Importance of Irrigation to Global Agriculture (USDA, 1996)

About 1/6th of cropland around the world is grown using supplemental irrigation and provides:

- ~1/3 of annual global harvests.
- ~1/2 of the monetary value of crops harvested.
- Frees ~450 million ha for nature.
- Provides greater food and economic security by improving reliability of yields.

http://www.ars.usda.gov
‘Water resources dedicated to agricultural irrigation will likely decline over time in response to increasing urban and environmental demands’

State of Texas (2009)  
*Liquid Assets*

Conducted an inventory of water resources and projected water demand to the year 2060.

Source: Liquid Assets on-line at http://www.window.state.tx.us/specialrpt/water/
Since 1990, rice production has declined by ~ 4,600 ha/yr in large part to increasing costs of water.
Rice farmers in the region have greatly reduced rice acreage in recent years largely because of water problems. But more is going to be needed if rice farming is to survive this and future water problems in Texas,” says Dick Ottis, president of Rice Belt Warehouse in El Campo, Texas.

Ottis refers to a voluntary move by Texas rice growers in the 1980s that reduced total acreage from 450,000 to just over 170,000 acres last year.

http://southwestfarmpress.com/grains/uncertain-future-has-texas-rice-growers-praying-rain

National Research Council (1996)

‘Water resources dedicated to agricultural irrigation will likely decline over time in response to increasing urban and environmental demands’

Improving Irrigation Efficiency is Important for the Mid South

**Estimated Irrigation Water Use (A-ft/A)**

247,000 A rice @ 100% flood irrigated x 3.07 A-ft/A =

~758,000 A-ft water/yr (rice crop)

1,054,000 A soybean @ 65% irrigated x 0.76 A-ft/A =

~520,000 A-ft water/yr (soybean crop)

Estimated combined water use: ~1.3 million A-ft/yr
Average Water Use by Different Rice Irrigation Systems

YMD (2010)

2011 Intermittent Irrigation Trials
Kline 38-A field, clay soil

Water Pumped: 18 A-in/A

Top of Paddy: 8 wet-dry cycles

Red Line = Mud Exposed in Upper Paddy

Date
Good Rice Yields & Quality Observed to Date

2010 Variety x Intermittent Irrigation Trial
Clay soil w/ 5 wet-drying cycles using 23 A-in/A

<table>
<thead>
<tr>
<th>Variety</th>
<th>Top of Paddy (int flood)</th>
<th>Bottom of Paddy (cont flood)</th>
<th>Type III Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>6004</td>
<td>10,548</td>
<td>9,067</td>
<td>0.0326</td>
</tr>
<tr>
<td>Bowman</td>
<td>9,838</td>
<td>9,905</td>
<td>0.9004</td>
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<td>CL111</td>
<td>10,850</td>
<td>11,380</td>
<td>0.5048</td>
</tr>
<tr>
<td>CL131</td>
<td>9,142</td>
<td>9,762</td>
<td>0.2304</td>
</tr>
</tbody>
</table>

Replicated trials in 2010 and 2011 indicate intermittent rice yields ≥ continuous flood.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Rice Yield (lb/A) dry</th>
<th>Type III Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLX745</td>
<td>12,386</td>
<td>0.1889</td>
</tr>
<tr>
<td>Cheniere</td>
<td>10,576</td>
<td>0.1017</td>
</tr>
<tr>
<td>Cocodrie</td>
<td>10,796</td>
<td>0.2154</td>
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<tr>
<td>Neptune</td>
<td>10,396</td>
<td>0.0756</td>
</tr>
<tr>
<td>Rex</td>
<td>10,481</td>
<td>0.1846</td>
</tr>
<tr>
<td>Taggart</td>
<td>11,486</td>
<td>0.3535</td>
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<tr>
<td>Templeton</td>
<td>11,083</td>
<td>0.0618</td>
</tr>
<tr>
<td>XL723</td>
<td>12,809</td>
<td>0.9986</td>
</tr>
</tbody>
</table>
Irrigation Efficiency Research

Furrow Irrigation Optimization

Savings ≥ 20% above standard furrow irrigation using USDA Phaucet program and pump timers.

Systematic Approach to Water Conservation

Crop Breeding & Selection
Agronomic Management
Economics
State/Federal Regulations
Irrigation Technology
Water Conservation and Jevons’ Paradox:

Human Nature, Technology, and the Key Role of Regulation in Conserving Natural Resources

The Coal Question (1865)
by William Stanley Jevons

- Jevons asked the question:
  
  ‘How long will England’s coal last?’

- Available free on-line at GOOGLE Books

- An economic classic
Jevons’ Paradox

• He argued that, contrary to common intuition, technological improvements could not be relied upon to reduce coal consumption.

• He observed that technological improvements that increased the efficiency of coal-use led to the increased consumption of coal in a wide range of industries.


Jevons’ Paradox

The phenomenon of using more of a resource after widespread adoption of technology(s) designed to conserve the resource has been observed for coal, oil, and electricity.

Economists call the phenomenon:

• “Take-Back”

• “Rebound”
Jevons’ Paradox

• May also hold true in our attempts to conserve water resources.

• Example:

Water conservation efforts in the state of Kansas to protect the Ogallala aquifer.

Major Aquifers in the US
(USGS, 2002)
V.L. McGuire (2007)

Changes in Water Levels and Storage in the High Plains Aquifer, Predevelopment to 2005

USGS Fact Sheet 2007-3029

• Intensive irrigation became widespread in the 1970s.

• Agriculture accounts for 99% of the over 20 million acre-feet of annual groundwater withdrawals.

• Recharge to its southern portion is extremely low, making it an essentially nonrenewable resource.

V.L. McGuire (2007)

• In parts of southwestern Kansas and in the Texas panhandle, the water table has declined by more than 50 meters.
To decrease rates of extraction from the Ogallala, policymakers provided incentives to KS farmers to convert from:

**Center Pivot Irrigation**
To: Low pressure nozzles and drop tubes on center pivots. (Photo credit: USDA NRCS)

Pfeiffer and Lin (2010)
The Effect of Irrigation Technology on Groundwater Use
“Our estimates indicate that for every 1% increase in the percent of acres irrigated with dropped nozzle irrigation systems, total water extraction increases by 1.8%, compared to what would have happened had the acres been irrigated by standard center pivot systems.”
• “Additionally, farmland that has the potential to be irrigated because it has an irrigation system installed, but was not irrigated, decreased by 0.24% for every 1% increase in dropped nozzles.”

• “These results indicate that when crop choices are considered, efficient irrigation technology does not reduce overall water use.

It is unlikely that the shift toward more efficient irrigation technology has resulted in real water conservation in western Kansas.

In fact, it significantly increased water use relative to flood and standard center pivot irrigation systems.”
• He argued that technological improvements could not be relied upon to reduce coal consumption.


• This is not an argument against conservation.

• Rather, it is an argument that, owing to Human Nature, non-technological means to govern use will be needed to protect the alluvial aquifer.
Systematic Approach to Water Conservation

- Crop Breeding & Selection
- Agronomic Management
- Economics
- State/Federal Regulations
- Irrigation Technology

New Irrigated Acres in MS Delta (YMD, 2011)

- Of the 3,151 water-use permits approved in the Delta, 1,039 were issued as new permits.

- Historically ~35,000 new acres come under irrigation each year.

- 1Q 2012: 12,000 new acres

=> 48,000 per yr
Commodity Prices Near All Time Highs

http://www.indexmundi.com/commodities/?commodity=corn&months=120

USDA Economic Research Service (2011)

Rising commodity prices and input costs may create further demand for irrigation water.

Source: Economic Research Service, USDA.
Technological improvements alone can not be relied upon to reduce water consumption.

Effective conservation requires effective limits (financial; regulatory) on resource extraction.

Systematic Approach to Water Conservation

- Crop Breeding & Selection
- Agronomic Management
- Human Nature
- State/Federal Regulations
- Irrigation Technology