Irrigation Systems Overview

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Asequate Water Supply?

- Surface water
  - – Regulated by the State
  - – A water right or a contract is required
- Groundwater
  - – Generally, belongs to the landowner
  - – Managed through local groundwater conservation districts

Water Supply

- Groundwater
  - Groundwater pumpage is regulated only in special districts:
    - » Edwards Aquifer Authority
    - » Harris and Galveston Subsidence Districts

Major Aquifers of Texas

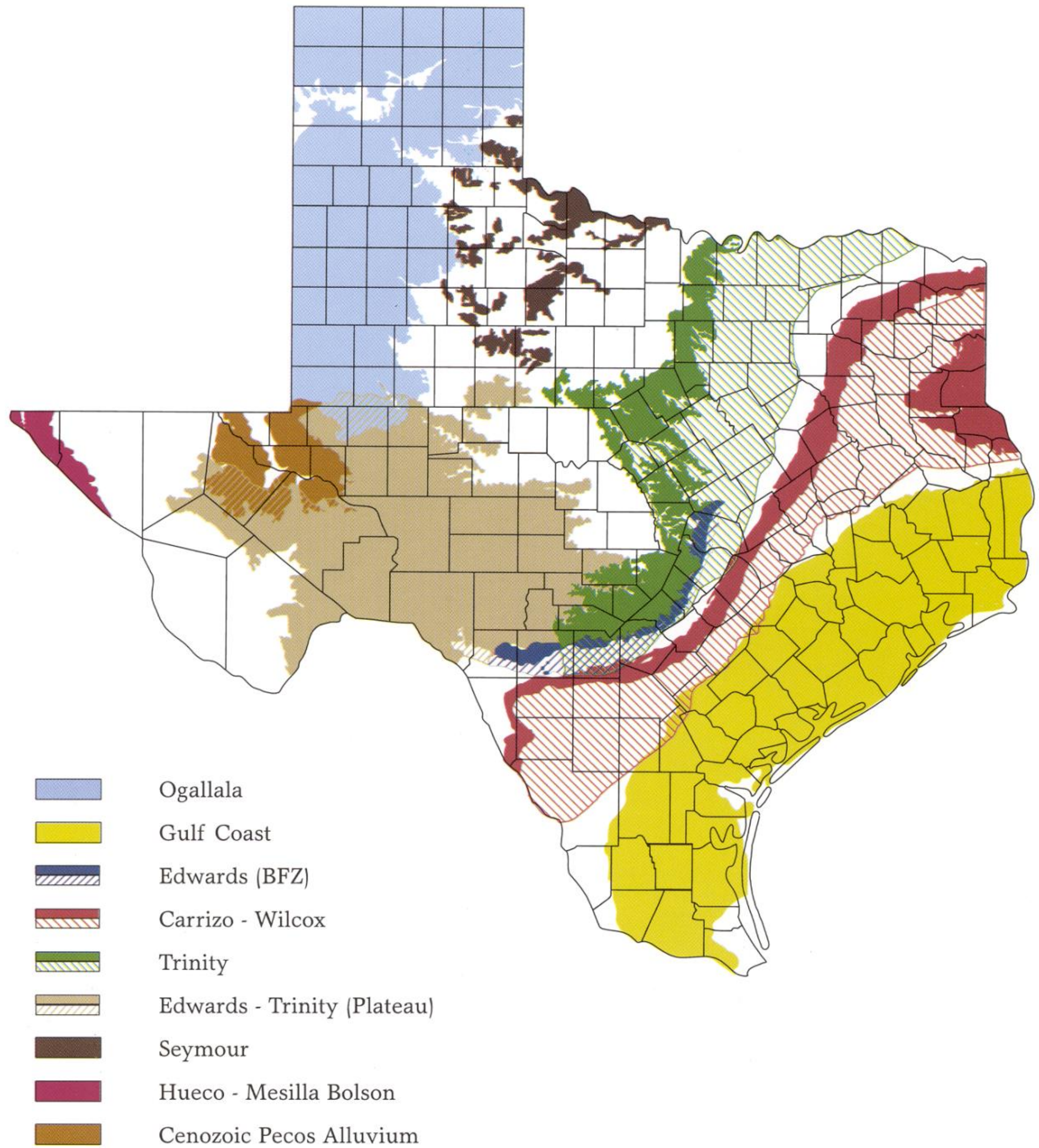


Figure 1. Nine major aquifers account for 96.3 percent of all groundwater withdrawals in Texas.

Minor Aquifers of Texas

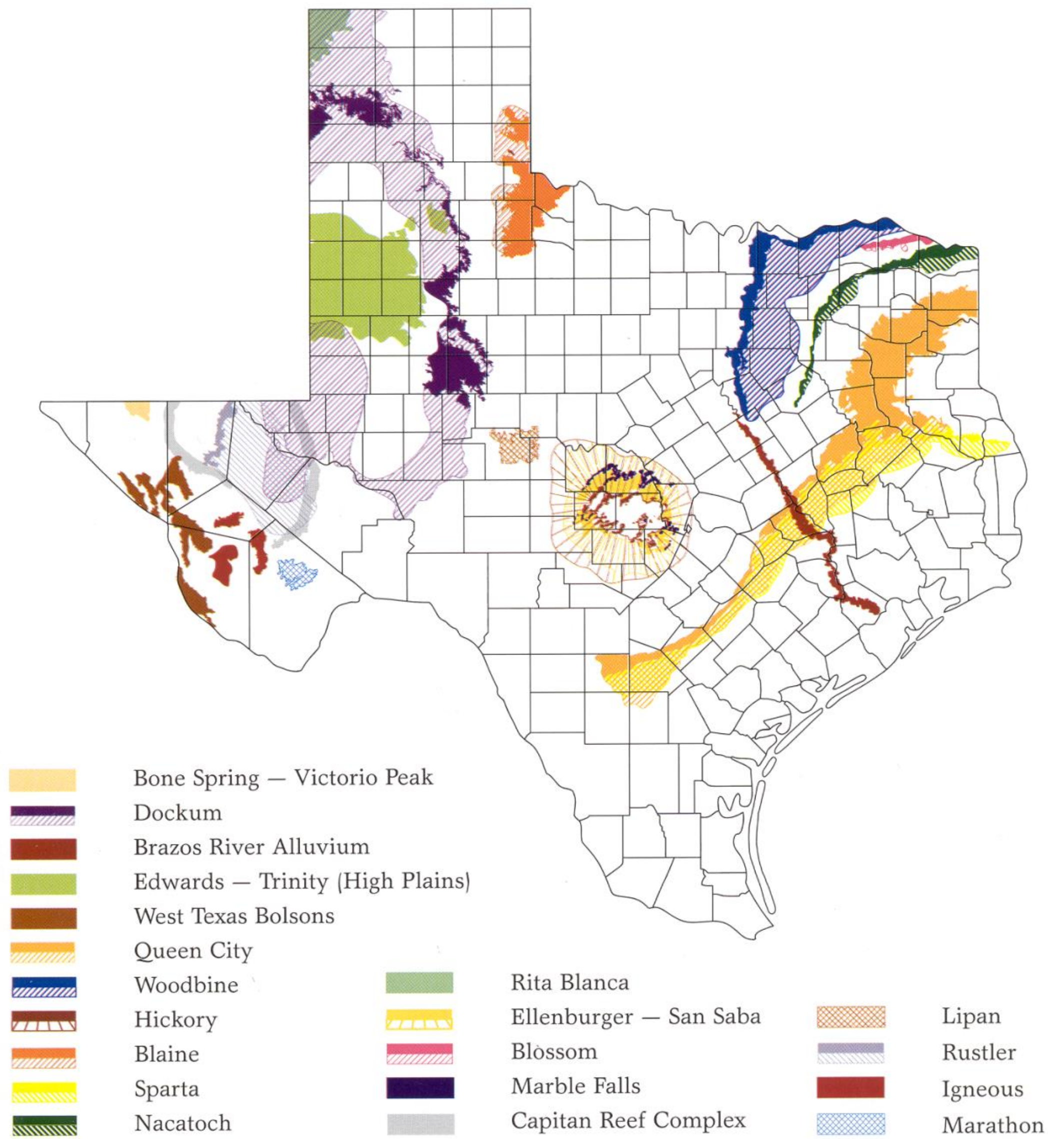


Figure 2. The 20 minor aquifers of Texas account for 3.7 percent of all groundwater withdrawals.

Do I need a permit for a new water well?

- Depends –
  - Do you live in an area with a Groundwater Conservation District?
  - Most (not all) GCDs require a permit
  - GCDs are also a good source on expected well yield and extent of local groundwater formation
- The State of Texas does not require permits

Groundwater Conservation Districts

FIGURE 1.3. GROUNDWATER CONSERVATION DISTRICTS IN TEXAS.

Recommended Steps

1) Define goals
2) Do you have enough water?
3) What is the water quality?
4) Collect field information (size, shape, soils, slopes, etc.)
5) Pre-screen irrigation technologies
6) Obtain rough cost estimates for selected irrigation alternatives
7) Select irrigation system
8) Obtain site specific design and detailed costs/bids from more than one dealer

Terms

- Wells
  - Depth of well
  - Depth where pump is set
  - Depth to the water level
    - » Depth to the static water level
    - » Water depth when pump is running (LIFT)
- HEAD = lift + (operating pressure requirements of irrigation system)

Step 1: Define Goals

- **Full irrigation**
- **Supplemental irrigation**

  irrigating during short, dry periods
- **Deficit irrigation**

  purposely supplying less water than crop needs
- **Chemigation**

Step 1: Define Goals

- **Chemigation**

  supplying fertilizers and crop protection chemicals through irrigation system

  requires an irrigation system with good to excellent efficiency

  requires specialized equipment including an injector, mixing tank, and devices to prevent accidental spills

Step 2: Determine Available Water Supply

Irrigation Systems are designed to supply peak water demand of crops

(inches per day, inches per week etc.)

Bulletin 6019

Crop water demand information useful for sizing irrigation systems (shown are typical values Central/East Texas)

(copy of bulletin are posted at http://texaset.tamu.edu)

Crop	Peak Demand (inches/day)
cotton	0.23
corn	0.32
citrus	0.16
sorghum	0.22
perennial pasture	0.25
small grains	0.26
vegetables	0.16

Example: Pasture/forage in South Texas

Peak water demand

0.25 inches/day = 6789 gal/acre/day

(note: 1 ac-in = 27,154 gal)

Total Gallons Needed per day

10 acres	50 acres	100 acres
67,885	339,425	678,850

Example: Pasture/forage in South Texas

Peak water demand

0.25 inches/day = 6789 gal/acre/day

Pumping rate – 24 hours @ 100% efficiency

10 acres	50 acres	100 acres
47 gpm	235 gpm	470 gpm

Example: Pasture/forage in South Texas

Peak water demand

0.25 inches/day = 6789 gal/acre/day

Pumping rate – 12 hours @ 80% efficiency

10 acres	**50 acres**	**100 acres**
117 gpm	587 gpm	1175 gpm

Example: Pasture/forage in East Texas

Is your pond large enough to provide

0.25 inches/day?

Calculate pond size:

surface area x average depth = water volume

(acres) (feet) (ac-ft)

Example: Pasture/forage in Central Texas

Is your pond large enough to provide 0.25 inches/day?

Water Supply in Weeks (at 100% efficiency)	10 acre field	50 acre field	100 acre field
1	2 ac-ft	7 ac-ft	15 ac-ft
2	3 ac-ft	15 ac-ft	30 ac-ft
3	5 ac-ft	22 ac-ft	45 ac-ft

Example: Pasture/forage in Central Texas

Is your pond large enough to provide 0.25 inches/day?

Water Supply in Weeks (at 80% efficiency)	10 acre field	50 acre field	100 acre field
1	2 ac-ft	9 ac-ft	19 ac-ft
2	4 ac-ft	18 ac-ft	37 ac-ft
3	6 ac-ft	27 ac-ft	56 ac-ft

Irrigation System Evaluation Factors

Level of control

Efficiency

Management skill

Purchase cost

Labor requirements and costs (time and effort)

Operational costs (pressurization of water)

Irrigation System Evaluation Factors

Level of Control

Being able to put on just the amount of water needed

The amount of water applied at each irrigation is based on the concept of "*Filling up the Root Zone*"

Level of Control

Amount of water applied at each irrigation is based on the principle of

FILLING THE ROOT ZONE

Calculated based on:

- soil water holding capacity of the soil
- depth of the root zone
- minimum moisture level that should be maintained in the root zone

  (“MAD” – managed allowable depletion)

FIGURE 17. The larger the soil particle size, the lower the water-holding capacity. (a) A relatively small amount of water is held by coarse-textured soil as compared to (b) the amount held by fine-textured soil.

Typical Values

- **Soil Water Holding Capacity**

Clay soil	2.2 inches/foot
Loam	1.8 inches/foot
Sand	1 inch/foot

Typical Values

Managed Allowed Depletion

% of water that can be deleted from the soil between irrigation without stressing plants

Most field crops	50%
Fresh vegetables	25%

Water Needed for Each Irrigation

- **3 foot root zone**

Soil Type	Field Crops	Vegetables
sand	1.4 inches	0.6 inches
loam	2.7 inches	1.1 inches
clay	3.3 inches	1.7 inches

Step 3: Water Quality

- Salinity (*EC*, *TDS*, *total salinity*)
- Sodium *(SAR*, *soluble sodium %)*
- Boron (mainly a problem in South Texas)

High salinity may damage plant foliage with spray irrigation or accumulate in soil

(leaching for control)

High sodium (SAR) may affect soil structure

(chemical treatment and leaching for control)

Boron is toxic at a few ppm

Water Quality

KNOW YOUR WATER QUALITY!!

While the groundwater quality is generally good in East Texas, some aquifers do have elevated levels of salt

For more information, see

Irrigation Water Quality Standards and Salinity Management Strategies, B-1667

Operational costs

Today we will focus on the costs to pressurize water

Typical Pumping Costs:

Acre-inch per 100 ft head (or 43 psi)

type	Natural gas	Electric turbine	Electric centrifugal	Diesel
Cost	$1.49	$2.00	$2.52	$3.07
Fuel cost*	$11 MCF	$0.11 kwh		$2.65 gal

** my fuel costs on Oct 22, 2008*

Operational costs -

Costs of Pressurizing Water

Per acre-foot of water,

electric centrifugal pump

at 0.11 kwh

pressure	15 psi	30 psi	45 psi	60 psi	90 psi
cost (per ac-ft)	$10.44	$20.76	$31.20	$41.64	$57.72

Irrigation System Evaluation Factors

Level of control

Efficiency

Management skill

Purchase cost

Labor requirements and costs (time and effort)

Operational costs (pressurization of water)

Irrigation System Evaluation Factors

Level of control

ability to apply just the amount of water that is needed

Efficiency (varies by type of system)

application efficiency -

(losses in the air with sprinkler irrigation)

distribution efficiency

(evenness of coverage in furrow and drip irrigation)

Irrigation System Evaluation Factors

Purchase cost

Note: the size of the system and/or field influences costs

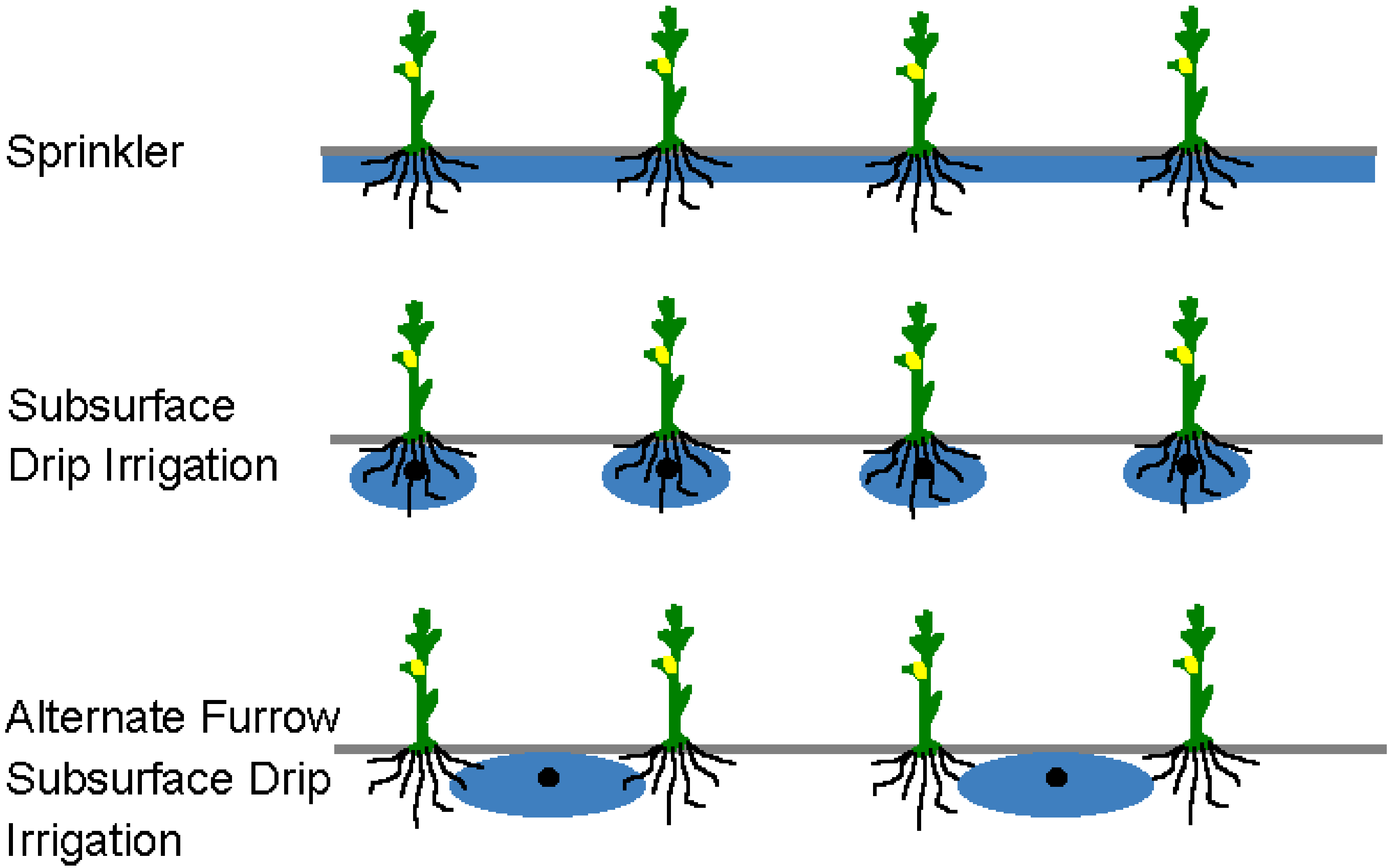
Labor requirements and costs (time and effort)

- will use the following scale

"low"	1 – 3
"medium"	4 – 6
"high"	7 - 10

Irrigation System Evaluation

Drip Irrigation


Sprinkler
Subsurface Drip Irrigation
Alternate Furrow Subsurface Drip Irrigation

Drip Irrigation

Many Types of products

- Drip tape
- Drip tubing with in-line or insertion emitters
- Micro spray and sprinklers

Drip Irrigation

Forage and Row-crop Applications

- drip tape

under $500/acre for larger fields

$500 - $1000 ac for small acreage

Row-crop only due to expense

- drip tubing / emitters

T*ypically $1000 to $1200 per acre)*

Drip Irrigation

REASONS FOR SUCESS

Frequent irrigations with small amounts of water

- this maintains an optimal soil moisture environment

(no wet stress or dry stress)

Drip Irrigation

control		purchase costs	
efficiency		labor	
skill		operating	

Drip Irrigation

control	excellent	**purchase costs**	
efficiency	Excellent to fair	**labor**	
skill	high	**operating**	

Drip Irrigation

control	excellent	**purchase costs***	high to very high
efficiency	excellent to fair	**labor**	low (2 – 3)
skill	high	**operating**	moderate to low

Drip Irrigation

- **COSTS**

Very high for large acreage

May be cost-competitive with other types of irrigation systems for fields less than 40 acres

Top Ten Drip Irrigation Problems

1. Starting too big.
2. Laterals too long.
3. System not matched to available flow rate.
4. Insufficient pressure.
5. Inadequate filtration.

Top Ten Drip Irrigation Problems

6. Improperly sized mainlines and manifolds.
7. No flow meter.
8. No (or insufficient number of) pressure gages.
9. No flushing manifold.
10. No method for irrigation scheduling.

Top Ten Drip Irrigation Problems

11. Improper or inadequate chemical injection program for clogging control.
12. Unrealistic expectations.
13. No market window or adequate cash crop to pay for system.
14. Insufficient water supply for crop.

Drip Irrigation

Keys to Success

- **Good Filtration**
- **Routine Chemical Injection to Control Clogging**
- **Soil Moisture Management**
- **High Value Crop**

Irrigation System Evaluation

Surface Irrigation (furrow, flood)

Surface Irrigation

Poor to good efficiency

- Cutting of field ditches
- Siphon tubes
- Gated pipe (plastic/aluminum)
- Gated pipe with cutback irrigation
- Gated pipe with surge flow irrigation

Flooding

- Micro-basin or basin irrigation
- Can be efficient if basin is level, heavier soils and is flooded quickly

Furrow Irrigation

- Not normally used for hay crops, but is used for other types of forages and grain crops
- Need sufficient water to flood rows quickly
- Need efficient system to deliver water to each row


Field Ditch


Siphon Tubes


Polypipe


Gated Pipe


Stand Pipe

Surface Irrigation

control	Poor to good	**purchase costs**	low
efficiency	Poor to good	**labor**	Moderate (6) (10 with siphon tubes)
skill	moderate	**operating**	low

Surface Irrigation
Keys to Success

USE:

- Large water stream per row
  (25 + gallons per minute for each row)

  - depends on soil type –check with NRCS

- Gated pipe: plastic or aluminum

- Surge flow?

Irrigation System Evaluation

Sprinkler

Sprinkler Irrigation

- **Small acreage**

  solid set (aluminum pipe with sprinklers on risers)

- **Small acreage, occasional irrigation, or with lots of labor**

  hand-move (portable solid set)

  wheel-move (side-roll)

Sprinkler Irrigation

- **Large Acreage**

  Center Pivot or Linear-move is the way to go!

- Linear-move machines are designed for rectangular fields
- Both use the same type of water applicators *("sprinklers")* and have similar design considerations


Side-roll (wheel-move)

Side-roll Irrigation (wheel-move)

control		purchase costs	
efficiency		labor	
skill		operating	

Side-roll Irrigation (wheel-move)

control	good	**purchase costs**	
efficiency	poor to moderate	**labor**	
skill	low	**operating**	

Side-roll Irrigation (wheel-move)

control	good	**purchase costs**	low
efficiency	poor to moderate	**labor**	medium (6)
skill	low	**operating**	high

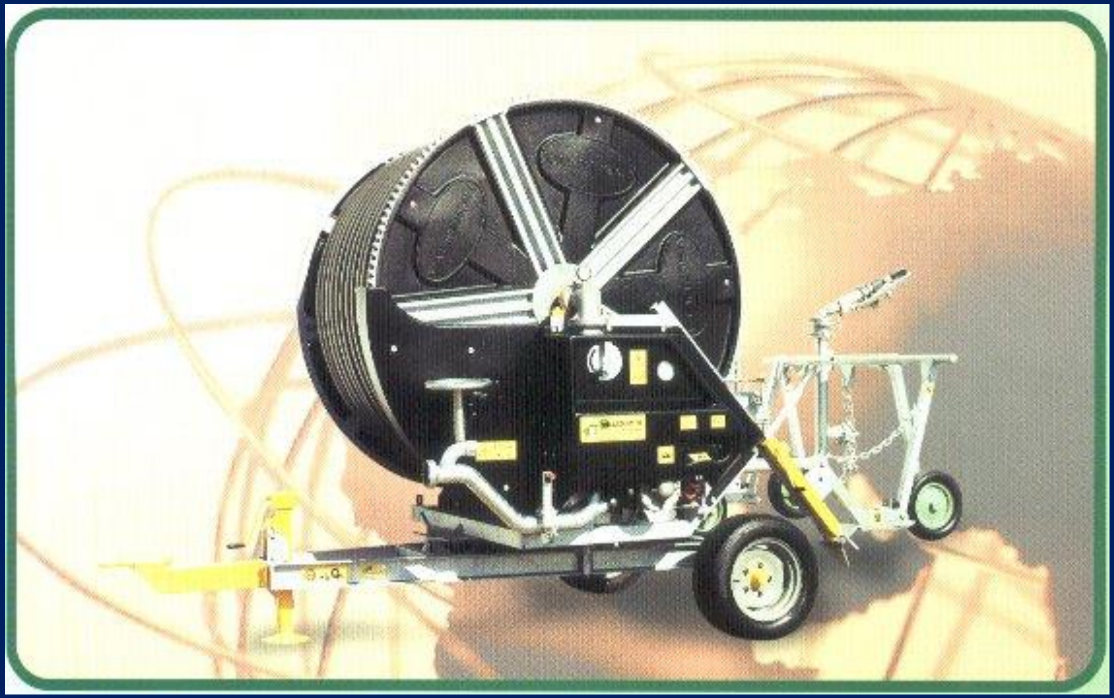
Big gun

“Good application for a big gun”

Merry Christmas Tree Farm – a choose and cut operation.

Occasional irrigation, no pipes or sprinklers in field when public comes.

Big gun – travelers (*reel-move*)



Big Gun (traveler)

control		purchase costs	
efficiency		labor	
skill		operating	

Big Gun (traveler)

control	moderate to good	**purchase costs**	
efficiency	poor	**labor**	
skill	low	**operating**	

Big Gun (traveler)

control	moderate to good	**purchase costs**	moderate to high
efficiency	poor	**labor**	medium (4)
skill	low	**operating**	very high

Sprinkler Irrigation

Types of Pivot/Linear-move Water Applicators

(1) high pressure impacts

(2) medium elevation spray applicators (MESA)

(3) low energy precision applicators (LEPA)

(4) low elevation spray applicators (LESA)

Water-move pivot

Older pivot
with high pressure impact sprinklers


MESA
(medium elevation spray applicators)

MESA
(medium elevation spray applicators)

Over-pressured MESA system

LEPA
(low energy precision applicators)


LEPA
with alternate row furrow dikes

Every row furrow dikes (West Texas)

Center Pivot Irrigation

Costs:

- **as low as ~ $325 per acre for larger fields**
- **~ $500 to $1000 per acre for smaller fields**
- **linear-move machines cost ~ 50% more than same length pivot**

Center Pivot Irrigation

Most Common Problems:

- mainline too small
- elevation changes in field not considered in the design
- end gun added
- system designed for incorrect flow rate

Center Pivot Irrigation
Keyes to Success

Choose Water Applicator with:

- low pressure requirements
- to be positioned below main line

Consider LEPA or LISA:

- best in high winds
- may require method for controlling runoff

Center Pivot Design

Be sure that the system is properly designed!

- **elevation changes in field considered**
- **mainline pipe sized correctly**
- **efficient water applicators**
- **matched to available water supply**
- **matched to water requirements of crop**

Center Pivot (properly designed)

control		purchase costs	
efficiency		labor	
skill		operating	

Center Pivot (properly designed)

control	good to excellent	**purchase costs**	low to moderate
efficiency*	good to excellent	**labor**	low
skill	moderate	**operating**	low to moderate

* MESA, LESA, LEPA

Center Pivot (LESA or LEPA)

control	excellent	**purchase costs**	low to moderate (field size)
efficiency	excellent	**labor**	low (1)
skill	moderate	**operating**	low

KEYS to Successful Irrigation

Step 1: Examine Site Conditions
– soil type, soil depth, slopes

Step 2: Determine Water Supply
– volume, pumping rate, availability, quality

Step 3: Choose Appropriate Irrigation Technology
– consider labor, energy cost, and management requirements

Step 4: Properly Size Pipelines, Pumps, etc.

KEYS to Successful Irrigation

Step 5: **Don't Forget Accessories**
– pressure gauges, flow meters, filters, etc.

Step 6: **Choose Method for Irrigation Scheduling**
– when to irrigate, how much water to apply

Step 7: **Implement Appropriate Management Practices**
– furrow diking, conservation tillage, etc.

Copies of this presentation:

Copy of this PowerPoint presentation and irrigation publications on the web site:

http://gfipps.tamu.edu

Crop water requirements

and Bulletin 6019 on the web site:

http://texaset.tamu.edu

Thank You