Conservation from Efficient System Design

Jim Thomas

Leader

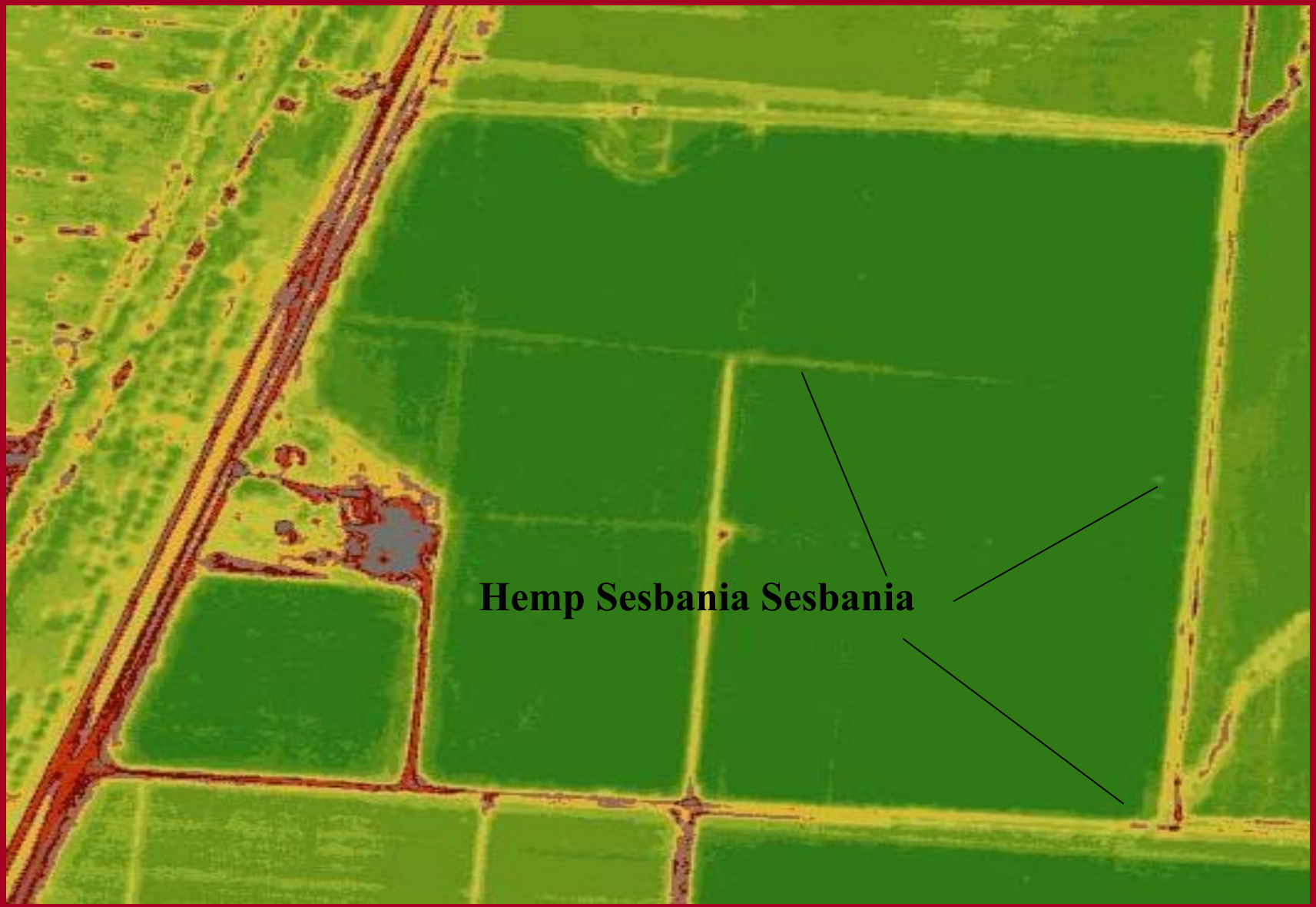
MSU Extension Ag Engineering

Efficiency

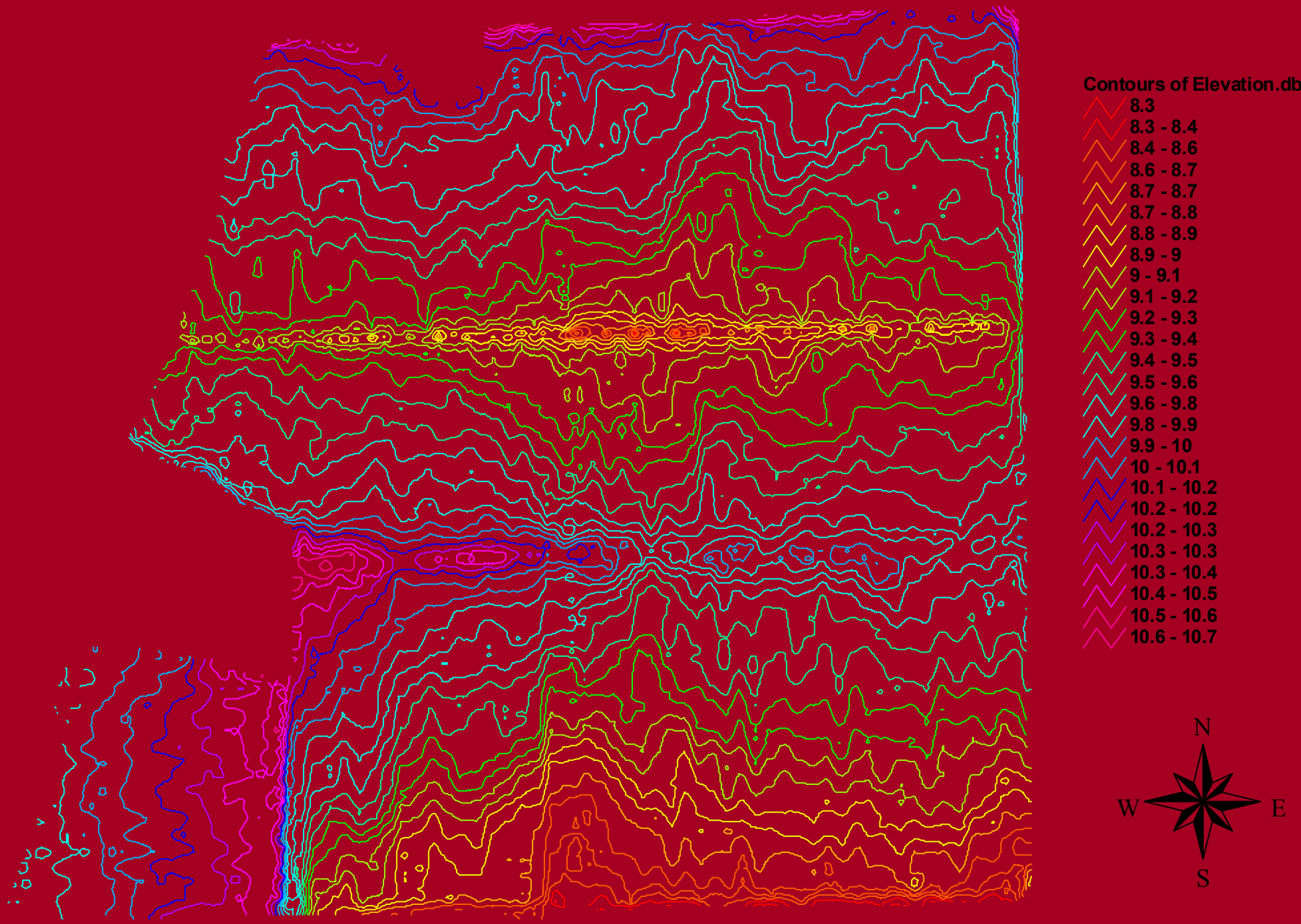
- Application Efficiency of the system-deals with the ability of the irrigation system to add to soil water
- Irrigation Efficiency-deals with the net result of irrigation – how much of the diverted water was used beneficially
- Water-use Efficiency of the crop
- Labor Efficiency
- Fuel Efficiency

System Efficiency Variables

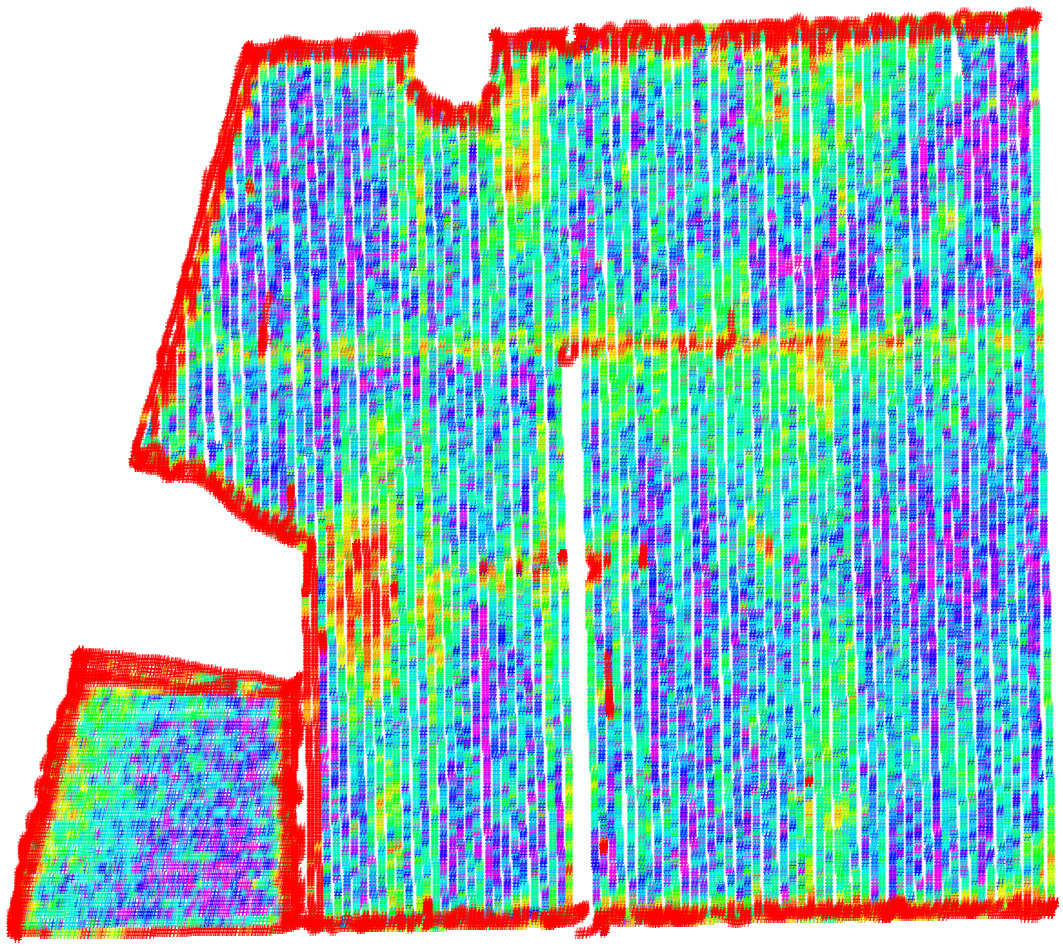
- Weather/weather patterns
  - Wind
  - Humidity
  - Temperature
  - Rainfall
- Soil type
  - Depth/percolation
  - Intake
  - Slope
  - Uniformity of soils
- Management
- Scheduling
- Run-off/re-use
- Mechanical design
- Crops
- Yield goals
- Water supplies
- Water quality
- Soil cover/tilth
- Tillage


Hemp Sesbania Sesbania

Elevation Contours



Curtis Yield

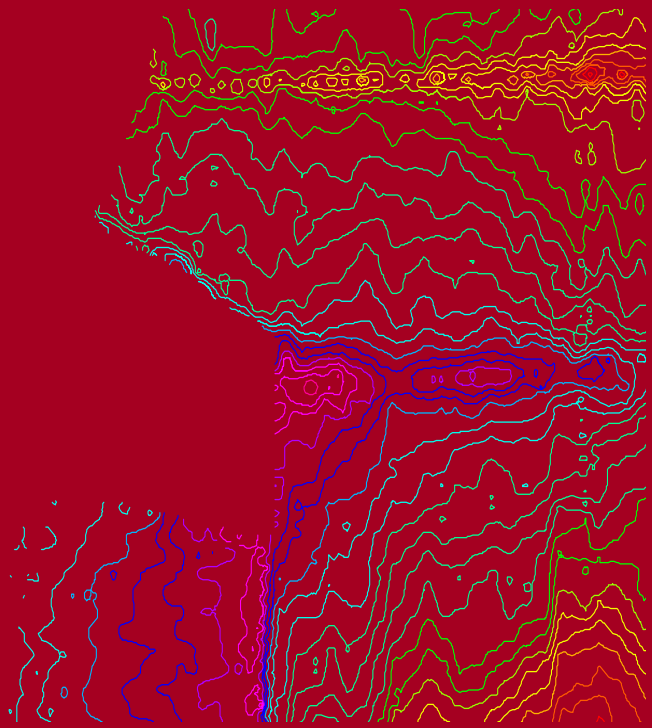


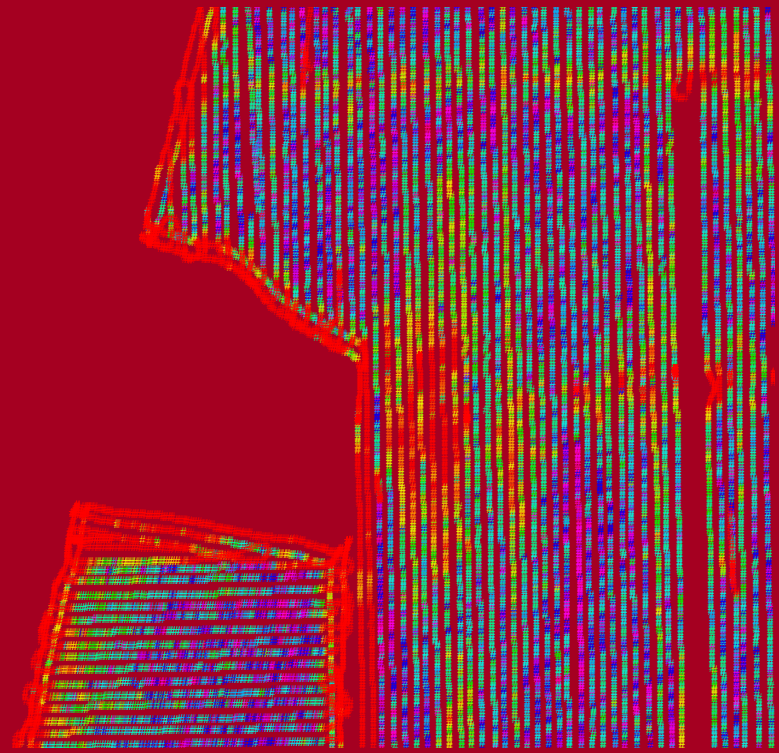
Curtisal.dbf 1997

- 0 - 40
- 40 - 42
- 42 - 44
- 44 - 46
- 46 - 48
- 48 - 50
- 50 - 52
- 52 - 54
- 54 - 56
- 56 - 58
- 58 - 60
- 60 - 62
- 62 - 64
- 64 - 68
- 68 - 70

0.2 0 0.2 0.4 Miles

N
W E
S





System Types

- **Surface Application Systems**
  - Furrow
    - Gated Pipe/Roll-out Pipe
      - H-valve
      - Surge flow
    - Siphons
    - Flume pads
  - **Flood**
    - Conventional Flood
    - Multiple Inlet
    - Intermittent
    - Zero Grade
  - **Border**

System Types

- Pivots/Lateral Move
  - Conventional sprinklers
  - Low Pressure Sprinklers
  - Sprinklers on Drops
  - LEPA
- Travelers
- Solid Set/Hand Move

System Types

- Drip Irrigation or Micro Irrigation
  - Emitter systems in line or point of use
    - Buried
    - Above ground
  - Micro Sprays

System	Range (%)	Average
Sprinkler		
Solid Set	60-75	70
Center Pivot	70-85	75
Linear Move	65-85	75
Big Gun	55-65	60
Traveler	60-80	70
Trickle	70-95	
Furrow/Flood	40-80	60

Furrow Systems

- Roll-out pipe punched is probably the least efficient system, sets are to large, and stream sizes are often to small-Popular because of labor
- Gated pipe or gated roll-out pipe offers flow control at the top of each furrow to be watered-High labor
- H-valve system is pre-designed set sizes, and punched holes of the desired size for flow-Low labor, semi automated
- Surge flow is pre-designed and automatic but has shown variations in water savings

Furrow System-Efficiency Factors

- Type of delivery system
- Soil characteristics such as depth, intake, cover, pans, and other soil factors can effect surface distribution/uniformity.
- Deep percolation
- Slope of the field and length of run
- Water delivery and stream size
- Scheduling
- Re-use

Furrow Efficiency

- In MS, length of run is not a factor on many soil types because of clay subsoil, only 2-2.5” of water goes in the soil regardless, this would also apply on other pan soils.
- Deeper soils should have shorter runs to eliminate deep percolation.
- Field slopes of 0.15-0.25% are the most efficient in the Delta
- Mid-west fields often run as high as 2% or more but have deep silt loam soils with good intake.

Furrow Efficiency

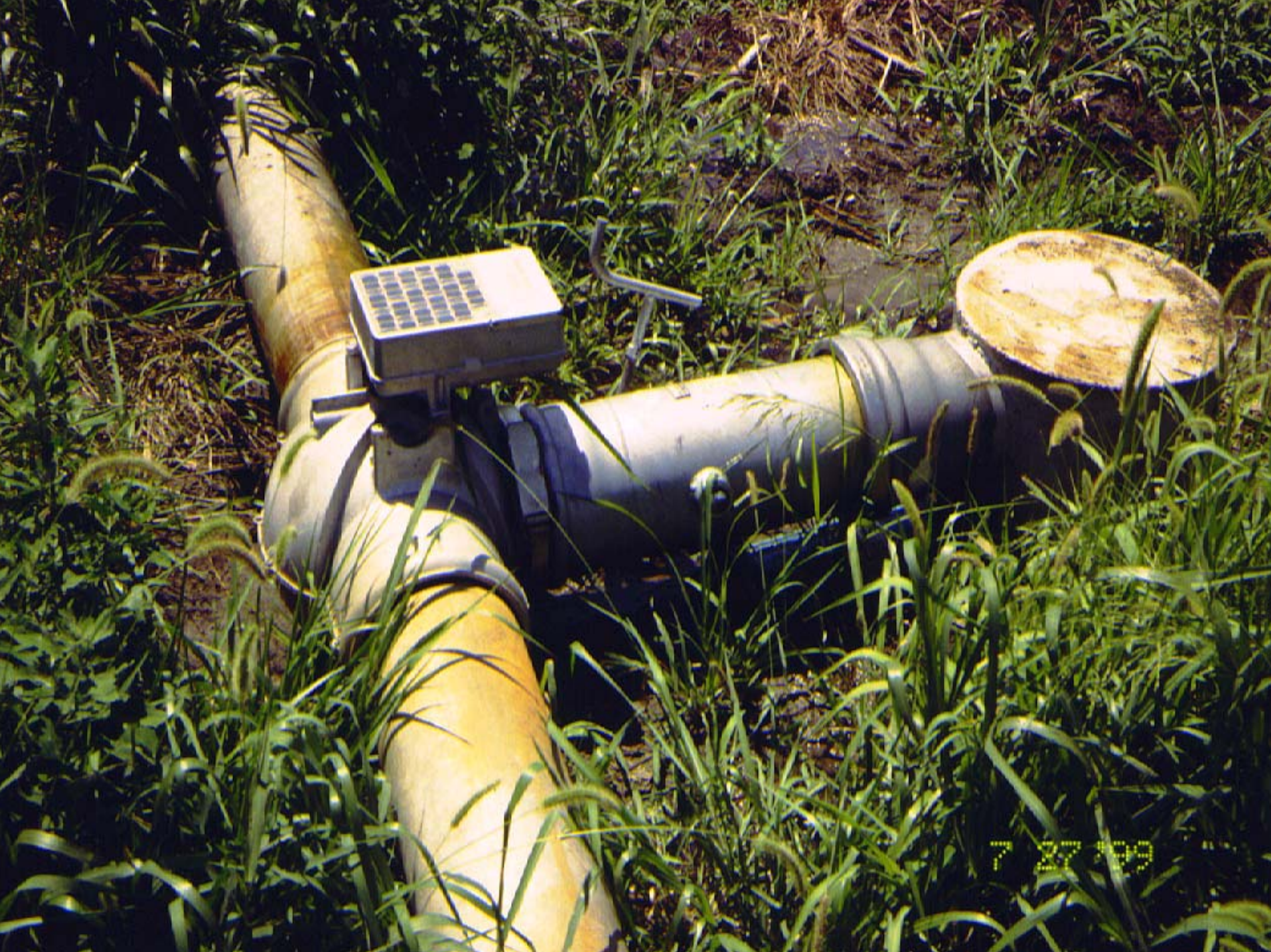
- Run time seems to affect efficiency to some degree in the Mississippi Delta.
- Small stream sizes, low flow, long duration of irrigation (>24 hours)
- Starting in soils that are very dry vs soils that still have 50% soil moisture or better also makes a big difference
- Some slopes are to flat for long duration sets and low flows, they go to saturation instead of field capacity-very poor internal drainage-loss to evaporation is higher

Furrow Efficiency

- In MS the rule of thumb is 4-4.5 gpm/foot of width on ¼ run length for a 12 hour set started at optimum moisture.
- In the western states stream size is calculated as 50/slope %, in MS this converts to 5/slope %.
- If deep percolation and evaporative losses can be decreased, re-use will increase the efficiency tremendously, if the water is pumped back on the same field or utilized on another field to decrease water supply use.

Furrow Efficiency-Other Tools

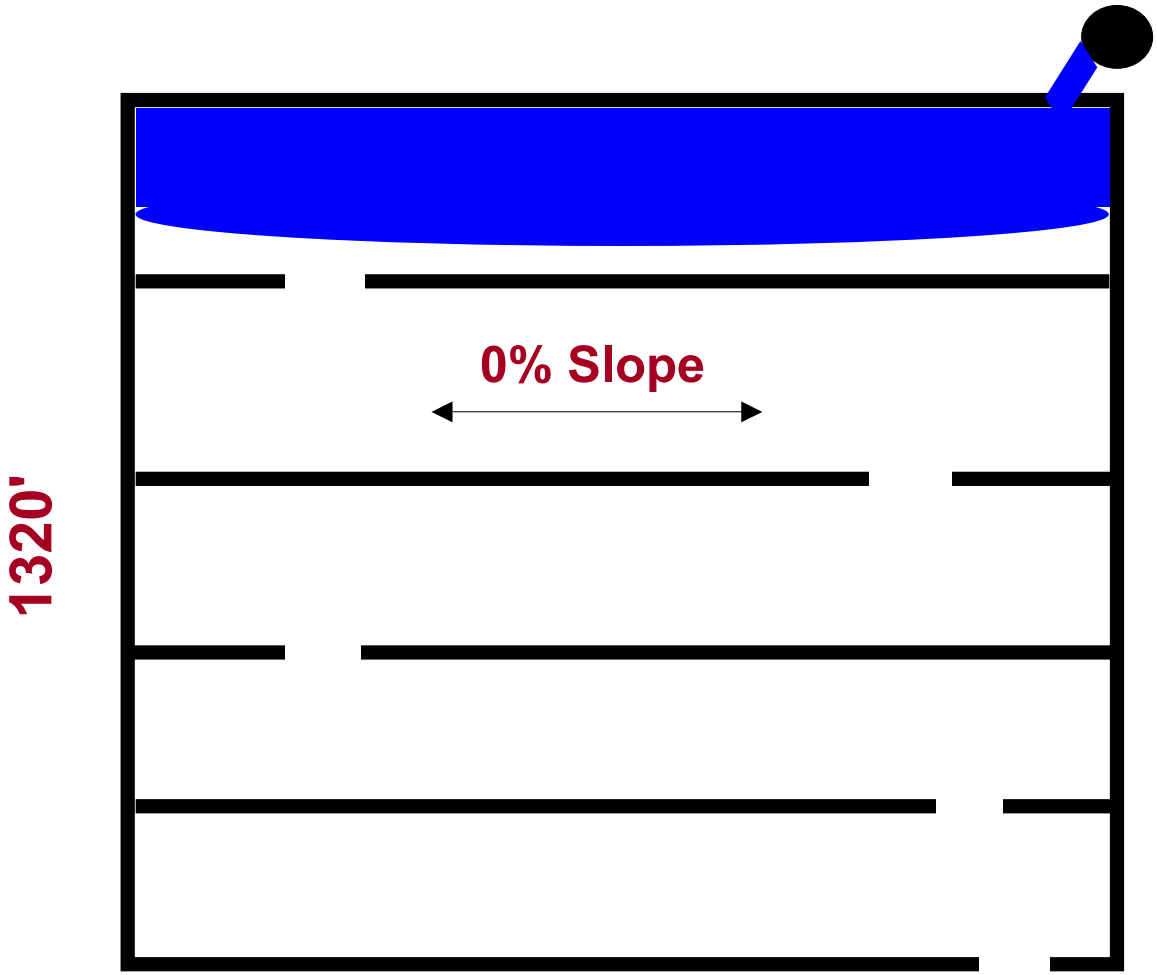
- H-valves-basically a mechanical surge valve, uses pre-designed set sizes, pre punched holes in roll-out pipe or pre set gate sizes in gated pipe. With proper timing can increase efficiency tremendously over running punched pipe alone.
- Surge valves have shown to be very efficient in many soil types, because of the leap frog effect. It has not shown to be much more efficient than a well designed set on some of the low organic soils in the MS Delta.



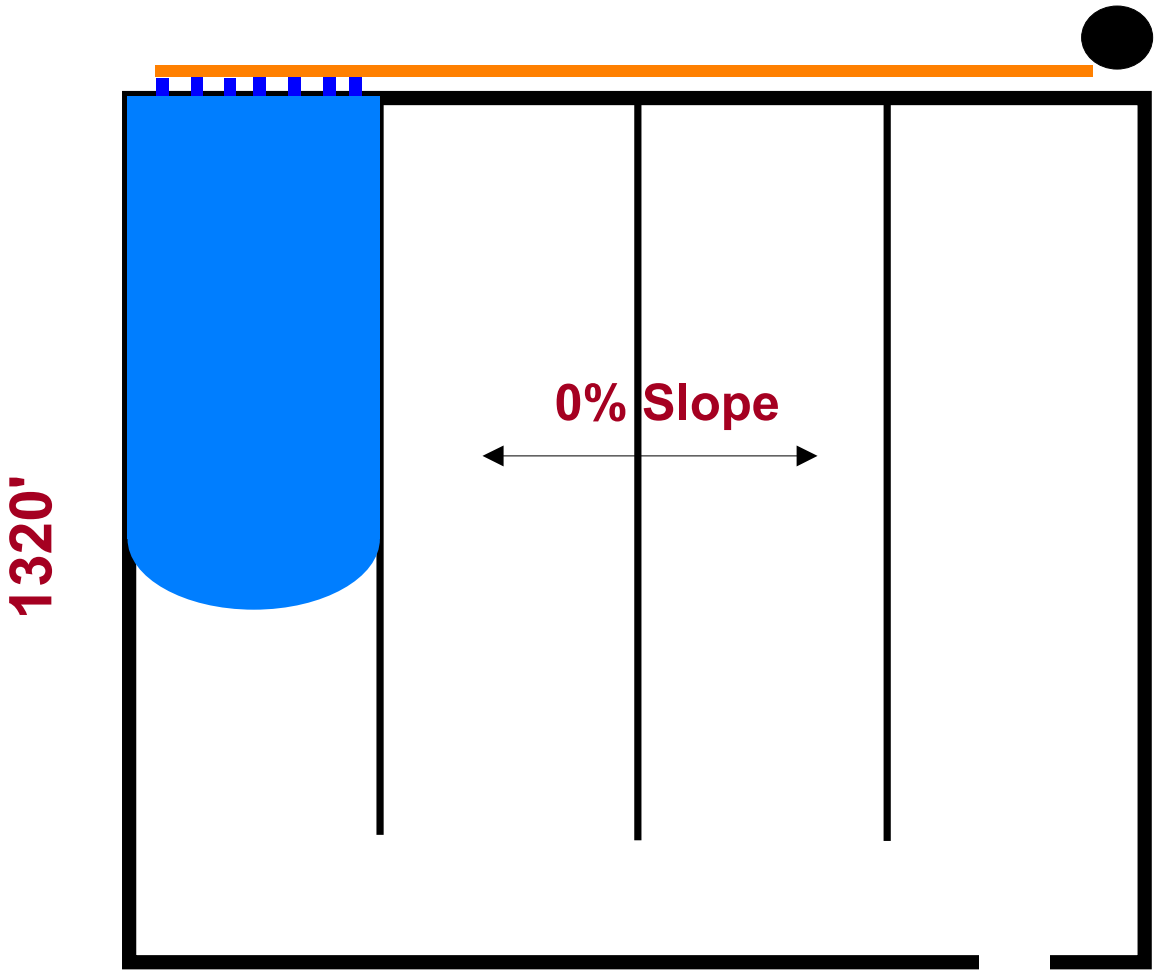
Keys to Efficiency with Furrow

- Uniform slopes
- Short set times
- Adequate stream sizes
- Proper length of run for the soil type
- **Good Management**

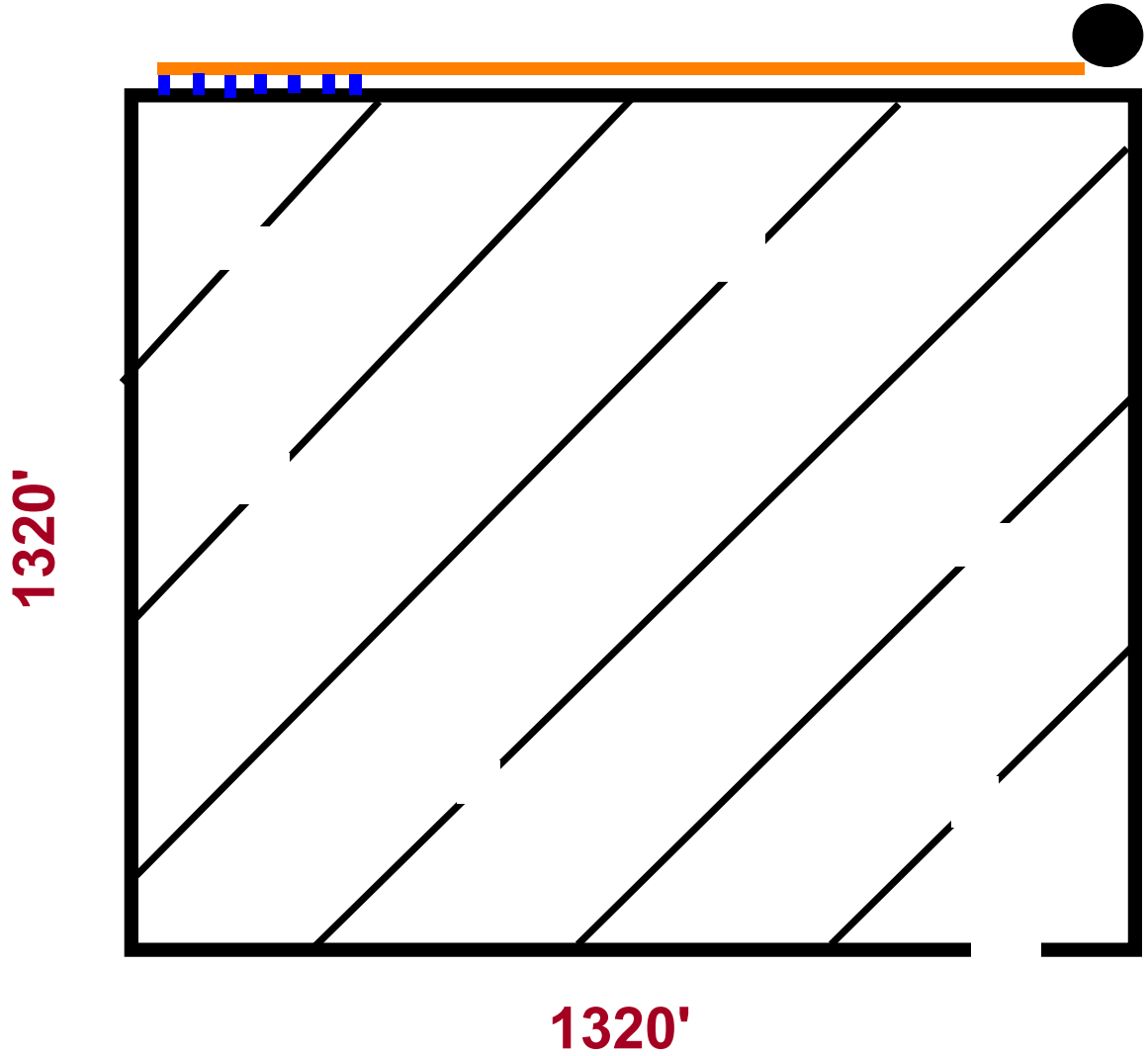
Border Irrigation



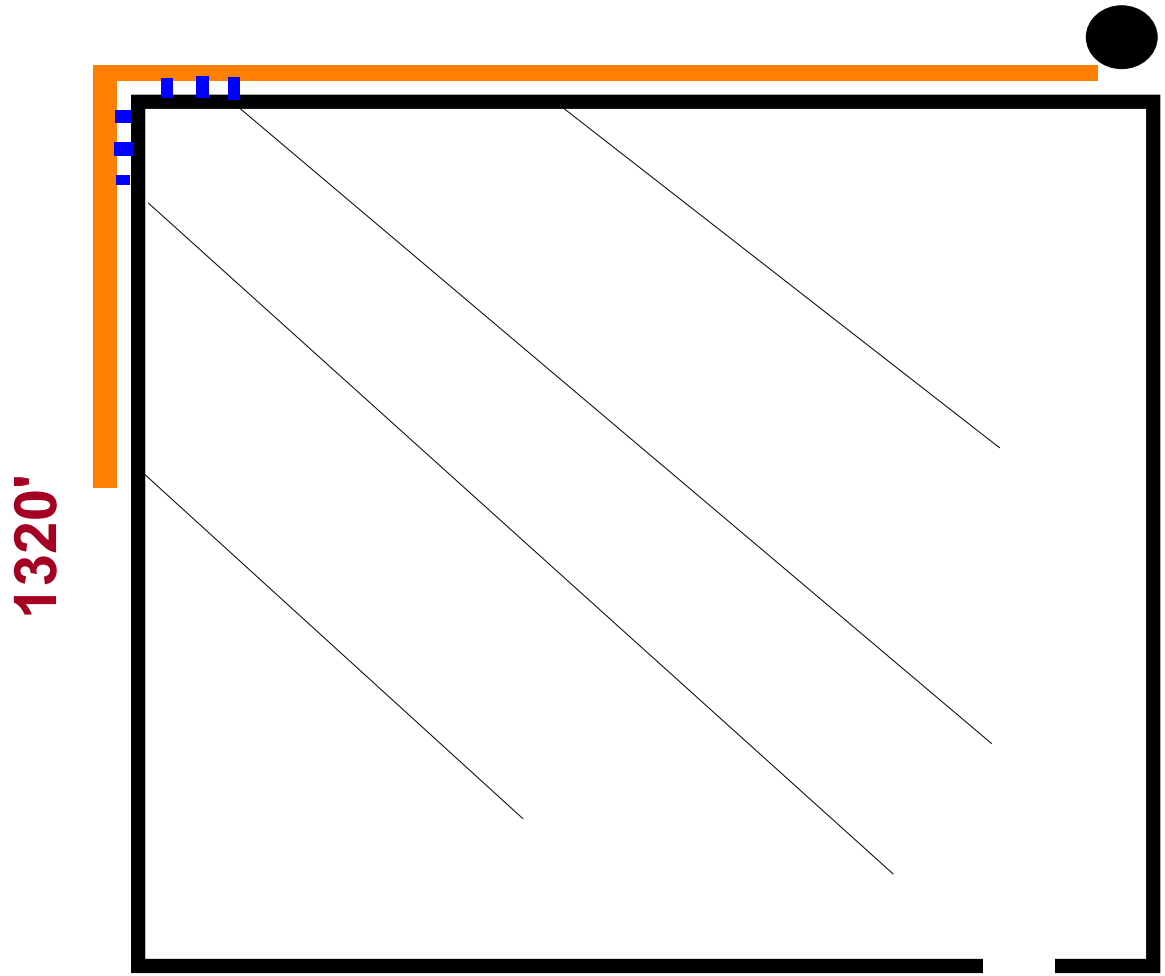
Typical Flood Irrigation Layout



Border Irrigation Layout



Parallel levee Field for Flood Irrigation



Border Irrigation Layout

Parallel Levee's

Border Irrigation

- System based on western border design, used on flat planted crops instead of flood
- Field must be zero side slope or uniform cross slope
- Borders are designed for 12 or 24 hours set times
- Based on 4-4.5 gpm per foot of width on a ¼ mile run length.
- If started at proper soil moisture they decrease the amount of run-off dramatically.

Border Irrigation

For a ¼ mile run length borders are set up using:

flow rate (gpm)/4.5=Border width

Field width/border width=number of borders per field-(adjusted to even number or same size borders)

Other lengths: 4.5/1320=new flow/new length

Multiple Inlet Rice

Zero Grade

- Zero grade fields for rice seem to have many advantages over graded fields for rice, less water use, less run-off and faster flooding, lower labor, more set-up.
- They don’t offer much versatility for other crops such as soybeans, corn or cotton.
- As good or better on rice than Multiple inlet.

Other Surface Management Tools

- Deep tillage on pan soils and some clays in the fall--must disk down after tillage
- Reduced tillage
- Furrow diking alternate rows
- Winter flooding on clays
- Other options ?

Other Surface Management Tools

- **Scheduling!**
- Does it save water?
- Does it use more?
- More efficiently used, better yields!

Other Systems

- Pivots- Georgia work, plus, furrow dikes potentially, cover, organic mater, good drainage, decrease wheel tracking, and lower application intensities.
- Drip-Efficiency is high, cost is a factor, water quality is a huge factor, and repair costs and maintenance for row crops is very high.

Conclusions

- Good education to growers
- Good grower management
- Demonstrations of newer technology
- Encouragement to adapt newer system technology when affordable or applicable
- **Good Extension Programs**

Thank You

References

- **“Irrigation Development in Eastern Arkansas: Water Supplies, Uses, and Efficiencies”**, P. Robinson, A. J. Clemmens, D. K. Carman, Z. DalmutT. Fortner
- **“Water Resource Development and Irrigation Management For Sprinkler and Subsurface Drip Irrigation”, Larry M. Curtis, Charles H. Burmester, David H. Harkins, B.E. Norris, James W. Baier, Wheeler Foshee**