IRRIGATION IN THE CONTEXT OF TODAY’S GLOBAL FOOD CRISIS

Chandra A. Madramootoo
Vice President Hon. ICID
Dean of Agricultural and Environmental Sciences
McGill University

75,000 protest tortilla prices in Mexico
Unionists, farmers, leftists march against price increases that hurt the poor

Tortilla Revolution - Mexico
Droughts and recurring famine since the 1940s -

Advent of the Green Revolution – 1970s
### World Irrigated Area by Region

#### 2004

<table>
<thead>
<tr>
<th>Region</th>
<th>Irrigated Area (Million ha)</th>
<th>Share of World Total* (Per cent)</th>
<th>Share of Cropland That is Irrigated (Per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>193.9</td>
<td>70</td>
<td>33</td>
</tr>
<tr>
<td>North and Central America</td>
<td>31.4</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Europe</td>
<td>25.2</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Africa</td>
<td>12.9</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>South America</td>
<td>10.5</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Oceania</td>
<td>2.8</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>World</strong></td>
<td><strong>276.7</strong></td>
<td><strong>100</strong></td>
<td><strong>18</strong></td>
</tr>
</tbody>
</table>

* Scope for irrigation expansion.

FAOSTAT, 2004

---

### Global Irrigated and Rainfed Cropland Statistics

- 1,500 million ha of global cropland
- 275 m ha irrigated (17%)
- Irrigated lands produce 40% of world’s food
- 1,250 m ha of rainfed lands producing 60% of the world’s food
Main dietary food sources

Values in kcal/person/day:

- Food item: 2,054 (100%)
  - Cereal: 2,136 (86%)
  - Animal: 48 (2%)
  - Beans: 227 (11%)
  - Other animal (fish, eggs, milk): 223 (10%)
  - Fruits and vegetables: 26 (1%)

Note: Cereals, in particular rice and maize, dominate food supply and provide the largest share of energy to the world's population. Although the livestock and fisheries sectors remain marginal in global terms, they play an important role in the supply of protein. These global figures hide large geographical variability in people's dietary energy supply.

Evolution of Irrigation Development

Global Population 1960 - 2050

- **High variant**
- **Medium variant**
- **Low variant**

Rehab, maintenance, upgrading

Freshwater availability per capita 1950-2050

- **1950**: 12,050 m³
- **2000**: 7,310 m³
- **2025**: 5,120 m³
- **2050**: 4,580 m³
Water use by sector, 2000

- Agriculture: 71%
- Industry: 20%
- Domestic: 9%

- Agriculture
- Industry
- Domestic
ON FARM WATER MANAGEMENT

CONCERNS OVER IRRIGATION SYSTEM PERFORMANCE AND INVESTMENT BENEFITS
Furrow Irrigation Efficiencies
(Rice et al., 2001)
Irrigation Efficiency Gains

1. On-Farm:
   - 4.5% of gross diversion

2. Conveyance Works:
   - 1.2% of gross diversion

3. Reservoir Evaporation:
   - 0% of gross diversion

4. Return Flow:
   - 14% of gross diversion

1990s:

Social aspects of irrigation

PIM

WUAS
Water Quality Impairment

THE DEBATE ABOUT DAMS
Irrigation Expansion

Ref: Hopper
Long term trend in per capita food production

![Graph showing long term trend in per capita food production.]

Source: FAO 2006

Virtual water content of selected products

<table>
<thead>
<tr>
<th>Product</th>
<th>Litres of water per kilo of crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>1,150</td>
</tr>
<tr>
<td>Rice</td>
<td>2,656</td>
</tr>
<tr>
<td>Maize</td>
<td>450</td>
</tr>
<tr>
<td>Potatoes</td>
<td>160</td>
</tr>
<tr>
<td>Soybeans</td>
<td>2,300</td>
</tr>
<tr>
<td>Beef</td>
<td>15,977</td>
</tr>
<tr>
<td>Pork</td>
<td>5,906</td>
</tr>
<tr>
<td>Poultry</td>
<td>2,828</td>
</tr>
<tr>
<td>Eggs</td>
<td>4,657</td>
</tr>
<tr>
<td>Milk</td>
<td>865</td>
</tr>
<tr>
<td>Cheese</td>
<td>5,288</td>
</tr>
</tbody>
</table>

Virtual water is the total amount of water used in the production and processing of a given product.

Source: Hoekstra, 2003 adapted by UNESCO-WWAP 2006
Persisting hunger

Number of undernourished in the developing world: observed and projected ranges compared with the World Food Summit target

- Close to one billion remain malnourished
- Close to 800 million in less developed countries
- World Food Summit → reduce by 50% by 2015
- Need to reduce by 22 million / yr
- Current rate – 6 million / yr
- 2.8 billion people earn $2 or less
Food Production and Consumption Patterns in Selected Countries


Overall food prices (US$) up 75 percent since 2000

Source: World Bank, DECOR
Fears mount as rice prices soar

SUPPLIES SHORT
Basmati has gone from $550 to $1,600 a tonne.

CONSUMERS HIT
Food, gas costs also rising, experts say
A perfect storm, grocers say

Source: FAO
ACCESS TO FOOD ... DENIED

Civil wars may come, UN food chief warns

A 'predictable catastrophe'

AGENCE FRANCE-PRESSE

Tripled rice price threatens Asian stability: ADB

BILLIONS SERIOUSLY AFFECTED

Export restrictions, subsidies could make situation worse

The Economist

The silent tsunami

The food crisis isn't over yet

Cameroon, Ivory Coast, Mauritania, Ethiopia, Madagascar, the Philippines and Indonesia, in what UN Secretary-General Ban Ki-moon called a "global crisis."

Cameroon's prime minister said a special fund was being
Average percent of income spent on food
Source: Globe and Mail April 30, 2008
(Source: USDA)
Contribution of food to consumer price inflation
February 2007 to February 2008

Source: Ash 2008
Fertilizer Prices at Record Levels

Index of Fertilizer Prices Paid by Farmers, Jan. 1995 - Jan. 2008

Source: National Agricultural Statistics Service, USDA.

U.S. Corn Used For Ethanol Production

Source: USDA; Doane forecast.
WILL THE BIOFUELS CRAZE CAUSE MASS STARVATION?

Turning corn into fuel was seen as a solution to energy and climate problems. Instead, it may be taking food from the world's poorest.

Biofuels are blamed for food shortages

McGill Conference on Global Food Security

September 24-26, 2008
An International Consortium on Global Food Security

- International experts
- International scholars
- Government policy and decision makers
- Farmer organizations
- NGOs
- Business sector
- National and international relief organizations
Public spending on agriculture is lowest in the agricultural based countries, while their share of agriculture in GDP is highest.
Official development assistance to agriculture declined sharply between 1975 and 2004


World Bank lending in irrigation, 1960–2005

Source: Based on World Bank data summarized by UNESCO-WWAP 2006.
SOME KEY MESSAGES - 1

• The crisis will not come to an end very soon
  • Declining national and international investments in agriculture
    • One size does not fit all
  • Building resilience in vulnerable communities
    • Impacts of malnutrition on children
  • Linkages between agriculture, food and nutrition
    • Water, land and environment
SOME KEY MESSAGES - 2

• Breaking the cycle of poverty
• Farmers are the backbone of the economy
• Use the agricultural sector as an engine of growth
• Building institutional support for local, regional and international markets
• Reinvesting in agriculture and associated infrastructure
• Building a rapid innovative research agenda
• Building capacity at all levels

REINVEST IN IRRIGATION
Consumptive use of water for food supply as a function of GDP

THE WAY FORWARD

Provide storage

Public-private investments in infrastructure
Invest in water savings technologies

Gro-Points

Capacitance probes

Hortau tensiometers
Manage the soil water reservoir

IRRIG, PRECIP

ET

Leaching Fraction

IRRIG, PRECIP

ET

Soil Water Reservoir

Active root zone

Capillary fluxes

Capillary fringe

Surface runoff

Return flows (Q,L)

Interflow

Percolation

GW accretion

Upward GW movement

Subsurface drainage

Return flows (Q,L)

Manage the soil water reservoir

COMBAT THE TWIN MENACE OF WATERLOGGING AND SALINITY
Subsurface pipe drainage installation

- Cereal Production
- Irrigated and Rainfed Agriculture

Irrigation - developing countries: 39%
Irrigation - developed countries: 11%
Rainfed - developing countries: 30%
Rainfed - developed countries: 20%
Food Security: Issues, challenges and opportunities in Amhara

McGill Conference on Global Food Security
September 25 – 26, 2008

Sustainable Water harvesting and Institutional Strengthening in Amhara (SWHISA)

Dereje Biruk and Dev Sharma, P.Eng.

SWHISA contribution to Food Security Initiatives

- 90 Pilot household water harvesting systems – results show that HH can earn an income of $250 to 300 during the dry season from a 85 to 120 m3 storage
- Participatory design and community ownership of irrigation systems
- Demonstration of community watershed management in 6 woredas
- Adaptive on-farm research to technological packages for crop diversification
Withdrawals as percentages of renewable resources in key basins, 1995 and 2025

GLOBAL JITTERS

CANADIAN OUTLOOK DARKENS As Europeans prop up banks, recession becomes apparent on horizon

NASDAQ Composite Index

(c) www.advfh.com
THANK YOU

Annual percent change in crop and livestock production

Source: FAO 2006b
World cereal stocks and stocks-to-utilization ratio*

Source: State of Food and Agriculture 2006

Days of average flow which reservoirs in semi arid countries can store
In different Basins around the world

Report on India by World Bank 2005 from Gopalakrishnan 2008

<table>
<thead>
<tr>
<th>Social and Economic Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
</tr>
<tr>
<td>China</td>
</tr>
<tr>
<td>India</td>
</tr>
<tr>
<td>Pakistan</td>
</tr>
<tr>
<td>Egypt</td>
</tr>
<tr>
<td>Ethiopia</td>
</tr>
<tr>
<td>Kenya</td>
</tr>
<tr>
<td>Uganda</td>
</tr>
<tr>
<td>South Africa</td>
</tr>
<tr>
<td>Canada</td>
</tr>
</tbody>
</table>

### Land Resources

<table>
<thead>
<tr>
<th></th>
<th>1000 ha</th>
<th>ha/person</th>
<th>1000 ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>932,641</td>
<td>554 851</td>
<td>.42</td>
</tr>
<tr>
<td>India</td>
<td>297,219</td>
<td>180 804</td>
<td>.17</td>
</tr>
<tr>
<td>Pakistan</td>
<td>77,872</td>
<td>25 130</td>
<td>.16</td>
</tr>
<tr>
<td>Egypt</td>
<td>99,545</td>
<td>3424</td>
<td>.05</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>115,968</td>
<td>17169</td>
<td>.44</td>
</tr>
<tr>
<td>Kenya</td>
<td>56,925</td>
<td>20512</td>
<td>.82</td>
</tr>
<tr>
<td>Uganda</td>
<td>19,971</td>
<td>12462</td>
<td>.47</td>
</tr>
<tr>
<td>South Africa</td>
<td>121,991</td>
<td>99640</td>
<td>2.2</td>
</tr>
<tr>
<td>Canada</td>
<td>909,350</td>
<td>67505</td>
<td>2.1</td>
</tr>
</tbody>
</table>


### Water Resources

<table>
<thead>
<tr>
<th></th>
<th>Total Renewable Water Resources (TRWR) (surface + ground-overlap)</th>
<th>Total Surface water</th>
<th>Total Ground water</th>
<th>Total Freshwater Withdrawal (TFW)</th>
<th>TFW/TRWR</th>
<th>Agricultural Water Withdrawal</th>
<th>Per capita Freshwater Withdrawal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>km³</td>
<td>km³</td>
<td>km³</td>
<td>km³/y</td>
<td>%</td>
<td>km³/y</td>
<td>m³/y</td>
</tr>
<tr>
<td>China</td>
<td>2,830 (1999)</td>
<td>2728</td>
<td>828</td>
<td>617</td>
<td>22</td>
<td>427</td>
<td>485</td>
</tr>
<tr>
<td>India</td>
<td>1,897 (1999)</td>
<td>1858</td>
<td>419</td>
<td>646</td>
<td>34</td>
<td>558</td>
<td>613</td>
</tr>
<tr>
<td>Pakistan</td>
<td>225 (2003)</td>
<td>218</td>
<td>55</td>
<td>169</td>
<td>75</td>
<td>163</td>
<td>1,138</td>
</tr>
<tr>
<td>Egypt</td>
<td>58.3 (1997)</td>
<td>56</td>
<td>2.3</td>
<td>65.2</td>
<td>111</td>
<td>59</td>
<td>977</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>122 (1987)</td>
<td>120</td>
<td>20</td>
<td>5.6</td>
<td>4.6</td>
<td>5.2</td>
<td>77</td>
</tr>
<tr>
<td>Kenya</td>
<td>30.7 (1990)</td>
<td>30.2</td>
<td>3.5</td>
<td>2.7</td>
<td>8.8</td>
<td>2.2</td>
<td>80</td>
</tr>
<tr>
<td>Uganda</td>
<td>66 (1970)</td>
<td>66</td>
<td>29</td>
<td>0.3</td>
<td>0.5</td>
<td>0.12</td>
<td>10</td>
</tr>
<tr>
<td>South Africa</td>
<td>50 (1990)</td>
<td>48</td>
<td>4.8</td>
<td>12.5</td>
<td>25</td>
<td>7.9</td>
<td>268</td>
</tr>
<tr>
<td>Canada</td>
<td>2902 (1985)</td>
<td>2892</td>
<td>370</td>
<td>44.72</td>
<td>1.5</td>
<td>5.37</td>
<td>1,386</td>
</tr>
</tbody>
</table>

Source of all data: FAO Aquastat Database
Agricultural trade balance of least-developed countries

Source: FAO State of Food and Agriculture 2007

Agricultural and food trade in China
1993-2008

(Billion US $)

(Source Zhu 2008)