Improve Water Productivity and Climatic Resilience for Agriculture: Chinese Lessons and Outlook

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Climate, water and food in China

% of the world

Vegetable & fruits 38%
Animal protein 30%
Cereal + legume + tube 21%
Population 20%
Chemical fertilizer 34%
Arable land 9%
Renewable water... 6%

Arable Land Irrigation Ratio (%)

Cereal Production (MMT) Water Consumption (BCM) Water Productivity (CM/MT)

China 52 World Average 20 USA 15 Russia 10

AgWater Panorama, BCM

Rain 6188 100% Blue 2810 45%
Green 3378 55% Rainfed
?? 750 410 Irrigation
620 370 180

National Agriculture Actual

2017/9/22
In recent 15 yrs, drought tend to severe Northeast-Southwestward
By 2030, plant production may reduce 5%-10%, cereal crops are mainly loss yield due to high temperature, frequent drought and flood, and water scarcity.
Climate, water and food in China

Annual Variation of GGP in China (1949~2010)

Caused by extreme climatic events in 2009

- grain losses reached **55** million tones
- **10%** of total grain production

Drought

Flooding

Hail
Improve water productivity and resilience

\[ WP = \frac{\text{Crop Yield (kg)}}{\text{Water Consumption (m}^3\text{)}} \]

\[ = \frac{\text{Biomass} \times \text{Harvest Index}}{\text{Evaporation} + \text{Transpiration}} \]

- Increase water availability
- Reduce non-productive water use
- Improve crop yield under water limitation
Soil moisture content (V/V, %)

- Increase water availability – water harvesting

- Ridged water harvesting (RWH, Tr1)
- RWH + plastic mulching (Tr2)
- RWH + straw mulching (Tr3)

Improve water productivity and resilience

- Increase water availability – water harvesting

Soil moisture content (V/V, %)

Date (month/day)

2017/9/22
Improve water productivity and resilience

- Increase water availability – water harvesting & irrigation

Cistern water harvesting combine with gravity drip irrigation system becomes a good solution small-scaled greenhouse
Improve water productivity and resilience

- Increase water availability – irrigation

<table>
<thead>
<tr>
<th>Irrigation methods</th>
<th>Water Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface, Flood</td>
<td>40%~60%</td>
</tr>
<tr>
<td>Furrow</td>
<td>50%~70%</td>
</tr>
<tr>
<td>Sprinkler</td>
<td>70%~80%</td>
</tr>
<tr>
<td>Trickle, drip</td>
<td>90%~95%</td>
</tr>
</tbody>
</table>
Improve water productivity and resilience

- Reduce non-productive water use – minimize soil evaporation

Partitioning Es from ET by using isotope techniques to maximize the plant Transpiration

Alternative furrow irrigation -20%~30% irrigation water

Full plastic film mulching -90% Es & WP 4.2 kg/m³ (240m³/t)

Straw mulching -50% Es and -200 m³/t
Improve water productivity and resilience

- Improve WUE/ WP – genetic explore and W-F integration

![Drought tolerant wheat](image1)

![High productive maize](image2)

![Intercropping](image3)

**Nitrogen Use Efficiency %**

- Straw out
- Straw in

\[ Y(\text{straw-out}) = 53.364e^{-0.0977x} \]
\[ R^2 = 0.9944 \]

\[ Y(\text{straw-in}) = 71.745e^{-0.0666x} \]
\[ R^2 = 0.9971 \]

**Number of year**

**Yield (kg/ha) & ET (mm)**

**NUE of dryland maize (\text{^{15}N}, 1997\text{~}1999)**

**Yield, Fertilization and ET**
Improve water productivity and resilience

- Improve WUE/WP – Fertigation
Improve water productivity and resilience

- Enhance climatic resilience - Optimize cropping system and biodiversity
  
  WUR 60% ↑ 70%, WUE 0.60 ↑ 1.20

- Potato ⌄ canola
- Alfalfa ⌄ foliar maize
- Grazing
- Contour planting
- Stubble mulching
- Hedgerow
Climate Smart Agriculture Approach

- **Climate Smart Agriculture (FAO)**
  
  It integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges. It is composed of three main pillars:
  
  - sustainably increasing agricultural **productivity and incomes**;
  - adapting and building **resilience** to climate change;
  - reducing and/or removing **GHGs** emissions, where possible.

- **Ecological Intensification (CGIAR, 2011)**

  Meet food demand under acceptable environmental standards
  
  - Increase **Productivity** and **Sustainability**
    
    Light capture
    N use efficiency
    Water use efficiency
    Land use efficiency
    Biological control
    Ecosystem resilience
    Ecological engineering
    Reduce GHGs emissions
    Maintain agro-biodiversity
Climate Smart Agriculture Approach

- Improve *crop productivity for* food supply
  - Genetic exploring and climate change ready varieties
  - Enhance soil organic carbon and fertility
  - Irrigation technical Integration and intensification
- Enhance *biodiversity & climatic resilience* for ecosystem healthy
  - Multi- and/or Inter-cropping system to improve profit and reduce environmental and natural disaster risks
  - Crop-based livestock (dry subhumid)
  - Grassland-based livestock (arid and semiarid)
- Develop *horticulture/food processing* for poverty reduction & livelihood
- Intensify *Carbon management* for C sequestration & GHGs reduction
  - Soil water reservoir enrichment
  - Biological fertility enrichment and chemical fertilizer (NPS) reduction
  - GHGs emission Reduction
Climate Smart Agriculture Approach
CDCC: Common Duties for Common Challenge!!

Thank You!