DLG Test Report 7283

JOHN DEERE GmbH & Co. KG

HarvestLab 3000
(calibration model LKS 05/18)

Ingredients in liquid digestate

JOHN DEERE HARVESTLAB 3000 (LKS 05/18)
✓ Ingredients in liquid digestate: N_{total}, NH_4-N, K_2O
DLG Test Report 7283

Overview

A test mark "DLG-APPROVED for single, value-determining criteria" is awarded for agricultural products which have successfully fulfilled a reduced usability testing conducted by the DLG according to independent and recognised evaluation criteria. The test is served to highlight particular innovations and key criteria of the test object. The test may contain criteria from the DLG test frame for total tests, or focus on other value-determining characteristics and properties of the subject of the test. The minimum requirements, the test conditions and procedures, as well as the bases of evaluation of the test results are set in agreement with a DLG Experts group. They correspond to the recognised rules of technology as well as the science and agricultural knowledge and requirements. A successful test ends with the publication of a test report and the awarding of the test mark, which is valid for five years from the date of the award.

The DLG test for "Precision of mobile sensors for the determination of ingredients in passing liquid manure of animal origin and liquid digestate" was carried out on the **JOHN DEERE HarvestLab 3000 with the calibration model LKS 05/18**. At the time of testing, software version SW 132 was used.

The measurements for determining the contents of ingredients were carried out in liquid digestate. Five different practice slurries were examined through the tested HarvestLab sensor for their levels of important ingredients, for example total nitrogen (N_{Total} in kg/m^3). During the measurements each slurry sample was collected.

The taken samples were analysed by five different accredited specialised laboratories, preferably with wet-chemical methods and threefold repetition. For each ingredient, the averages from the results of the laboratory analyses were calculated. For the evaluation, the differences between the value measured by the mobile Sensor and the mean value of the laboratories were determined as the relative measurement deviation. The precision of the sensor was examined at different flow rates too.

Other criteria were not tested.

Assessment – Brief Summary

On the basis of the results the mobile NIR sensor "JOHN DEERE HarvestLab 3000 with the calibration model LKS 05/18" is awarded the DLG test mark "DLG APPROVED in single criteria" in the measurement of ingredients in liquid digestate for the parameters listed in the following table 1.

The DLG approval applies in combination with the software version SW 132 and above.

Table 1:
Approved parameters

Manure type	Ingredient
Digestate	Total nitrogen (N_{Total})
	Ammonium nitrogen (NH_4-N)
	Potassium oxide (K_2O)

The Product

Manufacturer and applicant

Product:
John Deere HarvestLab 3000
with calibration model LKS 05/18

Applicant:
JOHN DEERE GmbH & Co. KG
Intelligent Solutions Group
Strassburger Allee 3
67657 Kaiserslautern
Germany

Description and technical data

John Deere Harvestlab 3000 NIR sensor is a measuring system to determinate the ingredients. It is on offer for choppers, slurry tankers and for stationary use. For each implementation an appropriate calibration model is needed. With the calibration model LKS 05/18 the sensor is equipped for liquid digestate.

The Harvestlab 3000 flexibly can be used on different slurry tankers and branches. To ensure correct functionality the installation instructions has to be followed.

The HarvestLab 3000 NIR sensor allows the measurement of ingredients in real time. It is capable of having more than 4,000 measuring points per second. Measurements are able during the filling of the tank but also while application in the field.

This allows the application of the liquid manure based on a target quantity (kg/ha) of a single ingredient and an optional maximum amount of a second ingredient, or based on a predetermined application map.

All recorded nutrient values, application rates and application amounts are displayed on the fully integrated GS3 2630, Gen4 4600 CommandCenter and the 4640 Universal Display, and at the same time up to four different values are site specific recorded.

Using the wireless Data transfer (WDT) from John Deere the documented data can immediately transmitted via mobile for data storage, further analysis or common use with customers or agronomic advisers to the John Deere operations center.

Table 2:
Measuring range JOHN DEERE HarvestLab 3000 with calibration model LKS 05/18

Digestate	N_{Total} [kg/m³]	NH_4-N [kg/m³]	K_2O [kg/m³]
Range	1.0 - 7.0	1.5 - 4.0	2.0 - 5.5

Advantages of the HarvestLab 3000 Near Infrared Technology:

- High accuracy through multiple readings
- Measurement during application
- Analysis of the whole substrate instead of just single sampling
- Simultaneous analysis of several ingredients
- Non-destructive measurement
- Application according to target rate and marginal rate or according to prescription map
- Adjustment of nutrient delivery rate by automatic speed and flow rate control

Method of near-infrared measurement (see picture 2)

A light source (A) projects a beam directly onto the substrate or manure passing the lens of the sensor (B). Parts of the light are absorbed and the rest of the light is reflected. The reflected portion is detected and with a subsequent calculation the HarvestLab 3000 Sensor (C) can determine the dry matter content and the ingredient values.

The manufacturer specifies the measurement ranges listed in Table 2 for the calibration model used in the system.

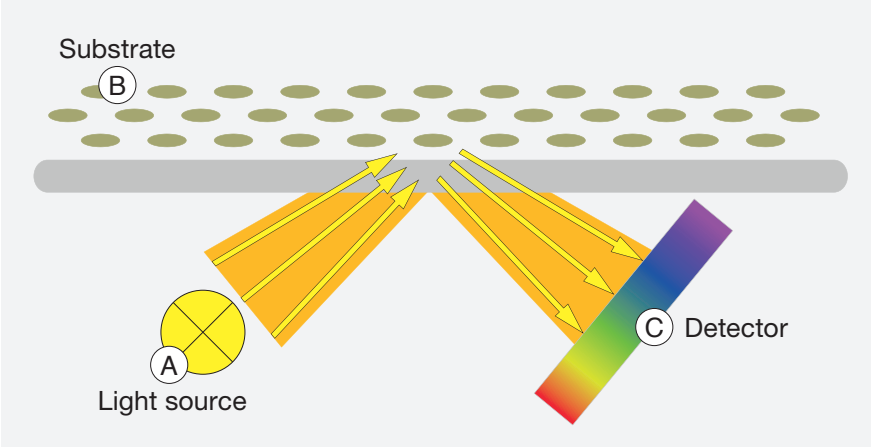

Figure 2:
Functional principle and system design of the NIR Sensor

The Method

The aim of the DLG Test „Precision of mobile sensors for the determination of ingredients in passing liquid manure of animal origin and liquid digestate“ is to examine the accuracies of mobile sensors in conjunction with appropriate calibration models in comparison to laboratory analysis with officially recognized methods.

A major advantage of NIR measuring technology compared to the conventional methods for the determination of ingredients in liquid manures through sampling and laboratory analysis, consists in the immediate availability of measurement results, and in the permanent measurement of the ingredients along the complete manure volume.

The scope in the DLG Test is limited on substrates, which are described as manure according to the German Fertilizer Act, so on cattle manure, pig manure, mixed manure from cattle and pig manure, and liquid digestate from cattle or pig manure with renewable raw materials.

The DLG test is available for the measurement of the following ingredients:

- Dry matter content (DM in % Weight.)
- Total Nitrogen amount (N_{Total} in kg/m³)
- Ammonium nitrogen amount (NH_4N in kg/m³)
- Phosphate content (Phosphorous Pentoxide; P_2O_5 in kg/m³)
- Potassium (Potassium Oxide; K_2O in kg/m³)

In order to cover a wide range of applications, the test attempts to use a diverse spectrum for each type of substrate:

- Cattle manure: 4 % DM – 9 % DM, where possible from dairy cows and fattened cattles
- Pig manure: 2 % DM – 7 % DM, where possible from sow-keeping + fattened pigs
- Mixed manure from cattle and pig manure: concentration series as follows
  10 %cattle : 90 %pig / 30 %cattle : 70 %pig / 50 %cattle : 50 %pig / 70 %cattle : 30 %pig / 90 %cattle : 10 %pig
- Liquid digestate from cattle or pig manure with renewable raw materials: 5 % DM – 8 % DM

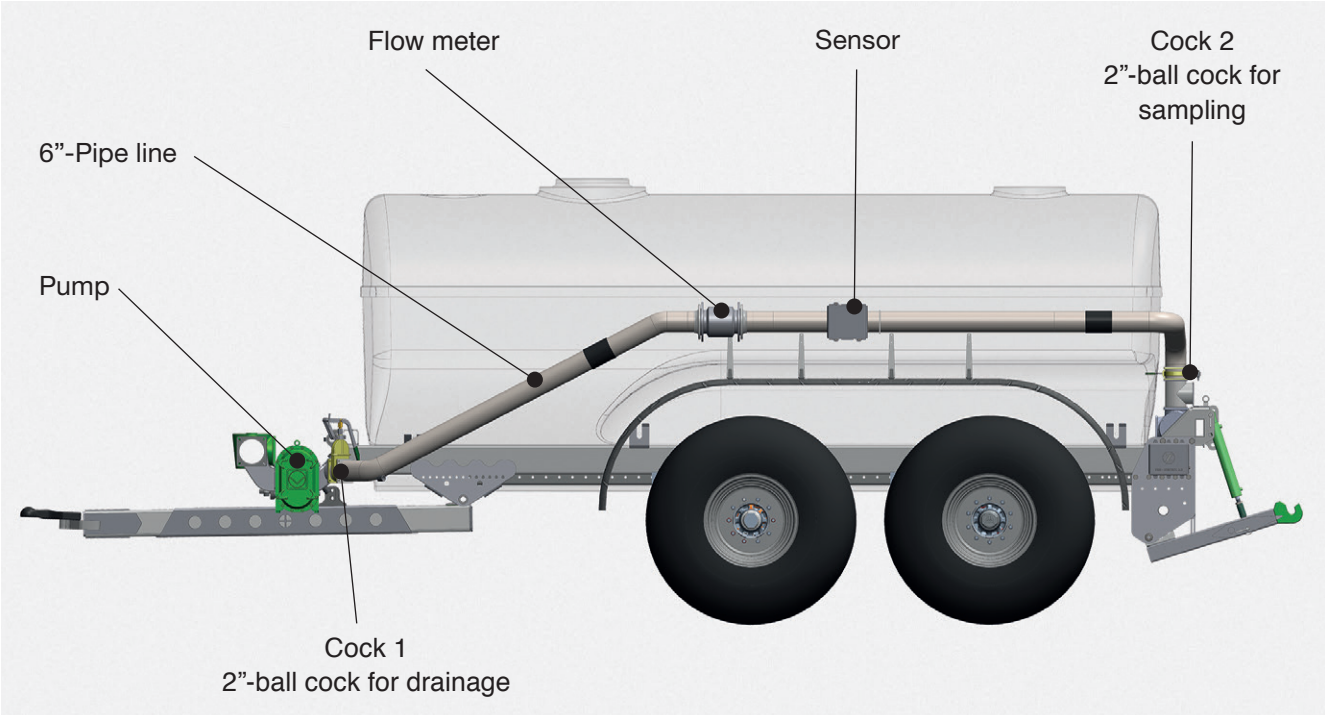

Figure 3:
Schematic structure of the DLG measuring system

The DLG approval can be awarded for individual types of manure and individual ingredients. To get a DLG recognition, at least the requirements for the measurement of the total nitrogen content (N_{Total}) need to be met. When the requirements for the measurement of the total nitrogen content are met, other ingredients can be freely chosen.

The process

Depending on each type of manure (cattle manure, pig manure, mixed manure from cattle and pig manure, liquid digestate from cattle or pig manure with renewable raw materials) five individual and as diverse as possible samples are measured and sampled on different farms. For this purpose, a subset of 3 m^3 to 5 m^3 is pumped from the previously stirred slurry storage in an intermediate tank.

At the intermediate tank, a pump and a common piping system are installed. On the piping system one or more sensors to be tested and a bypass for sampling are attached. If necessary, a flow meter for the control of flow rates can be attached (see figure 3).

In a preliminary phase the collected manure is intensively homogenized in the intermediate tank by continuous circulation in a closed circuit.

Following this preliminary phase, the measured values of the sensor are documented. Afterwards sub-samples for the reference analyses are then taken via the bypass while maintaining inflation around the closed circuit. In order to determine any possible influence on the sensor values, subsequently the flow velocity is varied and the measured values are re-documented.

The manure samples are clearly marked, frozen and stored frozen. Five suitable laboratories are commissioned with the reference analysis. Each laboratory receives partial samples of each manure. The analyses in the laboratory must be carried out using officially recognized methods, preferably wet-chemical methods.

For each manure and each ingredient, the arithmetic mean value is calculated as a reference value from the laboratory results. The assessment of accuracy is based on the relative deviations from the sensor value in comparison with the reference value.

The Test Results in Detail

The trials were conducted 2018 in the surrounding area of the DLG Test Center at Gross-Umstadt. Flow rates from 6 m^3/min to 9 m^3/min were set during the measurements. The different flow rates showed no influence on the measured values of the sensor. In table 3 the individual results are given.

Based on the obtained results, the mobile NIR Sensor “JOHN DEERE HarvestLab 3000 with the calibration model LKS 05/18” is awarded the test mark “DLG-APPROVED in individual criteria” for the measurement of:

– Ingredients in liquid digestate: N_{Total}, NH_4-N, K_2O

Table 3:
Individual results

Type designation	JOHN DEERE HarvestLab 3000	Evaluation*
Calibration Model	LKS 05/18	
Installation position (tilt)	90°	
Installation position	horizontal 6“ pipe	
Digestate	N_{Total} in kg/m³	+
	NH_4-N in kg/m³	○
	K_2O in kg/m³	○

*** DLG-assesment scheme:**

++ = passed, very good (4/5 value pairs within a manure type ≤ 10 % and no > 20 % rel. deviation)
\+ = passed, good (4/5 value pairs within a manure type ≤ 15 % and no > 25 % rel. deviation)
○ = passed (3/5 value pairs within a manure type ≤ 25 % and no > 35 % rel. deviation))
– = failed

Summary

The NIR sensor “JOHN DEERE HarvestLab 3000 with the calibration model LKS 05/18” fulfilled the requirements for DLG approval in the accuracy of measurement of total nitrogen (N_{Total}), ammonium nitrogen (NH_4-N) and potassium oxide (K_2O) in liquid digestate.

The DLG approval applies in combination with the software version SW 132 and above.

A major advantage of NIR measuring technology compared to the conventional methods for the determination of ingredients in liquid manures through sampling and laboratory analysis, consist in the immediate availability of measurement results, and in the permanent measurement of the ingredients along the complete manure volume

Within the DLG Competence Center Agriculture, the DLG Expert Committee for technology in plant production among other topics deals with the application of liquid and solid manure. As an outcome from this voluntary specialist work the DLG Expert Knowledge series gives up-to-date information on 15 topic areas (download free of charge at www.DLG.org/ExpertKnowledge). Even more publications of the DLG Expert Committee can be found in German at https://www.dlg.org/de/landwirtschaft/themen/technik/technik-in-der-pflanzenproduktion/). Within the “DLG Compact” series, the 8/2019 issue with the title “Online Determination of nutrient content in liquid manure with sensors”, which was created under the leadership of the DLG Examination Commission for Fertilizer Technology in the DLG Test Center, is also available there.

More information

Test performed by

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

Chamber of Agriculture of North-Rhine Westphalia, Germany (LWK Nordrhein-Westfalen)

Teaching and research Institute Riswick, Elsenpass 5, 47533 Kleve, Germany

DLG test scope

DLG-APPROVED for single, value-determining criteria “Precision of mobile sensors for the determination of ingredients in passing liquid manure of animal origin and liquid digestate” (current as of 09/2020)

Department

Technology for outdoor work equipment

Test engineer(s)

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The DLG

In addition to being the executing body of well-known tests for agricultural engineering, farm inputs and foods, the DLG is also an open forum for the exchange of knowledge and opinions in the agricultural and food industry.

Some 180 full-time employees and more than 3,000 volunteer experts are developing solutions to current problems. The more than 80 committees, working groups and committees thereby form the basis of expertise and continuity for the professional work. At the DLG, a great deal of specialist information for agriculture is created in the form of information leaflets and working papers, as well as articles in journals and books.

DLG organises the world’s leading professional exhibitions for the agriculture and food sector. This contributes to the transparent presentation of modern products, processes and services to the public. Secure the competitive edge as well as other benefits, and contribute to the expert knowledge base of the agricultural industry. Further information can be obtained under www.dlg.org/mitgliedschaft.

The DLG Test Center Technology and Farm Inputs

The DLG Test Center Technology and Farm Inputs in Groß-Umstadt is the benchmark for tested agricultural products and farm inputs, as well as a leading testing and certification service provider for independent technology tests. The DLG test engineers precisely examine product developments and innovations by utilizing state-of-the-art measurement technology and testing methods gained from practice.

As an accredited and EU registered testing laboratory the DLG Test Center Technology and Farm Inputs offers farmers and practitioners vital information and decision support for the investment planning for agricultural technology and farm inputs through recognized technology tests and DLG testing.

The JOHN DEERE HarvestLab 3000 already received the DLG-ANERKANNT test mark in 2018 for the prediction of N_{Total}, NH4-N and K_2O in liquid digestate. The results presented in the report are based on DLG test report 6887. According to the manufacturer, the HarvestLab 3000 is used with the calibration model LKS 05/18 is produced unchanged in the tested version.

Internal test code DLG: 2022-0013c

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