_theme II

Presentation at the 7th Meeting of the WG-Water Management in Water Stressed Regions (WG-Drought)
1- Iranian Experience in Coping with Water Scarcity and Drought

Main Hydrological Watershed Basins of IRAN
WATER SHORTAGES IMPOSED ON WATER CONSUMER SECTORS

<table>
<thead>
<tr>
<th>Water Consumer</th>
<th>Supplied</th>
<th>% Water Shortage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>06-07</td>
<td>07-08</td>
</tr>
<tr>
<td>Agriculture</td>
<td>7809</td>
<td>5887</td>
</tr>
<tr>
<td>Domestic</td>
<td>1912</td>
<td>1814</td>
</tr>
<tr>
<td>Industries</td>
<td>265</td>
<td>137</td>
</tr>
<tr>
<td>Others</td>
<td>1327</td>
<td>894</td>
</tr>
<tr>
<td>Total</td>
<td>11313</td>
<td>8732</td>
</tr>
</tbody>
</table>

Meteorological Variation

- Range of Variations in 30 Years of Precipitation: +38% to –41%
- Range of Variations in 30 Years of Runoff: +71% to -61%
- Drought Occurrence Probability: 50% - 27% in arid central, southern and eastern parts of the country
Administrative Actions for Drought Risk Management

- Use of meteorological models for precipitation forecasting
- Forecasting reservoirs inflow
- Preparing annual reservoir operation program prioritizing:
  1. Drinking water
  2. Sanitary water
  3. Sustaining orchards and perennial crops
  4. Sustaining more valuable crops

Administrative Actions for Drought Risk Management

- Preparing annual operation plan for irrigation
  Considering:
  - Reservoir operation
  - Cropping modifications for reduced water requirements
- Updating supply and demand operation plan with meteorological and hydrological data
- Adequate budget for:
  1. Water resources development projects
  2. Water loss reduction projects
  3. Water use reduction
Drought Management Actions by National Water Bureau (Institutional)

- Establishing National Crisis Headquarter with participation of relevant ministries.
- Establishing Drought Crisis Management Committees at provincial levels.
- Preparing water allocation plans by provincial committees.
- Establishing indices for evaluating intensity of drought.
- Establishing multi-provincial basin committees for shared waters.

Drought Management Actions by National Water Bureau

- Documentation of provincial drought management actions.
- Informing people through public relations bureaus.
- Using energy price to reduce pumping from surface and ground water resources.
- Persuading farmers for
  - Night irrigation
  - Irrigation scheduling
  - Modifying annual cropping pattern
Drought Management Actions by National Water Bureau

- Frequent attendance of water managers in the field
- Increasing water patrol
- Establishing rules and regulations and monitoring their implementation
- Expediting water resources development projects
- Implementation of urgent projects
- Deployment of local police and army force, equipment and machinery

Actions by IWRMC and RWA

- Demand Management
- Water Resources Management
- Facilities
- Distribution Control
- Public Awareness
Demand Management

- Water policing, monitoring and surveillance by police or army forces
- Release of water in high discharges to prevent water offtake
- Confiscation of drilling equipment used to drill unauthorized new wells
- Demolition of unauthorized river intakes
- Early planting of rice and summer crops
- Scheduling rice irrigation

Water Resources Management

- Using water from marshes and swamps
- Using groundwater to compensate for surface water
- Using dead storage of reservoirs by pumps for urgent irrigation and domestic uses
- Providing budge for cloud harvesting
- Collecting water from springs and downstream of dam drainage systems
Water Resources Management

- Use of treated sewage for irrigation and its qualitative study for probable implications
- Qualitative allocation of water (for domestic uses)
- Substituting treated sewerage for fresh irrigation water allocated to domestic use
- Estimation of surface runoff from snow cover on the mountains for planning water allocation
- Coordination of hydroelectric production with irrigation water demand

Providing Facilities

- Dredging small reservoirs and water pools
- Rehabilitation of traditional and modern irrigation canals to improve conveyance efficiency
- Rehabilitation of off-stream reservoirs and their feeder canals
- Authorizing well and Qanat development
Irrigation Water Reservoir (Abandan) in Mazandaran

Abandan Filled with Pumping
Abandan Filled Gravitationally

Abandan being Filled by Flood Flow
Abndan Being Filled with Upland Return Flow

Schematic Profile of Qanat (Kariz)
Areal View of Qanat Access wells in Yazd Province

Maintaining Qanat by Dredging the Gallery
Facilities

- Persuading farmers for pressurized irrigation system with incentives
- Using police and army mobile tankers for drinking water distribution
- Separation of park and lawn irrigation system from urban water supply

Distribution Control

- Volumetric water distribution among farms
- Overdraft notice for users upstream of reservoirs
- Zoned scheduling of the irrigation networks
- Establishing SMS to direct farm representatives
Public Awareness

- Public visit from water resources
- Using mass media for informing people of the severity of water shortage

Concrete Canal Lining Expansion Joints In Regions with Water Scarcity

Canal Observations

Observing a conveyance canal located in an arid region of south-western Iran, which is 107 km long with initial discharge capacity of 82 cms, having 4.10 m height of lining and 9 m bed width, a 10 cm thick gravel filter and 2 corrugated drainage pipes were devised under the canal lining.

The canal has been under construction in 4 reaches which took a few years, in a way that constructed portions have been subject to hot summer weather of about 50°C ambient temperatures (the concrete slabs themselves certainly at more than 60°C), during which some damage due to thermal expansion was observed.
Concrete Canal Lining Expansion Joints In Regions with Water Scarcity

Canal Observations

However, the major damage continued to occur during the operation, which was interrupted frequently due to persistent continued droughts of the past few years resulting acute water shortages during hot summer months. In such hot weather the asphaltic sealant of contraction joints didn’t last long either.

It has been observed that concrete slabs of canal lining, are more frequently susceptible to thermal expansion damage in embankment sections rather than in excavated sections and have been subject to different degrees of spalling, buckling and crushing and sometimes slid over one another.

Observations

Occurrence of the damage is at distances from 8 slabs (24 m) to 15 slabs (45 m) due to stress induced by thermal expansion of canal lining concrete slabs, with most frequent spacing of 10 slabs (30 m). Therefore, in that canal, with the spacing of 10 slabs for expansion joints, the width of joint could be calculated as:

\[ \Delta l = \alpha . l . \Delta t = (10 \times 10^{-6}) \times (3000) \times (60-25) = 1.05 \text{ cm} \]

Hence, providing a width of 2 cm for the expansion joint could leave enough space for the sealant material to be squeezed in the joint after expansion occurs. However expansion joints with more than 2 cm width are not recommended because of sealing difficulties of
Concrete Canal Lining Expansion Joints In Regions with Water Scarcity

**Observations**

are susceptible to being widened due to plastic nature of thermal expansion in canal concrete lining.

For larger expansions due to higher temperature gradients, however, the spacing of canal concrete lining expansion joints might be reduced, leading to larger number of joints without necessity of widening expansion joints.
### Irrigation Management Techniques in Iran In Coping with Water Scarcity

#### Tabulated Results of Alternate Furrow or Corrugation Method

<table>
<thead>
<tr>
<th>Research</th>
<th>Constant Alternate Furrow</th>
<th>Variable alternate Furrow</th>
<th>Regular furrow irrigation</th>
<th>Border irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ref. No.</td>
<td>crop</td>
<td>WUE %</td>
<td>WP %</td>
<td>Yield %</td>
</tr>
<tr>
<td>[1] 1984</td>
<td>beans</td>
<td>+20</td>
<td>+27</td>
<td>-</td>
</tr>
<tr>
<td>[2] 1984</td>
<td>Sugar beet 6,10,14 days</td>
<td>+</td>
<td>6 day interval</td>
<td>Same yield</td>
</tr>
<tr>
<td>[3] 1984</td>
<td>Sugar beet 6,10,14 days</td>
<td>+</td>
<td>6 day interval</td>
<td>Same yield</td>
</tr>
<tr>
<td>[4] 1994</td>
<td>Maize</td>
<td>+</td>
<td>6 day interval</td>
<td>Same yield</td>
</tr>
<tr>
<td>[5] 1996</td>
<td>Sugar beet 6,10,14 days</td>
<td>+</td>
<td>6 day interval</td>
<td>Same yield</td>
</tr>
<tr>
<td>[6] 1997</td>
<td>Maize 4,7,10 Days II</td>
<td>+</td>
<td>6 day interval</td>
<td>Same yield</td>
</tr>
<tr>
<td>[7] 2000</td>
<td>Maize Up to flowering</td>
<td>+10</td>
<td>6 day II</td>
<td>Same yield</td>
</tr>
<tr>
<td>[8] 2006</td>
<td>Rice</td>
<td>+32</td>
<td>-13</td>
<td>-32</td>
</tr>
<tr>
<td>[9] 2006</td>
<td>Sugar beet &amp; Cotton</td>
<td>+44</td>
<td>-22</td>
<td>-22</td>
</tr>
<tr>
<td>[10] 2008</td>
<td>Wheat</td>
<td>+52</td>
<td>-47</td>
<td>-47</td>
</tr>
<tr>
<td>[11] 2008</td>
<td>Safflower</td>
<td>+55</td>
<td>-45</td>
<td>-45</td>
</tr>
<tr>
<td>[12] 2008</td>
<td>Safflower With water Scarcity</td>
<td>+60</td>
<td>-35</td>
<td>-35</td>
</tr>
<tr>
<td>[13] 2008</td>
<td>Safflower With water Scarcity</td>
<td>+60</td>
<td>-35</td>
<td>-35</td>
</tr>
<tr>
<td>[14] 2008</td>
<td>Maize</td>
<td>80% IWR</td>
<td>--</td>
<td>+</td>
</tr>
<tr>
<td>[15] 2008</td>
<td>Maize</td>
<td>60% IWR</td>
<td>--</td>
<td>+</td>
</tr>
</tbody>
</table>

**Abbreviations and Symbols**

- * = The method not tested or compared
- II = Irrigation Interval
- WUE = Water use efficiency
- IWR = Irrigation Water Requirement
- WP = Water productivity
- + = more or better achievement
### Tabulated Results of Deficit irrigation Method

#### Irrigation Management Techniques in Iran In Coping with Water Scarcity

<table>
<thead>
<tr>
<th>Research</th>
<th>Crop</th>
<th>Irrigation Int. days</th>
<th>Soil Moisture Deficit %</th>
<th>Yield Loss %</th>
<th>WUE %</th>
<th>WP %</th>
<th>Overall Yield %</th>
<th>Other Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>[22]</td>
<td>Rice</td>
<td>5-8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[23]</td>
<td>Clover</td>
<td>10-20</td>
<td>50↓</td>
<td>20↓</td>
<td>50↑</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[24]</td>
<td>Sugar Beet</td>
<td>30↓</td>
<td>16↓</td>
<td>Max</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[25]</td>
<td>Rice</td>
<td>permanent submergence</td>
<td>NCD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[26]</td>
<td>Barley</td>
<td>14-7</td>
<td>60↓</td>
<td>NCD</td>
<td>↑</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[27]</td>
<td>Maize</td>
<td>21↓</td>
<td>8↓</td>
<td>30↑</td>
<td></td>
<td></td>
<td></td>
<td>Water consumption reduces from 1023 mm to 800 mm</td>
</tr>
<tr>
<td>[28]</td>
<td>Sugar beet</td>
<td>30↓</td>
<td>10↓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[29]</td>
<td>Cottton</td>
<td>15↓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[30]</td>
<td>Alfalfa</td>
<td>64↓</td>
<td>35↓</td>
<td>30↑</td>
<td></td>
<td></td>
<td></td>
<td>Max net income/cum</td>
</tr>
<tr>
<td>[31]</td>
<td>Wheat</td>
<td>30↓ 25 30 30 20</td>
<td>10↓</td>
<td>8↓ 12↓</td>
<td>12↓</td>
<td>7.5↓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[32]</td>
<td>Maize</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[33]</td>
<td>Rice</td>
<td>40↓</td>
<td>severe↓</td>
<td>Full irrigation during critical periods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[34]</td>
<td>Wheat</td>
<td>65↓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[36]</td>
<td>Rice</td>
<td>31↓</td>
<td>NCD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[37]</td>
<td>Rice</td>
<td>25↓</td>
<td>8↓</td>
<td>Max</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[38]</td>
<td>Sunflower</td>
<td>20↓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Irrigation Management Techniques in Iran In Coping with Water Scarcity

Tabulated Results of Deficit irrigation Method-continued

<table>
<thead>
<tr>
<th>Research</th>
<th>Crop</th>
<th>Irrigation Int. days</th>
<th>Soil Moisture Deficit %</th>
<th>Yield Loss %</th>
<th>WUE %</th>
<th>WP %</th>
<th>Overall Yield %</th>
<th>Other Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(39) (2007)</td>
<td>Local Rice</td>
<td>Less sensitive</td>
<td>Less</td>
<td>Less</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(41) (2007)</td>
<td>Soybean</td>
<td>30-40</td>
<td>NCD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(42) (2007)</td>
<td>Sunflower</td>
<td>Variable amount of water</td>
<td>NCD in seed oil percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(41) (2007)</td>
<td>Soybean</td>
<td>Skip</td>
<td>Skip</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(44) (2008)</td>
<td>Maize</td>
<td>Sow at the</td>
<td>20-22%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations and Symbols
NCD = No Considerable Difference
P = Profit
NP = Net Profit
SAFI = Same As Full Irrigation
II = Irrigation Interval

SAND DAMS

1-Consecutive short stone, brick or concrete walls (dams) across seasonal rivers or floodways.
2-Deposition of sand and sediment during flash floods.
3-Storage of water in the sand deposits upstream of in the sand deposits and river banks.
SAND DAMS

5- Gradual release of the stored water in the river bed and banks during dry period or droughts.
6- Possibility of using the stored water in the sand dams by digging wells during severe droughts for drinking.

THE END