WATER MANAGEMENT FOR FOOD SECURITY

Chandra A. Madramootoo P.Eng.
Visiting Scholar, J-WAFS, MIT
James McGill Professor of Bioresource Engineering
McGill University, Montreal
Water use by sector, 2000

- Agriculture: 71%
- Industry: 20%
- Domestic: 9%
RISING WATER DEMAND FROM OTHER SECTORS (Source: FAO, 2009)
Increases, over 2002 water requirements, needed to eradicate poverty by 2030 and 2050 respectively.

Increase, over 2002 water requirements, needed to meet the 2015 hunger target.
Automated canal structures
IMPROVED ON-FARM WATER MANAGEMENT
Invest in water savings technologies
Flood damage – June 2002 Growing season
Subsurface pipe drainage installation
Under-investment in infrastructure and rehab and maintenance
4% of its agricultural land is irrigated
• Producing 20% of the province’s agricultural output
• Over 200 times more productive than global average
Irrigation Efficiency Gains

On-Farm:
- 4.5% of gross diversion

Conveyance Works:
- 1.2% of gross diversion

Reservoir Evaporation:
- 0% of gross diversion

Return Flow:
- 14% of gross diversion
## Eastern Irrigation District, Alberta

<table>
<thead>
<tr>
<th>Irrigation type</th>
<th>2002 (end of season)</th>
<th>2010 (end of season)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area, ha</td>
<td>% of total irrigation</td>
</tr>
<tr>
<td>Low pressure pivot</td>
<td>34,803</td>
<td>30.4</td>
</tr>
<tr>
<td>High pressure pivot</td>
<td>17,806</td>
<td>15.6</td>
</tr>
<tr>
<td>Wheel move</td>
<td>21,448</td>
<td>18.8</td>
</tr>
<tr>
<td>Other sprinkler</td>
<td>202</td>
<td>0.2</td>
</tr>
<tr>
<td>Flood irrigation (levelled)</td>
<td>32,577</td>
<td>28.5</td>
</tr>
<tr>
<td>Flood irrigation (non levelled)</td>
<td>7,487</td>
<td>6.5</td>
</tr>
</tbody>
</table>
Increasing the Productivity of Irrigation Water

Barley Yield (tonnes/ha)

Irrigation Water (millimeters)

2.5 t/ha

380 mm

6.5 t/ha

900 mm

11 t/ha
Today we use 30% less water to grow a crop than we did 25 years ago.
Manage the soil water reservoir

IRRIG, PRECIP → ET

Surface runoff → Soil Water Reservoir

Return flows (Q,L) → Active root zone

Interflow ← Percolation

GW accretion

Capillary fluxes → Capillary fringe

Upward GW movement

Subsurface drainage

Return flows (Q,L) → Leaching Fraction

Manage the soil water reservoir
Permanent TDR

Weather station

Gravimetric sampling
Gro-Points

Capacitance probes

Hortau tensiometers
Making use of wireless technologies, GIS, remotely sensed data for precision water management on a large scale
Soil and Crop Sensing Coupled With Environmental Sensing Linked to Mobile Platforms
Creation of Management Zones Based on Elevation and EC
VRI Technology for Water Conservation and Environmental Presentation
Egypt’s Water and Agriculture

- 3.25 m ha of cropland
- Approx. 3% of land area
- Population – 65 million
- 55% of population is rural
- 2.1% population growth
- 55.5 BCM released from AHD
- Land and water constraints
- Employment limitations
- Food security
### Egypt Water Use

<table>
<thead>
<tr>
<th>Water input</th>
<th>BCM/yr</th>
<th>Water use</th>
<th>BCM/yr</th>
<th>%use</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW</td>
<td>56</td>
<td>Agr</td>
<td>47.4</td>
<td>83.3</td>
</tr>
<tr>
<td>GW</td>
<td>2.3</td>
<td>Domestic</td>
<td>3.1</td>
<td>5.45</td>
</tr>
<tr>
<td>ADW</td>
<td>4.0</td>
<td>Industry</td>
<td>4.6</td>
<td>8.08</td>
</tr>
<tr>
<td>Waste/w</td>
<td>0.2</td>
<td>Navig/reg</td>
<td>1.8</td>
<td>3.16</td>
</tr>
<tr>
<td>Total</td>
<td>62.5</td>
<td>Total</td>
<td>56.9</td>
<td></td>
</tr>
</tbody>
</table>
- Irrigation of 620,000 feddans
- Mixed DW and FW (1:1) – 4.45 million cubic metres/yr
- Reclamation of waterlogged, saline and sodic soils
- Provision of new villages and associated infrastructure
El Salam Command – west of Suez
220,000 feddans
The environmental and socio-economic challenges of drainage water reuse, reclamation, and intensive agriculture
Reclamation – leaching, drainage, cropping restrictions, water availability
Drainage and Irrigation Water
El Rowad


Drainage & Irrigation Water Salinity

EcdS/m

Irrigation Water
Drainage Water
Soil Salinity – El Rowad

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>36.19</td>
<td>48.06</td>
<td>38.48</td>
<td>20.74</td>
<td>9.08</td>
<td>23.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>30.08</td>
<td>27.30</td>
<td>24.16</td>
<td>9.31</td>
<td>17.36</td>
<td>22.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>22.50</td>
<td>19.70</td>
<td>26.25</td>
<td>16.08</td>
<td>17.45</td>
<td>21.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>20.80</td>
<td>18.30</td>
<td>18.88</td>
<td>18.39</td>
<td>14.91</td>
<td>20.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper</td>
<td>33.14</td>
<td>37.68</td>
<td>31.32</td>
<td>15.03</td>
<td>13.22</td>
<td>23.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Yearly Distribution of Winter Crops
El Rowad Pilot Area

% of Total Land Area

Year
Fallow Wheat & Barley Berseem


El Rowad Pilot Area
Yearly Distribution of Summer Crops
El Rowad Pilot area

% of Total Land Area

Year
Fallow Rice

Yearly Distribution of Summer Crops
El Rowad Pilot area
Narrowing the yield gap

Management and Climate Scenarios

1. Low Input Practices + Current Climate
2. Low Input Practices + Climate Change
3. Improved Practices + Climate Change
4. Improved Practices + Adapted Germplasm + Climate Change
5. Improved Practices + Improved Germplasm + Current Climate

Average Crop Yields

Current Climate Yield Gap
Yield Gap 1
Yield Gap 2
How to develop irrigation value chains?