Identifying and Addressing Water-Food Research Needs

COST and WssTP Joint Strategic Conference: Water in the Urban Environment - Bringing Research to the Market

Enrique Playán, Coordinator
Brussels, April 16-18 2013
Exploring the water-food link

The hungry and the thirsty worlds
It costs on average just US 25 cents a day to feed a hungry child and change her life forever.

While food is the most basic of human needs required for survival, on average, 1 in 8 people go to bed hungry each night.

Hunger kills, maims, reduces IQ, lowers wages, reduces school attendance and undermines economic growth.

Hunger Map 2012

Proportion of total population undernourished, 2010-13

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Water - Food

- Essential link for agricultural production
- Water, more scarce than land in key agricultural environments
- Affecting both rainfed and irrigated agriculture... there is not so much of a difference
- Recent change in trends in the prices of agricultural commodities...
21st Century food prices

FIGURE 20
FAO Food Price Index in real terms, 1961–2010

Index (1990 = 100)

(FAO Word Food and Agriculture In Review, 2012)
Drivers down:
- Research and development
- Technology
- Politics: subsidies
- …

Drivers up:
- Development
- Energy
- Resources
- Speculation
Predicting the future?
US Drought and Your Food Costs

Note: Graphics represent all food (food at home + food away from home).

Historical Food Price Inflation

<table>
<thead>
<tr>
<th>Year</th>
<th>Inflation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-2011</td>
<td>3%</td>
</tr>
<tr>
<td>2008</td>
<td>5.5%</td>
</tr>
<tr>
<td>2009</td>
<td>1.8%</td>
</tr>
<tr>
<td>2010</td>
<td>0.8%</td>
</tr>
<tr>
<td>2011</td>
<td>3.7%</td>
</tr>
<tr>
<td>2012*</td>
<td>3%</td>
</tr>
<tr>
<td>2013*</td>
<td>3.5%</td>
</tr>
</tbody>
</table>

*Forecast as of July 25th 2012

What it means: Food price inflation is expected to be close to the historical average this year and just slightly above that next year.

What Affects Your Food Costs?

- **14% Commodity Prices**
- **86% Everything Else**
  - Food Processing
  - Packaging
  - Retail Trade
  - Food Services
  - Energy + Transportation
  - Finance
  - Other

What it means: Commodity prices are just one of many factors affecting retail food prices. Commodities make up about 14% of the average retail food purchase, so even if all commodity prices doubled, retail food prices would increase by about 14%.*
Figure III.14. Investor and target regions and countries in overseas land investment for agricultural production, 2006–May 2009
(Number of signed or implemented deals)

Source: UNCTAD.

Notes: This map covers only confirmed deals that have been signed, some of which have been implemented. However, not all signed deals have been implemented, and all signed deals that were rescinded by one or both parties before the end of May 2009 are excluded. Prospective deals reported in the press, but which have not progressed to the stage of agreement are excluded. The total number of deals was 48, shown by both source and destination countries.
Enabling needs for agro-industry competitiveness

**Source:** Christy et al., 2009.
Enabling needs for agro-industry competitiveness

About Water?
Enabling needs for agro-industry competitiveness

About Water?

Source: Christy et al., 2009.
Returns to public spending: India

Agricultural Performance

Poverty reduction
Plant gas exchange: Stoma

$\text{CO}_2 \text{ in, Water out}$
Water and food

- Water: Transpiration, evapotranspiration
- Food: biomass, yield
- A lineal relation between transpiration and biomass is extremely common
Evapotranspiration and Yield

Yield (t/ha)

Evapotranspiration (mm)
Water and food

- **Water**: Transpiration, evapotranspiration
- **Food**: biomass, yield

A lineal relation between transpiration and biomass is extremely common

- Affected by the differences between biomass and economic yield (i.e., fruit yield, fruit quality)
- Very difficult to change through plant breeding
- Prospects for change are not quantitatively revolutionary
- **Vegetal production shows and will show a large dependency on water** (about 500 L/kg of corn grain)
## Possible sources of agricultural water cost

<table>
<thead>
<tr>
<th></th>
<th>Irrigated</th>
<th>Dryfarming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriation and conveyance</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Scarcity</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pollution</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Irrigation map in Europe

Fig. 6 – Global map of irrigation areas – irrigation intensity in the EU as area equipped for irrigation in % of total area by 5’ cell.
European agricultural water stress

(Vörösmarty et al., 2010)
World agricultural water stress

(Vörösmarty et al., 2010)
Irrigation: water use vs. consumption

- Evapotranspiration = water consumption
  - The final use of water
  - Water goes back to the atmosphere
- A volume of water is used for irrigation
  - Use > consumption
  - Part of the water percolates or runs off the field
  - Returning to the water bodies
  - Carrying variable pollutant loads
- Irrigation efficiency: \[ \frac{\text{Consumption}}{\text{Use}} \times 100 \]
Alternative ways to address scarcity (in this order?)

- Using **Virtual Water**
  - Import products requiring large amounts of water in their elaboration
- Improve **Economic Efficiency**
  - Reassign water uses to obtain maximum return per unit of water
- Improve **Irrigation Efficiency**
  - Perform the same activities, with less water
  - Mainly irrigation efficiency, also conveyance…
  - Two ways:
    - Improve the water use structures
    - Improve water management

(Allan, 1997)
Irrigation efficiency

- In the agricultural sector, irrigation efficiency is the key to technical efficiency
- Large investments are devoted these days to the modernization / rehabilitation of irrigation systems worldwide
EU Policy on irrigation efficiency

- The blueprint document (DG Environment)
  - Water accounting
  - Water efficiency targets
  - Funding to improve irrigation efficiency
    - Consistent with WFD
    - Preventing rebound effect
  - Leakage control
  - Water reuse in irrigation
## Nitrate leaching to drainage water

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Irrigation</th>
<th>N application (kg ha(^{-1})yr(^{-1}))</th>
<th>NO(_3)-N in drainage (kg ha(^{-1})yr(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bardenas DXXX-3</td>
<td>Surface</td>
<td>357</td>
<td>144.0</td>
</tr>
<tr>
<td>Bardenas DXIX-6</td>
<td>Surface</td>
<td>233</td>
<td>47.4</td>
</tr>
<tr>
<td>Bardenas DXXV-3</td>
<td>Surf+Sprin</td>
<td>203</td>
<td>41.4</td>
</tr>
<tr>
<td>Monegros D-IX</td>
<td>Sprinkler</td>
<td>199</td>
<td>13.9</td>
</tr>
<tr>
<td>Monegros D-XI</td>
<td>Sprinkler</td>
<td>225</td>
<td>49.0</td>
</tr>
</tbody>
</table>

(Playán et al., 2002; Cavero et al., 2003)
An analysis of irrigation performance in the Ebro Basin (1,617 plots)

Irrigation Requirements (m$^3$/ha)

Irrigation Water Use (m$^3$/ha)

- Sprinkler
- Drip
- Surface

(Salvador et al., 2011)
The human factor in irrigation

Irrigation Requirements (m³/ha)

Irrigation Water Use (m³/ha)

Training?

Automation?
Comparing to urban irrigation
Estimating landscape irrigation efficiency

The diagram shows the efficiency estimates (%) for different deficit levels across the years 2005, 2006, and 2007. The x-axis represents the efficiency estimate categories (Deficit, 100, 50, 33, 25, 20, <20), and the y-axis represents the percentage of households (%). The bars indicate the distribution of households across these categories for each year.
Building a Strategic Research Agenda exploring the Water-Food nexus

Distilled information obtained through consensus
Developing a Strategic Agenda

- **Research Questions:**
  - Maintaining Ecosystem Sustainability
  - Developing safe water systems for the citizens
  - Promoting competitiveness in the water industry
  - **Implementing a water-wise bio-based economy**
  - Closing the water cycle gap

- Work in progress...
A Water-Wise Bio-Economy

- Bio-economy: “use of renewable resources from land and sea, and the use of waste to make value added products, such as food, feed, bio-based products and bioenergy”
- Leading to the intensification of agriculture
- More pressure on natural resources to increase the production of food and biomass, more water and more agrochemicals
- Water depletion and pollution applies to both rainfed and irrigated systems
A Water-Wise Bio-Economy

- Resource efficiency
  - Less water consuming crops, Water conservation techniques,
  - Irrigation scheduling and technologies
  - Advances in hydrological modelling

- Reduction of soil and water pollution
  - On-farm measures… efficient use of inorganic and organic fertilizers
  - Modifying crop rotations and sowing dates,
  - Selecting more pest-resistant crop varieties,
  - Designating buffer strips along water courses.
  - Sustainable chemical consumption patterns through a mix of policy responses
  - Need for better understanding of contaminants transfer within soils and water systems.
A Water-Wise Bio-Economy

- Water pricing
- Agrochemicals
- Salinity
- Agronomy
- Resource Efficiency
- Climate Change
- Nitrogen
- Organic
- Water Reuse
- Irrigation Efficiency
- Crop Water Requirements
- Evaporation
- Bio-fuels
- Pesticides
- Policy Response

- Hydrology
- Farmers’ Incentives
- Rainfed Systems
- Regulatiions
- Modeling
- Groundwater Protection
- Biomass
- Irrigation Efficiency

- Awareness
- Pharming
- Water Framework Directive
- Bioenergy
- Micro Irrigation
- Water Pricing
- Soil and Water Pollution
- Phosphorus
- Fertilizers
Concluding remarks

The take-home message
Water and Food

- International focus on agricultural development brings additional pressure on water
- Pressures increasing with the development of bioeconomy
- Crop physiology establishes difficult to move limits
- Improving agronomy in rainfed and irrigated systems
- Improving structures and management in irrigated systems
- Research as a high-return public investment
- Coordination as a key to effectiveness