Improving Water Use Efficiency in Agriculture

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Optimizing Resource Use Efficiency for Sustainable Intensification of Agriculture
Kunming, China, 27 February – 2 March 2006
Four Case Studies

Case 1 - Platte River Valley
**Platte Valley Nitrogen and Irrigation Management Demonstration Project**

Over the life of the project, average values:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected corn yield</td>
<td>11.0 Mg/ha</td>
</tr>
<tr>
<td>Actual corn yield</td>
<td>10.7 Mg/ha</td>
</tr>
<tr>
<td>Recommended N rate</td>
<td>145 kg/ha</td>
</tr>
<tr>
<td>Soil N credit</td>
<td>75 kg/ha</td>
</tr>
<tr>
<td>Irrigation water N credit</td>
<td>31 kg/ha</td>
</tr>
</tbody>
</table>

**Trends in the Central Platte Valley**

![Graph showing trends in Irrigation Water Nitrate N and Soil Residual Nitrate N from 1985 to 2005.](image)
Fertilizer N, kg km\(^{-2}\) year\(^{-1}\)

N loss, kg km\(^{-2}\) year\(^{-1}\)

US Corn Belt Tile-Drained Lands

- >200,000 km\(^2\) in US Midwest
- Subsurface and surface drainage
- Documented loss of nitrate to streams
- Contributes to Gulf of Mexico hypoxia
- Potential to reduce nitrate loss by 30-50%
Effect of Controlled Drainage on Nitrate Loss

<table>
<thead>
<tr>
<th>Nitrate Loss (kg/ha)</th>
<th>Conventional Drainage</th>
<th>Controlled Drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Soybeans</td>
<td>30</td>
<td>25</td>
</tr>
</tbody>
</table>

Ohio Data: N.R. Fauney et al.

Methods to Control Drainage

Drainage Valve
Case study 3 - Lower Mississippi River Valley (LMRV) Delta

All was cypress swamps, cut for timber in late 1800’s.
Surface drainage was done in early 1900’s.
It has ~70,000 km² of cropland, with very little other industry.
Approximately half is irrigated.
The LMRV is where new irrigation is being added in the USA.
Alluvial Aquifer is a good irrigation water supply.
Despite that, some areas now have water shortages.
Case 4 - Precision Irrigation

Florence SC

- Modified commercial center pivot
- Control 9-m sections independently
- Used it to find production functions for water and N for corn

![Precision Irrigation System](image)

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**Yield**

<table>
<thead>
<tr>
<th>Year</th>
<th>Max Yield</th>
<th>Max Profit</th>
<th>Max Yield - Max Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td><img src="image" alt="Max Yield 1999" /></td>
<td><img src="image" alt="Max Profit 1999" /></td>
<td><img src="image" alt="Max Yield - Max Profit 1999" /></td>
</tr>
<tr>
<td>2000</td>
<td><img src="image" alt="Max Yield 2000" /></td>
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<td><img src="image" alt="Max Profit 2001" /></td>
<td><img src="image" alt="Max Yield - Max Profit 2001" /></td>
</tr>
</tbody>
</table>

**Legend**

- 0
- 10
- 14

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## Irrigation

<table>
<thead>
<tr>
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<th>Max Yield</th>
<th>Max Profit</th>
<th>Max Yield - Max Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td><img src="image1" alt="Irrigation Map" /></td>
<td><img src="image2" alt="Irrigation Map" /></td>
<td><img src="image3" alt="Irrigation Map" /></td>
</tr>
<tr>
<td>2000</td>
<td><img src="image4" alt="Irrigation Map" /></td>
<td><img src="image5" alt="Irrigation Map" /></td>
<td><img src="image6" alt="Irrigation Map" /></td>
</tr>
<tr>
<td>2001</td>
<td><img src="image7" alt="Irrigation Map" /></td>
<td><img src="image8" alt="Irrigation Map" /></td>
<td><img src="image9" alt="Irrigation Map" /></td>
</tr>
</tbody>
</table>

**Savings**
- 51 mm (18%)
- 40 mm (16%)
- 61 mm (32%)

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## Spatial Irrigation Water Use Efficiency for two fertilizer rates on maize

Calculated N Use Efficiency (marginal response to N)

\[
\text{NUE} = \frac{Y_H - Y_L}{N_H - N_L}
\]

Where

- \( Y \) = yield, kg/ha
- \( N_H \) = 225 kg/ha
- \( N_L \) = 135 kg/ha

Marginal corn yield benefit from N fertilizer
150% irrigation, 2000

Economic Breakeven Point (1998)

Economic Breakeven Point (2006)
Conclusions

- **WUE can be improved**
  - Identify and reduce losses of water
  - Increase yield

- **Must address both WUE and fertilizer use efficiency, particularly N**
  - Identify and reduce losses of N (P, K...)
  - Optimize irrigation with N (P, K...)