Intensive Agriculture in Punjab: An Environmental Appraisal

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Indian Agriculture: Strides since independence

- From food shortages and import to self-sufficiency and exports.
- From subsistence farming to intensive and technology-led cultivation

- 218 MT total food grain production
- Contributes to 25% of GDP
- Produces 51 major Crops
- Contributes 21% of Exports and raw materials to Industries
- One of the 12 Bio-diversity centers in the world with over 46,000 sp. of plants and 89,000 sp. of animals recorded
Indian Agriculture - Some Facts

- **Net Area Sown**: 43.3% (142 M.H)
- **Gross Cropped Area**: 57.9% (190 M.H)
- **Net Irrigated Area**: 17.1% (56 M.H)
- **Area threatened by land degradation**: 50% of TGA
- **Drought-Prone Area**: 57.9% (190 M.H)

**STRENGTHS**
- Rich biodiversity, ecologically adopted species/breeds
- Arable land
- Climate
- Strong and well dispersed research and extension system

**WEAKNESS**
- Fragmentation of land
- Low Technology Inputs
- Unsustainable Water Management
- Poor Infrastructure
- Low value addition
- Declining work force (rural to urban shift)

**OPPORTUNITIES**
- Bridgeable yield gap in all crops
- Large number of food crops due to regional preferences
- Exports
- Agro-based Industry
- Horticulture
- Untapped potential in the N.E.

**THREATS**
- Unsustainable Resource Use
- Decline in productivity under intensive use
- Climate Change/Global warming
- Unsustainable Regional development
- Imports
- Heavy burden of floods/droughts/pests
Development of Agriculture in Punjab

➢ Thrust to green revolution in late 1960s for National Food Security (Multi-cropping → wheat/rice rotation)
➢ Increased MSP, fertilizer subsidy, improved irrigation facilities, mechanization and HYVs → intensive agricultural practices.
➢ Food grain production in state increased from 3.16 MT in 1960 to 27 MT in 2010.
➢ With 1.5% of geographical area of India, state is producing 21% wheat, 11% rice, 11% cotton and 12% of the total food grain production in the country.
➢ Change in average land holding size
   (increased up to eighties, decreased thereafter)
Agriculture is a complex biological production process which embraces conventional factors of production along with political, cultural and religious characteristics.
Approaches to Mechanization in Agriculture

**Engineering**
- Agricultural equipments for sowing, weeding, harvesting
- Machines to carry equipments (tractors)
- Machines for production of energy & fuel for mechanization
- Engineering wrt irrigation & drainage structures
- GIS/GPS based prediction & Control measures

**Biotechnology**
- Developing breeds & varieties (including GE), enabling equipment industry
- Production/application of farm chemicals for nutrition & protection
- Cold storages, tissues culture labs
- Post harvest technologies

**Socio-economic**
- Financial packages & pricing strategies
- Competitive marketing
- Extension services including agricultural machinery service centres
- Better business management
Merits & Demerits

**Merits**
- Reduced reliance on unpredictable weather conditions
- Reduced reliance on labour
- Year round production - self sufficiency
- Improved entrepreneurial capacity
- Quality improvement

**Demerits**
- Abandoning traditional cropping practices (multi-cropping with legumes → monoculture)
- Pesticide abuse → environmental health issues
- Dependence on external sources of energy
- Social imbalances
- Reduced crop diversity index
- Labour and farm waste mgmt issues including GHGs from livestock waste
- Imposing external costs on society [UK £ 208/ha (2005), USA $ 30-96/ha (2005)]
Area (%) under different land forms of Punjab

Legend:
- Hills
- Piedmont Plain
- Alluvial Plain
- Sand Dunes
- Flood Plains

PUNJAB
LAND USE / LAND COVER

LEGEND
LAND USE CATEGORY | %AREA
-------------------|-------
AGRICULTURE       | 87.11
BUILT-UP          | 5.88
FOREST            | 3.11
WATER BODIES      | 1.59
WASTELANDS        | 2.01
WETLANDS          | 0.30

PREPARED BY:
PUNJAB REMOTE SENSING CENTRE,
P.A.U. CAMPUS, LUDHIANA.
Production of foodgrains (cereals and pulses) in Punjab and India from 1970-2010

Percentage distribution of GSDP at factor cost by sectors in Punjab at current prices
The land use pattern of Punjab from 1960-2010 (in thousand ha)

Changes in Cropping Pattern of Punjab (1960—2010)

Increase in Cropping Intensity (%) in Punjab (1960-2010)
Punjab at Crossroads

- Present Agricultural system in state becomes unsustainable and non profitable

- Reached at highest production levels possible under available technologies and natural resources base and growth has stagnated

- Gains resulting from ever increasing food production, not been without consequent environmental and social costs

- Over intensification of agriculture over the years
Environmental Issues

- Water quality & quantity
- Reduced soil fertility and micro nutrient deficiency
- Non judicious use of farm chemicals & problems of pesticide residue
- Reduced genetic diversity
- Soil erosion
- Atmospheric pollution due to straw burning
- Water pollution from non point sources
- Overall degradation of fragile agro-ecosystem of state
- Affect on socio-economic conditions of farmers due to high cost of production and diminishing economic returns
Categorization of Blocks in Punjab based on Ground Water Development

Increase/decrease in number of various categories of blocks in Punjab from 1984-2005

Tubewells in Punjab (1980-2010)

Net irrigated area by different sources in Punjab (1980-2010)
Fall/Rise in water table (in metres) in Punjab (June 1984 to June 2004)
District wise ground water availability, draft and net availability for future irrigation in Punjab.
Reduced soil fertility & micronutrients

Trends in available organic carbon content in soils in Punjab

Trends in available K content in soils in Punjab

Trends in available P content in soils in Punjab

Changes in micronutrient status in various districts of Punjab

<table>
<thead>
<tr>
<th>District</th>
<th>Year</th>
<th>Zinc</th>
<th>Copper</th>
<th>Iron</th>
<th>Manganese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ludhiana</td>
<td>1970</td>
<td>86</td>
<td>–</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1986</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>7</td>
<td>2</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>Jalandhar</td>
<td>1977</td>
<td>45</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1996</td>
<td>14</td>
<td>0</td>
<td>13</td>
<td>39</td>
</tr>
<tr>
<td>Sangrur</td>
<td>1977</td>
<td>71</td>
<td>4</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>14</td>
<td>0</td>
<td>18</td>
<td>35</td>
</tr>
<tr>
<td>Patiala</td>
<td>1980</td>
<td>23</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>12</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Gurdaspur</td>
<td>1982</td>
<td>52</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>42</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Kapurthala</td>
<td>1983</td>
<td>45</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1992</td>
<td>15</td>
<td>0</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Amritsar</td>
<td>1984</td>
<td>47</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>36</td>
<td>0.5</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Hoshiarpur</td>
<td>1985</td>
<td>59</td>
<td>1</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>31</td>
<td>6</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>Mukatsar</td>
<td>1992</td>
<td>70</td>
<td>2</td>
<td>61</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>37</td>
<td>5</td>
<td>31</td>
<td>8</td>
</tr>
</tbody>
</table>
Non Judicious use of farm chemicals and farm mechanization

Consumption of Chemical Fertilizers (1970-2010)

Consumption Trend of Technical Grade Pesticides (1980-2010)

USA invests 40b$ in pesticides control to save 16b$ worth crops

Tractors in Punjab (1980-2010)

Consumption of electricity by agriculture sector in Punjab
## Reduced genetic diversity

### Domesticated Plant Diversity

<table>
<thead>
<tr>
<th>Crops</th>
<th>Pre-green revolution varieties</th>
<th>Post-green revolution varieties</th>
<th>No. of varieties in use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>41</td>
<td>49</td>
<td>13 (3 main)</td>
</tr>
<tr>
<td>Rice</td>
<td>31</td>
<td>27</td>
<td>9 (4 basmati)</td>
</tr>
<tr>
<td>Cotton</td>
<td>17</td>
<td>32</td>
<td>12 (included 4 varieties of BT Cotton)</td>
</tr>
<tr>
<td>Maize</td>
<td>4</td>
<td>24</td>
<td>11</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>11</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Bajra</td>
<td>3</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>Pulses</td>
<td>18</td>
<td>47</td>
<td>24</td>
</tr>
<tr>
<td>Oil Seeds</td>
<td>8</td>
<td>35</td>
<td>19</td>
</tr>
<tr>
<td>Vegetables</td>
<td>35 spp.</td>
<td>148 var.</td>
<td>-</td>
</tr>
<tr>
<td>Fruits</td>
<td>16 spp.</td>
<td>67 var.</td>
<td>-</td>
</tr>
</tbody>
</table>

### Total Area & Area Under HYVs of Major Food crops in Punjab (000 ha)

<table>
<thead>
<tr>
<th>Year</th>
<th>Wheat</th>
<th>Rice</th>
<th>Maize</th>
<th>Bajra</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>HYVs</td>
<td>Total</td>
<td>HYVs</td>
</tr>
<tr>
<td>1970-71</td>
<td>2299</td>
<td>1589</td>
<td>390</td>
<td>130</td>
</tr>
<tr>
<td>1980-81</td>
<td>2812</td>
<td>2757</td>
<td>1183</td>
<td>1095</td>
</tr>
<tr>
<td>1990-91</td>
<td>3273</td>
<td>3271</td>
<td>2015</td>
<td>1906</td>
</tr>
<tr>
<td>2000-01</td>
<td>3408</td>
<td>3408</td>
<td>2612</td>
<td>2506</td>
</tr>
<tr>
<td>2004-05</td>
<td>3481</td>
<td>3481</td>
<td>2647</td>
<td>2647</td>
</tr>
<tr>
<td>2009-10</td>
<td>3522</td>
<td>3522</td>
<td>2802</td>
<td>2802</td>
</tr>
</tbody>
</table>
Crop Rotation Map of Punjab
Agriculture Waste Burning

- **GHGs Contribution**: CO, NOx, CH₄, PM10
  - CO: 113 Gg
  - NOx: 8.6 Gg
  - CH₄: 1.33 Gg
  - PM10: 13.0 Gg

- Wheat straw burning:
  - CO: 113 Gg
  - NOx: 8.6 Gg
  - CH₄: 1.33 Gg
  - PM10: 13.0 Gg

- Rice straw burning:
  - CO: 261 Gg
  - NOx: 19.8 Gg
  - CH₄: 3.0 Gg
  - PM10: 30.0 Gg

Carbon credit potential thru’ rice diversification
- Rs. 200 billion in 10 yrs (Rs. 10,000/ha in 3 months)
- Presently 2500 th ha under rice

[Map of Wheat Straw Burnt Area (14th May 2005)]

[Map of Paddy Straw Burnt Area (10th Oct 2005)]
Other Environmental Impacts

- Soil erosion
- Water pollution and eutrophication from non point sources
- Overall degradation of fragile agro-ecosystem of state
- Affect on socio-economic conditions of farmers due to high cost of production and diminishing economic returns
Secondary Impacts

- Over-exploitation of land & water leading to genetic erosion (including eutrophication)
- Pesticides residues in food & effect on human health
- Resistance of pests & emergence of new pests
- High cost of production & low productivity leading to farmer debts, etc.
- Environmental Impacts during production of fertilizers & pesticides
- Environmental impacts of energy generation for use in agriculture
Responses: Administrative responses


Administrative responses  
contd..

- Punjab State Farmers Commission
- 4 Agriculture councils
- State Medicinal Plant Board & PBB
- Veterinary & Animal Science Univ.
- Agricultural Diversification, Infrastructure, Research & Dev Fund
- Task Force to Tackle Rice Straw Burning Problem
- Biotechnology Cluster
- State Strategy & Action Plan for Climate Change
  - Mitigation policies
    - Shift from non renewable to renewable energy sources
    - Energy conservation programs
    - Demand side management of electricity
    - reducing transmission distribution losses
  - Adaptation policies
    - R&D for climate resilient crops
    - R&D for renewable energy
Technological Responses

- Timely Transplantation of Paddy
- Area under zero till
- Rigde planting method of paddy
- Micro irrig. techniques, drip & sprinkler
- Revival of village ponds
- Watershed management
- Organic farming in 4800 ha, vermicomposting (>1500 units), biofertilizers & biopesticides IPM in 514 villages
- Value addition and 46 agro processing units
- Ban on certain chemical pesticides
Suggestions

- Freeze prime agriculture land
- Promote sustainable low input agriculture and precision farming
- Cost benefit analysis to include water & environment issues in agricultural system/crops
- Extend MSP & assured market for alternate crops
- Protect traditional crop varieties & native animal breeds
Thank you for your kind attention
## Inputs or technologies used in ‘traditional’ and ‘modern’ conventional farming

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>TRADITIONAL</th>
<th>MODERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area</td>
<td>Small (1-5ha)</td>
<td>Large (10-100ha or more)</td>
</tr>
<tr>
<td>Tools</td>
<td>Simple: Fire, hoe, axe, digging sticks, matches</td>
<td>Complex: Tractors and implements, threshers etc.</td>
</tr>
<tr>
<td>Crops</td>
<td>Many species (5-80) landraces, no genetic improvement, wide genetic base</td>
<td>Few species (1-3) improved narrow genetic base</td>
</tr>
<tr>
<td>Animals</td>
<td>Several species</td>
<td>Usually 1 or 2 species</td>
</tr>
<tr>
<td>Labour</td>
<td>Manual, human energy or animal power</td>
<td>Mechanical, Petroleum fuels, electric energy</td>
</tr>
<tr>
<td>Soil fertility maintenance</td>
<td>Fallows, ash, organic manures</td>
<td>Inorganic fertilizers, sometimes manures, soil amendments, e.g. lime etc.</td>
</tr>
<tr>
<td>Pests and Disease management</td>
<td>Physical/ Cultural</td>
<td>Mainly mechanical/ chemicals, (Insecticides, fungicides, etc)</td>
</tr>
<tr>
<td>Crop Management</td>
<td>Manual</td>
<td>Growth regulators for defoliation, control of flowering, fruit drop, etc.</td>
</tr>
<tr>
<td>Harvesting</td>
<td>Manual or with simple tools</td>
<td>Mechanical-Tractors plus implements: threshers, combine harvestors</td>
</tr>
<tr>
<td>Post harvest handling and drying</td>
<td>Simple sun-drying or over fires</td>
<td>Mechanical forced air, artificial drying using petroleum fuels, sometimes refrigeration.</td>
</tr>
</tbody>
</table>