Water management issues at the farm level

Dr Martin Burton
Irrigation Water Management Specialist
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Outline of presentation

• Background
• Key issues at farm level based on case studies from West Bengal and Odisha
• Proposed solutions and action plan
• Summary and conclusions
Background

- Well documented concerns with growing water scarcity in India
- National Water Mission identified the need for increasing water use efficiency (WUE) by 20%.
- Following measures identified:
  - Improving field irrigation methods (graded border, furrow, surge irrigation, pressurised irrigation, etc.)
  - Adoption of scientific water management practices
  - Mass awareness campaigns for farmers
  - Use of modern technology to ensure adequate and timely irrigation

Putting drip and sprinkler in context

- Irrigation methods in USA & Australia:

<table>
<thead>
<tr>
<th>Country</th>
<th>Surface</th>
<th>Sprinkler</th>
<th>Micro</th>
<th>Irrigated Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA in 2003</td>
<td>43.4</td>
<td>50.5</td>
<td>6.1</td>
<td>21,591,000</td>
</tr>
<tr>
<td>Australia, 2008-09</td>
<td>44.0</td>
<td>42.7</td>
<td>13.3</td>
<td>1,826,000</td>
</tr>
</tbody>
</table>


- Irrigation efficiencies (Australian study)
  - drip and micro (75-95%)
  - sprinkler (60-90%) and
  - surface (60-85%)

Note: Highest surface irrigation efficiency (85%) is higher than the lowest drip and micro (75%) and sprinkler 60% efficiencies
Regional summary of irrigation technology

• Opportunities for drip, sprinkler and surface irrigation

<table>
<thead>
<tr>
<th>Region</th>
<th>Surface</th>
<th>Sprinkler</th>
<th>Drip</th>
<th>Un-defined</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>South and East Asia (Mill. ha)</td>
<td>171.2</td>
<td>4.3</td>
<td>1.3</td>
<td>3.6</td>
<td>180.4</td>
</tr>
<tr>
<td>(%)</td>
<td>94.9%</td>
<td>2.4%</td>
<td>0.7%</td>
<td>2.0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

• As % of current area

Source: IWMI, 2016

Key issues at farm level

• Large number of irrigation farmers, > 200+ million in India
• Lack of knowledge of improved water management practices at the on-farm level amongst farmers and professionals
• Questions not asked:
  – How much water farmers apply each irrigation
  – What flow rates are used and what the duration of irrigation is and should be
  – What is the depth and uniformity of each irrigation relative to crop rooting depth
  – What improvements can be made
Case Study I – Measuring application depth

Key observations:
- Clay loam soil
- 10 cm water went 30 cm into soil
- Root system was 15 cm
- Infiltration took 2-3 hours

Case Study I - Findings

- Farmers do not check how far the water infiltrates into the soil
- Most of the project staff had never seen an infiltration test; none had done a test in practice
- Farmers estimates were incorrect:
  - Time to infiltrate - Estimated 10-15 mins, actual >2 hrs
  - Depth of infiltration - Estimated 10-15 cms, actual >30 cms
- The exercise was a revelation for both farmers and project staff
Case Study II – Measuring water application

Farmer from BJKU WUA, irrigated from spout
- Lay-flat pipe at top end of field
- 1.5 hours for water to reach tail-end of field
- 2 hours total irrigation
- Water contact times
  - Top 2 hrs
  - Tail 0.50 hrs

Case Study II - Findings

- Flow size was too small for the field size
- Uniformity of water distribution poor – top end 106 mm cumulative infiltration, bottom end only 39 mm
- Application efficiency and uniformity of distribution can be increased by simple, practical measures
Case Study III – Water management study

Poor flow control – mud used to close/open outlets

Poor flow control – stones used as cross regulators in main on-farm canal

Case Study III - Findings

• Canal lining is beneficial in reducing travel time and improving distribution
• Flow control is generally very poor, measurement non-existent
• Need radical re-think and study of how farmers use water at this level
• Change design procedures – need to design for on-demand irrigation, not proportional distribution
Possible solutions – Field level

- Raise awareness and knowledge of ways to improve water management at field level
- Observation and measurement of farmers’ practices by agency staff
- Identify and apply simple measures for improvement
- Provide training and guidance to farmers on appropriate field application practices
- Laser land levelling and grading – 12% increase in PoW (kg/m$^3$) and 11% increase in land productivity (kg/ha)

Possible solutions – Examples of good practice

![Improving conveyance efficiency](image1)

![Good even furrows](image2)

![Improving conveyance efficiency](image3)

![Well formed furrows in basin](image4)
Possible solutions – Field level options

Reduce the difference in contact time by irrigating the field in two halves

Possible solutions: Agricultural initiatives

- Considerable “value added” by combining IWM with agricultural improvements (good seed, fert., etc)
- Measures on MPWSRP showed significant benefits:

<table>
<thead>
<tr>
<th></th>
<th>Soybean</th>
<th>Wheat</th>
<th>Paddy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (q/ha)</td>
<td>5.7 up to 8.1 (43%)</td>
<td>27.0 up to 37.2 (38%)</td>
<td>27.8 up to 38.6 (39%)</td>
</tr>
<tr>
<td>Productivity of water (kg/m³)</td>
<td>0.9 up to 1.6 (87%)</td>
<td>1.1 up to 2.1 (82%)</td>
<td>4.8 up to 7.7 (60%)</td>
</tr>
<tr>
<td>Productivity of water (Rs/m³)</td>
<td>24.4 up to 42.8 (76%)</td>
<td>17.5 up to 31.6 (80%)</td>
<td>67.3 up to 107.8 (60%)</td>
</tr>
<tr>
<td>Net margin (Rs/ha)</td>
<td>8,193 up to 13,986 (71%)</td>
<td>36,159 up to 51,112 (41%)</td>
<td>32,444 up to 47,819 (47%)</td>
</tr>
</tbody>
</table>
Proposed solutions: Training and capacity building

- Training and capacity building for both farmers and field staff
- Training **must** be practical, field based and visual – seeing is believing!
- Essential to develop suitable training approaches and training material
- Computer models of field irrigation, such as BASCAD, with visual displays can be very valuable

Practical training: Field and farmer based

**Process:**
- Identify soil
- Set up infiltration test
- Auger and “feel” dry soil
- Dig up plant with root
- Complete infiltration
- Auger wetted soil
- Compare wetted soil to crop root depth
Practical training: Measuring infiltration rate

(a) Set up infiltrometer in the field

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Elapsed time from start (min)</th>
<th>Volume of water added to return water level to zero point (ccs)</th>
<th>Equivalent depth of water added (mm)</th>
<th>Infiltration rate (mm/hour)</th>
<th>Cumulative infiltration amount (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1072</td>
<td>15.2</td>
<td>162</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>907</td>
<td>12.8</td>
<td>154</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>695</td>
<td>9.8</td>
<td>118</td>
<td>38</td>
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<tr>
<td></td>
<td>20</td>
<td>1342</td>
<td>23.3</td>
<td>74</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>1573</td>
<td>22.2</td>
<td>80</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>1379</td>
<td>19.5</td>
<td>78</td>
<td>103</td>
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<td></td>
<td>75</td>
<td>1361</td>
<td>19.1</td>
<td>77</td>
<td>122</td>
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<tr>
<td></td>
<td>90</td>
<td>1343</td>
<td>19.0</td>
<td>76</td>
<td>141</td>
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<tr>
<td></td>
<td>115</td>
<td>1360</td>
<td>18.8</td>
<td>74</td>
<td>172</td>
</tr>
<tr>
<td></td>
<td>130</td>
<td>1308</td>
<td>18.5</td>
<td>74</td>
<td>191</td>
</tr>
</tbody>
</table>

(b) Record infiltration rate

(c) Plot infiltration rate and cumulative infiltration

Practical training: Water application across field

(a) Plan of field with marker pegs to measure advance and recession waves

(b) Cross section of field showing infiltration depth across field

(c) Plot of advance and recession waves measured in field

(d) Plot of cumulative infiltration rate versus time from infiltrometer test
Practical training: Water application

Test different application methods – traditional and upgraded

Practical demonstrations: Soil wetting profile I

Dry soil

1 litre applied, initial infiltration

Infiltration after 1 minute
Practical demonstrations: Soil wetting profile II

2 litres added

Deep percolation below shallow rooting crop

Infiltration after 3 minutes

Practical demonstrations: Relative infiltration rates

Dry soil

Initial infiltration

Infiltration after 1 minute

07 April 2016
Practical demonstrations: Water holding capacity

Dry “soil” (sponge)

Water holding capacity exceeded

Water leaking from sponge

“Soil” (sponge) at field capacity, excess water drained off

Summary and conclusions

• Improving surface irrigation is essential if water use efficiency and productivity of water are to be improved
• Drip and sprinkler irrigation have their place BUT surface irrigation will remain the predominant irrigation method for next 30-40 years
• Current level of understanding and knowledge of measures to improve surface irrigation is poor
• Education and training of a large number of farmers is required….and training of field staff
• Internationally funded projects need to pay more attention to on-farm and field level water management
• Web-based training by INCID is timely and welcomed
Thank you

The End
Irrigation methods

• Pressurized irrigation (sprinkler and drip):
  – Suits high value row crops
  – Expensive – capital and operating costs

• Surface (flood) irrigation:
  – Various forms (basin, border, furrow)
  – Suited to major crops of rice and wheat
  – Key features
    • Balance flow rate across the field with the vertical infiltration
    • Maximize water stored in root zone whilst minimizing infiltration below root zone

Water management – Problem areas

Poor quality field channel

Uneven planting

Poor quality land preparation

Poor line sowing & furrow formation

Poor irrigation practice
Possible solutions - On-farm

- Examples of good water management practices:
  - Design:
    - Buried pipes
  - Farmer practice:
    - On-demand irrigation
    - Use of lay-flat pipes
  - Irrigation methods:
    - Division of larger plots into smaller plots for some crops
  - Introduction by projects of demonstration plots for drip and sprinkler irrigation

- Good irrigation water management requires control:
  - **Social** control: Agreement from farmers on what’s fair
  - **Management** control: Organization to allocate and distribute water
  - **Physical** control: Cross regulators and gates (and measurement?)