PEL-Tuote Oy

Liquid manure injector Gramline 8 M

Working width: 8 meters
The Gramline 8 M liquid manure injector was able to convince in all aspects of the test criteria laid down in the DLG test framework. On the basis of the attained results, the Gramline 8 M liquid manure injector was awarded the test mark “DLG-APPROVED FULL TEST 2016”.

Lateral spreading
In all eight conducted tests to determine the lateral distribution, the best possible DLG assessment (++) was achieved. During the test rig testing, movements perpendicular to the slope and the plain were carried out with cattle and pig manure.

Recurring maintenance activity
During the DLG test, the times required for the maintenance by four proficient practitioners are measured with a stop watch.

Practical use
The DLG practice usage of the liquid manure injector Gramline 8 M was conducted between April 29, 2016 and August 20, 2016 at five farming operations in southern Hesse. The arithmetic average of all queried individual evaluations results in a value of 1.7. The overall rating is between very good and good. Table 1 shows the practitioner ratings for the various series of questions.

<table>
<thead>
<tr>
<th>Series of questions</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>practitioner grading</td>
<td>1.7</td>
</tr>
<tr>
<td>Accessibility of the maintenance points</td>
<td>1.7</td>
</tr>
<tr>
<td>Evaluation of the handling</td>
<td>1.7</td>
</tr>
<tr>
<td>Evaluation of the work quality</td>
<td>1.7</td>
</tr>
<tr>
<td>Overall score</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Compliance with occupational safety-technical specifications
The liquid manure injector Gramline 8 M has been examined by the DPLF (German Test and Certification Center for Agriculture and Forest Engineering). There are no objections to the use of the device on industrial safety grounds.
The Product

Applicant and manufacturer

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Product:
Liquid manure injector Gramline 8 M
(Working width: 8 meters)

Distribution partner:
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94149 Kößlarn
Germany
M.Graml@t-online.de
Tel. +49 (0)8536 1267

Figure 2:
Injector machine Gramline 8 M side-photographed during the liquid manure distribution in a catch crop stuck

Description and technical data

The Gramline 8 M injector machine has its own axle and is therefore particularly suitable for the attachment of manure tankers, whose axle load is already exhausted through the loading with liquid manure. The injector machine is suitable for the slurry on grassland and arable land.

The device can be attached to all manure tankers, for which the approval of the manufacturer has been obtained. The working width is eight meters. For the applied driving lane distance between 15m or 30m it is possible to switch off the two outer tubes through a ball valve. Through this, the working width is reduced from 8 meters to 7,50 meters.

For road transport, the unit is folded up. In the transport position, it has a width of 2.96 meters and a height of 3.78 meters. The device is equipped with its own light bar which has a length of 4.47 meters.

The device is equipped with 32 discs to open up the soil. The distance between the discs is 25.5 cm. The discs have a diameter of 46 cm. A disk has a width of 5 mm. If the liquid manure distribution is to be performed on loosened soil, all 32 discs can be fitted with a disk attachment to perform a widening. This attachment is attached to the base disk with four screws. Through the widening of the discs a wider slot is created in the processed soil, which can absorb more liquid manure.

Figure 3:
Disc with mounted disc attachment for the liquid manure distribution on processed arable land

Figure 4:
Two Harse distributors with 16 outlets each
Each disc has maintenance-free bearings with an oil bed. Scrapers for the discs are offered optionally. The device does not have a drip stopper.

The Gramline 8 M injector machine is equipped with two Harso distributors to distribute the manure. Each distributor has 16 outlets.

A levelling bar is attached behind each pair of discs. During the liquid manure injection on machined loose soil this levelling unit closes the soil again into which the liquid manure was inserted. The levelling bars are adjustable in height.

The operator at the terminal can execute the functions for lifting/lowering and folding/unfolding. The entire hydraulic system of the injector machine is powered by the tractor through load-sensing.

The injector machine tested in the present DLG test was attached to a pump tank from the company Fuchs. The manoeuvring and reverse driving with the tandem is easily possible. The angle between tractor and pump tanker is measured with an angle sensor. This same angle is then adjusted via two hydraulic cylinders on the pivot of the subsequently towed injector machine.

**Figure 5:**
*Injector machine Gramline 8 M attached to a pump tank from the company Fuchs*

### The Method

#### Determination of the transverse distribution of cow manure and pig manure

The lateral distribution with cow manure and pig manure in the plane and on the slope with two volume streams is determined on the test bench pursuant to the standard DIN EN 13406. The discharged liquid manure is separately collected here during each discharge and then weighed. The average deviation (MA) and the coefficient of variation (VK) are then calculated from the individual values. Smaller are the two key figures, the more uniform the lateral distribution will be.

\[
MA = 100 \cdot \frac{1}{n \cdot \bar{X}} \cdot \sum_{i=1}^{n} \left| X_i - \bar{X} \right|
\]

The average deviation is evaluated with the DLG assessment scheme presented in table 2.

#### Characterization of the liquid manure used

The DM, the flow and the density of the used liquid manure types are determined. For this, samples of the liquid manure are directly extracted during the test. The DM content is then determined in the laboratory.

<table>
<thead>
<tr>
<th>Average deviation rate</th>
<th>DLG evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 5 %</td>
<td>++</td>
</tr>
<tr>
<td>≤ 10 %</td>
<td>+</td>
</tr>
<tr>
<td>≤ 15 %</td>
<td>o</td>
</tr>
</tbody>
</table>

**Table 2**: Evaluation of lateral distribution on the basis of the average deviation (test bench test)
The flowability is measured with a fluid meter (Figure 6). For this, a precisely defined volume of the fluid meter is filled with liquid manure, and then the time is determined that elapses until the container has emptied himself completely. Afterwards, the time is determined that elapses until the container has emptied himself completely.

Several representative samples of the liquid manure are extracted from the pump tank to determine of the density. Then the density is determined with a measuring cup that has a defined volume. The average value is then calculated from the measured values.

Recurring maintenance activities

The following recurring maintenance activities are performed during a review of a liquid manure injector through expert practitioners. Thereby, the required working time is acquired with a stopwatch.

1. Greasing of all grease nipples on the device:
   The grease gun is available next to the device for calculating work time. Two or five bursts of grease are pressed fat into the grease nipple. After the greasing of all nipples, the grease gun is again placed next to the device to be tested. Time acquisition is then performed by the timekeeper.

2. Conversion of the machine from the transport position to working position: The time acquisition is started as soon as the test person presses the two buttons on the display to execute the unfolding. The time acquisition is ended when the device is in the working position (headland position).

3. Alteration of the slot disk working depth:
   The time measurement starts when the driver rises from the tractor seat. He adjusts the working depth, return back to the cabin and sits down on the seat. Afterwards, the time acquisition will be concluded.

4. Check of the two distributor heads for foreign objects: A screwdriver is available next to the device. The test person takes this screwdriver and opens the service door of distributor No. 1. After reclosing, the test person will move to the distributor No. 2 and open the service door. After this is closed again the time acquisition will be concluded.

As described above, all activities will be carried out by several test persons. Afterwards, the average value is calculated from all measured times. Additionally, the tools which were used during the execution of the activities will be listed in the inspection report.

Practical use of the test specimen at farming operations

The test specimen is used at several forming operations. After the deployment, the practitioners will be interviewed using a standardised questionnaire. The questionnaire includes sections for evaluating the handling, quality of work and maintenance of the injector machine. The practitioners will grade all individual questions according to the following five-step scheme: very good (1) – good (2) – satisfactory (3) – sufficient (4) – poor (5).

Compliance with occupational safety-technical specifications

The examination will be conducted by the DPLF (German Test and Certification Center for Agriculture and Forest Engineering). The check includes the compliance with the requirements listed in the relevant standards and requirements for work safety.
The Test Results in Detail

Transverse distribution of cow manure and pig manure

The transverse distribution was tested in mid April 2016 with the mobile test rig of the DLG Test Center Technology and Farm inputs in Groß-Umstadt with cow manure and pig manure in the plane and on the slope, each with two volume flows.

Thereby, average deviations between 2.8 % and 5.0 % were determined. All results for the liquid manure processing were rated with „+ +“ according to the DLG test framework. In Table 3, the test results are shown in an overview. Table 4 shows the results including the DLG assessment for each experimental variant.

Figures 7 and 8 show two examples for the transverse distribution.

Table 4:
Results of the transverse distribution measurements

<table>
<thead>
<tr>
<th>Lateral spreading</th>
<th>Spreading rate at 8 km/h [m³/ha]</th>
<th>Variation coefficient [%]</th>
<th>Average deviation [%]</th>
<th>Evaluation of the average deviation*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow manure in the plane (Flow rate: 3890 l/min)</td>
<td>36</td>
<td>6.2</td>
<td>4.8</td>
<td>++</td>
</tr>
<tr>
<td>Cow manure in the plane (Flow rate: 2034 l/min)</td>
<td>19</td>
<td>5.6</td>
<td>4.9</td>
<td>++</td>
</tr>
<tr>
<td>Cow manure at 7° slope (Flow rate: 4150 l/min)</td>
<td>39</td>
<td>5.3</td>
<td>4.2</td>
<td>++</td>
</tr>
<tr>
<td>Cow manure at 7° slope (Flow rate: 2027 l/min)</td>
<td>19</td>
<td>5.7</td>
<td>5.0</td>
<td>++</td>
</tr>
<tr>
<td>Pig manure in the plane (Flow rate: 4125 l/min)</td>
<td>39</td>
<td>3.6</td>
<td>2.9</td>
<td>++</td>
</tr>
<tr>
<td>Pig manure in the plane (Flow rate: 2096 l/min)</td>
<td>20</td>
<td>5.1</td>
<td>4.3</td>
<td>++</td>
</tr>
<tr>
<td>Pig manure at 7° slope (Flow rate: 3823 l/min)</td>
<td>36</td>
<td>3.6</td>
<td>2.8</td>
<td>++</td>
</tr>
<tr>
<td>Pig manure at 7° slope (Flow rate: 1966 l/min)</td>
<td>18</td>
<td>5.7</td>
<td>4.8</td>
<td>++</td>
</tr>
</tbody>
</table>

* Assessment range of the average deviation: ++ = ≤ 5% / + = ≤ 10% / o = = ≤ 15%

Figure 7:
Transverse distribution of cow manure in the plane at a flow rate of 3890 l/min
(for example, this is would be equivalent to an application rate of 36 m³/ha at a speed of 8 km/h)
Figure 8:
Transverse distribution of pig manure in the plane at a flow rate of 3823 l/min
(for example, this would be equivalent to an application rate of 36 m³/ha at a speed of 8 km/h)

Recurring maintenance activities

The maintenance times were determined in June 2016 in the DLG Test Center Technology and Farm Inputs in 64823 Groß-Umstadt. The results of this partial test are shown in table 5.

1. Lubrication: The test persons require between 187 and 272 seconds for the lubrication of all 29 grease nipples (average value: 239 seconds). In addition to grease gun and a roll aboard, no another tools will be required for this.

2. Conversion from the transport position to working position: To unfold the injector machine, all four test persons require 26 seconds (average value: 26 seconds). The duration more is dependent on the tractor hydraulics and less on the operator. According to safety regulations a certain minimum time must be required for the unfolding, which is adhered to.

3. Setting of the working depth: The test persons require between 49 and 68 seconds to adjust the work depth (average value: 59 seconds). No tools are needed for this activity. The adjustment of the work depth can be performed by the operator outside of the scope.

4. Check of the two distributor heads for foreign objects: During the DLG test, the check of the two distributor heads for foreign bodies lasted between 52 and 68 seconds (average value: 62 seconds). For the opening and closing process, the user needs a screwdriver (required provision from the safety standards).

In addition to the maintenance activities listed in table 5, the time to convert the discs was determined. During this activity, a hollow disc was screwed onto every flat disk of the injector machine. These hollow discs produce an approximately 1 cm wide slot during their operation, into which a greater manure amount can be placed.

Two experienced practitioners together required 100 minutes to unscrew all 32 hollow discs. In impact wrench was utilized to loosen and tighten the screws.

Table 5:
Maintenance times on the liquid manure injector Gramline 8 M

<table>
<thead>
<tr>
<th>Maintenance activity</th>
<th>Test person</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lubrication of all 29 grease nipples</td>
<td>[s]</td>
<td>187</td>
</tr>
<tr>
<td>Conversion of the machine from the transport position to working position</td>
<td>[s]</td>
<td>26</td>
</tr>
<tr>
<td>Setting of the working depth</td>
<td>[s]</td>
<td>51</td>
</tr>
<tr>
<td>Check of the two distributor heads for foreign objects</td>
<td>[s]</td>
<td>52</td>
</tr>
</tbody>
</table>

Test Report 6415
Utilization in practice on five farming operations

The DLG practice usage of the liquid manure injector Gramline 8 M was conducted between April 29, 2016 and August 20, 2016 at five farming operations in southern Hesse. All farmers used a CLAAS Arion 650 as a towing vehicle (rated output: 175 HP). The liquid manure injector was thereby connected to a pump tank from the company Fuchs (filling capacity: 10 m³).

During the utilization in practice, an area of 41.5 hectares was processed by all five farmers (23.5 ha of arable land and 18 ha of green land). Thereby, 1192 m³ liquid manure were applied (572 m³ cow manure, 140 m³ pig manure, and 480 m³ biogas manure).

Table 6 shows the utilization spectrum of the liquid manure injector during the deployments in practice at the five farming operations. The evaluations, that the farmers have provided regarding the injector machine after the practical application, are depicted in table 7. In addition to the individual valuations, the resulting average scores are shown in the right column. No blockages occurred in the hoses during operations in practice. There was only one occurrence of obstructions before the discs with one farmer. Damages to the test specimen did not occur during the utilization in practice.

Three of the five respondent practitioners criticized the lack of a drip stop. In the tested version of the injector machine, the shut-off valve was closed with

### Table 6:

<table>
<thead>
<tr>
<th>Utilization conditions</th>
<th>Usage operation no.</th>
<th>Ø</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Usage operation no. 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Utilization on a single-crop plot with segregated catch crop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– The liquid manure application took place before the maize sowing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Soil type: Sandy loam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Spreading rate: 30 m³ cow manure/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Usage operation no. 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Utilization on a single-crop plot with shallow integrated catch crop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– The liquid manure application took place before the maize sowing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Soil type: Sandy loam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Spreading rate: 40 m³ pig manure/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Usage operation no. 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Utilization on a single-crop plot with mowed agricultural grass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– The liquid manure application was carried out after the first cut</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Soil type: Loamy sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Spreading rate: 55 m³ cow manure/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Usage operation no. 4</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Utilization on permanent grassland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– The liquid manure application was carried out after the second cut</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Soil type: Sandy loam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Spreading rate: 20-30 m³ cow manure/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Usage operation no. 5</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Utilization on arable land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– The liquid manure application was carried out after the barley harvesting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Soil type: Sandy loam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Spreading rate: 20 m³ biogas manure/ha</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 7:

Results from the operation in practice with five farmers

<table>
<thead>
<tr>
<th>Characteristic*</th>
<th>Usage operation No.</th>
<th>Ø</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Accessibility of the maintenance points</td>
<td></td>
<td>1.7</td>
</tr>
<tr>
<td>Accessibility of the grease nipples</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Accessibility of service doors on both Harsø distributors</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Evaluation of the handling</td>
<td></td>
<td>1.7</td>
</tr>
<tr>
<td>Driving behaviour on the road</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Reversing and manoeuvring</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Unfolding and folding</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Menu guidance on the operating terminal</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Setting of application pressure/working depth</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Simplicity of the operating instructions</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Evaluation of the work quality</td>
<td></td>
<td>1.7</td>
</tr>
<tr>
<td>General work quality of the test specimen</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Liquid manure absorption capability of the created slots</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Visual assessment of the work results</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Uniformity of the created slots</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Overall rating*</td>
<td></td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>1.8</td>
<td>1.5</td>
</tr>
</tbody>
</table>

* Rating options: very good (1) – good (2) – satisfactory (3) – sufficient (4) – poor (5)
a lifting of the discs. Thus, a subsequent dripping of manure sometimes occurred at the outlets. In the future, PEL-Tuote will integrate a delay time. After the lift-out process is triggered by the operator, the gate valve will be closed, and the left-out then started with a delay. This is intended to ensure that the hoses have already emptied themselves before the discs are lifted.

A farmer negatively reviewed the small buttons on the control panel. In addition to the control unit used in the DLG test, a 12.1-inch TFT LCD monitor with a large keypad is also offered by the manufacturer.

All farmers have stated a very positive assessment for the accurate in-lane driving of the entire combined vehicle.

Figures 9 and 10 show the quality of the work of the liquid manure injector during the utilization in practice.

Figure 9:
Work results on a single-crop plot after a single shallow soil tillage
(Spreading rate: 40 m³ pig manure/ha)

Figure 10:
Work results on permanent grassland (Spreading rate: 20 m³ cow manure/ha)
Compliance with occupational safety-technical specifications

The visual examination of the injector machine was conducted by the DPLF (German Test and Certification Center for Agriculture and Forest Engineering), taking into account the legislation of the EC for machinery (Machinery Directive 2006/42/EC). Additionally, the visual inspection was conducted under the observation of the following standards:

   (Safety of machinery: Minimum spacing to avoid body parts from being crushed)

2. DIN EN ISO 4413:2010
   (Fluid technology: General rules and safety requirements for hydraulic systems and their components)

3. DIN EN 707:2009
   (Agricultural and forestry machinery - liquid manure tankers: Safety)

4. DIN EN ISO 12100-1:2010
   (Safety of machinery: General principles for design, risk assessment and mitigation)

The safety distances to rotating or moving parts required in the standards are maintained on the machine. Warnings are prominently attached to all affected areas, and the operating manual contains instructions and information about all aspects regarding the safe use of the machine. There are no objections to the use of the machine according to the assessment of the DPLF regarding industrial safety aspects.

The test specimen was also measured during this partial test. The measured values are contained in table 8.

Table 8:
Dimensions of the test specimen

<table>
<thead>
<tr>
<th>dimension</th>
<th>measured value [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of the injector machine</td>
<td>4.47</td>
</tr>
<tr>
<td>Height of the injector machine (in transport position)</td>
<td>3.78</td>
</tr>
<tr>
<td>Width of the injector machine in transport position</td>
<td>2.96</td>
</tr>
<tr>
<td>Width of the injector machine in working position</td>
<td>8.03</td>
</tr>
</tbody>
</table>
Conclusion

The Gramline 8 M injector machine was able to achieve good and very good results across all areas of the test criteria laid down in the DLG test framework.

During the determination of the transverse distribution average deviations between 2.8 % and 5.0 % were determined in all eight conducted test variants. These test results are rated with the best possible rating (+++) according to the DLG evaluation matrix.

The utilization in practice was conducted at five farming operations. The overall rating is between very good and good with a total score of 1.7.

During the examination of the work safety, no safety deficiencies could be identified. There are no objections to the use of the machine according to the assessment of the DPLF regarding industrial safety aspects.

On the basis of the attained results, the Gramline 8 M injector machine from the manufacturer PEL-Tuote was awarded the test mark „DLG-APPROVED FULL TEST 2016“. 

Members of the competent DLG Test Commission “Fertilising Technology“:

Prof. Hans W. Griepentrog, University of Hohenheim
Prof. Nils Fölster, University of Osnabrück
Prof. Bernd Scheufler, University of Osnabrück
Dr. Harm Drücker, Chamber of Agriculture of Lower Saxony
Dr. Horst Cielejewski, Chamber of Agriculture of North Rhine-Westphalia
Dr. Fabian Lichti, State Institute of Agriculture Bavaria
Peter Seeger (farmer), Otzberg
Frank Reith (farmer), Groß-Umstadt
Sven Schneider (farmer and contractor), Brensbach
Internal test code DLG: 2015-964
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