

DLG Test Report 6244 F

Maschinenfabrik Bernard Krone GmbH TS 680 Twin Side-Delivery Rake

Forage contamination and raking losses in grass silage



DLG FOKUS
TEST

11/14 Forage contamination
and raking losses
in grass silage



Test Center
Technology and Farm Inputs

www.DLG-Test.de

Overview

The FokusTest is a 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 "Forage contamination and raking losses in grass silage" was performed on the KRONE TS 680 Twin rake. This was equipped with the newly devel-



oped "Lift tines" during the DLG test. The Lift tines make it possible to set higher raking heights than with the previous model without causing an increase in raking losses. This also reduces the amount of contamination introduced into the forage. In order to demonstrate these effects in the DLG test, corresponding comparative measurements were taken with the previous model, the KRONE Swadro 810, which was not equipped with the new Lift tines.

The measurement runs took place on a level test field during the first mowing of 2014. The raking losses and amount of contamination introduced into the forage, as well as the theoretical area treated per hour, were determined for different rake settings (raking heights) and multiple travel speeds (8 km/h, 10 km/h, 10.5 km/h).

oped "Lift tines" during the DLG test. The Lift tines make it possible

Samples were taken from the forage before and after windrow formation for laboratory analysis of the dry matter and crude ash content. The results from the analysis of the crude ash content before and after windrow formation were compared in order to determine the amount of contamination introduced into the forage. The raking losses over the entire working width are determined after each measurement run. In addition, the power consumption at the power take-off is recorded, along with the travel speed, measuring distance and travel time. The yields and windrow parameters were measured and described in order to document the harvesting conditions.

Other criteria were not investigated.

Assessment – Brief Summary

In the DLG test, the KRONE Swadro TS 680 Twin, with its newly developed "Lift tines" mounted at a steep angle, results in significantly lower raking losses than the previous model, the KRONE Swadro 810, which does not have "Lift tines".

At a travel speed of 8 km/h, the raking losses of the KRONE Swadro 810 are low (+), at 1.5%, and those of the KRONE Swadro TS 680 Twin are very low (++), at 0.6%. Increasing the travel speed to 10 km/h

causes only an insignificant increase (to 0.7%) in raking losses with the KRONE Swadro TS 680 Twin, whereas with the KRONE Swadro 810, which does not have "Lift tines", the raking losses increased to 2.8% at the higher travel speed, therefore reaching an average level (o).

The amount of contamination introduced into the forage was low (+), at values of up to max. 0.3%, with both rakes and in all variants.

With single windrow formation and a working width of 6.8 m, the theoretical area treated per hour is 5.4 ha/h at 8 km/h and approximately 7 ha/h at 10 km/h. For both machines, the power consumption per metre of working width is very low (1.2 kW/m to 1.3 kW/m) at a travel speed of 8 km/h and low (1.6 kW/m to 1.7 kW/m) at a travel speed of 10 km/h or 10.5 km/h.

Table 1:
Overview of results

Test criterion	KRONE Swadro 680 Twin		KRONE Swadro 810	
	Test result	Evaluation*	Test result	Evaluation*
Contamination	low	+	low	+
Raking losses	very low/low	++/+	low/average	+/o
Power consumption	very low/low	++/+	very low/low	+ / ++

* Evaluation range: ++ / + / o / - / -- (o = standard, N/E = not evaluated)

The Product

Manufacturer and Applicant

Maschinenfabrik
Bernard Krone GmbH
Heinrich-Krone-Straße 10

Product:
Side-delivery rake
KRONE Swadro TS 680 Twin

Contact:
+49 (0)5977 935-0
info.ldm@krone.de
www.landmaschinen.krone.de

Description and Technical Data

With single windrow formation, the KRONE Swadro TS 680 Twin has a maximum working width of 6.80 m. With double windrow formation, the working width is 2 x 3.80 m (7.60 m). Unlike the previous model, all TS rakes form the windrow on the right-hand side. The rake is driven with the 540-rpm power take-off and mounted in the linkage arms of the towing tractor. According to the manufacturer, the newly designed linkage-arm mounting ensures that no torsional forces are transmitted to the linkage arms, as the mounting frame is held in a ball joint and an oblong hole. On roads, the running gear of both rakes assists in steering, which makes it easier to drive around bends.

The rotor unit, with 13 tine arms on each of the two rotors, is identical to that of the previous model, the KRONE Swadro 810. In the new rake generation, it is possible to achieve a transport height of less than 4 m without folding in the tine arms. The KRONE Swadro TS 680 Twin is equipped with new so-called "Lift tines". These tines are 10.5 mm thick and have crooked ends. On the rotor running gear, the rear pivot pins have been reinforced. The cross slope can now be adjusted steplessly thanks to a pattern of holes and an eccentric pivot pin.

Another new feature included in the KRONE Swadro TS 680 Twin test machine was the electrical rotor



Figures 2 to 6:

(Above) "Lift tines" with crooked ends, eccentric pivot pins, adjustment of cross slope using fine-step hole pattern, mechanical and (below) electrical adjustment of working height (KRONE product photos)

height adjustment, which is available as optional equipment. The series model comes with a mechanical variant (Figures 2 to 4). Both variants allow the working depth to be altered in a reproducible manner.

Manufactured entirely of shaped steel with a thickness of 5 mm, the new trapezoidal transport frame permits lift-out heights of up to 50 cm thanks to a modified rotor lift system.



The Method

In the DLG FokusTest “Forage contamination and raking losses in grass silage”, rakes are tested in a field trial at multiple common travel speeds and with various raking height settings. The harvesting conditions are documented by describing the forage types, terrain characteristics and prevailing weather during the trial and by determining the yields (projected based on 1 m windrow length and the actual working width) and the dry matter yields. In the DLG FokusTest, the basic configuration of the rakes is adapted to the respective harvest conditions on-site. So-called configuration areas are therefore provided next to the measurement plot on the respective test area; these allow neutral runs to be performed before the actual measurement runs begin in order to determine the suitable configuration for the machines.

Once the configuration runs are completed, the actual working width is measured. A sufficient distance is maintained between the

driving tracks during the measurement runs in order to avoid undesired overlap.

To determine the forage’s dry matter content, samples are taken from the windrow for laboratory analysis. In order to determine the amount of contamination introduced into the forage by the working process, samples are taken both from the tedded area and from each windrow. The sampling is carried out with three repetitions for each trial variant. The crude ash content pursuant to DIN 10353 is determined as a measure of the level of contamination. The amount of contamination introduced into the forage by the operation is determined by finding the difference between the respective pairs of values for the crude ash content.

After the working process is complete, the windrow parameters (windrow width, windrow height, windrow spacing) are determined. For this purpose, the stubble height on the cleared area is determined

at three points on each track by taking five measurements transversely to the direction of travel across the full working width; alternatively, the windrow is surveyed at a minimum of three points on each track.

In order to determine the raking losses, the residual stalks between the windrows are raked up and weighed. The weighed quantities are then compared with the yield measured in the windrow.

In PTO-driven machines, the power consumption is measured using torque-measuring hubs (WALTERSCHEID 5.0 kNm measuring hub and/or 2.5 kNm measuring hub). The travel speeds and route distances are recorded using a Correvit L400 from the company KISTLER MESSTECHNIK.

The theoretical area treated per hour (ha/h) is calculated from the measured travel speed and the actual working width and therefore does not take account of turning times.



Figure 7:
Grass samples in perforated bags



Figure 8:
Recording the raking losses by raking up and weighing the residual stalks



Figures 9 and 10:
Kistler Correvit L400 and Walterscheid 2.5 kNm measuring hub on the rear PTO

The Test Results in Detail

Test

The DLG FokusTest "Forage contamination and raking losses" took place on an agricultural holding near Spelle. A largely level area of ryegrass measuring approx. 12 ha was available for the test.

The area was mowed the day before the DLG test using a mower combination (working width: 8.9 m) and then tedded with a rotary tedder (working width: 11 m).

In the configuration runs carried out immediately before the measurement runs, a raking height of 3 cm and travel speeds of 8 km/h and 10 km/h or 10.5 km/h were

determined, under the harvesting conditions encountered, to be suitable trial variants for comparing the new rake model, the KRONE Swadro TS 680 Twin, with the previous model, the KRONE Swadro 810. In addition, further measurement runs were performed at a greater raking height (3.5 cm or 4 cm) with the KRONE Swadro TS 680 Twin in order to determine the effects on raking losses and forage contamination. Table 2 (below) provides an overview of the different trial variants. A Deutz 5120 ttv (maximum power: 87 kW/118 PS according to ECE R 24) was used as the tractor.

The PTO speed was constant at 400 rpm. The analyses of the forage samples for dry matter and crude ash content were carried out by LUFA Nord-West in Oldenburg.

Harvesting conditions

The testing conditions were well suited to the field test. The average grass yield was 39.1 dt/ha of dry matter with a dry matter content of 29.4%. The forage was distributed over the area with sufficient uniformity. During the test, after the fog cleared up, the weather was sunny with temperatures of 20 °C.

Table 2:
Test variants

Rake	Raking height	Travel speed
KRONE Swadro TS 680 Twin	3.0 cm	8.0 km/h
	4.0 cm	8.0 km/h
	3.0 cm	10.5 km/h
	3.5 cm	10.5 km/h
KRONE Swadro 810	3.0 cm	8.0 km/h
	3.0 cm	10.0 km/h

Table 3:
Theoretical area treated per hour as a function of travel speed

Travel speed	Theoretical area treated per hour
8.0 km/h	5.4 ha/h
10.0 km/h	6.8 ha/h
10.5 km/h	7.1 ha/h

Table 4:
Windrow parameters

Rake	Raking height	Travel speed	Windrow height	Windrow width
KRONE Swadro TS 680 Twin	3.0 cm	8.0 km/h	44 cm	110 cm
	4.0 cm	8.0 km/h	44 cm	115 cm
	3.0 cm	10.5 km/h	39 cm	117 cm
	3.5 cm	10.5 km/h	44 cm	118 cm
KRONE Swadro 810	3.0 cm	8.0 km/h	47 cm	118 cm
	3.0 cm	10.0 km/h	41 cm	117 cm

Actual working width and theoretical area treated per hour

The actual working width was set at 6.8 m for both rakes. The table below presents an overview of the resulting theoretical areas treated per hour as a function of travel speed.

Windrow parameters

The windrows were uniform along the entire length of the measurement tracks of each variant. The windrow parameters are shown in Table 3.

In the DLG test, the windrow parameters of the two machines were found to be almost identical. Changing the travel speed or raking height did not affect the shape of the windrow. Over all trial variants, the average windrow width was 116 cm with a windrow height of 43 cm.

Forage contamination

The contamination was characterised based on the difference in crude ash content (pursuant to DIN 10353) between forage samples taken before and after the

machine was used. For rotary rakes, the DLG testing framework classifies the introduction of less than 1.5 % contamination as low and of more than 3 % as high. In the determination of forage contamination due to combustion pursuant to DIN 10353, a crude ash content of up to 9 % applies as the limit for clean forage.

With respect to feed contamination, the DLG test showed that the contamination introduced into the forage was very low (+), at values of up to max. 0.3 %, with both rakes and in all variants. Under the prevailing conditions during the DLG test, no relevant differences were identified between the two machines in terms of the amount of contamination introduced. As expected, however, the low level overall means that increasing the raking height in the test leads to only a slight decrease in contamination.

Raking losses

More significant differences were identified between the two rakes in terms of raking losses. The DLG evaluation scheme classifies raking

losses of up to 0.75 % as very low (+ +), between 0.75 % and 1.5 % as low (+) and between 1.5 % and 3 % as average (o).

At a travel speed of 8 km/h and a raking height of 3 cm, the KRONE Swadro 810 caused losses of 1.5 % (+). Increasing the travel speed to 10 km/h caused the raking losses to rise to 2.8 % (o). At a raking height of 3 cm, the new KRONE Swadro TS 680 Twin rake exhibited significantly lower raking losses and also responded less sensitively to the increase in travel speed. At 8 km/h, the raking losses were very low (+ +), at 0.6 %, and at 10.5 km/h they increased only slightly to 0.8 % (+).

The additional trial runs with the KRONE Swadro TS 680 Twin also show that increasing the raking height to 4 cm at a travel speed of 8 km/h causes raking losses to increase only slightly to 0.9 % (+). Although, at the high travel speed of 10.5 km/h, the raking losses exhibited a stronger increase when the raking height was increased to 3.5 cm, they still remained at a relatively low level at 1.5 % (+) (see Figure 11).



Figure 11:
Test area before the measurement runs

Power consumption

The power measurements on the PTO were determined for each machine at two different travel speeds. Figure 17 (see page 10) shows that the rakes differ only slightly from one another in this regard. As expected, the power consumption increases with travel speed.

Overall, the power consumption per metre of working width is rela-

tively low in both machines. According to the DLG evaluation scheme* for rakes, the power consumption is very low (1.2 kW/m to 1.3 kW/m) at a travel speed of 8 km/h and low (1.6 kW/m to 1.7 kW/m) at a travel speed of 10 km/h or 10.5 km/h.

* DLG evaluation scheme
[kW/m of working width]:
≤ 1.5 = very low (++) ; 1.6 to 3.0 = low (+);
3.1 to 4.5 = standard

Operation

Before the test began, the company KRONE provided the DLG with operating instructions for each of the two rakes. These have a detailed and clear description of the rakes' operation during attachment and configuration.

Both rakes can be attached to the tractor's linkage arms easily, and the presets (cross slope) can be configured in a few easy steps.



Figures 12 and 13:
Windrow conditions on the test field

In the new TS series, the rear swath curtain can be automatically folded down to a height of less than 4 m, which reduces the preparation time for road travel. On roads, the running gear of both rakes assists in steering, which makes it easier to drive around bends.

In the DLG test on the KRONE Swadro TS 680 Twin, the rotors' raking heights could be adjusted electrically and read off on a

display (optional equipment). This made it significantly easier to configure and coordinate the raking heights of the front and rear rotors and facilitated their reproducibility.

The newly designed transport frame allows lift-out heights of up to 50 cm, which reduces the burden on the driver, especially during turning manoeuvres on headlands, and prevents forage

from being drawn unintentionally from a previously completed windrow.

Unlike the previous model, all TS rakes form the windrow on the right-hand side. This makes it easier to obtain an overview, thereby reducing the burden on the driver and simplifying the process of up and down operation in the case of a large double windrow.



Figures 14 and 15:
Attaching the KRONE Swadro TS 680 Twin to the tractor, rotor unit lifted out (KRONE product photos)

Measurement runs in perennial ryegrass

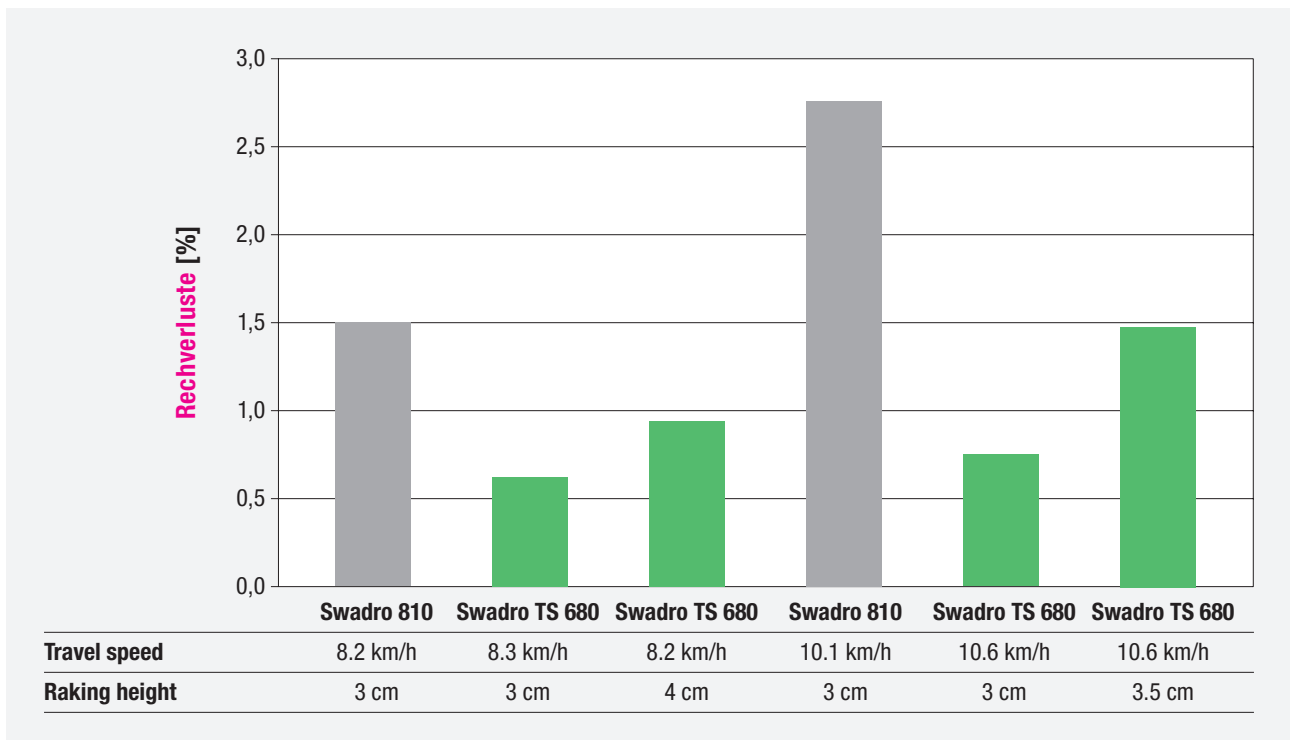


Figure 16:
Raking losses in the DLG test

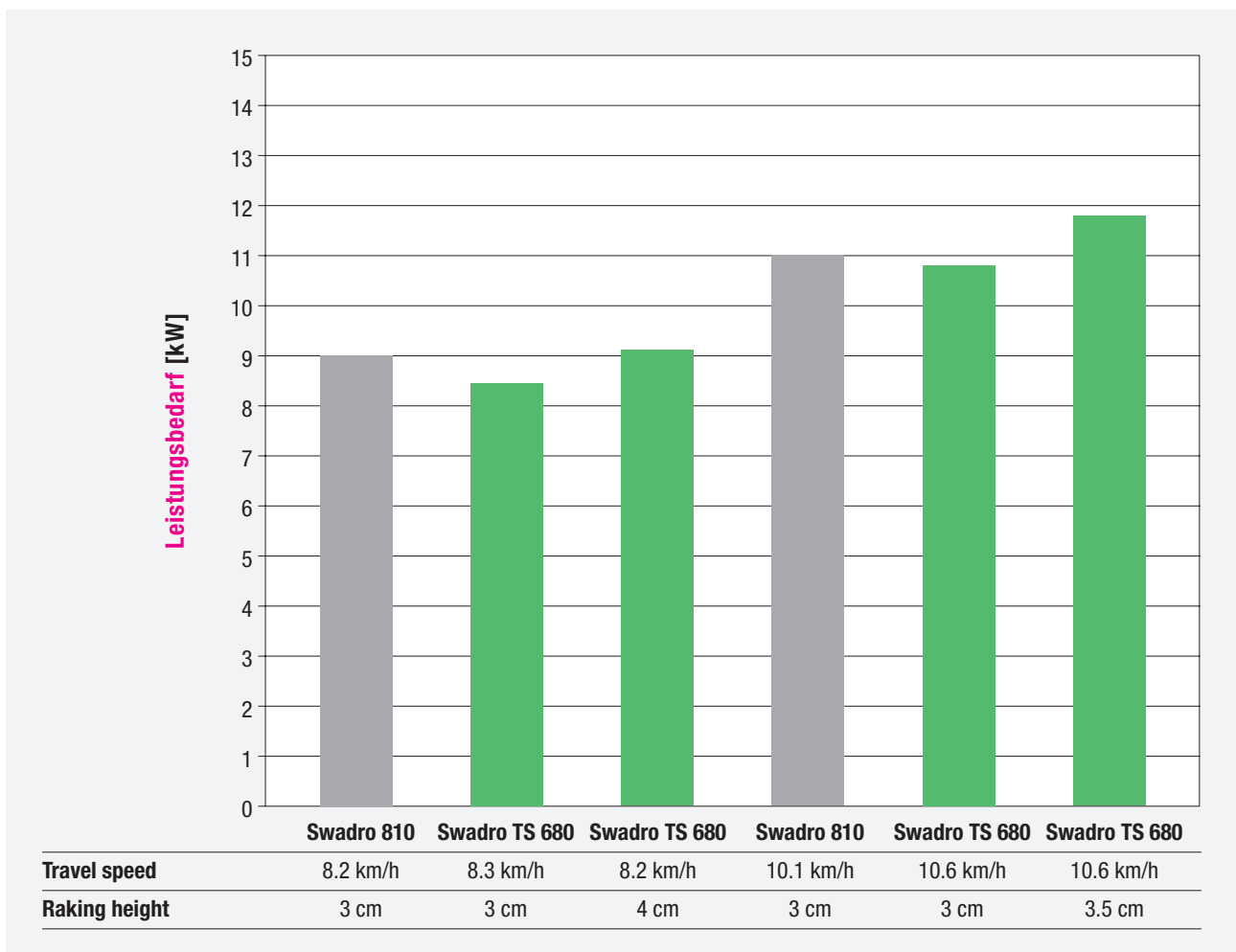


Figure 17:
Overview of power consumption measurements

Summary

In the DLG test, the KRONE Swadro TS 680 Twin with the newly developed "Lift tines" at steep angles results in significantly lower raking losses and responds less sensitively to an increase in travel speed than the previous model, the KRONE Swadro 810, which does not have "Lift tines". The amount of contamination introduced into the forage was low (+), at values of up to max. 0.3%, with both rakes and in all variants in the DLG test.

With single windrow formation and a working width of 6.8 m, the theoretical area treated per hour is 5.4 ha/h at 8 km/h and approximately 7 ha/h at 10 km/h. For both machines, the power consumption per metre of working width is very low at a travel speed of 8 km/h and low at a travel speed of 10 km/h or 10.5 km/h. The design of the new KRONE Swadro TS 680 Twin rake has been enhanced with various further

developments relating to operation and handling that make work considerably easier than with previous models.

Further information

Within the field of the DLG's technical work, the DLG Committee for Machinery and Equipment in Plant Production deals closely with the topic of pasture land technology. Instruction leaflets and documents relating to this technical work carried out on a voluntary basis are available for free in PDF format at:

[www.dlg.org/
technik_pflanzenproduktion.html](http://www.dlg.org/technik_pflanzenproduktion.html)

Test execution

DLG e.V.,
Test Center
Technology and Farm Inputs,
Max-Eyth-Weg 1,
D-64823 Groß-Umstadt

DLG Testing Framework

FokusTest
"Forage contamination and raking losses in grass silage" (revised 11/2014)

Field

Technology for outdoor operations

Project manager

Dr Ulrich Rubenschuh

Test engineer(s)

Jochen Buhrmester MSc
(Agriculture)*

* Reporting engineer

The DLG

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 organises 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.

Obtain access to knowledge advancement and other advantages, and collaborate on expert knowledge in the agricultural industry! Please visit http://www.dlg.org/membership_agriculture.html for further information.

The DLG Test Center Technology and Farm Inputs

The DLG Test Center 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 Technology and Farm Inputs provides farmers and practitioners with important information and decision-making aids, in the form of its recognised technology tests and DLG tests, to assist in the planning of investments in agricultural technologies and farm inputs.

14-230
© 2014 DLG



DLG e.V.

Test Center Technology and Farm Inputs

Max-Eyth-Weg 1 · 64283 Groß-Umstadt
Telephone +49 69 24788-600 · Fax +49 69 24788-690
tech@DLG.org · www.DLG.org

Download all DLG test reports free of charge at: www.dlg-test.de!