Overview of Korean Test code for Combine Harvesters

ANTAM Webtraining on Testing of Combine Harvester
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KOrea Agriculture Technology promotion Agency
CONTENTS OF TEST METHODS FOR COMBINES

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9. Convenience for operator
10. Safety Requirements
SCOPE

Test procedure and requirements for self-propelled head feeding type and whole feeding type combine harvesters

Head feeding type for rice

Whole feeding type for Soybean, barley, Rapeseed

TERMINOLOGY

Terminology regarding Grain loss and damaged grain e.t.c. is defined
Verifying the mechanism, dimensions, materials and accessories of the combine harvester.

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Dimensions</th>
<th>Engine</th>
<th>Header</th>
<th>Feeding System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length w/o header to auger end, mm</td>
<td>Rated power, kW</td>
<td>Header widths, m</td>
<td>Number of chains</td>
</tr>
<tr>
<td></td>
<td>Height in transport, mm</td>
<td>Maximum power, kW</td>
<td>Cut frequency, strokes/min</td>
<td>Slat design</td>
</tr>
<tr>
<td></td>
<td>Weight with tires, kg</td>
<td>Number of cylinders</td>
<td></td>
<td>Reverser drive type</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Piston displacement, L</td>
<td></td>
<td>Torque-sensing drive available</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rated speed, rpm</td>
<td></td>
<td>Housing lateral float available</td>
</tr>
</tbody>
</table>

<p>| Threshing &amp; Separating System         | Number of threshing cylinders                                            | Cylinder width, mm                                                    |                                                                    |                                                                              |
|                                       |                                                                           | Cylinder speed rpm, diameter                                          |                                                                    |                                                                              |
|                                       |                                                                           | Cylinder speed control                                                |                                                                    |                                                                              |
|                                       |                                                                           | Concave wrap angle, °                                                 |                                                                    |                                                                              |
|                                       |                                                                           | Concave area, m²                                                      |                                                                    |                                                                              |
|                                       |                                                                           | Beater speed rpm, diameter                                            |                                                                    |                                                                              |
|                                       |                                                                           | Separating cylinder width, mm                                         |                                                                    |                                                                              |
|                                       |                                                                           | Separating cylinder diameter, mm                                      |                                                                    |                                                                              |
|                                       |                                                                           | Total separating area, m²                                              |                                                                    |                                                                              |
| Separating Straw Walkers              | Number of straw walkers                                                  |                                                                        |                                                                    |                                                                              |
|                                       |                                                                           | Number of walker steps                                                |                                                                    |                                                                              |
|                                       |                                                                           | Straw walker length, m                                                |                                                                    |                                                                              |
|                                       |                                                                           | Straw walker area, m²                                                 |                                                                    |                                                                              |</p>
<table>
<thead>
<tr>
<th>Cleaning System</th>
<th>Grain Handling System</th>
<th>Power Train</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling system</td>
<td>Tailing elevator type</td>
<td>Drive type/number of gears</td>
</tr>
<tr>
<td>Total sieve area, m²</td>
<td>Clean grain elevator type</td>
<td>Ground speed, km/h</td>
</tr>
<tr>
<td>Total cleaning area, m²</td>
<td>Grain tank capacity, L</td>
<td>Transport speed, km/h</td>
</tr>
<tr>
<td>Fan type</td>
<td>Tank unloading rate, L/s</td>
<td>Brakes, turning against</td>
</tr>
<tr>
<td>Fan speed, rpm</td>
<td>Unloading auger length, m</td>
<td>Brakes parking</td>
</tr>
<tr>
<td></td>
<td>St’d unloading height, m</td>
<td>Final drive type</td>
</tr>
<tr>
<td>Grain Handling System</td>
<td>Steering</td>
<td>Tread width, adjustable axle, mm</td>
</tr>
<tr>
<td>Tailing elevator type</td>
<td></td>
<td>Tread width, rear wheel assistance, mm</td>
</tr>
<tr>
<td>Clean grain elevator type</td>
<td>Standard steering type</td>
<td></td>
</tr>
<tr>
<td>Grain tank capacity, L</td>
<td>Turning radius, mm</td>
<td></td>
</tr>
<tr>
<td>Tank unloading rate, L/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unloading auger length, m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>St’d unloading height, m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop Residue Disposal</td>
<td>Tires</td>
<td>Drive tire size</td>
</tr>
<tr>
<td>Straw chopper</td>
<td></td>
<td>Steering tire size</td>
</tr>
<tr>
<td>Straw spreader</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chaff spreader</td>
<td>Cab</td>
<td>Operator seat suspension</td>
</tr>
<tr>
<td>Quick switches chopping/swathing</td>
<td></td>
<td>Instructor/passenger seat</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control, position</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heating, Automatic air conditioning</td>
</tr>
</tbody>
</table>
## General Conditions for Field Test

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Check and Report</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crop</strong></td>
<td></td>
</tr>
<tr>
<td>▪ Good condition (uniform, normal MOG:G ratio, free of disease-weeds, standing, matured, moisture content of rice ≥ 20% w.b.)</td>
<td>Variety, maturity, disease, plant height, Max·min ground height of grain, moisture content of grain, grain weight per stem, populations (row·hill distance, rice stems/hill, plants/m²), stem angle, pre-cut loss, others</td>
</tr>
<tr>
<td><strong>Field</strong></td>
<td></td>
</tr>
<tr>
<td>▪ Fairly flat and no serious surface irregularities</td>
<td>Flatness, surface regularity, dryness, soil hardness, weeds, others</td>
</tr>
<tr>
<td><strong>Atmosphere</strong></td>
<td></td>
</tr>
<tr>
<td>▪ Preferable and stable</td>
<td>Temperature, humidity, wind</td>
</tr>
<tr>
<td><strong>Machine</strong></td>
<td></td>
</tr>
</tbody>
</table>
| ▪ Optimum setting  
▪ Adjustment of the threshing, separating, clean mechanisms shall be permitted only between test series | Selected forward range/gear, adjustment position of each part, others |
| **Operator** | | |
| ▪ Well-experienced  
▪ Adequate time for adjusting | Operator and guider, and their roles |
### Conditions for Grain loss, purity, damage test

<table>
<thead>
<tr>
<th>Combine operation</th>
<th>Test Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ 3 test series per ground speed levels: Min(0.4m/s), Mid, Max</td>
<td>▪ Length of test run - Load stabilizing section: ≥20m - Measuring section: ≥10m - After catch: ≥10m</td>
</tr>
<tr>
<td>▪ Replicate at least 3 test runs for each 3 test series, respectively</td>
<td>▪ Harvest full working width</td>
</tr>
</tbody>
</table>

![Diagram showing test section lengths and harvest area](image)

- Load Stabilizing Section
- Measuring Section
- Head Loss test section
- Uncut Crop

Lengths:
- Load stabilizing section: ≥20m
- Measuring section: ≥10m
- After catch: ≥10m

Harvest full working width.
A typical materials flow in Combine harvester

<table>
<thead>
<tr>
<th>Harvested crop</th>
<th>Grain</th>
<th>Straw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain, chaff and short straw</td>
<td>Returns</td>
<td>Chaff</td>
</tr>
</tbody>
</table>

< Source: Combine Harvesters, Petre Miu >
Before harvesting, remove pre-harvest losses in the head loss test section for measuring header loss.

When harvesting,

**Operator**
- Drive ground *speed constantly*, stubble height ≤ 10cm

**Speed checker**
- Measure the ground speed

**Supervisor**
- Check all *machine behavior*
- Safety First control.

**Dust man**
- Catch whole efflux *continuously without interruption*
- Catch straw outlet, sieve outlet separately
### Head Losses, Cleaning and Separating the Losses in the catches

<table>
<thead>
<tr>
<th>Head Losses</th>
<th>Losses in sieve catch</th>
<th>Losses in straw catch</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gather</strong> grains in 3 each loss test area (W x L 1m)</td>
<td><strong>Gather</strong> the loose grains from the sieve catch</td>
<td><strong>Gather</strong> the loose grains from the straw catch</td>
</tr>
<tr>
<td>- loose grains</td>
<td><strong>Separate</strong></td>
<td><strong>Separate</strong></td>
</tr>
<tr>
<td>- grains in the head/husk/stem cut</td>
<td>- Rice, Barley: grains in the head</td>
<td>- Rice: grain attached to the straw <strong>after passing drum</strong></td>
</tr>
<tr>
<td>- grains in the stem uncut</td>
<td>- Bean: grains in the husk</td>
<td>- Soybean: grain remaining in the husk</td>
</tr>
<tr>
<td><strong>Convert</strong> to total head losses of the measuring section by multiplying</td>
<td></td>
<td>- Barley: grain remaining in the head</td>
</tr>
<tr>
<td>the area ratio</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Gather grains in 3 each loss test area (W x L 1m)
2. Lose grains
3. Grains in the head/husk/stem cut
4. Grains in the stem uncut
5. Convert to total head losses of the measuring section by multiplying the area ratio

- Rice, Barley: grains in the head
- Bean: grains in the husk
- Rice: grain attached to the straw **after passing drum**
- Soybean: grain remaining in the husk
- Barley: grain remaining in the head
Kinds of Losses and catch positions

Grain Losses

Header Losses
- Loose grain
- Grain in the head/ear/husk/stem cut
- Grain in the stem uncut

Uncleaned Losses (Loose grains)
- Head feeding: Loose grain contained in the efflux from the sieves + from straw catch
- Whole feeding: Loose grain contained in the efflux from the sieves + Loose grain passed from the combine with the straw

Unthreshed Loss
- Head feeding: Grain attached to the straw after passing drum in straw catch and grain in head in sieve catch
- Whole feeding: Grain remaining in the ear or husk after passing drum in straw catch and sieve catch

Caught from
- Ground
- Sieve outlet
- Straw outlet
Estimation of the Total weight of grains and Grain losses

- Total weight of grains from measured section consists of:
  - Estimated weight of grains unloaded harvested from the measurement section, excluding impurities, calculated by multiplying the area ratio
  - Weight of head losses grain
  - Weight of unthreshed losses grain
  - Weight of uncleaned losses grain

- **Total Loss,% = Head losses + Unthreshed losses + Uncleaned losses**

- Head losses,% = \( \frac{\text{Weight of head loss grains}}{\text{Total weight of grains from the measurement section}} \times 100 \)

- Unthreshed losses,% = \( \frac{\text{Weight of unthreshed loss grains}}{\text{Total weight of grains from the measurement section}} \times 100 \)

- Uncleaned losses,% = \( \frac{\text{Weight of uncleaned loss grains}}{\text{Total weight of grains from the measurement section}} \times 100 \)

The Total Loss shall be less than: rice 2%, barley 2%, soybean 3%.
▪ Unload the harvest from whole test run (pre-section + measuring section + post-section)

▪ Measure the unloaded weight

▪ Measure the moisture content of the grain

▪ Sample ≥300g for grain analysis

▪ Sort the sample
- Damaged grains: broken + crushed + dehulled rice
- Impurities: broken straw, leaves, e.t.c.

▪ Damaged grain or impurities,%=100 × 

Weight of damaged grain or impurities

Total weight of sample including damaged grain and impurities

▪ Damaged grain shall be less than rice 1%, barley 1%, soybean 2%
▪ Rubbish shall be less than rice 1%, barley 1%, soybean 3%
Purpose
To test field work rate, mean ground speed, machine behavior, fuel consumption, e.t.c. in continuous harvesting.

Test conditions
- The combine should be operated at speed which can attain the best work rate.
- The size of field shall be larger than 20a (80m x 25m)

Procedure for rating the combine
1) When harvesting, work rate, and machine behavior, e.t.c. shall be tested.

\[
\text{Rate of work (a/h)} = \frac{\text{Area covered (a)}}{\text{Work time (min)}} \times 60
\]

*work time = cutting + turning + unloading time (excluding moving time for unloading)

\[
\text{Grain harvesting rate (t/h)} = \frac{\text{Total eight of harvested grain unloaded (t)}}{\text{Work time (min)}} \times 60
\]
2) **Ground speed** at the minimum of three tests between 20 m distance.

3) **Fuel consumption** measured by filling and weighing method

4) **Stubble height** shall be less than 10 cm

5) **Machine behaviors** shall be observed

6) **Damaged grain** shall be analyzed as in the quality of work test.

---

**Performance Requirements**

1) Height of stubble of barley and soybean shall be less than 10cm,

2) Damage grain shall be less than: barley 1%, soybean 2%

3) No malfunction shall be observed.
Adaptability for the laid rice
- in 4 directions of lateral left, lateral right, forward, backward direction
- in each 4 laid area larger than 10m x 10m
ENGINE PERFORMANCE

  - Tests the crankshaft output power with its fuel consumption.
  - Tests max. power test, full load and varying speed, and part load at varying load.

* Engine rated power output above 19kW requires Stage V emission certificate.
Convenience test

- Ease of access to driving position
- Accessibility and ease of operation of controls
- Ease of adjustment and routine maintenance
- Cleaning out combine
- Accessibility and number of grease points
- Others

Noise level test at the driving position

- Measurement when harvesting in maximum ground speed
- Microphone shall be face forward, position of center:
  - 250 mm to the side of the median plane of the seat
  - 700 mm above, 100 mm forward of the seat index point.
Safety mechanism
- The cutter bar shall not be operated without the operation of threshing parts.
- For head feeding type, emergency stop shall be located near the threshing input part.

Safety devices
- Automatical power cuts off the cutting part when clogged with rice straw, etc.
- For lifting part, mechanical supports or hydraulic locking devices shall be provided to prevent inadvertent lowering.

Warnings: grain tank full, flow of materials clogged, backward moving.

Lateral Stability: Left/right side overturning angle shall be above 30° on the tilt table.

Others:
- Observing of the grain level shall be possible from outside the grain tank.
- On the vehicle chassis, year of manufacture shall be marked according to ‘ISO 3779:2018 Vehicle identification number’.
Thank you very much for your attention!