Detection Technology of Combine Harvester and Loss Reduction of Mechanized Harvesting in China

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National Codes
Current national standards

**Product technical standard**

GB/T 8097  Equipment for harvesting-Combine harvesters-Test procedure
GB/T 20790  Technical requirements for head-feed combine harvester
JB/T 5117  Whole-feed combine harvester-Technical requirement
JB/T 6287  Reliability determination test methods for grain combine harvesters
GB/T 21962  Corn combine harvester
DG/T 014  Grain combine harvester
DG/T 015  Corn combine harvester

**The main contents** : Terms and definitions of combine harvesters, technical requirements, field performance test methods, production capacity test methods
Current national standards

Safety requirement

GB  10395.1  Agricultural and forestry machinery Safety Part 1:General requirements
GB  10396  Tractor, machinery for agriculture and forestry, powered lawn and garden equipment-Safety signs and hazard pictorials-General principles
DG/T  014  Grain combine harvester
DG/T  015  Corn combine harvester

The main contents  Combine harvester’s safety protection, safety equipment, safety performance (braking, noise, etc) and safety information (safety signs)
<table>
<thead>
<tr>
<th>Grain combine harvester</th>
<th>Types of machinery</th>
<th>Large</th>
<th>Medium</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole-feed combine harvester</td>
<td>Wheeled</td>
<td>a≥5.0</td>
<td>2.0≤a&lt;5.0</td>
<td>a&lt;2.0</td>
</tr>
<tr>
<td></td>
<td>Tracked</td>
<td>a≥4.0</td>
<td>1.5≤a&lt;4.0</td>
<td>a≤1.5</td>
</tr>
<tr>
<td>Head-feed combine harvester</td>
<td>Number of working rows</td>
<td>b≥5</td>
<td>2≤b&lt;4</td>
<td>b≤2</td>
</tr>
</tbody>
</table>

Whole-feed combine harvester, Tracked
Rating throughput: 5kg/s

Whole-feed combine harvester, wheeled
Rating throughput: 10kg/s

Head-feed combine harvester, Tracked
Working rows: 2 rows
Size division of combine harvester

<table>
<thead>
<tr>
<th>Corn combine harvester</th>
<th>Types of machinery</th>
<th>Large</th>
<th>Medium</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>maize head working width $b$ (cm)</td>
<td>$b \geq 280$</td>
<td>$160 &lt; b &lt; 280$</td>
<td>$b \leq 160$</td>
<td></td>
</tr>
</tbody>
</table>

- **Picking and peeling maize ear, self-propelled**
  - Harvest 5 rows, head working width: 201cm

- **Corn grain harvester, self-propelled**
  - Harvest 5 rows, head working width: 290cm

- **Picking maize ear, suspend**
  - Harvest 2 rows, head working width: 120cm
Detection technology
Main testing items of combine harvester

For combine harvester, the working performance indicators concerned are total loss rate, impurity rate and broken rate.

Tab 1 working performance in China

<table>
<thead>
<tr>
<th>standard requirements</th>
<th>Item</th>
<th>wheat</th>
<th>rice</th>
<th>maize ear harvester</th>
<th>maize threshing harvester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>total loss rate %</td>
<td>≤ 1.2</td>
<td>≤ 2.8</td>
<td>≤ 4</td>
<td>≤ 5</td>
</tr>
<tr>
<td></td>
<td>impurity rate %</td>
<td>≤ 2.0</td>
<td>≤ 2.0</td>
<td>≤ 1</td>
<td>≤ 5</td>
</tr>
<tr>
<td></td>
<td>broken rate %</td>
<td>≤ 1.0</td>
<td>≤ 1.5</td>
<td>≤ 1.5</td>
<td>≤ 3</td>
</tr>
</tbody>
</table>

caution: The above indicators are under the premise that the test conditions meet the standard requirements, including ratio between straw and grain, grain moisture content, lowest height of spicas, etc.
Main testing items of grain combine harvester

• Key operational indicator---Total loss

In Chinese combine harvester detection method, total loss includes process loss and gathering loss.

process loss----during the harvest process, grain loss due to threshing, separating and cleaning.

gathering loss----during the harvest process, grain loss due to falling of headers or other feeding devices.
How to detect the loss rate of combine harvester

- Taking Whole-feed combine harvester as an example

**Step 1**

- **Test area**: Length $\geq 25$ m
- **Test conditions**: basic conditions of crops and fields, including soil moisture content, ratio between straw and grain, grain moisture content, lowest height of spicas, etc.

According to the test results, determine whether the test area and test conditions meet the standard requirements. *(Satisfied continue, dissatisfied need to re-select)*
How to detect the loss rate of combine harvester

• Taking Whole-feed combine harvester as an example

Step 2

➢ Test process: recording operating time, receiving all discharge from machine (including collecting grain and stem samples).

1 person: recording time through the test area with a stopwatch

2-4 persons: using a sample-cloth to receive all grains and stems from machine through the test area, and weigh the collected samples with an electronic scale
Combine harvester detection field process
• Taking Whole-feed combine harvester as an example

**Step 3**

- **Result calculation:** throughput $Q$, process loss rate $S_t$, gathering loss rate $S_g$

$$Q = \frac{W_v}{T}$$

- $Q$ — Throughput, unit: kg/s
- $W_v$ — Total Mass of Grains, Stem and Cleaning Effluents Receiving by test area, unit: kg
- $T$ — Time through the test area, unit: s
How to detect the loss rate of combine harvester

• Taking Whole-feed combine harvester as an example

Step 3

➢ Result calculation: process loss rate $S_t$, gathering loss rate $S_g$

$$S_t = \frac{W_w + W_f + W_q}{W} \times 100\%$$

$$W = W_c (1 - Z_\tau) + W_w + W_f + W_q$$

$S_t$ — process loss rate;
$W_w$ — the underthreshing loss of grain weight, unit: g;
$W_f$ — the separation loss of grain weight, unit: g;
$W_q$ — the cleaning loss of grain weight, unit: g;
$W$ — The total mass of grains in the test area, unit: g;
$W_c$ — The total mass of all discharges from machine outlets, unit: g.
How to detect the loss rate of combine harvester

• Taking Whole-feed combine harvester as an example

Step 3

➢ Result calculation: process loss rate $S_r$, gathering loss rate $S_g$

\[
S_g = \frac{W_{gs} (B \times L)}{W} \times 100\% 
\]

- $S_g$—gathering loss rate;
- $W_{gs}$—actual loss per square meter of header, unit: g;
- $B$—average actual working width, unit: m;
- $L$—Test area: Length of the test area, unit: m

Total loss rate:

\[
S = S_r + S_g
\]
3

Suggestions
Government attaches importance to food loss

Promoting the loss reduction of grain crop machinery constantly. The national agricultural and rural system has widely organized and carried out large-scale training, publicity and competition activities for machine harvest reduction.
Machine loss reduction work in China

The video-competition activity for machine harvest reduction in Guangdong
Machine loss reduction work in China

➢ Strengthen the machine operator training

The technical level and professionalism of combine harvester drivers directly determine the quality of harvesting operations. Organization to carry out professional agricultural machinery hand training action, improve the operator's operating ability and reduce the food loss by machine-harvesting.
Publishing operation technical specifications

For guide the operators to reduce food loss when harvesting operations, publisheing the technical guidance of mechanized harvesting and loss reduction of rice, wheat and maize successively.
Main measures to reduce food Loss

1. Choosing suitable harvest time
wheat & rice: between the end of waxy maturity and the initial stage of complete ripeness

2. Adjusting harvester parameters
During the operation, should choose the appropriate operating parameters, and according to the different natural conditions and crop conditions to adjust the machine in a timely manner, so that the combine harvester to maintain good working condition, reduce machine loss, improve the quality of operation.

3. Selecting operation route and operation speed
During the operation, the machine should be flexibly selected according to the actual situation of the field. It is convenient and fast to unload the grain and minimize the empty line of the machine. Try to keep driving straight when working. According to field conditions and crop conditions, choose the right operation speed.
The Combine Harvester testing for reducing food losses is very important.

- Formulate reasonable detection methods and detection indicators, ensuring that combine harvesters are tested for efficiency helps achieve food security.

- Using the test results, feedback to the combine harvester production enterprises, promote them to improve product quality, to achieve the purpose of reducing food losses gathering loss.