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Equipment for harvesting — Combine harvesters — Test procedure

Matériel de récolte — Moissonneuses-batteuses — Méthode d'essai



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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8210 was prepared by Technical Committee **ISO/TC 23, *Tractors and machinery for agriculture and forestry***.

Annex A forms an integral part of this International Standard.

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International Organization for Standardization

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Equipment for harvesting — Combine harvesters — Test procedure

1 Scope

This International Standard specifies a test procedure for combine harvesters; it applies to all types of combine harvesters.

The test procedure specified in this International Standard deals with the measurement and testing of combine harvesters, either of self-propelled or trailed type, either directly cutting the crop or picking it up from a wind-row, for use in several crops. It indicates terminology and methods to be used for measuring important characteristics of combines. It includes both functional and capacity tests, i.e. those conducted over an extended period when ease of operation, ease of adjustment, rate of work and general operating characteristics may be assessed, and those carried out on specific occasions for the determination of grain loss and capacity characteristics.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 500 : 1979, *Agricultural tractors — Power take-off and drawbar — Specification.*

ISO 789-3 : 1982, *Agricultural tractors — Test procedures — Part 3 : Turning and clearance diameters.*

ISO 789-6 : 1982, *Agricultural tractors — Test procedures — Part 6: Centre of gravity.*

ISO 3600 : 1981, *Tractors and machinery for agriculture and forestry — Operator manuals and technical publications — Presentation.*

ISO 3767-1 : 1982, *Tractors and machinery for agriculture and forestry, powered lawn and garden equipment — Symbols for operator controls and other displays — Part 1: Common symbols.*

ISO 3767-2 : 1982, *Tractors and machinery for agriculture and forestry, powered lawn and garden equipment — Symbols for operator controls and other displays — Part 2 : Symbols for agricultural tractors and machinery.*

ISO 3789-1 : 1982, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Location and method of operation of operator controls — Part 1: Common controls.*

ISO 3789-2 : 1982, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Location and method of operation of operator controls — Part 2 : Controls for agricultural tractors and machinery.*

ISO 3965 : 1977, *Agricultural wheeled tractors — Determination of maximum travel speed.*

ISO 4254-1 : 1989, *Tractors and machinery for agriculture and forestry — Technical means for ensuring safety — Part 1 : General.*

ISO/TR 5007 : 1980, *Agricultural wheeled tractors — Operator seat — Measurement of transmitted vibration.*

ISO 5131 : 1982, *Acoustics — Tractors and machinery for agriculture and forestry — Measurement of noise at the operator's position — Survey method.*

ISO 5687 : 1981, *Equipment for harvesting — Combine harvester — Determination and designation of grain tank capacity and unloading device performance.*

ISO 5697 : 1982, *Agricultural and forestry tractors and machinery — Determination of braking performance.*

ISO 5702 : 1983, *Equipment for harvesting — Combine harvester component parts — Equivalent terms.*

ISO 6095 : - ¹⁾, *Agricultural machinery — Self-propelled combine harvesters — Operator's workplace and ergonomics.*

ISO 6689 : 1981, *Equipment for harvesting — Combines and functional components — Definitions, characteristics and performance.*

3 Definitions

For the purposes of this International Standard, the terms and definitions given in ISO 5702 and ISO 6689 and the following definitions apply.

3.1 test machine : Subject combine to be tested.

1) To be published.

3.2 comparison machine : Other machine being tested, if applicable.

3.3 test series : All the events and data comprising several test runs.

3.4 catch : Mass of any material collected during a test run.

4 General requirements

4.1 The way in which the combine was selected or obtained for testing, and the approximate duration of any running prior to test shall be stated in the test report.

4.2 The combine shall normally be operated in accordance with the manufacturer's instructions. The test report shall record and give reasons for any significant departure from them.

4.3 Commercially available accessories, as necessary or desirable for the various crops in which the combine is to be used, shall be provided.

4.4 Setting and adjustments of the machine shall be generally in accordance with the manufacturer's instruction manual: the actual settings shall be recorded and reported.

5 Characteristics of machine

5.1 Significant details

All significant details of the combine shall be established and verified in accordance with the definitions, characteristics and performance criteria laid down in ISO 6689. The terminology given in ISO 5702 and ISO 6689 shall be used.

5.2 Speeds

For self-propelled machines, measurements of the speed of any component shall be made under "no-load" conditions with the governor control lever set in the normal working position corresponding to the required working machine regime.

For PTO (power take-off) driven machines, these speeds shall be measured at standard PTO rotational frequency ($540 \text{ min}^{-1} \pm 10 \text{ min}^{-1}$ or $1000 \text{ min}^{-1} \pm 25 \text{ min}^{-1}$) (see ISO 500).

Ground speeds shall be measured on a hard horizontal surface (see ISO 3965), with the governor control lever in the normal working position and the crop processing mechanism disengaged.

If the machine is fitted with stepless speed change mechanism, the maximum and minimum speeds obtained for each gear shall be measured. Otherwise, speeds obtained for all combinations of the gears shall be measured.

5.3 Position of centre of gravity

It should be specified, for the machine tested, whether it is equipped with powered rear-wheel drive or not and if it has a chopper attachment.

NOTE — This is a supplementary measurement applicable to self-propelled machines only.

The position of the centre of gravity shall be determined under the following conditions (see ISO 789-6) :

- machine : empty of crop;
- header: fully raised;
- reel : most forward position;
- fuel tank(s) : full;
- grain tank(s) : full;
- driver: simulated by a mass of 75 kg placed on the driver's seat;
- bagger platform sacks in place to represent most unstable condition of normal field operation.

5.4 Grain tank

The grain tank capacity and unloading time shall be measured in accordance with ISO 5687.

6 Functional field tests

Functional field tests shall be carried out over an extended period, e.g. several months or a complete harvesting season in a particular area, and should include as wide a range as practicable of crops, crop varieties and/or crop conditions which are important to that area.

6.1 Information to be recorded

In each field worked, the following information shall be recorded :

- a) atmospheric conditions;
- b) slope and state of ground;
- c) shape of field;
- d) height of stubble;
- e) crop : variety, condition, weed content and approximate yield;
- f) hours of work;
- g) approximate area harvested;
- h) approximate volume of fuel used.

6.2 Behaviour and performance of combine

Throughout the test period, the general behaviour and performance of the combine shall be kept under observation, and shall subsequently be reported on, with particular reference to the information outlined in 6.2.1 to 6.2.4.

6.2.1 Functional aspects

The operator shall observe and report on the following aspects of the behaviour and performance of the combine ;

- a) the efficiency of cutting, gathering and/or picking up of the crop;
- b) the occurrence of blockages;
- c) the adequacy of engine power, governor control and cooling system;
- d) the grain tank filling or bagging arrangements;
- e) the discharge of non-grain crop materials;
- f) the stability of the machine as a whole;
- g) the adequacy of the means of adjustment;
- h) the speed of response to controls of individual mechanisms;
- i) the effectiveness of grain unloading devices, particularly with moist grain;
- j) the frequency of refuelling;
- k) the particulars of circumstances limiting performance;
- l) the tractive performance in adverse conditions.

6.2.2 Comfort, convenience and safety

6.2.2.1 The degree of compliance with ISO 3767-1, ISO 3767-2, ISO 3789-1, ISO 3789-2, ISO 4254-1, ISO 5697 and ISO 6095 shall be reported.

6.2.2.2 General remarks on the ease of access to the driving position, the identification and ease of operation of the controls, the visibility of the grain tank contents, the grain unloader and the cutterbar shall also be included in the test report.

Information on the adequacy, identification and visibility of instruments shall be included in the test report along with details relating to seating comfort and freedom from vibration, noise, dust, fumes, etc.

6.2.2.3 Measurements of seat vibrations and noise level at the operator's workplace, if made, shall be in accordance with ISO 5131 and ISO/TR 5007 respectively.

6.2.2.4 The test report shall also include information on

- a) the adequacy and ease of control of cab air conditioning system, if fitted;
- b) the adequacy of lighting arrangements, particularly for working after dark;
- c) the turning radius (see **ISO 789-3**);

d) the general ease of handling, and stability of machine, when manoeuvring or driving under road conditions;

e) any hazardous features noticed and not covered by the International Standards listed in 6.2.2.1.

6.2.3 Ease of adjustment and routine maintenance

The test report shall include information on the following aspects relating to the ease of adjustment and routine maintenance :

- a) the clarity of instructions in the operator's manual (see **ISO 3600**);
- b) the ease of adjustment, particularly for changes of crop or crop conditions;
- c) the ease of changing from field condition to transport condition, and vice versa;
- d) the ease of carrying out routine maintenance operations, e.g. cleaning air filters, changing oils and filters, greasing, checking oil levels, adjusting belt tensions, etc.;
- e) the arrangements for observation of fuel level and refuelling;
- f) the cleaning out provisions for the machine, especially for changing from one crop to another, and for clearing blockages;
- g) the arrangements for cleaning out the stone trap;
- h) the time needed to install the header.

6.2.4 Repairs

Any significant failures or repairs necessary during the test period shall be reported.

7 Capacity tests

Capacity tests shall be carried out on specific occasions, under particular conditions, to determine the machine capacity as defined in the following sub-clauses. It is preferred that when the test machine is being tested, a comparison machine of established reputation be tested simultaneously and in the same manner.

7.1 Crop selection and field conditions

Capacity tests should preferably be carried out on the crops and in the conditions specified in ISO 6689. Where this requirement has not been met, the reasons for departures shall be stated in the test report.

The ground shall be as level and as even as practicable, unless tests on sloping ground, as specified in annex A, are to be carried out.

Test runs shall be made in a direction relative to the wind direction which does not interfere with the performance of the functional elements of the combine.

Crops used for tests shall be reasonably uniform, free of disease, weeds and other crops. The crops shall in general be standing well; if local climatic conditions and/or local practices lead to different conditions typical of the locality (e.g. widespread lodging or the wind-rowing of crops), the circumstances shall be stated in the test report.

7.2 Test and comparison machines

If a comparison machine is used, it shall be fully identified as to make, model, year and other pertinent information. It shall be functionally sound and shall be a machine which has been available on the open market for a continuous period of at least one year prior to the date of the test.

At the time of test, both test and comparison machines shall be in good order and the working surfaces adequately run in.

7.3 Adjustment of test and comparison machines

Both test and comparison machines shall, immediately before being tested, be adjusted for optimum performance with the same crop as will be used for the tests.

Pre-test adjustments shall aim for optimum performance with harvesting conditions typical of normal practice in the relevant locality and for equivalent, and still locally acceptable, levels of foreign material in the "clean" grain discharged from both machines. The condition of the sample shall be stated in terms of trash, broken grain and unthreshed grain.

Persons responsible for adjusting the machines shall be given adequate time and opportunity to do so, with due regard being paid to the time requirements indicated for carrying out the test properly. They shall also be responsible for deciding when the optimum adjustments have been attained *for the top* throughput level that is possible with satisfactory gathering and cutting of the crop.

Adjustment of the threshing, separating or cleaning mechanisms shall be permitted only between test series.

7.4 Catching apparatus

Apparatus for catching crop material discharged from the combine shall be built and operated so that the following requirements are met :

- a) the whole of the effluents from the machine shall be caught during the catch period;
- b) the components for collecting crop material shall be such that the safety of the test personnel is not endangered;
- c) catches shall be started and stopped without the combine mechanism or forward travel being interrupted;
- d) the apparatus shall neither significantly interfere with the combine's normal performance (e.g. with the flow of air from the cleaning mechanism) nor cause any change in the condition of the material normally discharged from the combine;

e) catches shall be taken separately from the points of normal discharge from the combine's separating and primary cleaning mechanisms, at the normal rate of discharge;

f) if a combine is equipped with an auxiliary cleaning device, the output in each grade of recleaned grain delivered from it shall be added together to calculate the rate of grain output;

g) samples of grain for analysis shall be taken by passing a container through the stream of grain at the catching point immediately after taking the main catch; storage containers shall be completely filled and airtight.

7.5 Conditions and procedure for collecting catch

7.5.1 Prior to each catching period, operate the combine for a minimum of 50 m or for a distance taking at least 20 s, whichever is the longer, to ensure that conditions have become stabilized throughout the relevant mechanisms.

7.5.2 During this period and during the catching periods, the full gathering width of the header shall be utilized. If the crop is wind-rowed, the wind-row(s) should preferably be picked up wholly and smoothly to ensure flow of crop across substantially the full width of the threshing mechanism.

7.5.3 Field speed and stubble height shall be kept constant during each test run.

7.5.4 Successive runs shall be made at different forward speeds to cover the full range of practical throughputs. At the highest feasible throughput level, record any factor(s) limiting a further increase in forward speed, e.g. insufficient engine power, cutting, feeding or threshing difficulties for excessive gathering, threshing or separation losses.

7.5.5 The time of day selected for the test shall be when crop conditions are most stable. Comparative tests shall be carried out in conditions as close as possible to those of the actual test as far as time and locations in the field are concerned. Differing circumstances shall be reported.

7.5.6 The catches of grain and material-other-than-grain (m.o.g.) shall be taken over a minimum length of 25 m or amount in total to a minimum of 50 kg.

7.5.7 A test series shall consist of at least five, and preferably not less than seven, test runs, at different field speeds.

7.5.8 The test supervisor may discard attempted test runs at the time of tests if, in his judgement, there is good reason for doing so, e.g. functional failure, detrimental foreign objects entering the machine, overfilling or spillage from catch receptacle, etc. Otherwise the results of all test runs made shall be entered in the test report and comments on any unusual circumstance shall be included.

7.5.9 Samples for grain analysis shall be at least three in number, taken throughout the test series and these samples shall preferably be not less than 1 000 cm³ in volume.

7.5.10 Grain damage percentages shall be established

- a) from samples taken at the final delivery point of the unloading system when fully charged with grain harvested during the test run;
- b) in accordance with methods generally recognized in the locality where the tests are carried out and the results shall be expressed on the basis of relative mass.

7.5.11 Straw samples of at least 1 kg each for moisture testing shall be at least three in number and taken throughout the test series. They shall be taken from the straw discharged immediately after the end of the catching period and shall be stored in completely filled, airtight containers until analysed. Requirements are similar with regard to straw moisture measurements made by portable meter.

7.6 Treatment and analysis of catches

7.6.1 The separation and cleaning of catches shall be as fully mechanized as practicable to ensure consistency. Relatively low feed rates shall be aimed for when feeding crops so as to retain at least 99 % of the free grain contained in the samples before processing.

7.6.2 Separation and analysis of the constituents of grain samples shall be carried out in accordance with methods generally recognized in the locality where the tests are carried out.

7.7 Test data

The following data from the test runs shall be included in the test report :

- a) catch duration, in seconds to the nearest 0,1 s;
- b) test length, in metres;
- c) field speed, in kilometres per hour to the nearest 0,1 km/h;
- d) grain catch, in kilograms to the nearest 0,5 kg;
- e) separating mechanism catch : kilograms to the nearest 0,5 kg;
- f) cleaning mechanism catch : kilograms to the nearest 0,5 kg;
- g) free grain from separating mechanism : kilograms to the nearest 0,005 kg;
- h) free grain from cleaning mechanism : kilograms to the nearest 0,005 kg;
- i) grain mass from rethreshed m.o.g. catches : kilograms to the nearest 0,005 kg;
- j) moisture content of grain and straw samples, expressed on the wet basis to the nearest whole percentage: method of measurement to be included;
- k) sample constituents, in accordance with **7.6.2**.

The test report shall include a section in which the test supervisor shall record those results specified above together with notes of unusual changes in weather or other conditions during the tests, and general comments on the behaviour of the machines and the conduct of the tests.

Measurement of gathering losses is not required, but appropriate comments arising from observation of them may be included in the test report.

7.8 Calculations

Calculations shall include, for each test run on each machine, and as defined in **ISO 6689**, the following :

- a) the total, m.o.g. or grain feed rate, in metric tons per hour (t/h);
- b) the mean test length yield;
- c) the processing losses, recorded to the nearest 0,1 %;
- d) the m.o.g./grain ratio for the crop (i.e. the ratio of total amounts entering the machine) and the mean value from all runs in a series for each machine;
- e) the mean moisture content of the grain and m.o.g. samples.

The results from these calculations shall be tabulated in the test report.

7.9 Graphical presentation of results to obtain capacity

Graphs with linear scales are preferred for presentation of processing loss results, with total, m.o.g. or grain feed rates specified as the horizontal coordinate and percentage loss as the vertical coordinate. The data points for each run shall be plotted on the graphs.

The capacity of each machine shall be the feed rate level at which its loss curve intersects the specified level of loss, as defined in **ISO 6689**.

8 Test report**8.1 General**

All original data and measurements recorded for both test and comparison machines shall be included in the test report. This data shall include the following :

- a) the way in which the combine was selected or obtained for testing (see **4.1**);
- b) reasons for any departure from the manufacturer's instructions as far as the operation of the test machine is concerned (see **4.2**);
- c) full details about the combine and header;

- d) settings and adjustments for the combine, in particular those relevant to the crop-handling mechanisms, including height and width of cut;
- e) the location of the test site;
- f) the date and time of starting and stopping the tests;
- g) the duration of the running-in period prior to testing (see 4.1);
- h) details about the crop : variety, crop conditions and yield.

8.2 Functional field tests

In addition to the data specified in 8.1, the following test data relating to the functional field tests shall be included in the test report :

- a) general information on each field worked : atmospheric and ground conditions, shape of field, crop details, etc. (see 6.1);
- b) information about the behaviour and performance of the test combine, including :
 - functional aspects (see 6.2.1),
 - comfort, convenience and safety (see 6.2.2),
 - ease of adjustment and routine maintenance (see 6.2.3),
 - repairs (see 6.2.4).

8.3 Capacity tests

In addition to the data specified in 8.1, the following test data relating to the capacity tests shall be included in the test report:

- a) crop selection, crop and field conditions, and any departure from the requirements laid down in ISO 6689 (see 7.1);
- b) any local climatic conditions and/or local practices of relevance (see 7.1);
- c) full details about the comparison machine (see 7.2);
- d) any differences with regard to time and location between the comparative and actual tests (see 7.5.5);
- e) the results and data pertaining to the test runs, as specified in 7.7;
- f) any unusual conditions, as recorded by the test supervisor (see 7.7);
- g) general comments by the test supervisor on the behaviour of the machines and the conduct of the test (see 7.7);
- h) comments on the measurement of gathering losses, if appropriate (see 7.7);
- i) the calculated results, as specified in 7.8, in tabulated form;
- j) the capacity of the machine, as obtained from the graphical presentation of the test results (see 7.9).

Annex A (normative)

Tests on sloping ground

These tests shall be carried out to investigate the influence of slopes on grain losses and handling characteristics.

Tests shall be preferably carried out on slopes of approximately 20 % (i.e. 1 in 5 or 11°); however, other slopes may be used, if necessary.

The tests shall be carried out only after preliminary investigations to determine whether the machine is sufficiently safe from the point of view of stability, brakes, etc. The tests shall be carried out in one or more cereal crops selected by the station (or test supervisor); one of the crops selected shall be a crop in good condition for harvesting.

Four machine attitudes shall be examined in the same crop, as follows :

- a) machine inclined to the right;
- b) machine inclined to the left;
- c) working downhill;
- d) working uphill.

The handling characteristics shall first be examined briefly in all four attitudes and the evenness and position of the straw and chaff swath and any grain leakage from the body of the machine shall be noted. For many machines it will be possible to confine detailed loss measurements to two of the four attitudes outlined in a) to d), after preliminary investigations have been carried out.

Tests for attitudes a) and b) shall be carried out alongside or close to each other; the same criterion shall be applied to tests for attitudes c) and d).

Runs need not be carried out at a wide range of forward speeds, but they should at least be done at speeds close to the "optimum" (maximum throughout consistent with acceptable level of grain loss) for level ground.

To ensure that the combine circuits are filled to equilibrium prior to entering the test run (length), the field shall be long enough so that a sufficient run-in can be arranged on land having a slope similar to that in the test run. In all other respects, the test runs shall be similar to those described for tests carried out on level ground.

UDC 631.354.2

Descriptors : agricultural machinery, harvest equipment, harvesters, combines, tests, performance tests.