Irrigated Agriculture Groundwater Demand

NRCS Programs and Activities

EPA Ground Water Summit

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Natural Resources Conservation Service (NRCS)

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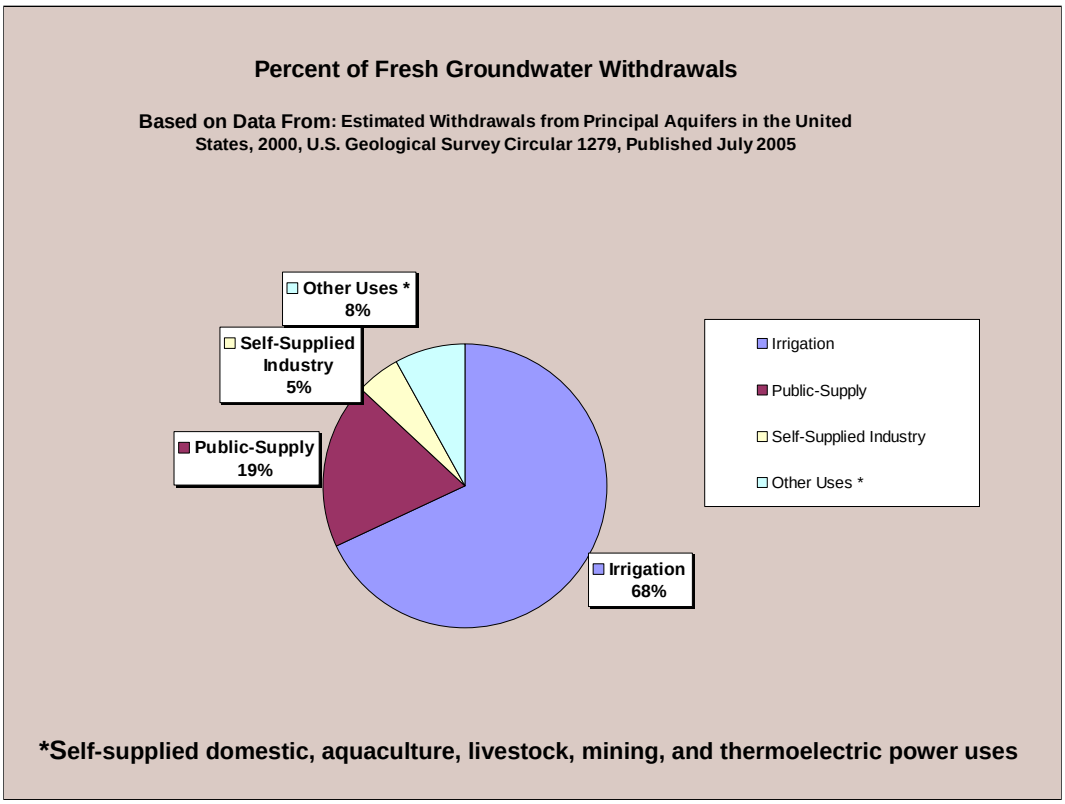


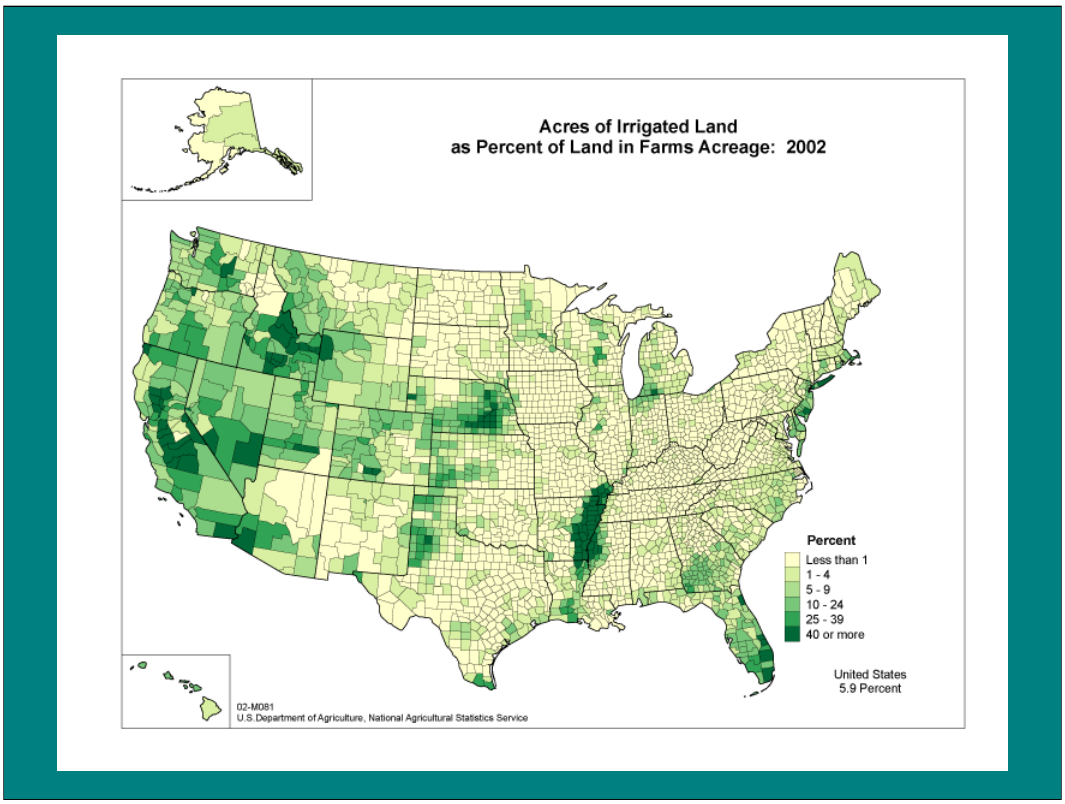
Estimated Withdrawals from Principal Aquifers in the United States, 2000;
Molly A. Maupin and Nancy L. Barber,

U.S. Geological Survey Circular 1279, 46 pages (Published July 2005)

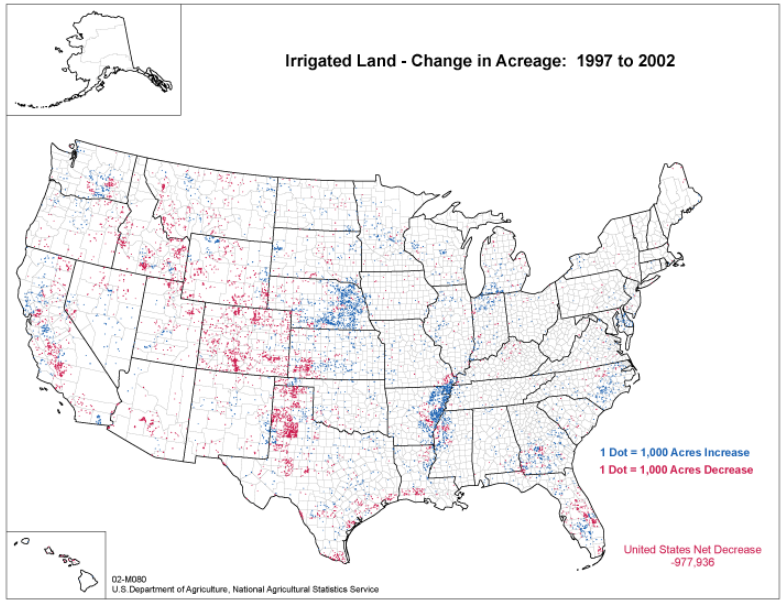
ABSTRACT

Fresh ground-water withdrawals from 66 principal aquifers in the United States were estimated for irrigation, public-supply, and self-supplied industrial water uses for the year 2000. Total ground-water withdrawals were 76,500 million gallons per day, or 85,800 thousand acre-feet per year for these three uses. Irrigation used the largest amount of ground water, 56,900 million gallons per day, followed by public supply with 16,000 million gallons per day, and self-supplied industrial with 3,570 million gallons per day. These three water uses represented 92 percent of the fresh ground-water withdrawals for all uses in the United States, the remaining 8 percent included self-supplied domestic, aquaculture, livestock, mining, and thermoelectric power uses.

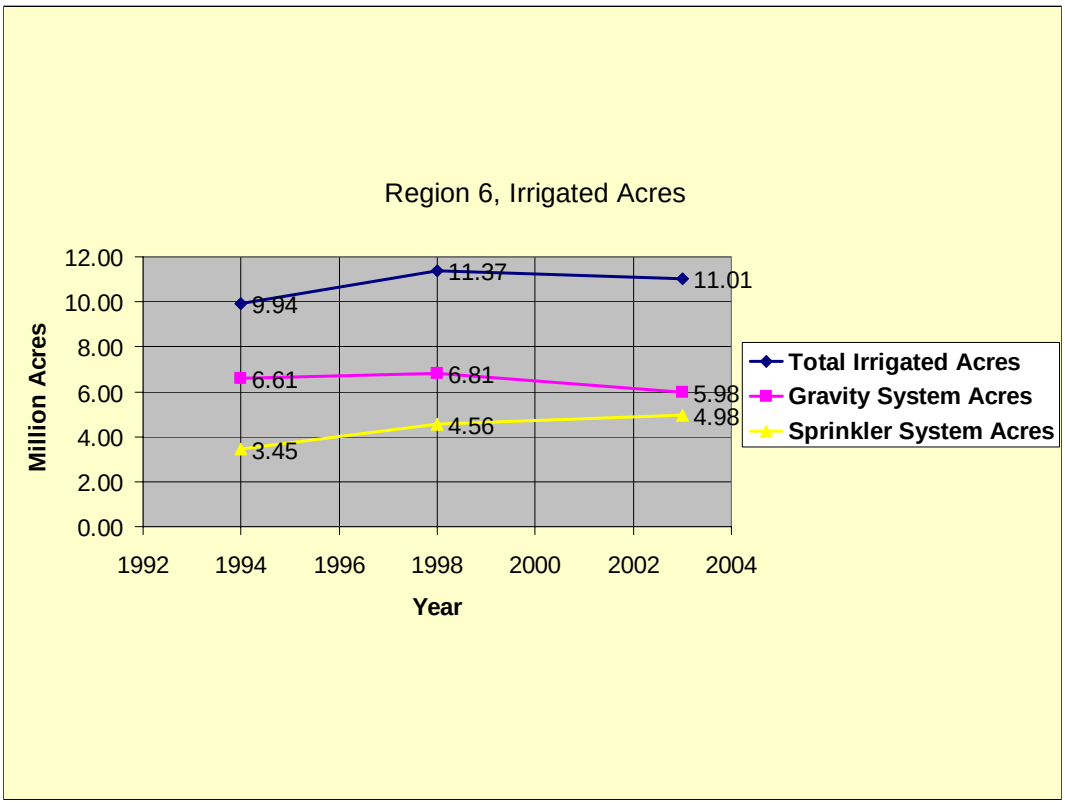
http://pubs.usgs.gov/circ/2005/1279/



Visual of irrigated areas of the US.

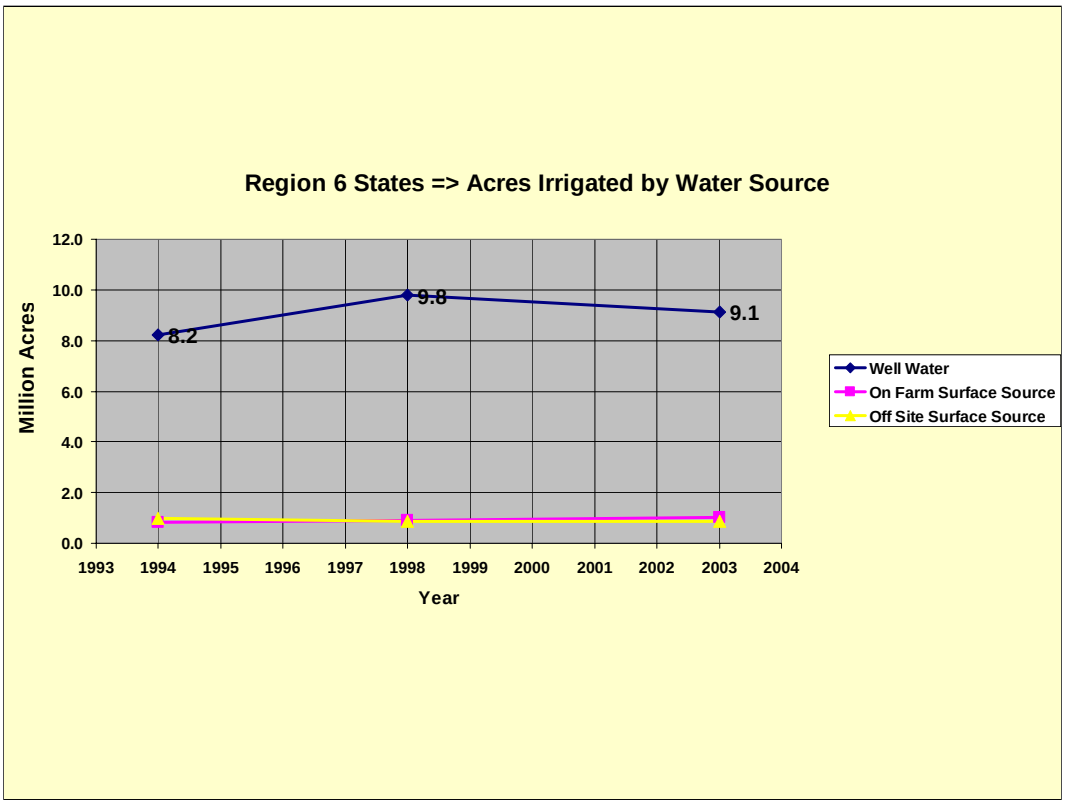


Visual of areas of the US where irrigated land has increased and decreased between 97 and 02.



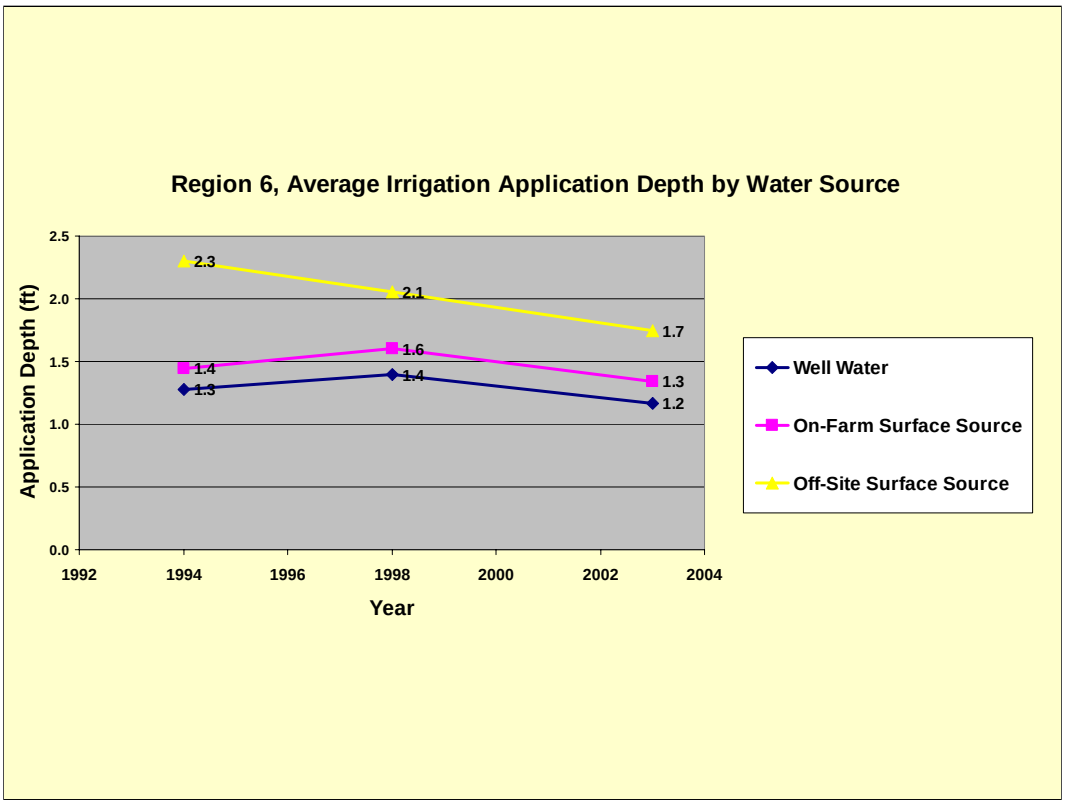
Farm and Ranch Irrigation Surveys 1994, 1998, and 2003: Region Wide sprinkler irrigated acres are increasing while surface irrigated acres are decreasing. This conversion is most pronounced in areas using groundwater than in areas with an adequate surface water supply. In Texas sprinkler irrigated acres surpassed Surface application systems between 1994 and 2000 (about 1996). The Farm and Ranch Irrigation Survey (2003) published by the National Agricultural Statistics Service was the first to report more acres irrigated nationally with sprinkler systems (51%) than all other system types. Microirrigation will likely may show significant increases in some states on the 2008 Farm and Ranch Irrigation Survey, when results come out later this year.

USDA, National Agricultural Statistics Service mailed 35,000 surveys in mid January 2009 to gather data for the 2008 Farm and Ranch Irrigation Survey. Responses are due 2/17/09.



Farm and Ranch Irrigation Surveys 1994, 1998, and 2003: From Table 11, Estimated Quantity of Water Applied by Source or Supplier, for 5 states of EPA Region 6.

Note: assuming all “well water” is ground water about 83% of Region 6 irrigation water applied in 2003 was Groundwater.



Reference: Farm and Ranch Irrigation Surveys 1994, 1998, and 2003:

Off-Site Surface Sources:

Largest average annual irrigation applications.

Why:1. Generally an irrigator has less control of timing and volume of water coming from an external source.

2. Systems supplied by off site surface sources are more common in drier climates where larger application depths are required due to limited rainfall.

3. These systems are more common on surface irrigation systems that sometimes require larger applications to adequately irrigate sets.

Off-Site Surface Sources:

Smaller average annual irrigation applications than offsite surface source.

Why:1. Irrigators have more control over application timing and volumes supplied from on- farm surface source supplies.

2. On-farm delivery losses are often reduced.

Well Water:

Smallest average annual irrigation applications than other sources.

Why:1. Well Water source gives irrigator maximum control over irrigation application timing and volume.

2. Significant irrigated areas supplied by well water have been converted to efficient automated sprinkler and microirrigation systems.

Current USDA Programs Impacting Water Quantity, Water Quality and Potentially Groundwater Demand

- Farm Bill: 2008 Food, Conservation and Energy Act
  - Draft Rules out for the EQIP program
  - Protocol and rules required to administer new programs and Farm Bill requirements are under development
- Conservation Technical Assistance

Farm Bill: 2008 Food, Conservation and Energy Act: New Farm Bill includes programs available from NRCS and other USDA Agencies.

Conservation Technical Assistance:

- NRCS Technical Services provided directly to farmers, ranchers, and other eligible entities (I.E. conservation planning, technical consultation, and assistance with design and implementation of conservation practices)
- NRCS Technical Infrastructure: Activities, processes, tools, and agency functions needed to support delivery of technical services (i.e., technical standards, resource inventories, training, data, technology, monitoring, and effects analysis)

Current USDA Programs Impacting Water Conservation (cont.)

- Environmental Quality Incentives Program (EQIP)
  - General Program
  - Agricultural Water Enhancement Program
  - Conservation Innovation Grant

Environmental Quality Incentives Program (When used to Address Water Quantity issues)

- Priority will be given to practices, contracts, and activities that reduce on-farm water use=> Leave water in the source.
- $ 1.3 Billion authorized by Farm Bill in FY 09.
- **General Program** is used to help producers upgrade or replace inefficient irrigation systems with newer, more efficient systems. This program is also used to improve or enhance on farm Irrigation Water Management to maximize water conservation and improve and/or protect water quality.
- **Agricultural Water Enhancement Program**
  - Replaces Ground and Surface Water Conservation Program
  - Offers financial and technical help to assist farmers and ranchers install or implement conservation practices for agricultural water conservation and water quality enhancement activities
  - Qualifying activities:
  - Conversion to less water intensive commodities,
  - Irrigation system improvement and efficiency enhancements, and
  - other steps to reduce drought impacts, improve water quality, and rescue water use
  - $ 58.4 Million authorized by Farm Bill in FY 09.
- **Conservation Innovation Grant**
  - Conservation Innovation Grant Program (CIG) used to develop and demonstrate new technology for improving irrigation and/or water use efficiency and management.
  - Also allow NRCS to transfer new technology across the nation.
  - $ 20 Million authorized by Farm Bill in FY 09.

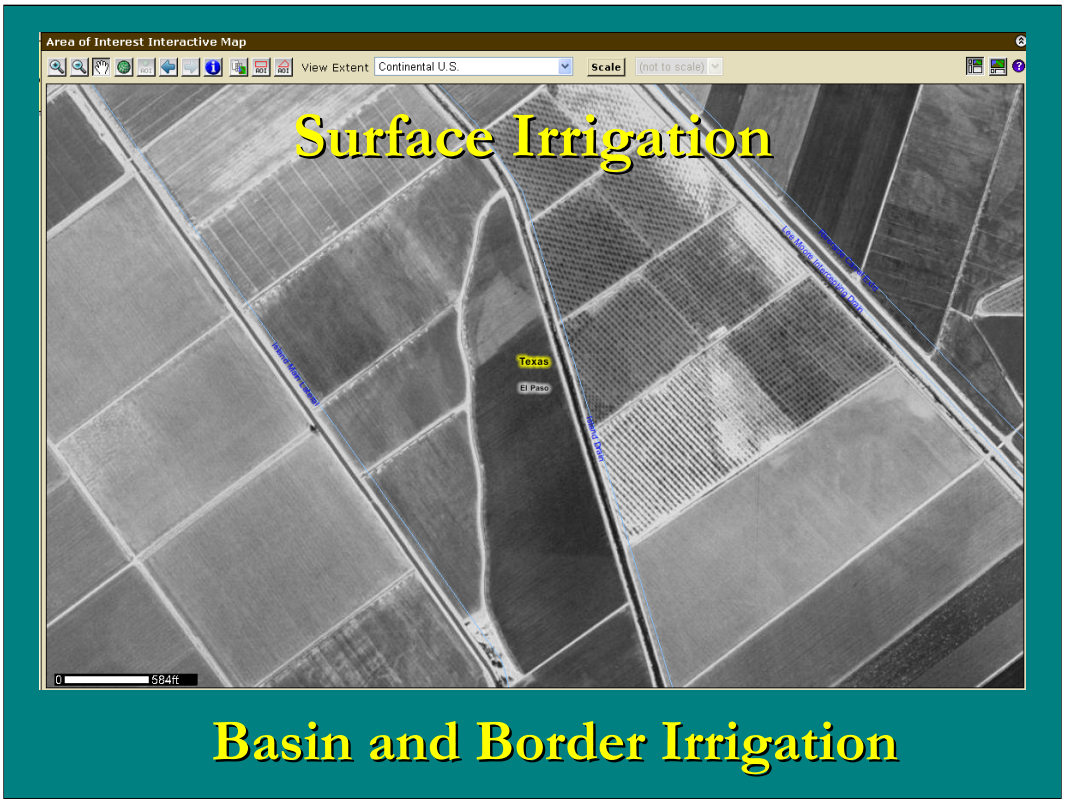
Current USDA Programs Impacting Water Conservation (cont.)

- Conservation Stewardship Program (CSP)
  - begins in FY2009.
  - Replaces Conservation Security Program (CSP)
  - Both provide enhancement payments to reward and encourage better management of irrigation systems to conserve water
- Conservation Reserve Enhancement Program (CREP) to retire irrigated acres

All Listed Programs are administered by USDA/NRCS with the exception of the Conservation Reserve Enhancement Program (CREP) which is administered by USDA/Farm Services Agency.

The FSA program is included here because it has been used very effectively in a number of states to plant grass or restore wetlands while retiring irrigated acres. The program varies with local control , and additional funding often provided by partners to purchase and retire water rights.

EQIP Funding Provided for Irrigation Practices in EPA Region 6 (FY 2005, FY 2006, FY 2007, and FY 2008)				
Conservation Practice	Code	Contracts	Federal Payments	% of Total
Irrigation System, Sprinkler	442	3,042	$54,178,088	59
Irrigation System, Microirrigation	441	1,175	$31,706,856	
Irrigation Land Leveling	464	2,365	$21,706,788	32
Irrig. Pipeline, Low Pressure, Plastic	430EE	2,691	$16,931,613	
Irrig. Pipeline, High Pressure, Plastic	430DD	1,095	$8,435,176	
Irrigation Ditch Concrete Lining	428a	222	$3,423,048	7
Irrigation Water management	449	1,152	$3,421,757	
Irrigation Storage Reservoir	436	82	$3,298,703	
Irrigation Regulating Reservoir	552	89	$1,209,847	2
Irrigation System, Tailwater Recovery	447	111	$917,416	
Well Decommissioning	351	122	$350,666	
5 State, 4 Year Total		12,146	$145,579,958	100



The following slides are pictures of irrigation systems and practices installed and/or managed by irrigators with NRCS assistance.

Note: National Engineering Handbook, Section 652, National Irrigation Guide includes additional information about these systems: http://policy.nrcs.usda.gov/RollupViewer.aspx?hid=17092

Note: The Web Based Soil Survey now includes Soil Interpretations Reports which provide potential soil limitations for specific types of irrigation systems at a particular location: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm Note => The irrigation interpretation reports don't apply to flood irrigated rice.

Irrigation systems selection are heavily impacted by water availability, source, and cost as well as local soils and suitable crops.

Surface Type irrigation systems with high quality water that are properly designed and managed (especially level systems) can have very high irrigation efficiencies.

Land Leveling is usually required to achieve and in some cases maintain design grades.

Basin Irrigation W/High Volume Turnout

Faster water can cover a level basin the more uniform the opportunity time and the more uniform the irrigation intake of irrigation water in Level basins.

High Volume Turnouts can allow safe inflow rate of 10, 15, or 20 cfs to a basin for the specified irrigation set.

Furrow Irrigation with Siphon Tubes

Graded Furrow Irrigation System with earthen ditch delivery system: At one time widely utilized irrigation system both with ground or surface water supplies.

Open earthen irrigation delivery ditches and have in many cases been replaced with concrete lined ditches and/or irrigation pipelines.

Every Other Row Furrow Irrigation with Gated Pipe

In groundwater areas with limited supplies, Graded Furrow Irrigation Systems often switched from open ditch to pipeline delivery to the field and in field gated pipe to convey irrigation water to individual furrows. Framers then began watering every other row in an effort to reduce soil surface evaporation and stretch supplies. Large acreages of these systems have been replaced by sprinkler systems.

Surge Irrigation

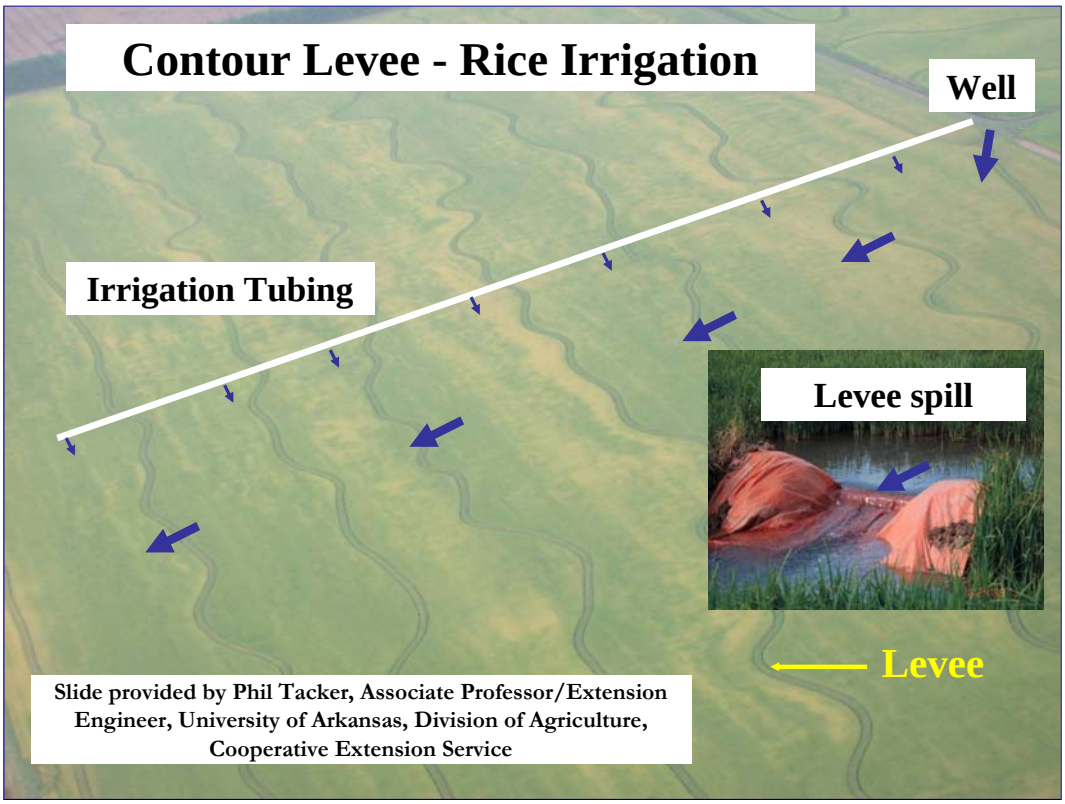
Surge Irrigation can increase rate of advance and increase uniformity of application on graded furrow irrigation systems while reducing gross applications. This system can achieve some of the benefits normally associated with sprinkler or microirrigation.

Tailwater Runoff => Capture and Reuse

Tailwater Storage => Irrigation Regulating Reservoir 552 => Designed for temporary storage and recycling of tailwater only with a bypass of surface runoff. Usually smaller structures (2-6 acft) of storage

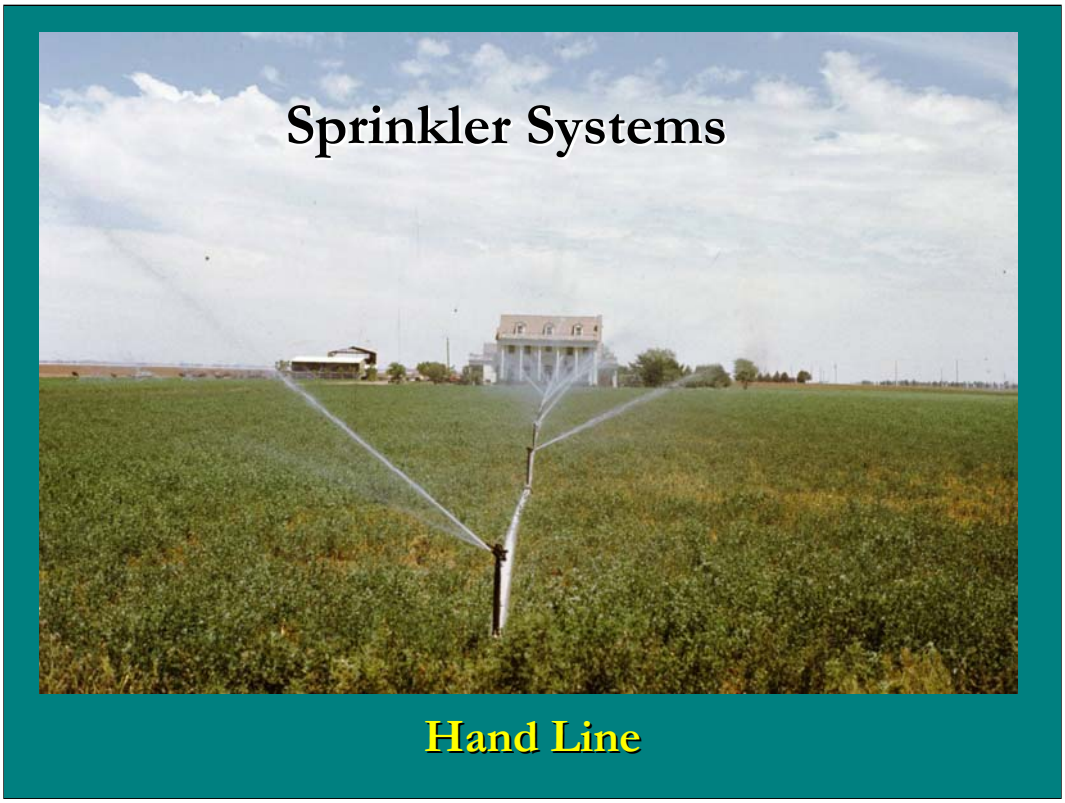
On Farm Tailwater and Surface Water Recovery and Storage System

NOTE: Must be very careful of state and local surface water right and ground water permitting regulations when planning this type of system. Tailwater/Surface Runoff Storage and reuse. Usually a 2 stage system. Example above: An Irrigation Regulating Reservoir (552) (25 acft proposed above), designed to capture all irrigation Tailwater and as much surface runoff as possible for transfer to an Irrigation Storage Reservoir (436) (190 acft) for storage and later use as an irrigation supply. These systems are very effective when allowed by state regulations and interstate agreements for substituting stored tailwater and surface runoff as the irrigation source replace groundwater use. This works only in regions with a surplus of surface water and adequate rainfall runoff to supply the system.



Multiple inlet systems supply water to rice levees during filling and flood maintenance replacing systems that historically pumped water into the upper cut and allowed water to fill each basin with overflow from the upper basin serving as inflow to the next basin until cascading water finally filled all basins. Results in MO and AR indicate that significant seasonal water savings (reduction in pumping) can be achieved with this system.

Multi-outlet Rice Irrigation System using Poly Pipe for delivery line.

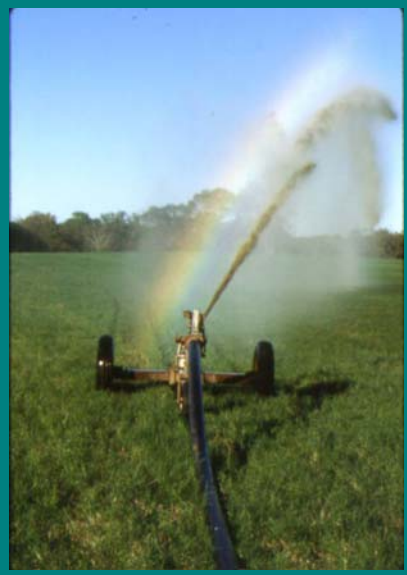


High Pressure systems

Wheel Line or Side Roll

Usually high pressure systems

Traveling - Big Gun



Traveling - Big Gun

IMPORTANT: NRCS technical and financial assistance provided on Irrigation Conservation Practices include assistance on systems that apply fresh water to meet crop needs, and also those that apply Animal Manure/wastewater according to a Nutrient Management Plan. These systems provide plant nutrients and protect water quality. Note the water from this Traveling gun is showing some color.

Center Pivot Sprinklers

Description of LEPA, LESA, MESA Sprinkler Systems and discussion of conversions, and estimates of potential application efficiency are provided in Texas Agricultural Extension Service, Publication B6095, Center Pivot Irrigation: http://itc.tamu.edu/documents/extensionpubs/B6096.pdf

Discussion of these and other irrigation system types are included in NRCS, National Engineering Handbook, Section 652, National Irrigation Guide: http://policy.nrcs.usda.gov/RollupViewer.aspx?hid=17092

Importance of Prior Planning Before Making System Changes

Example converting to a new low pressure spray on drop sprinkle irrigation system

- A switch from surface irrigation will likely reduce deep percolation losses
- A switch from graded surface irrigation should reduce deep percolation and runoff losses
- An upgrade of an older impact or spray sprinkler will usually result in increased application uniformity and potential energy savings
- Newer sprinklers generally provide more control over water application (can put on more frequent lighter applications)
- If sprinkler package not matched to soil, crop, and slopes, reductions in deep percolation losses may be offset by increased runoff
- If considered ahead of time can often be addressed by increasing surface storage, deep ripping, improving residue mgt, changing cropping pattern or changing IWM.

Newer Technologies Promoted to Replace Older Less Efficient Systems

- Lower Pressure Sprinkler Systems
  - LEPA - Low Energy Precision Application
  - LESA - Low-Elevation Spray Application
  - LPIC - Low Pressure In-Canopy
  - MESA - Mid-Elevation Spray Application
- Microirrigation Systems
  - Particularly Subsurface Drip Irrigation (SDI) Systems on Row Crops

Center Pivot – MESA

(Nozzles >36in, and above crop canopy)

Center Pivot - LEPA

Planted in circle w/dikes

Low Energy Precision Application System: LEPA Systems are one of the most efficient sprinkler irrigation systems. LEPA is only applicable on flat slopes. Planting in a circle is required when used with row crops. Furrow dams or dikes are required to provide additional surface storage. Application rates often exceed infiltration rates of soils. This is the reason supplemental surface storage is needed.

FURROW DIKING –

provides surface storage to reduce irrigation application, and rainfall runoff

Furrow diking to provide storage basins in furrows.

Properly Installed Flow Measurement Devices are Important

Flow measurement is very important to enable an irrigator to manage applications and monitor system performance. Wouldn't want to drive a car without an odometer or speedometer.

Important that flow meters be installed according to manufacturer specifications.

Filtration is critical to maintaining Subsurface Drip Irrigation (SDI) microirrigation systems

This system has enclosed building to protect electronic controllers, flow meters, etc,

Microirrigation Installation
Subsurface Drip Irrigation (SDI) Tape

SDI- Subsurface Drip Irrigation

Emitters are in the tubing.

Crop Response Where SDI Laterals Start

Slide to show distinct change in crop response at start of Subsurface Drip irrigation tape

Properly managed SDI with non saline water supply can be one of the most efficient irrigation systems possible. Soil surface is often not wetted which eliminates soil surface evaporation. Automation allows very light frequent irrigation applications. Germination of seeded crops in dry climates can be a problem. Operation and Maintenance, as well as, Management are critical to success with SDI. Water must be tested in planning stage of system conversion to assess water quality and plan for future water treatment needs and management requirements during chemigation.

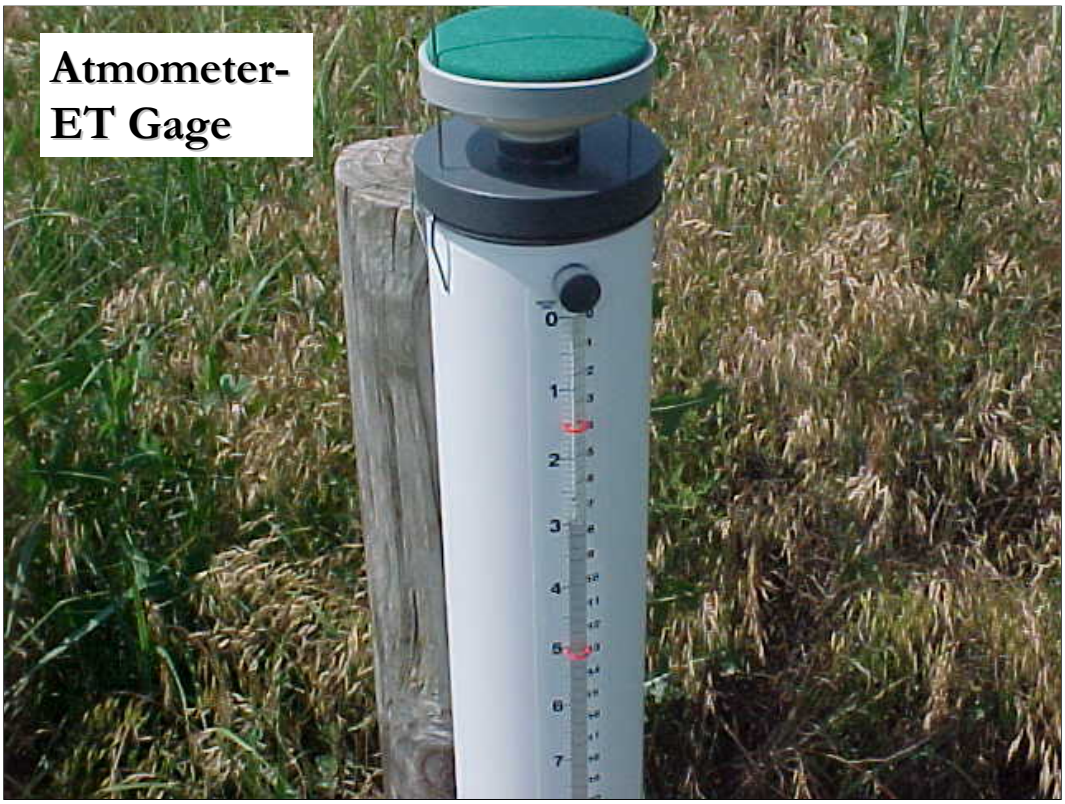
Irrigation Water Management

Save Water and Enhance Water Quality

- DEVELOP IRRIGATION WATER MANAGEMENT PLANS
- PROMOTE IRRIGATION SCHEDULING USING EVAPOTRANSPIRATION (ET)
- PROMOTING INSTALLATION AND USE OF
  - FLOW METERS,
  - CHEMIGATION CHECK VALVES,
  - WELL DECOMMISSIONING
  - LOCAL ET NETWORKS
- WHEN SYSTEMS ARE USED AS PART OF A NUTRIENT OR CHEMICAL APPLICATION SYSTEM
  - INSURE ADDITIONAL DESIGN AND PLANNING ISSUES ARE TAKEN INTO ACCOUNT AND DECISIONS DOCUMENTED

Irrigation Water Requirements must include leaching fraction is needed dues to water salinity issues.

IWM Plan must address Operation and Maintenance (i.e. periodic chemical treatment of SDI if anticipated due to water test results).



Atmometer –Water lost from evaporation though atmometer top simulates Evapotranspiration (ET) of growing crop in units of in. or cm. This information along with soil moisture monitoring can be used to schedule irrigation or determine how large an application is needed.

Field Testing

In response to irrigator requests or to spot check performance of practices installed with federal financial assistance, NRCS sometimes performs system field checks.

Ultrasonic Flow Meter

SDI system checks

Temporary Installation of Flow Meter and Pressure Gage

Slides taken during hydraulic evaluation of a number of SDI systems that used different manufacturer's products. We wanted to measure in-field flow rate, and operating pressures at various system points to compare field performance to design values from manufacturer design software.

Results were very encouraging. All systems were performing very close to design. The only exception was a system where we found a lower flow rate than expected for a particular SDI block. We discovered a malfunctioning solenoid valve that was remaining open continuously. We manually cycled the valve and reported the problem to the producer. The irrigator contacted the system installer who corrected the problem.

NRCS Water Conservation Practices Impact => Issues for Water Planners

- Component portions of water savings resulting from conservation practice installation or modification.
  - Where is the saved water, How much is there, How long will it be there,
  - Can it potentially be marketed and used for other purposes, and
  - How accurate are available assessment tools???
- Conservation Effects Assessment Project (CEAP)

Conservation Effects Assessment Project (CEAP)

In the future, nationally consistent estimates of beneficial environmental outcomes resulting from conservation practices and systems will be possible through the use of the results from the interagency Conservation Effects Assessment Project (CEAP). CEAP was established to develop a scientific understanding and methodology for estimating the environmental benefits and effects of conservation practices on agricultural landscapes at national, regional, and watershed scales. CEAP will become a science-based plan designed to help meet the conservation and technology challenges of the future through a coordinated multi-agency assessment, research, and outreach extension program to translate science into practice. CEAP has been underway since 2003, and is composed of multiple components focusing on cropland, grazing land, wetlands, and wildlife, and watersheds. Initial CEAP results will be available for the cropland component in FY2009.

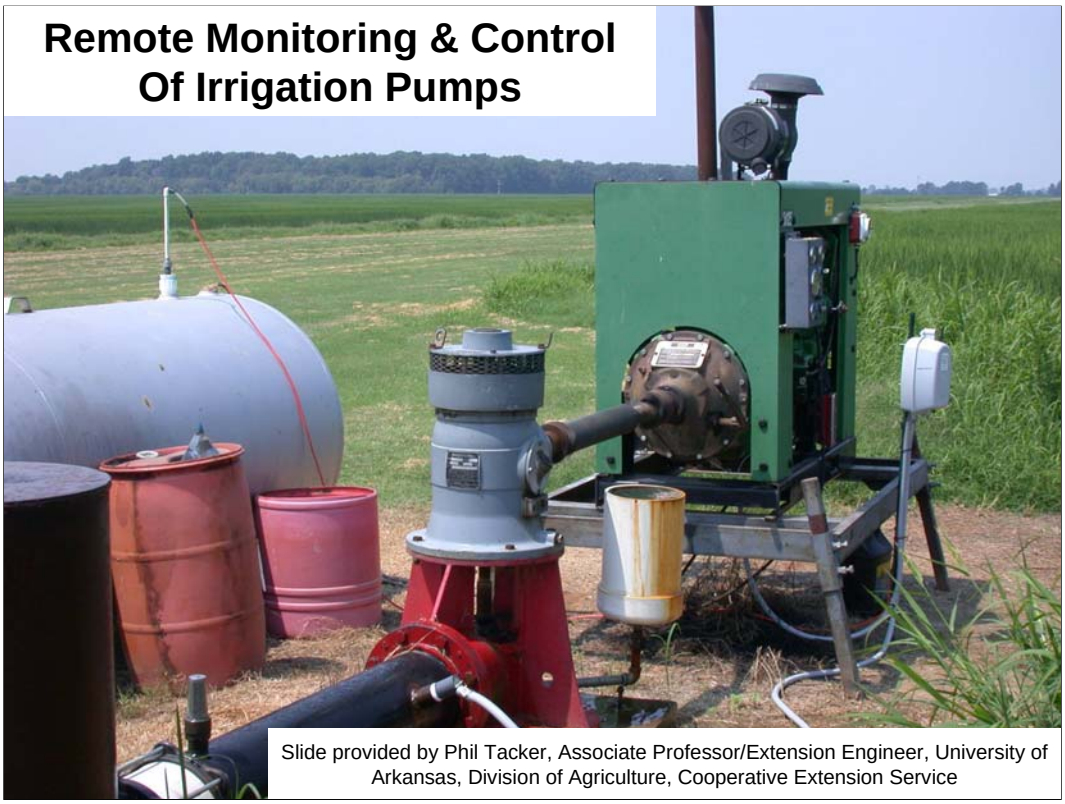
http://www.nrcs.usda.gov/TECHNICAL/NRI/ceap/

NRCS Water Conservation Practices Impact => Issues (cont.)

- NRCS provides technical and program assistance in response to locally led efforts and direction. State technical committees and local work groups provide guidance concerning local priorities and program direction within state laws and regulations.

- NRCS does not regulate what producers do with saved water. State and local units of government set water rules, allocation, and regulatory requirements to address local issues and priorities. NRCS Plans and documentation of some practices can assist producers in documenting regulation compliance.

New Technology Development and Demonstration



A few irrigation or water quantity related Conservation Innovation Grants (CIG):

CIG: AR 2006 =>Quantification of impacts of on-farm water capture, storage, and re-use of surface water on water quantity and water quality. This grant involves monitoring of water quality and system components, as well as, water volumes stored and applied,

CIG: NE 2006 => Use of LANDSAT data with the Metric Model to estimate ET of different crop and cover types (including irrigated agriculture) for predicting seasonal water use,

CIG: NE 2006 => Use of Hybrid-Maize Model in on-farm irrigation scheduling to optimize crop response with minimum water application,

CIG: NE 2004 => Demonstration to develop alternative dry land and supplemental irrigated cropping systems to maximize crop response with minimum irrigation water use,

CIG: AR 2008 => Grant to remote monitor and provide instantaneous pumping plant efficiency, pumping plant flow rate, and energy use data.

Questions ??