

# DLG Test Report 6283F

CNH Industrial Belgium N.V.

## New Holland FR650

Fuel consumption and throughput in corn



08/15 Fuel consumption and  
throughput in corn

[www.DLG-Test.de](http://www.DLG-Test.de)



Test Center  
Technology and Farm Inputs

# Overview

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The FokusTest is a smaller-scale DLG usability test intended to allow product differentiation and special highlighting of innovations in machinery and technical products used primarily in agriculture, forestry, horticulture, fruit cultivation and viticulture, as well as in landscape and municipal management.

This test focuses on testing a product's individual qualitative criteria, e.g. fatigue strength, performance, or quality of work. The scope of testing can include criteria from the testing framework of a DLG SignumTest, the DLG's extensive usability test for technical products, and concludes with the publishing of a test report and the awarding of a test mark.



The DLG FokusTest “Fuel consumption and throughput in corn” involved a field test of self-propelled forage harvesters in corn or grass, with harvesting conditions being kept as homogeneous as possible.

This DLG test mainly examined machine efficiency (fuel consumption in l/t). However, chopping quality was also taken into account, and throughput was expected to be at a sufficiently high level to be relevant for practical use. The present test focused primarily on a comparison of various engine generations or new engine management systems respectively.

Various settings (e.g. a range of chop lengths) were applied and tested under field conditions in order to investigate the potential of a new machine or new machine feature.

As grass often does not require the full engine power of forage harvesters, agricultural machinery manufacturers have developed new engine management systems specifically designed for use in various harvesting conditions.

This machine feature has now also been incorporated into the scope of the DLG FokusTest.

Other criteria were not tested.

## Assessment – Brief Summary

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New Holland's new FR650 forage harvester exemplifies that the introduction of the new FPT Tier 4 Final-compliant engines and other details has improved overall machine efficiency substantially compared to predecessor models. The DLG test “Fuel consumption and throughput in corn” collected sufficient measurement data to confirm an increase in both productivity and machine efficiency.

Overall, higher throughput of +5% and lower fuel consumption of -21% were achieved as a result under



*Fig. 2: Front view of the new FR forage harvester series (Photo courtesy of New Holland)*

the given harvesting conditions and with a theoretical chop length of 8 mm, compared to the FR700 with a Tier 3 engine. The comparison to the FR650 and FR600 with a Tier 3 engine, with the same theoretical chop length, showed an increase in throughput and reduction in fuel consumption by 19% each.

Table 1 provides an overview of measurement data for the FR650 at various chop length settings.

Theoretical chop length	FRESH MATERIAL		DRY MATTER		FIELD VALUES	
	Throughput	Fuel consumption	Throughput	Fuel consumption	Throughput	Fuel consumption
mm	tons/hour	gal/ton	tons/hour	gal/ton	acres/hour	gallons/acre
4	197.1	0.0158	63.9	0.0539	6.9	4.54
8	250.6	0.0120	85.1	0.0388	9.4	3.18
12	262.2	0.0113	90.5	0.0362	9.6	3.06
19	273.7	0.0108	93.4	0.0349	10.1	2.89
25	270.5	0.0110	89.2	0.0367	9.9	2.98

Table 1: Overview of partial results of the FR650 field test on “Fuel consumption and throughput in corn”

## The Product

### Manufacturer and applicant

Manufacturer:  
CNH Industrial Belgium N.V.

Product:  
New Holland FR650 forage harvester

Applicant:  
CNH Industrial Belgium N.V.  
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8210 Zedelgem  
Belgium

Contact:  
[www.newholland.com/eu/de-de](http://www.newholland.com/eu/de-de)

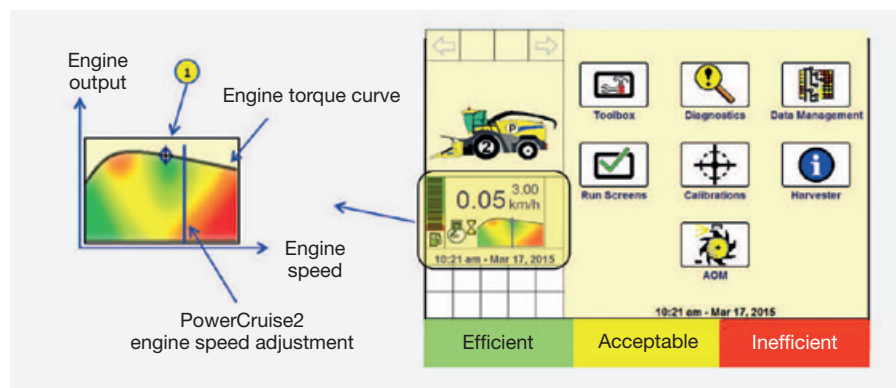


Fig. 3: ECO Mode engine management system, PowerCruise2 – extension on the IntelliView IV monitor (Image courtesy of New Holland)

## Description and technical data

The forage harvester New Holland FR650 Tier 4f used in the DLG test was equipped with a 10-row corn header (7.5 m working width). In this machine, the chopping unit, crop processor and discharge blower are driven directly via the power band. The new cabin is specifically designed for the needs of forage harvesters. It offers good panoramic visibility, sufficient space and lower in-cabin noise levels (Fig. 2).

Components and the operating concept were adapted in line with the combine harvester series to create a unified feel for the entire New Holland range of harvesting machines.

The forage harvester is driven by a Tier 4 final-compliant FPT Cursor 16 six-cylinder engine (Forage Cruiser model) with 16l capacity and 480 kW (653 HP) power at 1700 to 1900 rpm according to ECE R120. Exhaust after-treatment is handled by the well-established SCR (Selected Catalytic Reduction) system with AdBlue, which does not require EGR (exhaust gas recirculation) or a DPF (diesel particulate filter) to comply with high emission limits.

The new engines have been specifically optimized for the requirements of forage harvesting and now provide consistent maximum engine power in the speed range between 1700 and 1900 rpm.

According to the manufacturer, the engine torque increases sharply between 1700 and 1900 rpm. It is therefore recommended to operate the harvester within the range between 1700 and 1850 rpm to achieve maximum productivity at low fuel consumption.

The new engine management system provides operators with three management modes, which can be selected to match various harvesting conditions.

The engine speed is automatically reduced to 1700 rpm at headlands, independent on what mode is selected.

As soon as the harvester is moved back into the crop the engine speed increase to prevent blockages.

The large, clearly designed IntelliView IV color monitor (26.5 cm) gives a clear overview of the machine's various functionalities (Fig. 3).

The harvester's current performance status is displayed on the monitor (see left half of Fig. 3 with the diagram indicating the engine characteristics).

The blue circle (the so-called cursor) moves across the characteristics map shown in the diagram in line with the engine's load condition. The machine's efficiency is therefore always displayed to operators to assist them in operating the harvester within its optimum range. Ideally, the machine will always remain within the green range. Operators can keep the cursor at around the 1700 rpm mark by increasing or reducing their speed of travel.

### **ECO Mode – Low engine speed range (1850 to 1700 rpm), DEFAULT MODE:**

- Max engine speed is limited to 1850 rpm;
- Engine speed is automatically reduced to predefined rpm set point when harvesting in partial load conditions;
- Engine speed rpm set point value is configurable by operator within 1850 to 1700 rpm;
- Engine speed drops below 1700 rpm only if the engine load increases

### **ECO Mode – High engine speed range (2100 to 1950 rpm):**

- Max engine speed is 2100 rpm;
- Engine speed is automatically reduced to the fixed rpm set point of 1950 rpm when harvesting in partial load conditions;
- Engine speed drops below 1950 rpm only if the engine load increases;
- This mode is not recommended, but may be required in some crop conditions\*

### **ECO Mode Off (2100 rpm), ECO MODE IS DEACTIVATED:**

- Max engine speed is 2100 rpm;
- Engine speed is NOT automatically reduced when harvesting in partial load conditions;
- Engine speed drops below 2100 rpm only if the engine load increases;
- This mode is not recommended, but may be required in some crop conditions\*

\* crop conditions where high functional component speed is required  
(ex.: field opening in dry corn, low yield grass, grass or hay with high sugar content)

Table 2:  
*Engine management modes of the engine management system*

## The Method

The DLG FokusTest “Fuel consumption and throughput in corn” puts a forage harvester to the test in a field trial with at least two corn varieties. Alternatively, several forage harvesters of any agricultural machinery manufacturer can be compared.

This test was aimed at verifying the potential offered by the new Tier 4f engines in terms of reducing fuel consumption while improving machine efficiency. The test was conducted with an FR600 and FR700 (both Tier 3) in comparison with the new FR650 (Tier 4f). Test drives without evaluation were completed during the pre-testing phase. These served to define chop length in consultation with the farm manager; this length was subsequently set in all three forage harvesters. The basic settings selected for the forage harvesters for the actual test were made in keeping with local harvesting conditions.

All test drives were performed successively with all three machines, with each harvester load being considered one test drive. The speed range was selected to ensure that the forage harvesters were operated within their optimum working range at average engine speeds between 1700 and 1850 rpm, depending on harvesting conditions and set chop length. In this way, the objective of keeping engine loads within the optimum range of the characteristics



Fig. 4:  
New Holland T7 270 and Fliegl ASW 271 silage trailer combination with calibrated weighing system and trailer-side display



Fig. 5:  
New Holland FR600 in field use

map was achieved. The Fliegl forage trailer provided by the DLG was equipped with a calibrated weighing unit to allow the harvested crop to be weighed directly on the field.

The harvest size could then be immediately analyzed using the forage harvester's machine data. The monitors provided on the trailer sides (about 75 x 45 cm in size) display harvest sizes directly and thus indicate how evenly the yield is distributed between the various test drives (Fig. 4).

The FR650 and FR600 were compared using five different chop length settings to ensure that a wide range of commonly used lengths were covered. These settings included the chop lengths of 4 mm, 8 mm and 12 mm on the one hand, which are commonly

used in Germany and Europe, and 19 mm and 25 mm chop lengths on the other, which cover conditions on the North American market. The FR700 was only tested in the short chop length range (4 mm to 12 mm) and compared with the other two forage harvesters.

The tests were conducted using two different corn varieties to cover a broad range of potential applications. At least three trailer loads were harvested per chop length setting and test variety and compared between the three harvester models. Representative composite samples were also prepared from an adequate number of samples taken randomly once the various trailer loads had been discharged at the silo (Fig. 6 to 9).

The resulting composite sample was subsequently homogenized. Three representative subsamples each were then prepared using a large and small sample divider and transferred into suitable containers.

The fresh matter start weight was determined directly when filling the containers. The containers were then sealed, labeled and placed into intermediate refrigerated storage. Three subsamples from each trailer load were used to determine dry matter. Field conditions (corn variety, plant height, number of ears per plant, row spacing, maturity indices) were additionally documented during the test, and the technical quality of chopped forage was monitored.



Fig. 6 to 9:  
Silo-side taking and processing of samples

# The Test Results in Detail

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*Fig. 10:  
Harvesting conditions on a test site in Saxony-Anhalt*

In this DLG FokusTest, the new New Holland FR650 (Tier 4 final) was compared with its two predecessor models, the FR600 and FR700 (both Tier 3) in a field trial. Table 3 contains an overview of the various harvesters' engine power ratings.

The machine was equipped with a 2 x 16 knife cutterhead and a crop

processor with 99/126 teeth and a 30% speed differential. The crop processor was pre-set to 2.0 mm.

The new engine management system was deactivated, as the FR600 and FR700 models do not have this feature. These settings remained unchanged throughout all test drives.

## Harvesting conditions

The field test was conducted on a field in Saxony-Anhalt during the 2014 harvesting season. Adequately large test fields cultivated with two different varieties of corn were available at the test site (see Table 4).

The test site near Oschersleben in eastern Saxony-Anhalt contained homogeneous corn crops of both varieties, and harvesting conditions were comparable throughout the duration of the field test (Fig. 10). While there were inhomogeneous sections, these were not included in the evaluation.

## Comparison of test results: FR650 vs. FR600 vs. FR700

Table 5 gives an overview of the test results. The table provides the measurement data for processing times only, excluding times taken for turning, for the entire duration of each test.

The FR650 Tier 4f features an SCR catalytic converter with AdBlue, in contrast to the FR600 and FR700 Tier 3. Due to its new engine configuration, the FR650 Tier 4f achieves greater torque and more even engine characteristics compared to the FR600 and FR700.

	Engine	Capacity	Cylinders	kW/HP @2100 rpm, ECE R120	Max. kW/HP @1800-2000 rpm, ECE R120
<b>FR650</b>	FPT Cursor 16, Tier 4 final	15.9l	6	440/598	480/653*
<b>FR600</b>	FPT Cursor TCD 13, Tier 3	12.9l	6	400/544	441/591
<b>FR700</b>	Caterpillar C18, Tier 3	18.1l	6	470/639	504/685

\* at 1700-1900 rpm, ECE R120

Table 3:

Overview of engine outputs of the three forage harvesters, i.e. FR650, FR600 and FR700

Corn variety	Variety description	Crop	Average yield tons/acre*	Test site	DM [%]* Whole plant
Scandi	Silage and energy corn for biogas, medium-early, corn ripeness index approx. 320, Caussade Saaten GmbH	10.5-12.5 ft plant height 29.5 in row spacing	28.14	Saxony-Anhalt	28.0 [27.5 – 28.5]
Franki	Silage and energy corn, medium-early, corn ripeness index approx. 280, kernel maturity index approx. 260, Caussade Saaten GmbH	10.0-11.5 ft plant height 29.5 in row spacing	27.69	Saxony-Anhalt	33.5 [32.9 – 34.2]

\* Average from harvested trailer loads; determined by oven drying method

Table 4:

Overview of corn varieties and harvesting conditions

Table 5 shows that the new generation of engine was able to achieve fuel savings of up to 21% in gal/ton fresh material compared to the FR700 and 19% compared to the FR600 with a chop length of 8 mm in the above-mentioned test conditions. Throughput in tons fresh material/hour was increased by about 5% compared to the FR700 and by about 19% compared to the FR600. Refueling and calculated AdBlue consumption

values indicated that the ratio of diesel to AdBlue consumption can be assumed up to 8%, which should be taken into account correspondingly. Yet fuel consumption was significantly lower, even with the higher throughput achieved, in chopping mode alone.

Fig. 11 shows a comparison of the fuel consumption in l/t fresh material for the three forage harvesters across

the various chop length settings. In the short chop range (4–8–12 mm), the FR600 and FR700 performed equally with 4 mm, while the FR600 was only slightly superior with 8 and 12 mm lengths, even though it has substantially less engine power. The new FR650 achieved fuel savings at a level relevant for practical use across the full chop length range, with the largest savings being obtained with 8 and 12 mm lengths.



Fig. 12 shows that the FR650 additionally allowed greater throughput to be achieved compared to the FR700. However, the FR700 achieved greater throughput with the 4 mm chop length. The substantial difference between the FR650 and FR600 results to some extent from the higher engine power, but above

all from the new engine characteristics and overall machine efficiency.

These advantages were also clearly evident in relation to the FR700. The FR650 average throughput of about 250 tons fresh material/hour with 8mm chop length and a harvest size

of more than 150 tons per machine across all test drives confirm both the representative nature of the measurements and the overall results.

Theoretical chop length		FR650	FR600	FR700	FR650 vs. FR600	FR650 vs. FR700
4 mm	Fuel Consumption (gal/ton)	0.0158	0.0168	0.0168	-6.06%	-6.06%
	Throughput (tons/hour)	197.1	180.7	210.9	8.33%	-6.99%
	Engine Speed (RPM)	1860	1770	1798	–	–
8 mm	Fuel Consumption (gal/ton)	0.0120	0.0141	0.0144	-18.00%	-20.00%
	Throughput (tons/hour)	250.6	203.0	238.4	18.96%	4.84%
	Engine Speed (RPM)	1685	1727	1772	–	–
12 mm	Fuel Consumption (gal/ton)	0.0113	0.0134	0.0139	-19.15%	-23.40%
	Throughput (tons/hour)	262.2	213.2	246.4	18.71%	6.05%
	Engine Speed (RPM)	1670	1718	1714	–	–
19 mm	Fuel Consumption (gal/ton)	0.0108	0.0122	–	-13.33%	–
	Throughput (tons/hour)	273.7	233.8	–	14.58%	–
	Engine Speed (RPM)	1650	1718	–	–	–
25 mm	Fuel Consumption (gal/ton)	0.0110	0.0117	–	-6.52%	–
	Throughput (tons/hour)	270.5	238.4	–	11.86%	–
	Engine Speed (RPM)	1662	1670	–	–	–

The savings potentials set out above relate to the raw test data; rounding differences may occur.

Table 5:  
Overview of test results across the full duration of the test

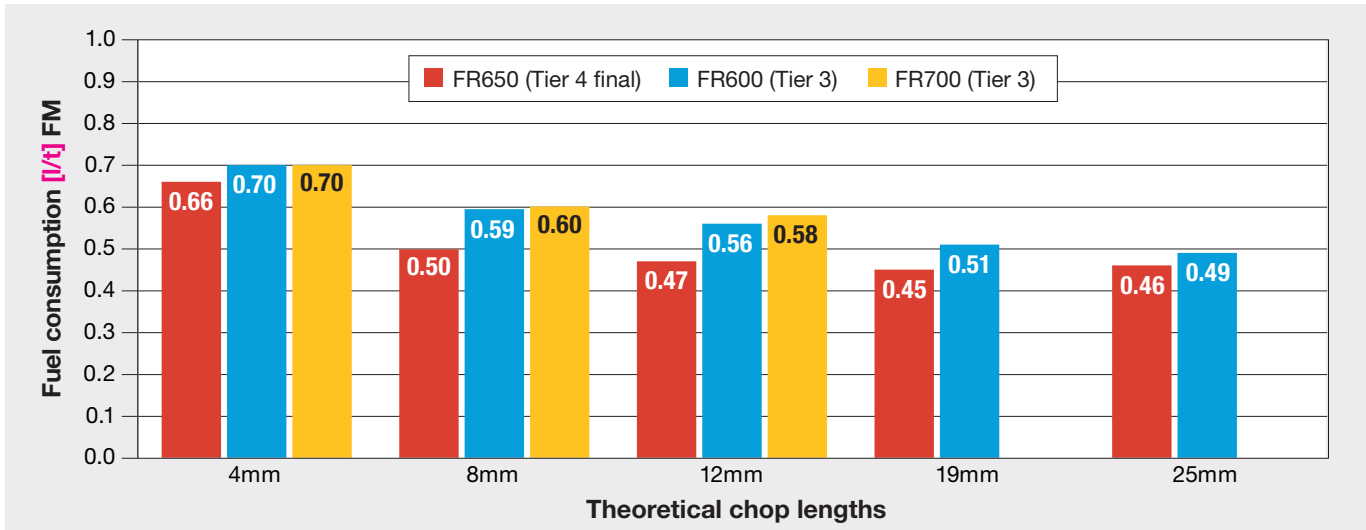


Fig. 11:  
Comparison of fuel consumption values in l/t fresh material for the three forage harvesters FR650 vs. FR600 vs. FR700 at various theoretical chop lengths

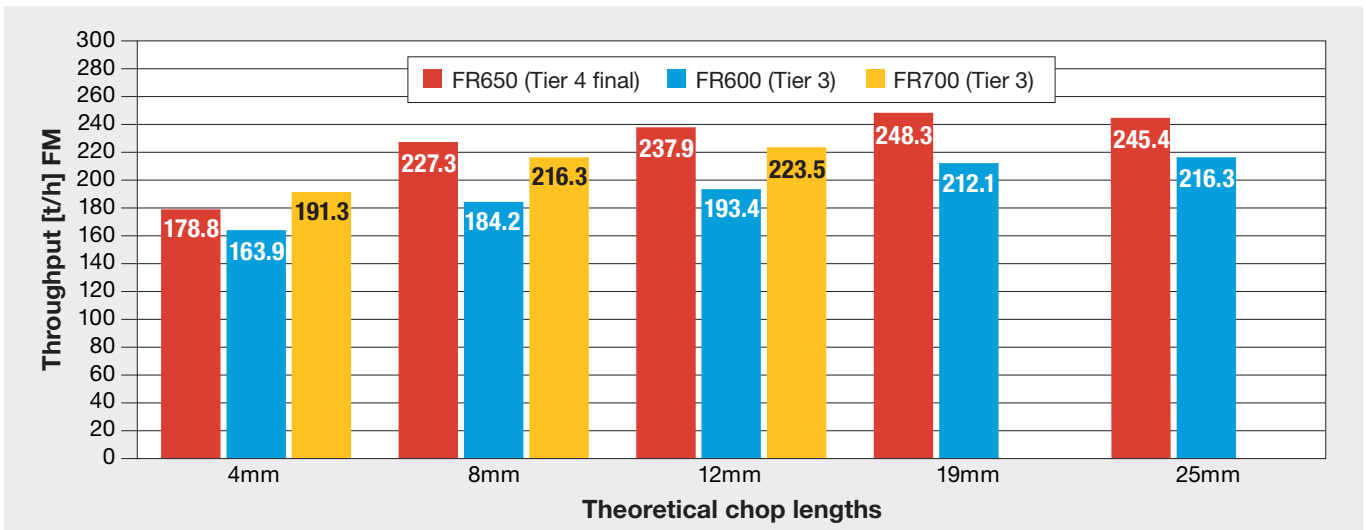


Fig. 12:  
Comparison of throughput in t fresh material/h across the theoretical chop lengths of the three forage harvesters FR650 vs. FR600 vs. FR700

# Summary

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With the new Tier 4 final-compliant engine generation, New Holland has improved the efficiency of its machine compared to the FR600 and FR700 predecessor models featuring engines complying with the Tier 3 exhaust emission standard. According to the measurements conducted by the DLG Test Centre, the new engine management system of the FR650 Tier 4 final engine allows fuel savings of 21% (in l/t fresh material) to be achieved at an engine speed of 1685 rpm with 8 mm chop length, compared to the FR700 predecessor model with its Tier 3 engine. At the same time, throughput was increased

by about 5% without increasing diesel consumption.

Compared to the FR600, the new FR650 achieved an increase in throughput and a reduction in fuel consumption of 19% each with 8 mm chop length.

AdBlue consumption was up to 8% of diesel consumption. The overall machine design of the FR650, with its improved machine efficiency, new engine management system and new cabin, shows that New Holland is intending to get off to a flying start with its new FR harvester, following

the success of its CR combine harvester series. The comparison between these three machines in practical use identified differences in the engine characteristics, namely a more even engine output in the FR650 Tier 4f at corresponding engine speed ranges. The FR650 additionally stands out through its well-organized operating console and good accessibility of the crop processor.

The Variflow system allows the machine to be easily converted from corn to grass within a few minutes, without requiring tools.

## Further Information

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Additional tests of mobile dry matter sensors on forage harvesters are available for download in the “Forage harvester” section at [www.dlg-test.de/ernte](http://www.dlg-test.de/ernte).

The DLG Plant Production Technology Committee closely examines harvesting technology as part of the DLG’s technical work. Information sheets and other publications produced by this volunteer technical committee are available free of charge from [http://www.dlg.org/technik\\_pflanzenproduktion.html](http://www.dlg.org/technik_pflanzenproduktion.html) in PDF format.

### Test execution

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### DLG Testing Framework

FokusTest  
“Fuel consumption and  
throughput in corn”

### Field

Field applications

### Project manager

Dr. Ulrich Rubenschuh

### Test engineer(s)

Dipl.-Ing. (FH)  
Johannes Speer\*

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\* Reporting engineer

# The DLG

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In addition to conducting its well known tests of agricultural technology, farm inputs and foodstuffs, the DLG acts as a neutral, open forum for knowledge exchange and opinion-forming in the agricultural and food industry.

Around 180 full-time staff and more than 3,000 expert volunteers develop solutions to current problems. More than 80 committees, working groups and commissions form the basis for expertise and continuity in technical work. Work at the DLG includes the preparation of technical information for the agricultural sector in the form of instruction leaflets and working documents, as well as contributions to specialist magazines and books.

The DLG organizes the world's leading trade exhibitions for the

agriculture and food industry. In doing so, it helps to discover modern products, processes and services and to make these transparent to the public.

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## **The DLG Test Center for Technology and Farm Inputs**

The DLG Test Center for Technology and Farm Inputs in Groß-Umstadt sets the benchmark for tested agricultural technology and farm inputs and is the leading provider of

testing and certification services for independent technology tests. With the latest measurement technology and practical testing methods, the DLG's test engineers carry out testing of both product developments and innovations.

As an EU-notified test laboratory with multiple accreditations, the DLG Test Center for Technology and Farm Inputs provides farmers and practitioners with important information and decision-making aids, in the form of its recognized technology tests and DLG tests, to assist in the planning of investments in agricultural technologies and farm inputs.

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**DLG e.V.**

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