsets	Area under rice
1970-71	5678	192	91	390
1980-81	6763	600	280	1183
1990-91	7502	773	600	2015
2000-01	7941	1073	788	2611
2010-11	7882	1381	1142	2818

Crop	Water requirement, cms
Rice	175
Maize	40
Cotton	40
Sugar-cane	130
Ground-nut	25
Pulses	25
Kh. Fodder	20

Processes leading to groundwater depletion

Expansion in irrigation network

-Started with canal net work in late 19th century

-Groundwater availability

Supported by:

-Rural electrification

-Power subsidies

-Private investments in tube-well irrigation

-Free access to ground-water

Irrigation expansion → **HYS** → Higher use of chemical fertilizers (supported by Institutional credit, fertilizer subsidies, strong network of primary cooperative credit societies)

Processes leading to groundwater depletion

Agricultural price and marketing policy:

- Introduction of MSP policy
- Effective procurement by FCI
- Effectively implemented MSP
- Continuous increase in MSP
- Fertilizer subsidy

Aim:

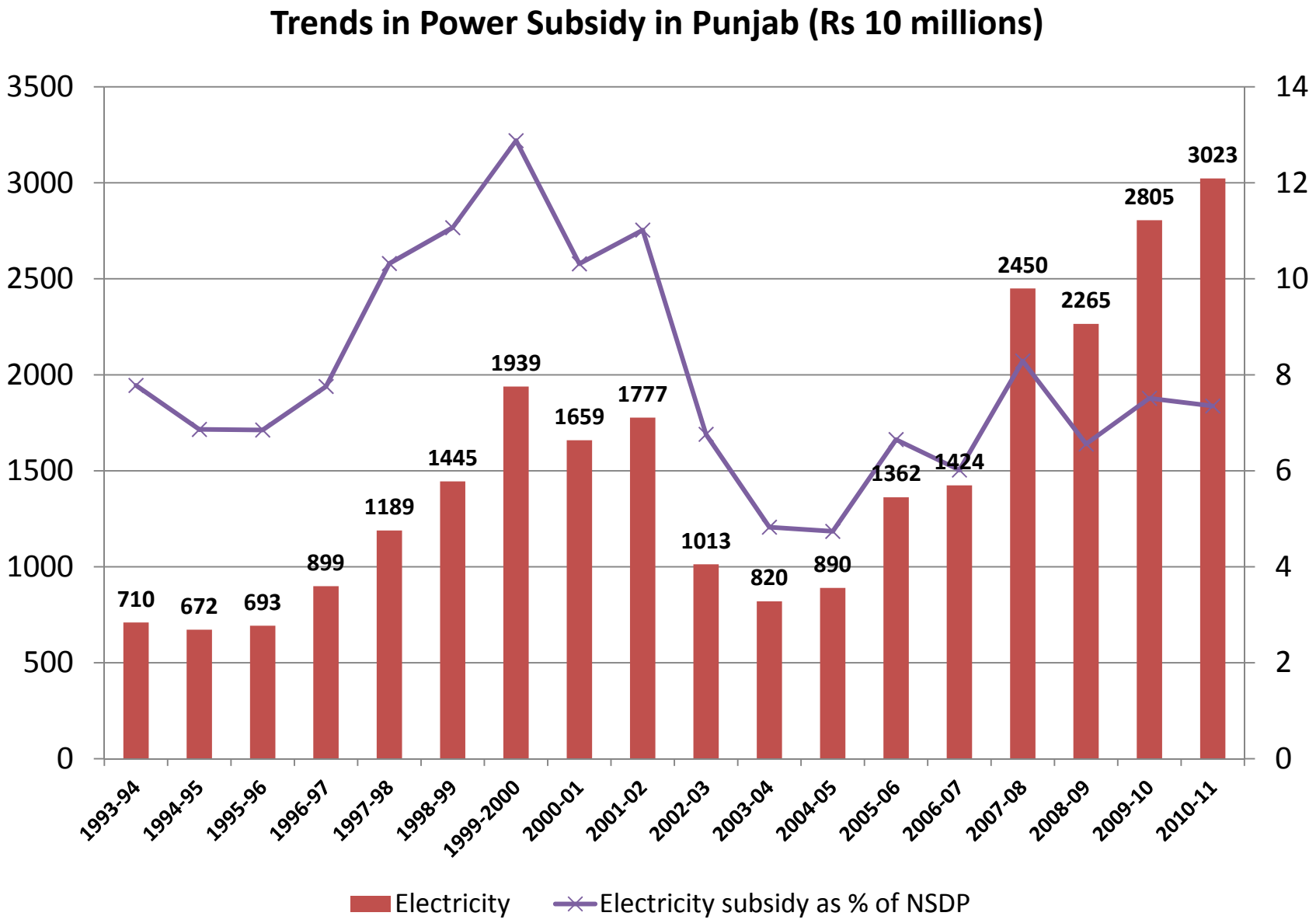
-Encouraging food security by promoting food grain production through:

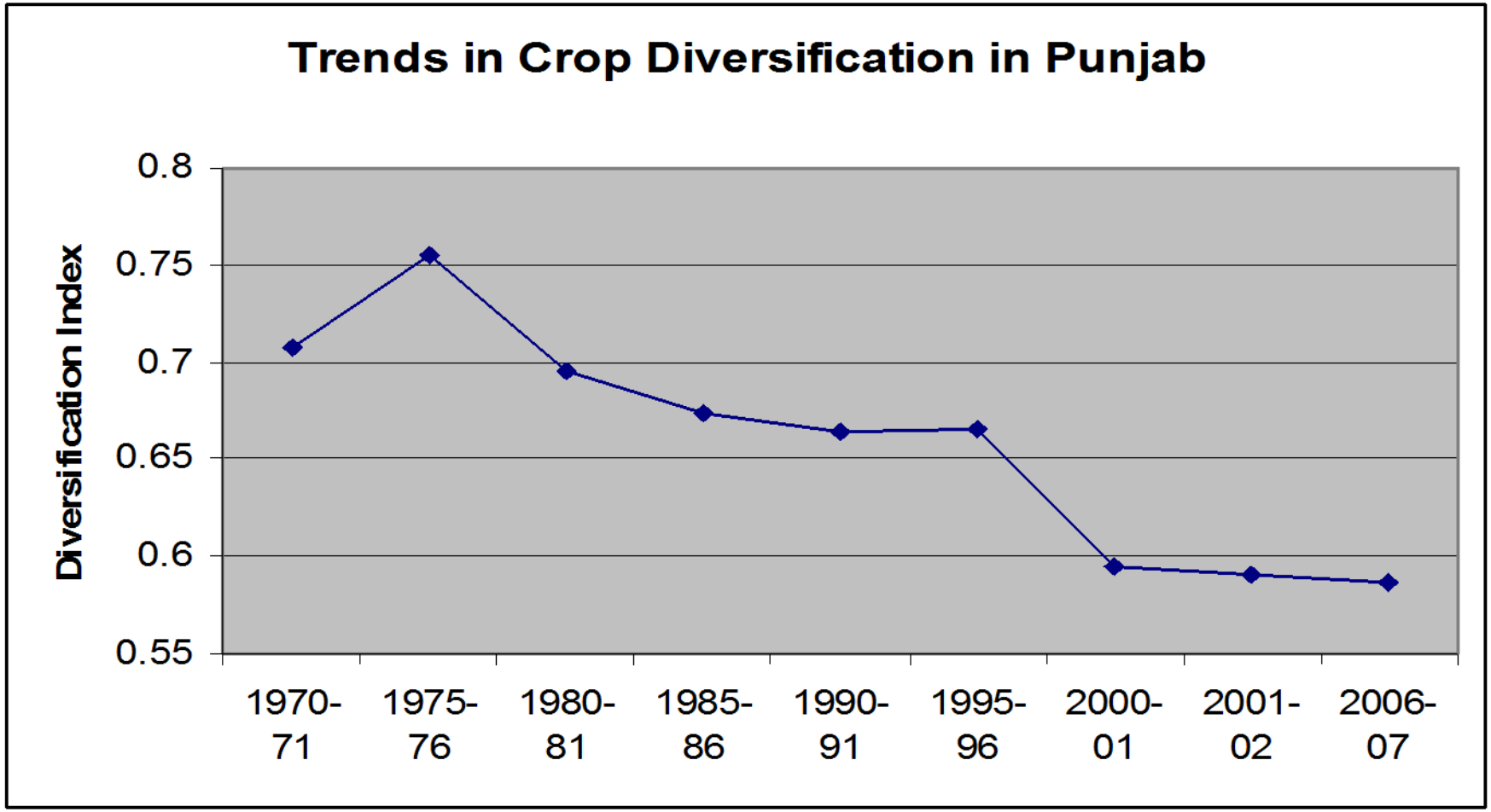
-Ensuring profits to farmers

-Ensuring public procurement

Other emerging issues related to groundwater

- Growing power subsidies
- Decline in crop diversification
- Increase in farm investments

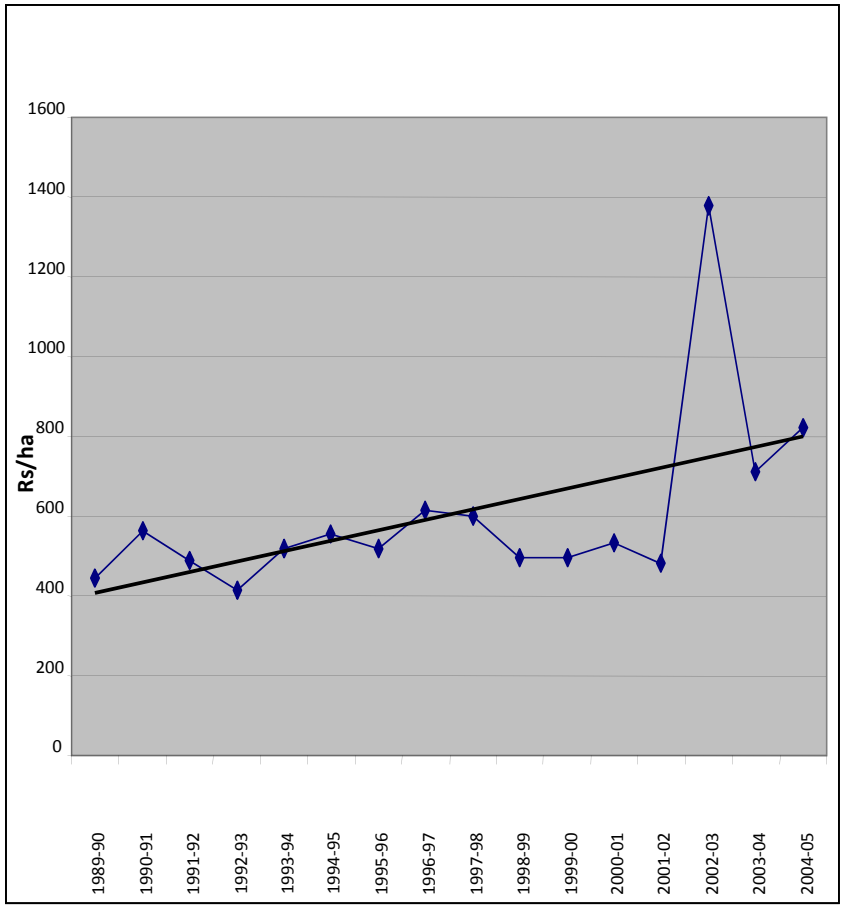

Trends in Power Subsidy in Punjab (Rs 10 millions)
3500
3000
2500
2000
1500
1000
500
0
14
12
10
8
6
4
2
0
710
672
693
899
1189
1445
1939
1659
1777
1013
820
890
1362
1424
2450
2265
2805
3023
1993-94
1994-95
1995-96
1996-97
1997-98
1998-99
1999-2000
2000-01
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
Electricity
Electricity subsidy as % of NSDP



Due to their higher relative profitability as well as assured marketing and very low production risk, wheat and rice crops replaced pulses, oilseeds and coarse cereals in the crop pattern of the state, resulting very into low bio-diversity

Overexploitation of Ground Water to Sustain Rice Production leads to increased expenditure on irrigation (Current + Capital)

- Water demand (39.75 MAF) exceeded ground water availability (29.64 MAF)
- Water table receded at the rate of above 80 cm per year during 2000-10
- Requires frequent deepening of borewells
- It requires more investments leading to indebtedness and suicides (especially in case of small holders)
- Vulnerability of small holders to income risk has increased



At 1981-82 prices

Though rice productivity remains unaffected, climate change (rainfall) has other socio-economic consequences for the farmers and society

- **Avg. Annual Rainfall 1998-2007 is 430mm against log-term average of 600mm**

  2001 (normal year): 9.1mt
  2009 (drought year): 9.1mt

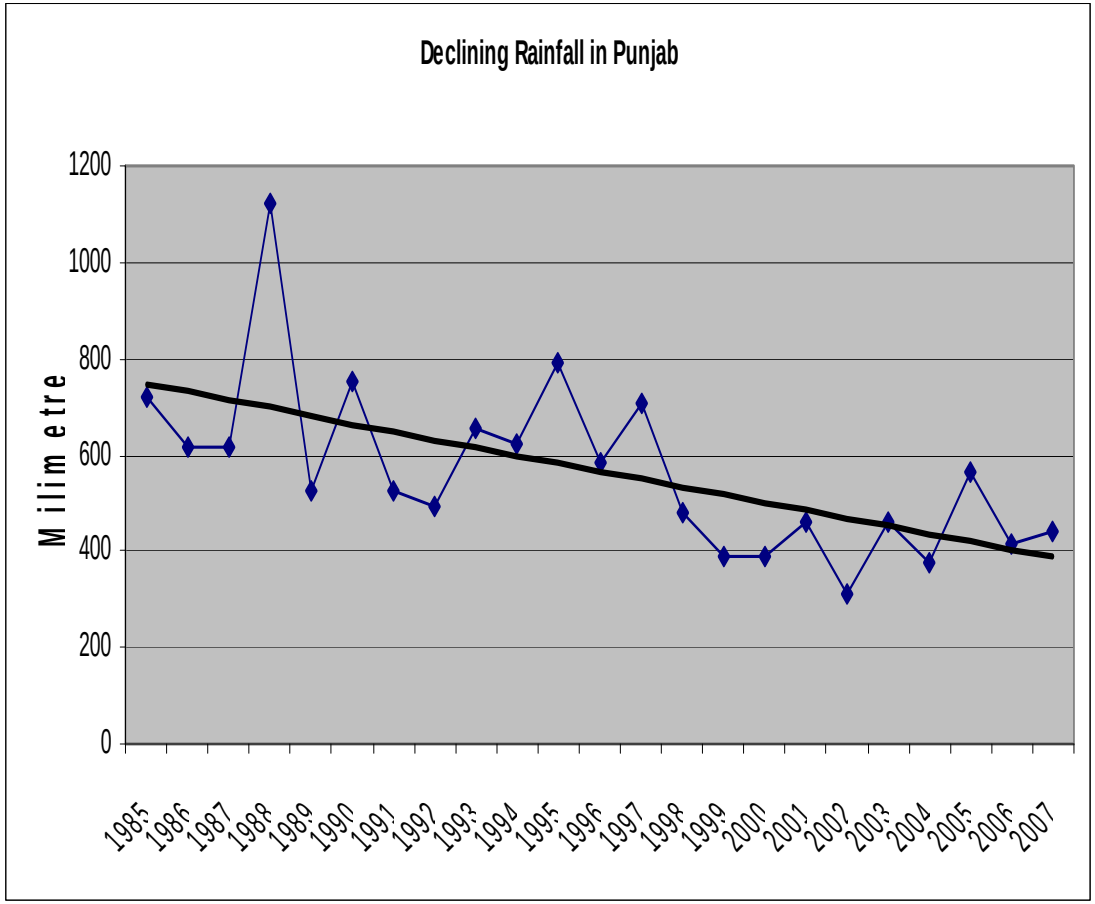
- **Increased expenditure on irrigation (2009 v/s 2008)**

  Additional Power Subsidy:
  Rs 4500 million

  Additional Diesel Use: Rs 3000 million

  Additional Expenditure per ha:
  Rs 2780

  Fall in water table: 103 cm



Strategies for groundwater sustainability

-Improving water use efficiency

-Diversification

-Restructuring power subsidies

Through:

1. Technology
2. Policy

Water Conservation Technologies

- Use of laser leveller
- Planting on permanent raised beds
- Use of Tensiometers in rice
- Delayed transplanting of rice nursery
- Direct seeding of rice

Water and energy saving through tensiometers

District	% Water Savings	Power Savings (Kwh/acre)
Amritsar	16.5	73
Jalandhar	18.0	69
Kapurthala	18.5	88
Ludhiana	17.9	112
Moga	20.2	126
Tarn Taran	18.9	104
Overall	18.6	101

Water saving with Direct Seeding of Rice (cubic meter)

Variety	Control Plot	DSR Plot	Water saving	% saving
Pusa Basmati 1121	126031	83046	42984	34.1
Normal duration	25766	24161	1605	6.2
Pusa 44	80787	57829	22958	28.4
Overall	232584	165037	67547	29.0

Farm Level Benefits of Water Conservation Innovations

Conservation Technology	Extent of Water Saving (cm/ha)	Extent of Power Saving (Kwh/ha)	Reduction in Power Subsidy (Rs/ha)	Total Water Saving (million ha metre)	Total Power Saving (million Kwh)	Reduction in Power Subsidy (Rs. Crore)
Laser Leveling in Rice[a]	36.19	213.35	610	0.99	583.51	167
Permanent raised bed in rice[b]	60	353.72	1012	1.64	967.42	276.68
Happy Seeder in wheat[c]	8.5	50.11	143	0.30	176.69	50.53
Tensiometer[d]	37	218.13	624	1.01	596.59	170.62
Delayed Transplanting of rice (15 June)[e]						
With respect to May 16	42	247.60	709	0.63	370.84	106.06
With respect to May 31	23	135.59	388	1.15	677.19	193.68

Sources: a) Sidhu *et al*, 2007, b) Dhaliwal *et al*,2008, c) Singh *et al*, 2009,
d) Singh *et al*, 2006, e) Singh, 2009

Constraints in the adoption of water saving technologies

- No economic incentives
  - No yield advantage
  - No reduction in cost of production
- Fear of fall in yield
- Electricity free to agriculture
- Groundwater un-priced
- Un-regulated access to groundwater
- Operational difficulties in adoption
  - Farm machinery
  - Laborious

Diversification

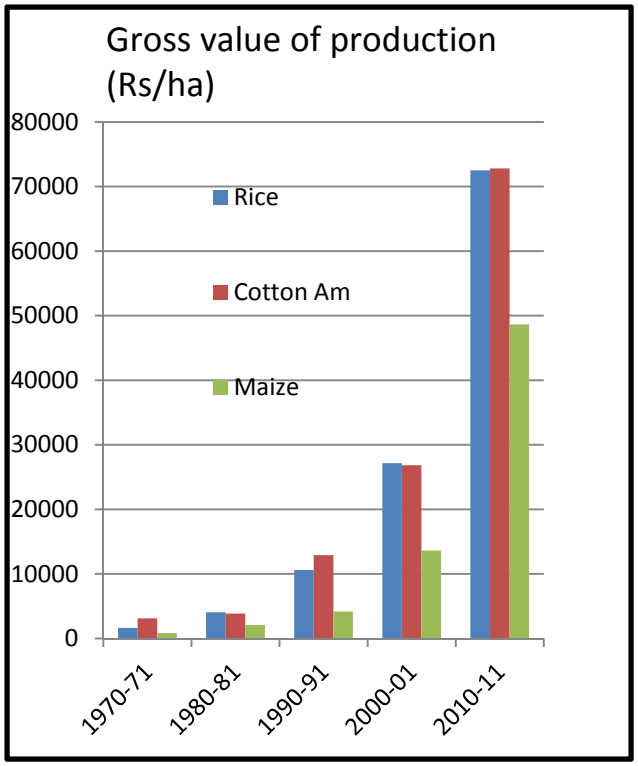
- Diversification options:

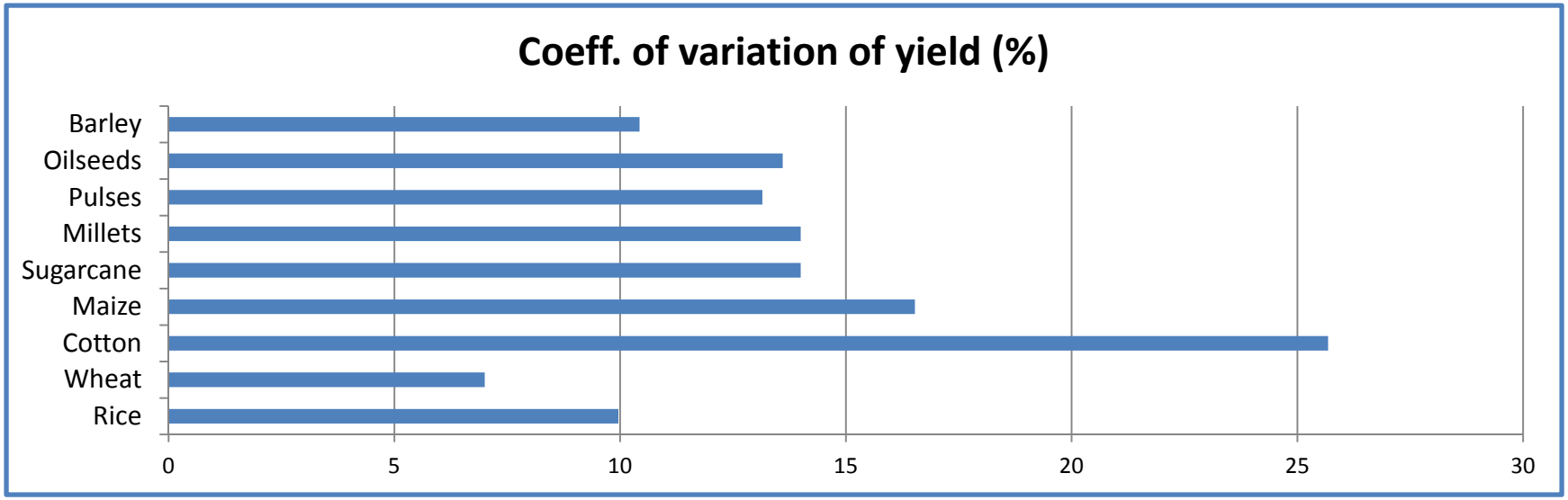
  Maize, Cotton, Sugarcane, Pulses,

  Fruits and Vegetables, Fodder

Constraints:

- Less profitable
- High marketing risk
- High production risk
- Less mechanized, thus labor shortages





Diversification

- Diversification options: Maize, Cotton, Pulses, fruits and vegetables, fodder

What is required:

- Remunerative Prices and/or increase in productivity
- Assured Marketing

  -Vertically integrated supply chains

  -Strengthening of cotton markets
- Value addition and processing
- Technology
  - Stability in the yield of pulses, cotton, vegetables and fruits
- Farm machinery
  - Maize planter, maize dryer,
  - Sugarcane harvester
  - Cotton picker

Way Forward

- Multipronged strategy would work
  - Energy pricing
    - Restructuring energy subsidy
  - Crop diversification
    - Development of markets for alternative crops
    - Development of agriculture supply chains
  - User friendly technologies
    - Use of sensor based technologies

Conclusion

- **Agricultural development in Punjab** started around the **Management and development of water resources**

- **It should not be allowed to end with its mismanagement**
  -**that had been depleting the underground water**

- The utmost priority needs to be accorded to
  -restore the groundwater balance

whatever are the means, measures and the policies necessary

Thanks

Q & A