Water-Conserving Irrigation Systems for Furrow & Flood Irrigated Crops in the Mississippi Delta

Joe Massey
Department of Plant & Soil Sciences
Mississippi State University

MISSISSIPPI MAFES AGRICULTURAL & FORESTRY EXPERIMENT STATION

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.

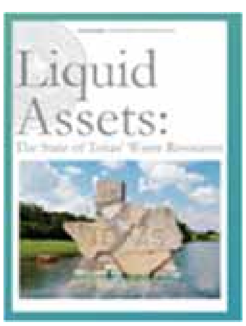
http://www.ars.usda.gov

National Research Council (1996)

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

National Research Council Water Sciences and Technology Board. 1996. *A New Era for Irrigation*. Washington, DC.

State of Texas (2009)
Liquid Assets

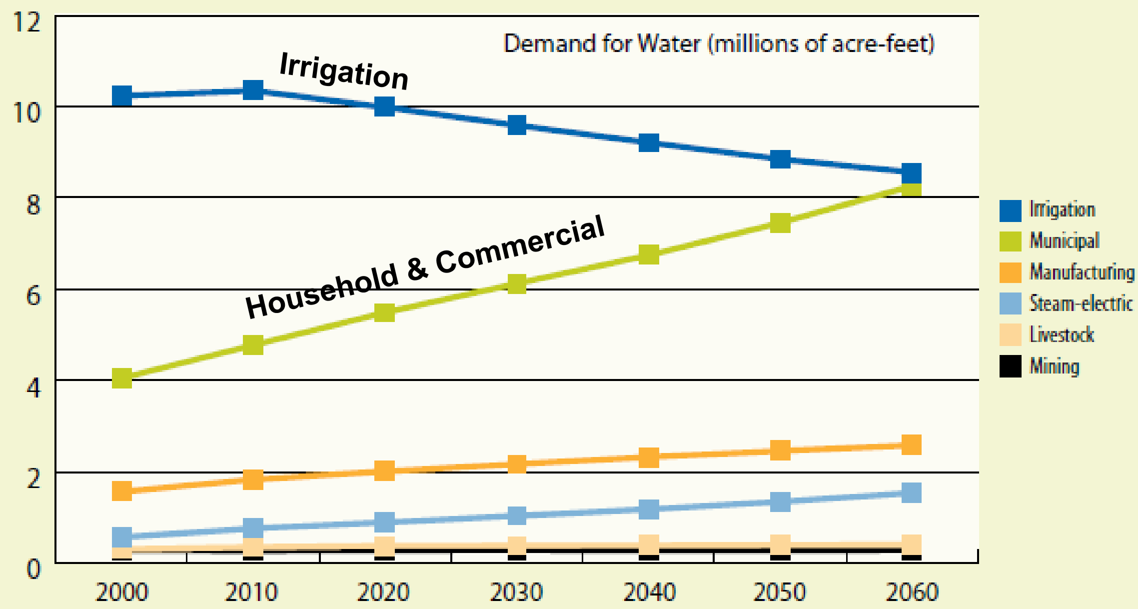


Conducted an inventory of water resources and projected water demand to the year 2060.

Source: Liquid Assets on-line at http://www.window.state.tx.us/specialrpt/water/

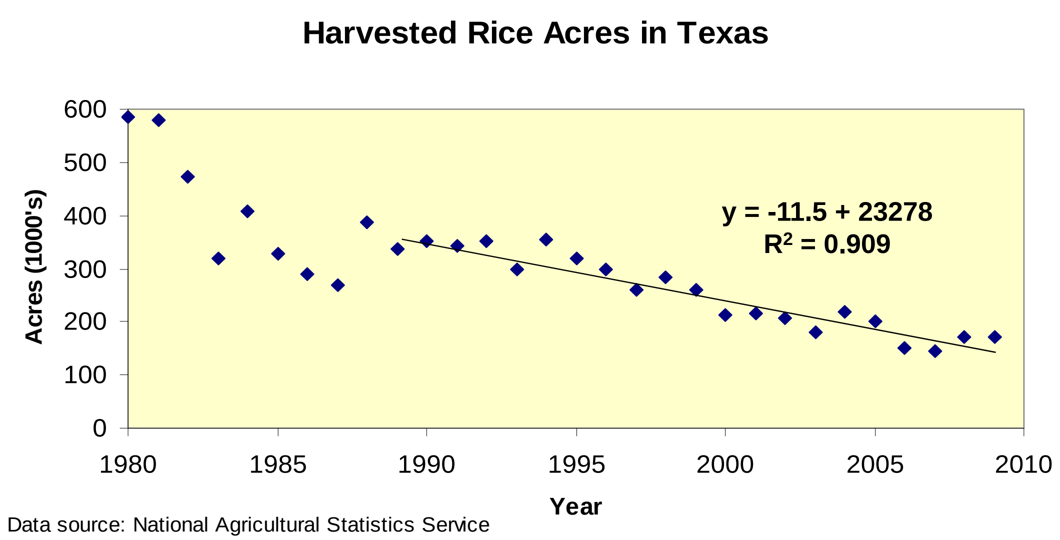
Exhibit 5

Texas Projected Water Demand by Category, 2000-2060



Sources: Texas Water Development Board.

Rice Production Shifting Away from US Gulf Coast
(USDA ERS, 2011)



Since 1990, rice production has declined by ~ 4,600 ha/yr in large part to increasing costs of water.

Southwest FARM PRESS
TIMELY RELIABLE INFORMATION FOR SOUTHWEST AGRICULTURE

Uncertain future has Texas rice growers praying for rain

Logan Hawkes
Nov. 3, 2011 10:54am

"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)

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Estimated Irrigation Water Use (A-ft/A)

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

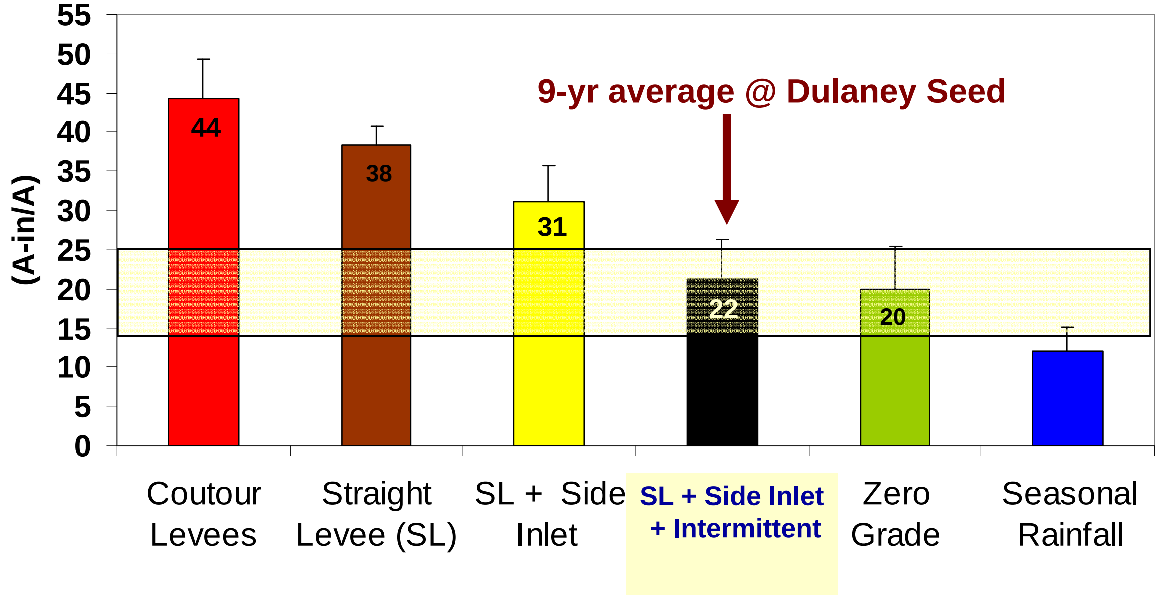
~758,000 A-ft water/yr (rice crop)

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

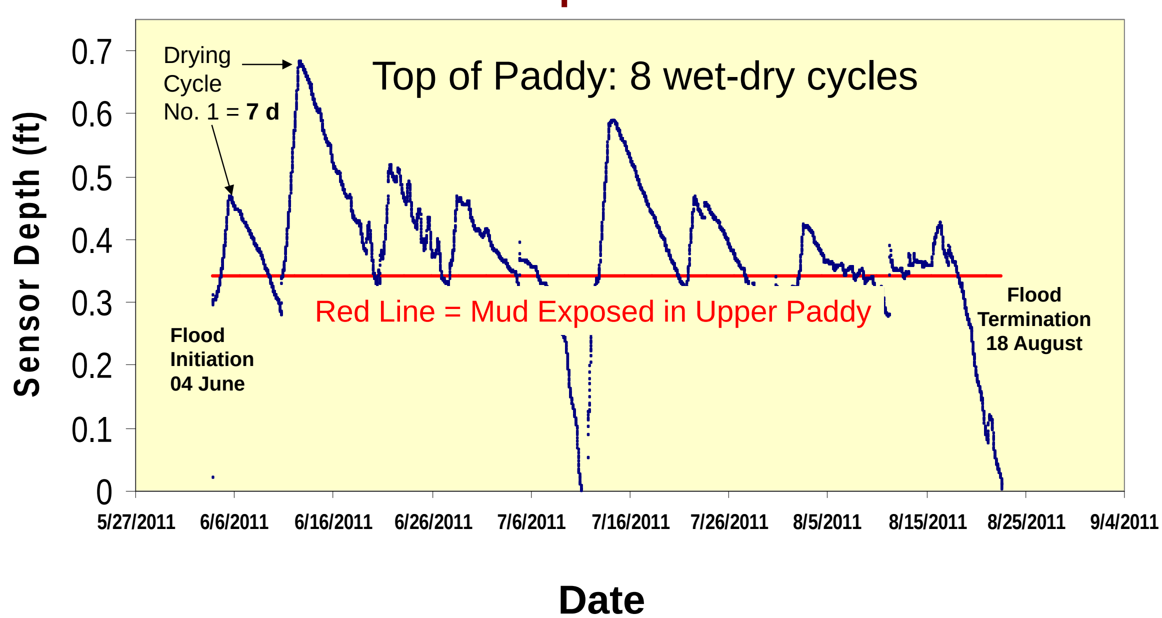
Average Water Use by Different Rice Irrigation Systems



YMD (2010)

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

Water Pumped: 18 A-in/A



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

Variety	Top of Paddy (int flood)	Bottom of Paddy (cont flood)	Type III Pr > F
	Rice Yield (lb/A) dry		
6004	10,548	9,067	0.0326
Bowman	9,838	9,905	0.9004
CL111	10,850	11,380	0.5048
CL131	9,142	9,762	0.2304
CLX745	12,386	11,698	0.1889
Cheniere	10,576	10,124	0.1017
Cocodrie	10,796	10,528	0.2154
Neptune	10,396	9,452	0.0756
Rex	10,481	9,899	0.1846
Taggart	11,486	10,961	0.3535
Templeton	11,083	9,933	0.0618
XL723	12,809	12,808	0.9986

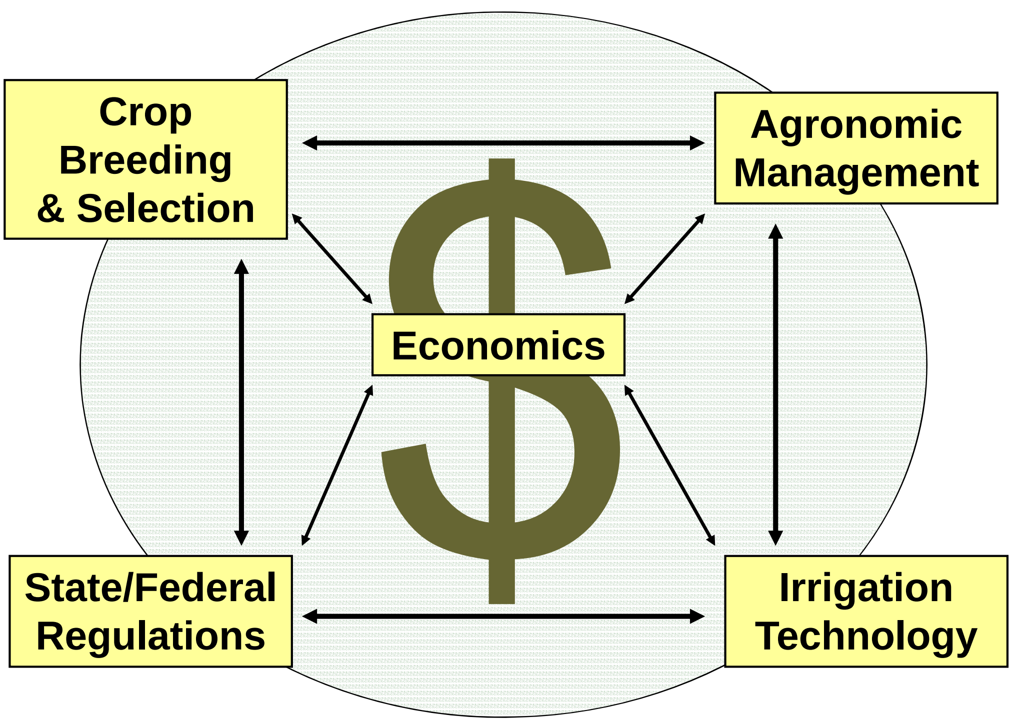
Replicated trials in 2010 and 2011 indicate intermittent rice yields ≥ continuous flood.

Irrigation Efficiency Research

Furrow Irrigation Optimization

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

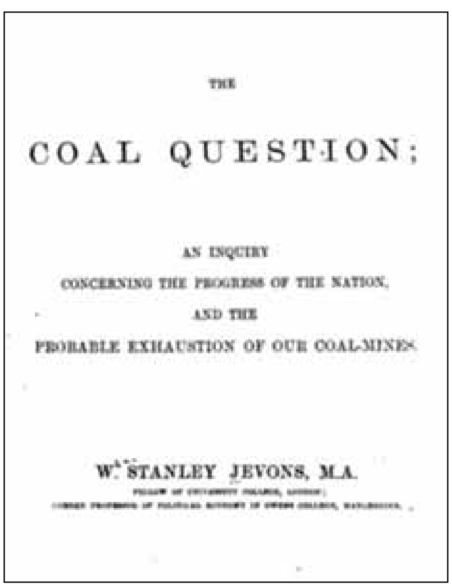
Systematic Approach to Water Conservation



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



THE

COAL QUESTION;

AN INQUIRY
CONCERNING THE PROGRESS OF THE NATION,
AND THE
PROBABLE EXHAUSTION OF OUR COAL-MINES.

W. STANLEY JEVONS, M.A.

- 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.

Source: Wikipedia

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”

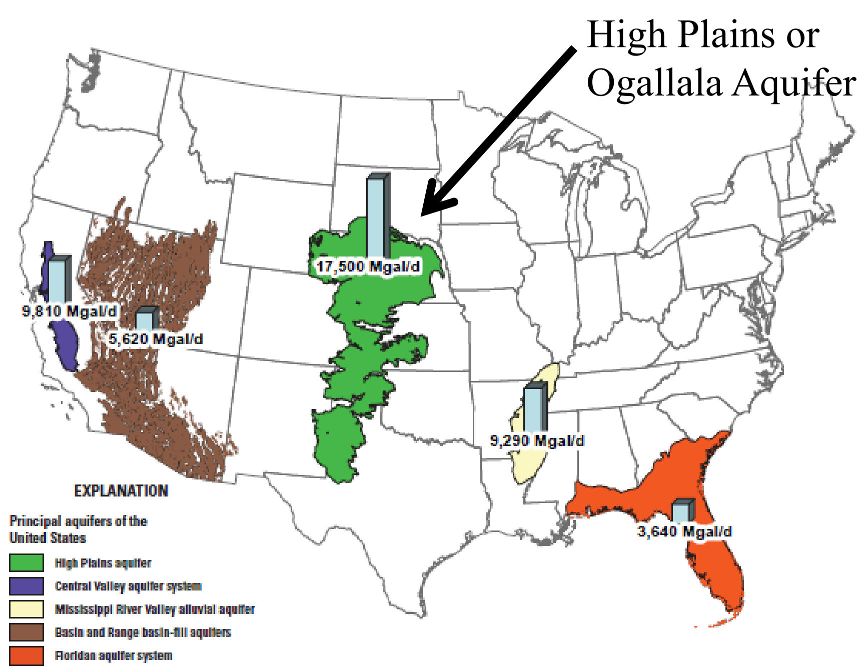
•“Rebound”

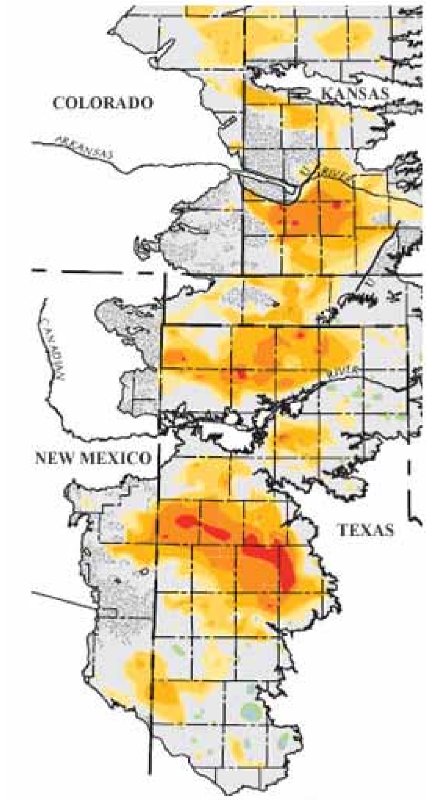
Jevons' Paradox

- **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)



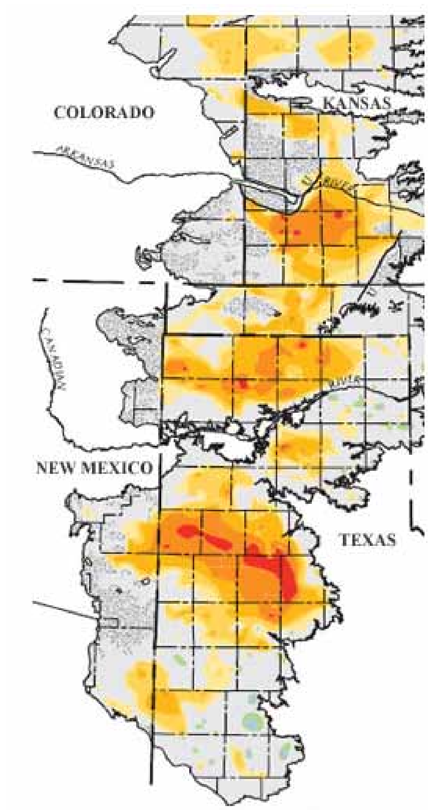


V.L. McGuire (2007)

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.**

EXPLANATION

Water-level change, in feet

Declines
- More than 150
- 100 to 150
- 50 to 100
- 25 to 50
- 10 to 25

No substantial change
- -10 to +10

Rises
- 10 to 25
- 25 to 50
- More than 50

Area of little or no saturated thickness

Faults—U, upthrown side

County boundary

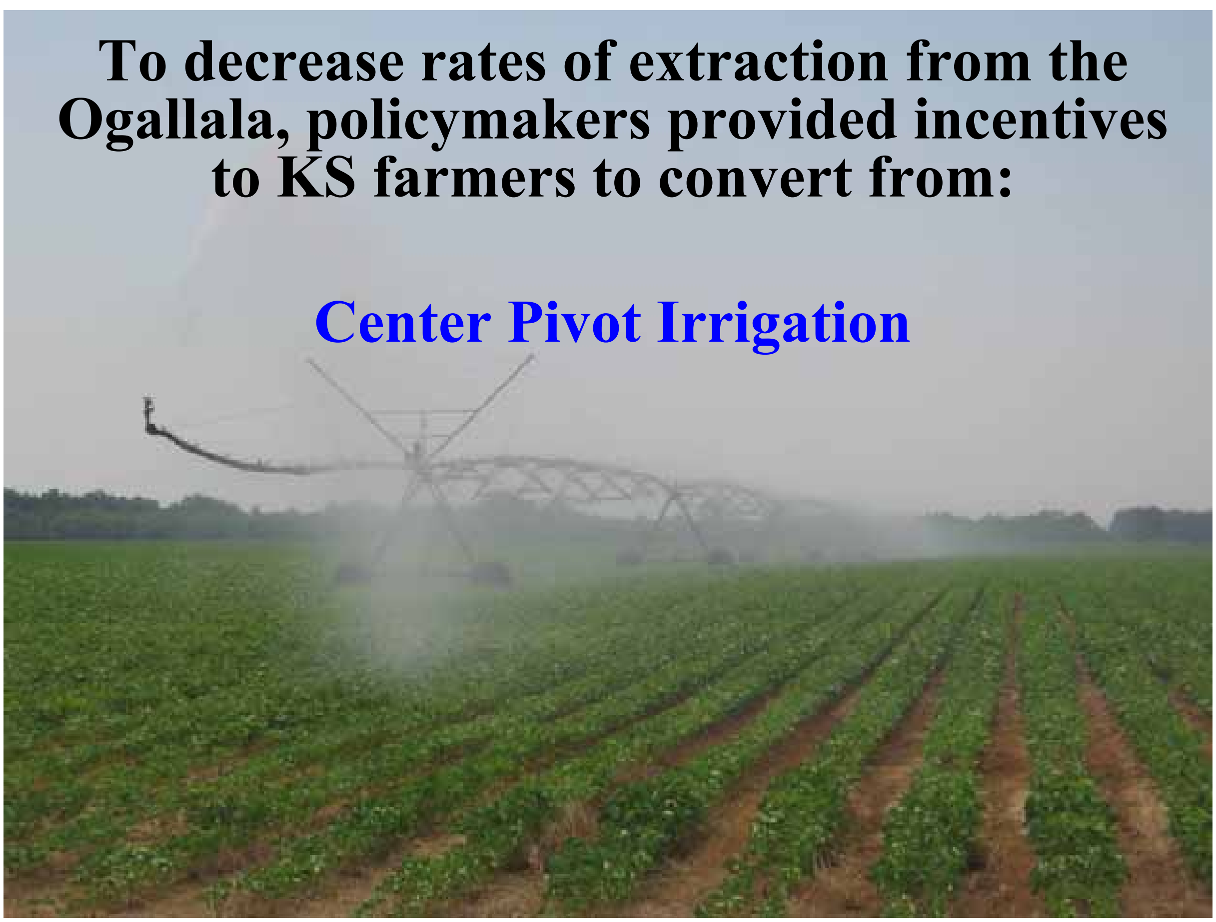
CHOICES
a publication of AAEA Agricultural & Applied Economics Association
The Magazine of Food, Farm and Resource Issues

3rd Quarter 2010 | 25(3)

The Effect of Irrigation Technology on Groundwater Use

Lisa Pfeiffer and C.-Y. Cynthia Lin
JEL Classifications: Q15, Q25, Q38

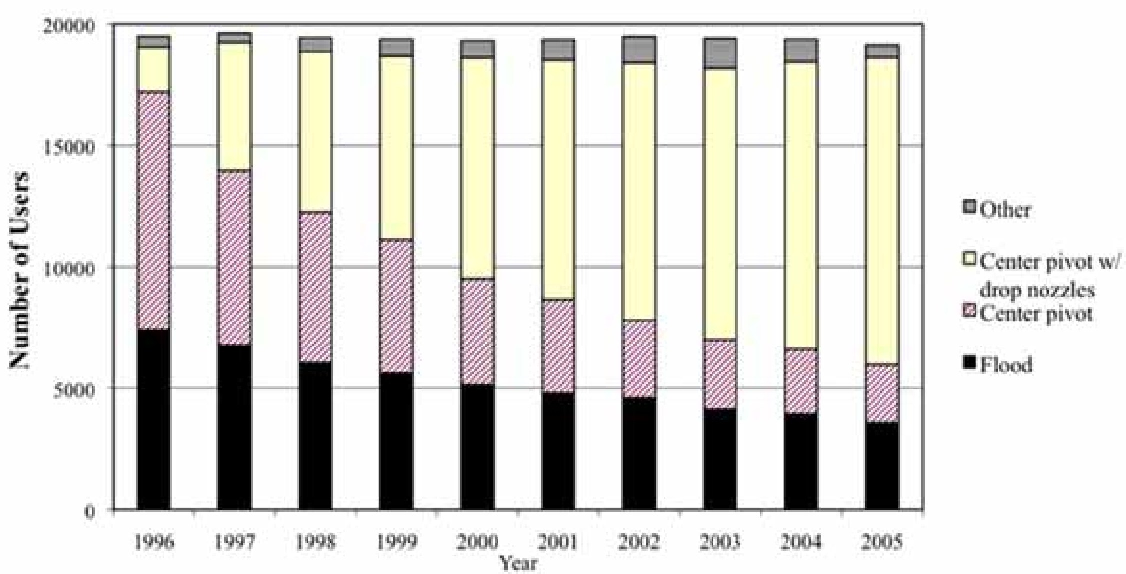
The High Plains (Ogallala) Aquifer is the largest freshwater aquifer system in the world. It is considered a fossil aquifer; it was formed around 10 million years ago and recharge to its southern portion is extremely low, making it an essentially nonrenewable resource. The region has experienced a decline in the level of the water table since intensive irrigation became widespread in the 1970s, and currently, agriculture accounts for 99% of the over 20 million acre-feet of annual groundwater withdrawals. In parts of southwestern Kansas and in the Texas panhandle, the water table has declined by more than 150 feet. These declines are expected given current rates of extraction, but concerns that the aquifer is being depleted too rapidly have become common. Similar discussions have arisen in many of the world's most productive agricultural basins. In many places, policymakers have attempted to decrease rates of extraction through incentive-based measures that encourage the conversion to more efficient irrigation technology.



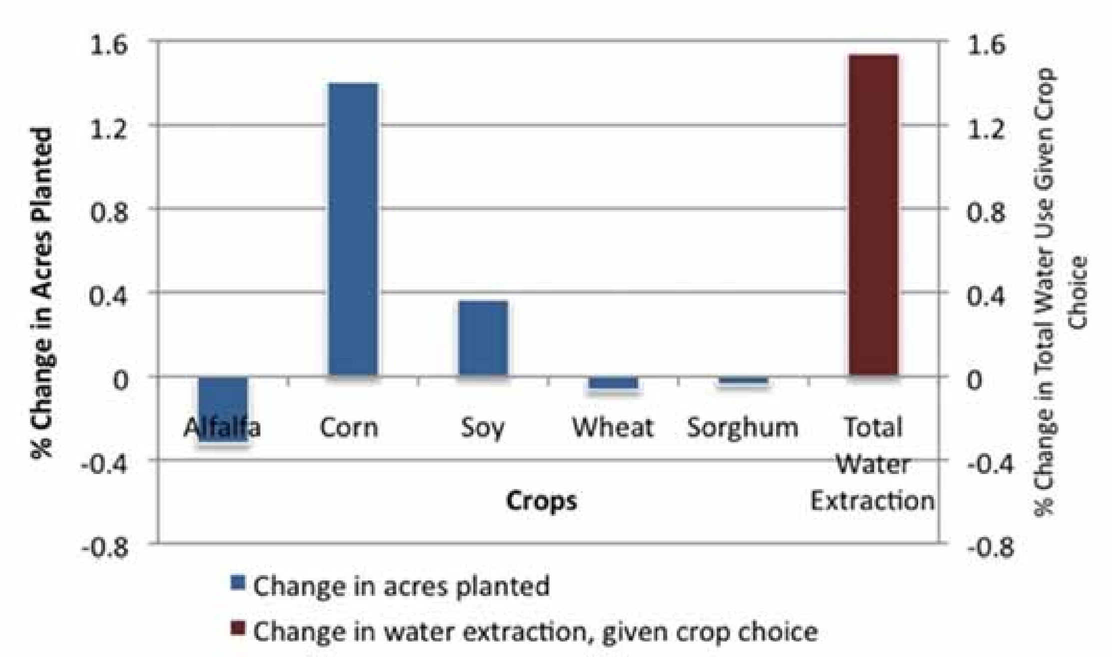
To: Low pressure nozzles and drop tubes on center pivots. (**Photo credit: USDA NRCS**)

Pfeiffer and Lin (2010)

The Effect of Irrigation Technology on Groundwater Use



Pfeiffer and Lin (2010)
The Effect of Irrigation Technology on Groundwater Use



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."

Pfeiffer and Lin (2010)
The Effect of Irrigation Technology on Groundwater Use

- "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."

Pfeiffer and Lin (2010)
The Effect of Irrigation Technology on Groundwater Use

- "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."

Jevons' Paradox

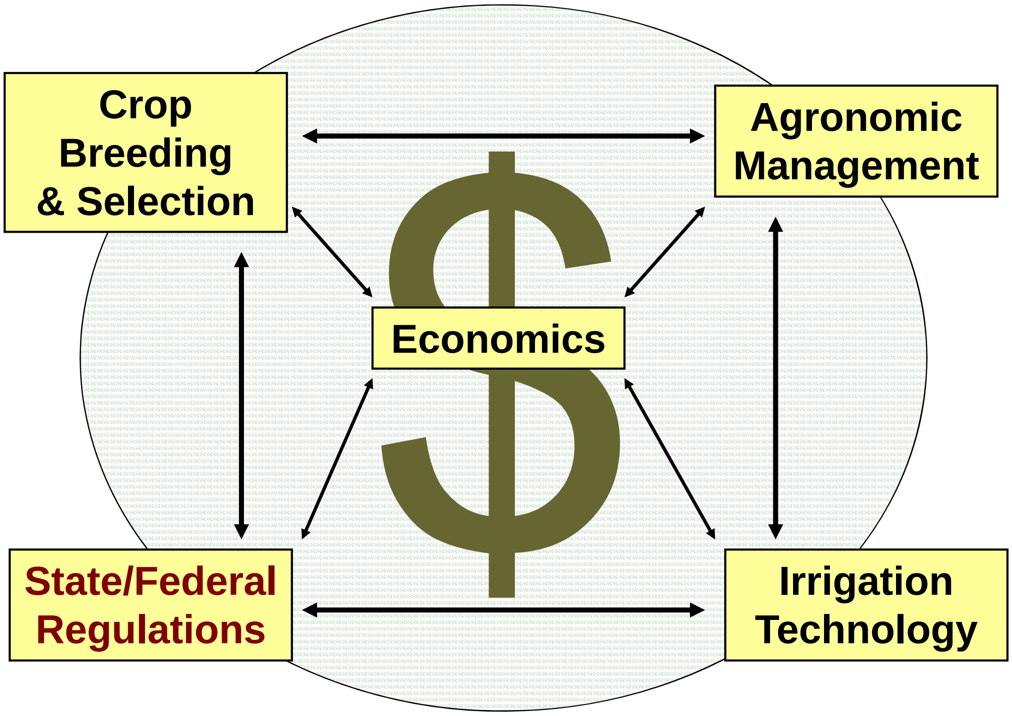
- He argued that **technological improvements could not be relied upon to reduce coal consumption**.

Source: Wikipedia

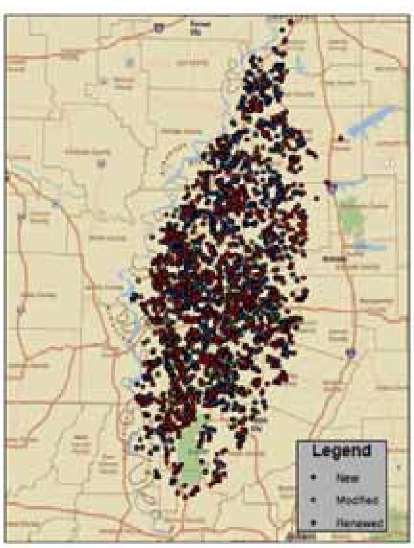
Jevons' Paradox

- **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



New Irrigated Acres in MS Delta
(YMD, 2011)



Graphic: 2011 YMD Work Summary

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

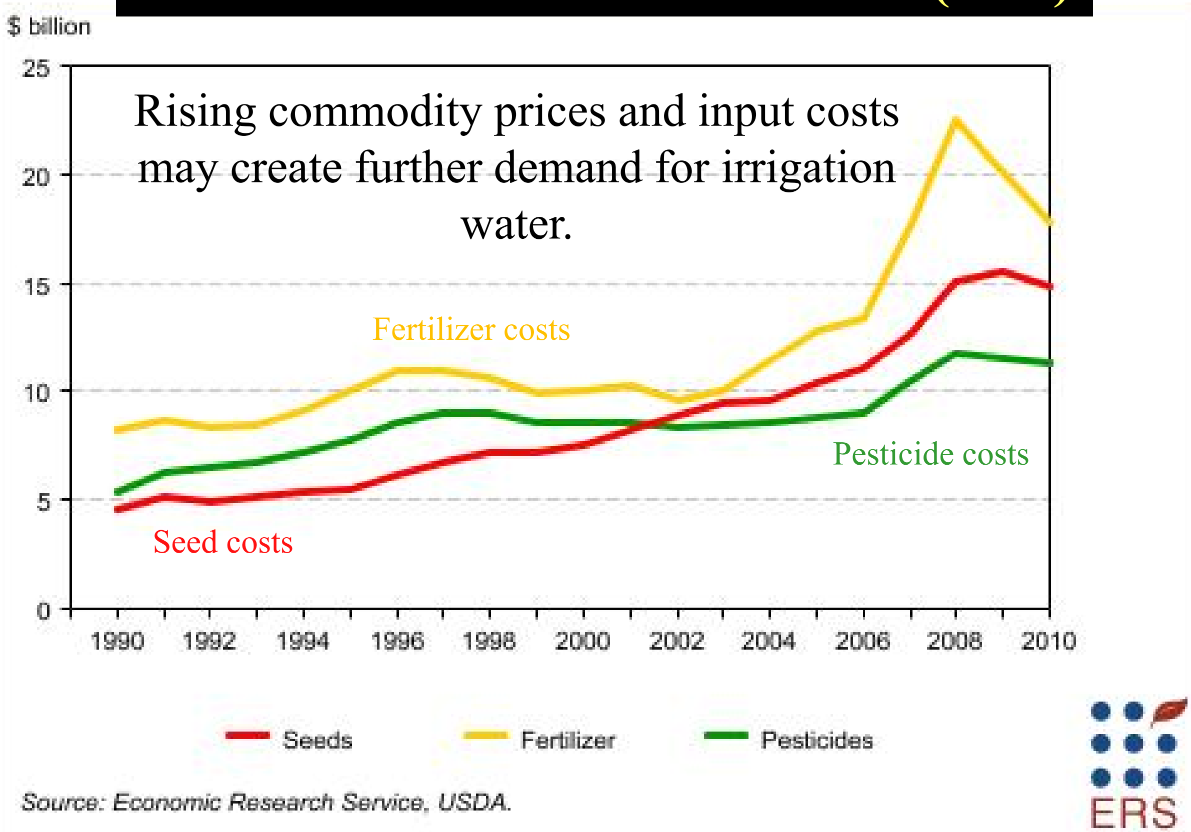
- Historically ~35,000 new acres come under irrigation each year.

- 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)



Jevons' Paradox

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