Conservation from Efficient System Design

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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
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
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
<table>
<thead>
<tr>
<th>System</th>
<th>Range (%)</th>
<th>Average</th>
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</thead>
<tbody>
<tr>
<td>Sprinkler</td>
<td>60-75</td>
<td>70</td>
</tr>
<tr>
<td>Solid Set</td>
<td>70-85</td>
<td>75</td>
</tr>
<tr>
<td>Center Pivot</td>
<td>65-85</td>
<td>75</td>
</tr>
<tr>
<td>Linear Move</td>
<td>55-65</td>
<td>60</td>
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<tr>
<td>Big Gun</td>
<td>60-80</td>
<td>70</td>
</tr>
<tr>
<td>Traveler</td>
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<td></td>
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<tr>
<td>Trickle</td>
<td>70-95</td>
<td></td>
</tr>
<tr>
<td>Furrow/Flood</td>
<td>40-80</td>
<td>60</td>
</tr>
</tbody>
</table>
Furrow Systems

- Roll-out pipe punched is probably the least efficient system, sets are too large, and stream sizes are often too 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 too 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 rollout 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