Innovations to enhance agroecosystem resilience and adaptation to climate change in drylands of China

Institute of Environment and Sustainable Development in Agriculture
Chinese Academy of Agricultural Sciences

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Outline

- The climate change and water crisis
- The matching of water resources, agrotechnologies and crops
- The innovation R&D, extension and adoption
The importance of enhancing resilience and adaptation of agriculture to climate change in the drylands of North China

Cultivated land area 51%
Water resource 19%
Total grain yield 59%
Dryland grain yield 30%
Vulnerable ecological area 70%

Mean annual temperature changes (1951-2001)

Annual air temperature $\uparrow \sim 1.1^\circ C$
Warming rate $\sim 0.22^\circ C/10a$

(China Climate Change Info-Net)
The increased frequency of severe drought in northern regions of China
Precipitation meeting crops’ need decreased 5%

Matching the precipitation with innovative technologies and crop patterns

**Precipitation**

**Agrotechnologies**
- Residue incorporation
- Plastic mulching
- Cropping systems
- Tillage
- Fertilization
- Irrigation techniques

**Crop species**
- Maize
- Wheat
- Potato
- Soybean
- Cotton
- Others
Plastic mulching increases crop yield and water use efficiency (WUE)

Plastic mulching effect on yield and WUE for different crop species of China

- **Mulching area for crops** 13%
- **Crop yield** ↑ 45.5%
- **WUE** ↑ 58.0%

(Sun et al., 2020)
Innovation R&D—Soil-Crop canopy system approaches

**Canopy manipulation**
- Intercropping
- Rotation
- Planting density

**Soil management**
- Plastic/organic mulching
- Organic input
- Deep/reduced tillage
- Green manure
Canopy manipulation

- Planting density

Crop transpiration ↑ **300-550 mm**
Crop yield ↑ **12.0%-20.6%**
WUE ↑ **12.7%-17.4%**

- Intercropping

Millet-peanut intercropping, Precipitation interception infiltration ↑ **45%-69%**
Maize-soybean intercropping, Radiation interception ↑ **13%-19%**
WUE by intercropping ↑ **21%**
Soil management

- Organic input
- Deep tillage

- Organic mulching
- Plastic mulching

- Water holding capacity $\uparrow$ 12%-23%
- Carbon footprint $\downarrow$ 15%-29%
- Crop yield $\uparrow$ >10%
- Yield fluctuation $\downarrow$ 15%-27%

- Soil water storage $\uparrow$ 25.4 mm
- Soil evaporation $\downarrow$ 8.9 mm
- Soil wind erosion $\downarrow$ 0.45 t/ha
Innovation extension and adoption—Northeast China

**Crop species**

<table>
<thead>
<tr>
<th>Year</th>
<th>Maize</th>
<th>Sorghum</th>
<th>Millet</th>
<th>Soybean</th>
<th>Peanut</th>
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<tbody>
<tr>
<td>2001</td>
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<tr>
<td>2018</td>
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- Precipitation WUE: ↑ 14%-19%
- Soil erosion: ↓ 36%-43%
- WUE by maize and peanut intercropping: ↑ 19%

**Agrotechnologies**

- Intercropping improving resource efficiency
- Straw mulching preventing soil erosion
- Deep tillage increasing soil water storage

Deep plowing combined tillage machine
Patent NO.: ZL201521003694.6
Innovation extension and adoption—Northwest China

Crop species

- Wheat
- Maize
- Potato
- Oilseed rape

- 2001
- 2018

Optimized planting density utilizing resources more efficiently

Furrows and ridges plastic mulching collection more rainfall

Green manure during fallow periods increasing soil health

Precipitation WUE: 73.2%

Soil water storage: 20-30 mm (before seeding)

Spring maize WUE: ~40.35 kg/mm·ha

With a maximum of: 54.6 kg/mm·ha
Innovation extension and adoption—North China Plain

**Crop species**

<table>
<thead>
<tr>
<th>Year</th>
<th>Wheat</th>
<th>Maize</th>
<th>Peanut</th>
<th>Soybean</th>
<th>Cotton</th>
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<tbody>
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<td>2001</td>
<td>100%</td>
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<td>0%</td>
<td>0%</td>
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<tr>
<td>2018</td>
<td>40%</td>
<td>60%</td>
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**Agrotechnologies**

- **Deficit irrigation and reduced water input**
- **Drip irrigation with fertilizers increasing resource use efficiency**
- **Deep tillage improving soil physiochemical properties**

Irrigation water ↓ 750 m³/ha

Winter wheat WUE ↑ ~10%
Your valuable comments and suggestions are highly appreciated.