CONSTRUCTION OF NEW IRRIGATION AND DRAINAGE SYSTEMS AIMED AT POLLUTION EMISSION REDUCTION IN RICE-BASED CROPPING SYSTEMS, SOUTH OF CHINA

Dong Bin, Cui Yuanlai and Mao Zhi

Wuhan University, China

dongbin@whu.edu.cn
Presentation outlines

1. Background
2. Research needed
3. General approaches
4. Methodology
5. Study sites
6. Results and conclusions
Rice, one of staple food crops in China, is also the crop consuming much water and fertilizer.

- 27.4% of total planting area
- 36.3% of total food crop production
- 55-65% of total agricultural irrigation water amount
- 180 kg/ha nitrogen fertilizer applied in average, double the world average level
- 20~30% nitrogen fertilizer utilization efficiency
Data in 2014 from Ministry of Agr. showed that in China, agricultural non-point source pollution (ANPSP) has already become the main source of total nitrogen and total phosphorus emissions.

Data shows that the nitrogen and phosphorus load in water in unit area of paddy field caused by seepage and runoffs is more than 4 times higher than that in dry land.
Research needed

1. From water quantity management only to both quantity and quality management through multiple disciplinary study

2. From the simply water saving and yield improving point view to integrated approaches for saving water, yield sustainability, efficient water and fertilizer use and nutrient loading reduction

3. Farm water environment restoration

4. Spatial and temporal variation of nitrogen and phosphorus losses

5. Modeling development for management, evaluation, knowledge transfer and scenarios simulation
Concept of **Four Lines of Defense**

1. **Efficient water and fertilizer utilization at farm level**
2. **Field drainage ditches (Eco-ditches)**
3. **Constructed wetlands: such as irrigation ponds & reservoirs, or created wetlands**
4. **Ecological trunk channels**
General approaches

Future of drainage environment challenges and emerging technologies
Methodology

**Method**

- **Lysimeter experiments**
- **Plot experiments**
- **Field experiments**

**Subject of Study**

- **Mechanism of saving water, fertilizer use**
- **Performance of water saving, yield improvement, efficient water & fertilizer use and nutrient loading reduction**
- **Typical regulation mode and its adaptability in different regions**

**Expected Results**

- Reducing nutrient losses at the source
- Target setting for saving water, sustaining yield, efficient use of water & fertilizer and nutrient loading reduction
Methodology

<table>
<thead>
<tr>
<th>Method</th>
<th>Subject of Study</th>
<th>Expected Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field drain. ditches, Pond wetlands &amp; ecological trunk channels</td>
<td>Impact factor and its variation of nutrient loading</td>
<td>Removal efficiency, Hydraulic efficiency Design criteria</td>
</tr>
<tr>
<td>Experiments at different scales</td>
<td>Scale effects of nutrient loading</td>
<td>• The variation and mechanism of nutrient loss from the source to water body (river/lake)</td>
</tr>
</tbody>
</table>
| Modeling development | Impact factor and its variation of nutrient loading | • Removal efficiency at different scales
• Eco-effect at sub/basin scale |
| Dissemination & application | Mobilization, organization and implementation | Economic, social and environmental benefits |
Study sites

Future of drainage environment challenges and emerging technologies
Future of drainage environment challenges and emerging technologies
### Combined effects of the Four lines of defence (%)

<table>
<thead>
<tr>
<th>Pollutants reduction</th>
<th>TN</th>
<th>TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(^{st}) line of defence</td>
<td>16</td>
<td>8.5</td>
</tr>
<tr>
<td>2(^{nd}) line of defence</td>
<td>23.7</td>
<td>14.9</td>
</tr>
<tr>
<td>3(^{rd}) line of defence</td>
<td>52.7</td>
<td>50.0</td>
</tr>
<tr>
<td>4(^{th}) line of defence</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>Total reduction</td>
<td>69</td>
<td>61</td>
</tr>
</tbody>
</table>
### Combined effects of the four lines of defence (%)

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>TP</th>
<th>TN</th>
<th>NH$_4^+$-N</th>
<th>NO$_3^-$-N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st reduction</strong></td>
<td>1.8~21.2</td>
<td>15.0~47.8</td>
<td>63.34</td>
<td>34.38</td>
</tr>
<tr>
<td><strong>2nd reduction</strong></td>
<td>7.9~51.6</td>
<td>23.7~49.2</td>
<td>49.90</td>
<td>35.50</td>
</tr>
<tr>
<td><strong>3rd reduction</strong></td>
<td>43.9~61.1</td>
<td>11.4~47.8</td>
<td>45.44</td>
<td>16.28</td>
</tr>
<tr>
<td><strong>4th reduction</strong></td>
<td>7.3</td>
<td>54.50</td>
<td>43.70</td>
<td>-23.30</td>
</tr>
<tr>
<td><strong>Total reduction</strong></td>
<td>61.0~82.8</td>
<td>69.0~92.3</td>
<td>94.4</td>
<td>64.6</td>
</tr>
</tbody>
</table>
Acknowledgment

1. National Natural Scientific Foundation of China
2. “948” Program, Ministry of Water Resources
3. Jiangxi Provincial Water Resources Bureau
Thanks!