Detailed findings of the East Asia Component of the CSAM Research and workplan of the pilot in China

Dr. He Jin
Professor, China Agricultural University
Conservation Tillage Research Center (CTRC), MoA, PRC
Email: hejin@cau.edu.cn

Regional Workshop of Integrated Straw Management in Asia and the Pacific
12-14 December 2017, Kathmandu, Nepal
Acknowledgements

- Center for Sustainable Agricultural Mechanization (CSAM)
- United Nations Economic and Social Commission for Asia and the Pacific
- Partners from East Asia Countries
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Status of Crop Straw Resources in East Asia
The three most cereal production countries in 2014: **China** (559Mt), **Japan** (12Mt) and **KOR** (6Mt).

Source: FAOSTATE, 2014
2. Main crop production in East-Asia

- The maximum three cereals in 2014: *Rice, Maize, Wheat*;
- Crop straw yield: **291, 447, 177 Mt**, respectively

Straw yield was calculated by the ratio of straw-grain: wheat-1.38; maize-2.05; rice-1.28

*Source: FAOSTATE, 2014*
### 3. Crop straw production (Mt) in China

<table>
<thead>
<tr>
<th>Crop</th>
<th>Straw-grain ratio</th>
<th>2010 Grain</th>
<th>Straw</th>
<th>2011 Grain</th>
<th>Straw</th>
<th>2012 Grain</th>
<th>Straw</th>
<th>2013 Grain</th>
<th>Straw</th>
<th>2014 Grain</th>
<th>Straw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>1.28</td>
<td>197</td>
<td>252</td>
<td>203</td>
<td>260</td>
<td>206</td>
<td>264</td>
<td>205</td>
<td>262</td>
<td>208</td>
<td>266</td>
</tr>
<tr>
<td>Wheat</td>
<td>1.38</td>
<td>115</td>
<td>159</td>
<td>117</td>
<td>161</td>
<td>121</td>
<td>167</td>
<td>122</td>
<td>168</td>
<td>126</td>
<td>174</td>
</tr>
<tr>
<td>Maize</td>
<td>2.05</td>
<td>178</td>
<td>365</td>
<td>193</td>
<td>396</td>
<td>206</td>
<td>422</td>
<td>219</td>
<td>449</td>
<td>216</td>
<td><strong>443</strong></td>
</tr>
<tr>
<td>Potatoes</td>
<td>1.16</td>
<td>82</td>
<td>95</td>
<td>88</td>
<td>102</td>
<td>93</td>
<td>108</td>
<td>96</td>
<td>111</td>
<td>96</td>
<td>111</td>
</tr>
</tbody>
</table>

**Source:** Yuyun Bi et al., 2010; FAOSTATE, 2014

Most crop straw: **maize**

**Distribution**
- Yangtze valley; South China; Southwest region; North-China plain; Northeast region; Yellow River valley

- **Others** 10.5%
- **Maize** 39.8%
- **Rice** 24%
- **Wheat** 15.7%
- **Potato** 10%
## Crop straw production (Mt) in Japan

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>1.28</td>
<td>10.6</td>
<td>13.6</td>
<td>10.5</td>
<td>13.4</td>
<td>10.7</td>
<td>13.6</td>
<td>10.8</td>
<td>13.8</td>
<td>10.5</td>
<td>13.5</td>
</tr>
<tr>
<td>Wheat</td>
<td>1.38</td>
<td>0.6</td>
<td>0.8</td>
<td>0.7</td>
<td>1.0</td>
<td>0.8</td>
<td>1.2</td>
<td>0.8</td>
<td>1.1</td>
<td>0.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Potatoes</td>
<td>1.16</td>
<td>2.2</td>
<td>2.6</td>
<td>2.4</td>
<td>2.8</td>
<td>2.5</td>
<td>2.9</td>
<td>2.4</td>
<td>2.8</td>
<td>2.5</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Most crop straw: rice

Resource: http://www.maff.go.jp/e; FAOSTATE, 2014
### Crop straw production (Mt) in KOR

#### Distribution

<table>
<thead>
<tr>
<th></th>
<th>Jeonnam; Chungnam; Jeonbuk; Gyeongnam</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Others</strong></td>
<td>5.4%</td>
</tr>
<tr>
<td><strong>Rice</strong></td>
<td>86.4%</td>
</tr>
<tr>
<td><strong>Potato</strong></td>
<td>8.2%</td>
</tr>
</tbody>
</table>

#### Crop straw production (Mt)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>1.28</td>
<td>5.81</td>
<td>7.44</td>
<td>5.62</td>
<td>7.19</td>
<td>5.41</td>
<td>6.92</td>
<td>5.63</td>
<td>7.21</td>
<td>5.64</td>
<td><strong>7.22</strong></td>
</tr>
<tr>
<td>Potatoes</td>
<td>1.16</td>
<td>0.62</td>
<td>0.72</td>
<td>0.62</td>
<td>0.72</td>
<td>0.61</td>
<td>0.71</td>
<td>0.73</td>
<td>0.85</td>
<td>0.59</td>
<td>0.68</td>
</tr>
</tbody>
</table>

**Most crop straw: rice**

Status of straw management in East Asia
Currently, crop straw is mainly used as fertilizer, fodder, new energy resource, base stock and industry material.
1. Current Situation of Straw Management in China

1. Used as fertilizer

- Directly returning into field

Straw used as fertilizer accounts for 43.2% of the total straw utilization.
1. Current Situation of Straw Management in China

1. Used as fertilizer

Indirectly returning into field

Carbonized straw returning
Pre-decomposed straw returning
Manure straw returning

Straw used as fertilizer accounts for 43.2% of the total straw utilization.
2. Used as fodder

Coarse fodder

Processed fodder

Used as fodder: accounts for 18.8% of the total utilization of straw.

3. Used as new energy resource

The number of straw gasification fuel, biogas and briquette companies

Used as new energy resource: occupies 11.4% of total straw usage.
4. Used as base material: only accounted for a small fraction of all the crop straw.

5. Used as industry material:
   - Paper
   - Knit
   - Sheet
   - 3D printing

China: the straw pulp can occupy >30% of total paper pulp in the country.
2. Current Situation of Straw Management in Japan

1. Used as fertilizer

- Straw directly returning to field
- Straw indirectly returning to field

- Straw used as fertilizer accounts for about **55%** of the total straw utilization.
- For **rice** straw, **75.9%** is mixed with soil and **6.4%** is made into manure.
2. Used as fodder

In Japan, rice straw used as fodder accounts for 10.3% and most fodder use straw was coarse fodder.

3. Used as new energy resource

In Japan, straw is mainly used as ethanol for energy.

Using straw to produce ethanol

Silage harvester
4. Used as industry material

- In Japan, rice straw for industry utilization accounted for 0.7%.
- Straw is thatched around wooden frames, and the actual number of straw bale buildings in Japan increases every year.
In Republic of Korea, about 45.7% of the rice straw used as fertilizer.

24.39 Mt of rice straw directly returned to field after chopping.

In Republic of Korea, rice straw used as fodder accounts for 20.8%, and most fodder use straw was silage.
## Beneficial Impacts

<table>
<thead>
<tr>
<th>Sites</th>
<th>Straw type</th>
<th>Straw management pattern</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>Maize</td>
<td>Directly returning to field</td>
<td>Increase yield; Increase net income</td>
</tr>
<tr>
<td></td>
<td>Wheat</td>
<td>Directly returning to field</td>
<td>Enhance soil fertility; Saved cost; Avoided the environment pollution.</td>
</tr>
<tr>
<td>Japan</td>
<td>Rice</td>
<td>Directly returning to field</td>
<td>Reduce greenhouse gas emission; Increase soil carbon sequestration.</td>
</tr>
<tr>
<td></td>
<td>Rice</td>
<td>Solidification molding</td>
<td>Prolong the relevant industries chain; Achieve multiple value-added income.</td>
</tr>
<tr>
<td>KOR</td>
<td>Rice</td>
<td>Extract ethanol</td>
<td>Rice straw used for ethanol can reduce the production cost compared to grain.</td>
</tr>
</tbody>
</table>
Workplan for Integrated Straw Management in China
Option 1. Four ways to use as fertilizer

1. Soil covered with straw

Typical technological process includes:

- **Harvesting**
- **Chopping and mulching**
- **No-till seeding**

**Typical steps:**

- **Chopping**
- **Seeding**

- Flail chopper
- Reciprocating-cutting chopper
- No/minimum -till seeder
Typical technological process includes:

1. Harvesting
2. Chopping and Mixing
3. Seeding

2. Straw mixed with soil

Typical steps:

- Tillage
- Seeding

Horizontal roto-tiller  Vertical roto-tiller  Seeder
Typical technological process includes:

- **Harvesting**
- **Chopping and ploughing**
- **Seeding**

3. Straw buried with soil

**Typical steps:**

- **Ploughing**
- **Seeding**

- **Plough**
- **Plough-rotary combined tiller**
- **Conventional Seeding**
Typical technological process includes:

- Harvesting
- Fodder
- Feeding stock
- Excrement
- Fertilizer spreading

Typical steps:

- Fertilizer spreading
- Side spreading
- Back spreading
Option 2. Used as fodder

Typical technological process includes:

- Collecting straw
- Processing
- Feeding

- Wheat straw
- Maize straw
- Briquetting
- Silken
- Feeding sheep
- Feeding cow
Typical steps:

**Harvesting**
- Self-propelled silage harvester

**Processing**
- Silken machine
- Briquetting machine
Research and Demonstration in China
1. Scientific research

a. Effect of the straw management

Management

- Direct returning
- Indirect returning

Effect

- Soil properties
- Crop

Physical properties
- Moisture content, Soil temperature
- Water stable aggregates, Bulk density

Chemical properties
- SOM, N, P, K

Crop yield
- Emergence rate, plant height, yield

- Straw mulching
- Straw mixing
- Straw burying
- Livestock excrement returning
## 1. Scientific research

### b. Improvement of technological process for straw returning

#### Straw mulching
1. Chop: supported/slide cutting
2. Chopping and spreading straw uniformly
3. Chopping while decomposition

#### Straw burying
1. Buried with plough
2. Ditch-buried returning
3. Combine of plough and rotary-till

#### Straw mixing
1. Rotary till-horizontal type
2. Rotary till-vertical type

#### Livestock excrement returning
- Biogas slurry/residue
1. Scientific research

c. Improvement of supporting equipments

- Chopper
- Chopper cum spreader
- Plow
- Vertical harrow
- No-till seeder
- Traditional seeder

➢ Combine of agronomy and agricultural equipment
2. Demonstration

Recommended partner

China Agricultural University

Partner advantages

- Rich experience of straw management
- Experts and well trained staffs, master and PhD students
- Relevant instrument and equipment
- Good relationship with local agricultural institutes, farms, etc
- …..
2. Demonstration

Recommended pilot: Qingdao

- Annual double cropping areas (Wheat-Maize), North-China Plain
- Huge amounts of straw
- Urgent for subsequent seeding
- Good economic condition support

Recommend partner: Agricultural Machinery Bureau of Qingdao

- Local policy support
- Long-term sites
- Machines
- Experiences in straw management (Used as fertilizer, fodder)
Sites that we can select in Qingdao

High yield/efficiency straw management

Advantages:
- Integration of water and fertilizer
- Area is >100ha
- Well trained farmers, equipment, agricultural cooperative

Combine farming and animal husbandry

Advantages:
- More than 200 head of cattle
- Area is >100ha
- Well trained farmers, equipment, agricultural cooperative

Long–term conservation agriculture

Advantages:
- Long–term CA since 2009
- Area is >100ha
- Well trained farmers, equipment, agricultural cooperative
Thanks !