Securing Water & Food: Opportunities in Irrigation

Peter G. McCormick, Executive Director, Robert B. Daugherty Water for Food Institute at the University of Nebraska

VISION
• A food and water secure world, where global food security is ensured while maintaining the use of water to meet other pressing human and environmental needs.

MISSION
• A lasting and significant impact on achieving more food security with less pressure on water resources through research and policy, stakeholder engagement, communication and education programs.

Robert B. Daugherty Water for Food Global Institute at the University of Nebraska

Resources and Expertise
• We are a distributed institute, drawing on Faculty Fellows and affiliates and centers of expertise (ie the National Drought Mitigation Center) across the University of Nebraska
• Expanding our reach through partnerships
• Research- supporting faculty and students with financial support and connections to pursue research projects and studies strategically important to furthering Water for Food’s mission.
• Policy- working with policy makers, community leaders and others to develop solutions to complex issues involving water for agriculture and water governance.

Our Approach
• Our approach is to extend the University of Nebraska’s expertise through strong partnerships with other universities, and other public and private sector organizations.
• Together, we are developing research, education and engagement programs in a focused effort to have an impact on increasing food security, while ensuring the sustainability of water resources and agricultural systems.
• We work locally and internationally, bridging the water and agriculture communities and the worlds of small and large scale farmers to deliver innovative solutions to this complex global challenge.
Subject Areas of Focus

• Closing Water and Agricultural Productivity Gaps
• Groundwater Management for Agricultural Production
• Enhancing High-productivity Irrigated Agriculture
• Agro-ecosystems and Public Health

Cross-cutting: Management of agricultural drought, in partnership with the UNL’s National Drought Mitigation Center (NDMC)

The Challenges

• At present, almost a billion people in the world are food-insecure
• Many of them are also lacking sufficient reliable water to meet their needs
• World population is estimated to reach nearly 10 billion by 2050
• Nearly 300 million of the poor in SSA are in rural areas where livelihoods depend on crops, livestock and fisheries.
• Increasing demand for high value, water intensive products, especially meat and dairy from growing economies

Global hunger index (GHI) 2015 (Xie et al, 2016)

Where is cropland area expanding? 
Sub-Saharan Cereal Import Dependency (%)

Global Cropland Trends

Evidence of yield plateaus or abrupt decreases in rate of yield gain, including rice in eastern Asia and wheat in northwest Europe, which account for a third of total global rice, wheat and maize production.

Revitalizing Large Scale Irrigation Systems

- Over 115 million hectares of large scale irrigation systems
- Can deliver significant local, regional and global benefits in terms of food and energy security, employment, economic growth and ecosystem services
- Past efforts have been costly and outcomes have been in many cases underwhelming.
- Solutions that consider social, institutional, infrastructure, politics, ecosystems, and economics/finances
- Opportunity for viable partnership models including private, public and NGOs
Groundwater – Sustaining the Resource

- Agricultural is the largest user of groundwater globally.
- 44% of global food production is produced by groundwater, of which 33% is from non-renewable sources.
- India, China, Bangladesh and Pakistan = 1 billion households depend on GW for agriculture.
- Critical role in mitigating the impacts of extreme events exacerbated by climate change.
- Governance and management are challenging.

Countries with the highest potential for irrigation (medium irrigation costs & IRR>5%)

- Comprehensive Africa Agriculture Development Program (CAADP) aims to triple the area (~20 million hectares) under sustainable land management and reliable water control systems.
- Many countries, including Ethiopia, Ghana, Kenya, Malawi, Mozambique, Nigeria and Tanzania, have prioritized investments, both large-scale and small-scale.
- Expansion of sustainable irrigation requires effective business models, finance, good science and innovation, governance systems, and capacity.
- Small-holder, informal irrigation is expanding within rain-fed landscapes.

Estimated economically viable irrigation potential in sub-Saharan Africa

- Estimate to be 18 million hectares of potential irrigation, of which potential 3.2 million is large scale, and 14.8 million is small scale.

<table>
<thead>
<tr>
<th>Country</th>
<th>Large-scale (million ha)</th>
<th>Small-scale (million ha)</th>
<th>Total (million ha)</th>
<th>Existing (million ha)</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>0.96</td>
<td>4.27</td>
<td>5.24</td>
<td>2.87</td>
<td>183%</td>
</tr>
<tr>
<td>Western</td>
<td>1.42</td>
<td>6.31</td>
<td>7.73</td>
<td>0.77</td>
<td>1010%</td>
</tr>
<tr>
<td>Central</td>
<td>0.32</td>
<td>0.94</td>
<td>1.26</td>
<td>0.05</td>
<td>2655%</td>
</tr>
<tr>
<td>Southern</td>
<td>0.51</td>
<td>3.32</td>
<td>3.83</td>
<td>3.30</td>
<td>116%</td>
</tr>
</tbody>
</table>

The Circles Consortium

Partnership between World Vision, Valmont and Daugherty Water for Food Global Institute

- Piloting the concept of community farming under a center pivot.
- Bottom up approach.
- Aim to produce high value crops, and foster the required value chain.
Water withdrawals in the U.S.

- Water withdrawals are lower than they have been for 40 years.
- Withdrawals for ag leveled off a few years after other sectors.

Nebraska Surface Water Projects

- Developed from 1850s to 1992
- 300,000 acres (120,000 ha) are private diversions
- 1.1 million acres (450,000 ha) are public
- Investments repaid from irrigation fees and power revenue
- More than 7 million acres (2.8 million ha) of groundwater irrigation.
- Developed with private funding (~$15-20 billion)

Groundwater - Nebraska

- More than 93,000 active irrigation wells
- $6-8 billion invested, primarily by farmers
- Major development occurred in the 1970s, but continues to expand at around 2000 wells per annum.
Nebraska’s 23 Natural Resource Districts

Groundwater is “virtually” transferred across U.S.

Source: University of Nebraska-Lincoln

Marston et al. 2015

Groundwater is “virtually” transferred across the Resource

Virtual Groundwater Transfer Volumes (10^6 m³)

- Central Valley
  - 0 - 20
  - 20 - 100
  - 100 - 250
  - 250 - 1,000

- High Plains
  - 0 - 20
  - 20 - 100
  - 100 - 250
  - 250 - 1,000

- Mississippi Embayment
  - 0 - 20
  - 20 - 100
  - 100 - 250
  - 250 - 1,000
  - 1,000 - 4,000
“Virtual” Groundwater Exports

- 51% of “virtual” groundwater exports goes to Asia
- 48% of “virtual” groundwater exports are from the Mississippi Embayment

Marston et al 2015

Continuing and emerging challenges

- Four counties in the south west of the state where the groundwater continues to be overdrawn
- Competition between surface and groundwater users in the republican river basins
- Water quality, including natural constituents and agricultural contaminants in the groundwater
- Ensuring environmental, ecosystems and inter-state requirements are met in the surface systems
- Variability of the agricultural markets

Key Messages / Concluding Points

- Further development of irrigation, to address food security and generate economic growth, is a priority in a number of regions, including Sub-Saharan Africa and Latin America.
- Irrigation has a variable record, with significant issues including over abstraction and degradation of groundwater resources, and underperformance of large scale systems.
- However, there are also regions where irrigation has been successfully managed, with production increased, and the emerging issues addressed.
- The specific challenges vary considerably by context.
- Need capacity, educational/mentoring resources, research, finance, marketing, communication, transportation and technology
- Knowledge and resources are available!

Water for Food Global Conference

“Water for Food Security: From Local Lessons to Global Impacts”
April 10-12, 2017 Nebraska Innovation Campus Lincoln, Nebraska, USA. http://waterforfood.nebraska.edu/
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