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Evaluation Report 222

Degelman LC14 Rock Rake

A Co-operative Program Between
ALBERTA FARM MACHINERY RESEARCH CENTRE
PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

DEGELMAN LC14 ROCK RAKE

MANUFACTURER AND DISTRIBUTOR:

Degelman Industries Ltd.
Box 830
Regina, Saskatchewan
S4P 3B1

RETAIL PRICE:

$6270.00 (March, 1981, f.o.b. Humboldt, complete with 540 rpm power take-off drive, and optional small stone deflector attachment).

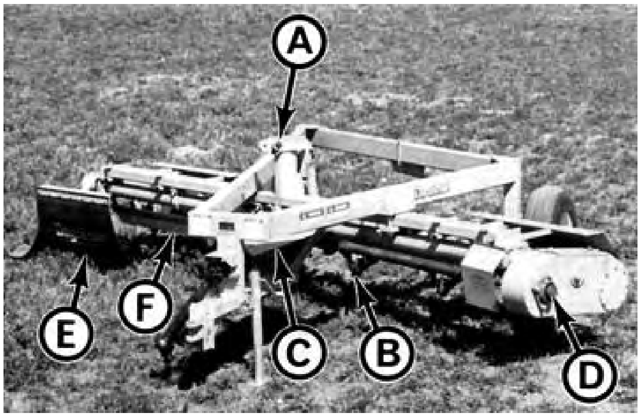

FIGURE 1. Degelman LC14: A) Depth Control, B) Rake Drum, C) Slip Clutch, D) Rock Shaft Assembly, E) Rock Deflectors, F) Optional Small Stone Deflector.

SUMMARY AND CONCLUSIONS

Overall functional performance of the Degelman LC14 rock rake was very good. Ease of operation was very good, while ease of adjustment and servicing were good.

Typical field speeds were from 3 to 7 km/h (2 to 4.5 mph) while the average workrates varied from 1.2 to 2.7 ha/h (3 to 6.6 ac/h). The Degelman LC14 worked well in rocks ranging in size from 40 to 400 mm (1.6 to 16 in). Performance was best in fields with average rock size less than 300 mm (12 in).

A tractor with 35 kW (47 hp) maximum power take-off rating had sufficient power reserve to operate the Degelman LC14 in most field conditions.

The Degelman LC14 transported well at speeds up to 40 km/h (25 mph). It was safe to operate as long as common sense was used and manufacturer's safety recommendations were followed.

Considerable breakage of rake teeth and tooth attaching bolts occurred in rocks greater than 400 mm (16 in) in size. Tooth breakage was insignificant in smaller rocks.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Expanding the operator's manual to include detailed information on windrower operation and adjustment.
2. Modifications to reduce the cyclic load fluctuations in the driveline, caused by the arrangement of the universal joints in the secondary drive shaft.
3. Modifying the recessed grease fittings on the rock shaft assembly to aid in servicing.
4. Modifications to improve the durability of the rock deflectors.

Chief Engineer - E.O. Nyborg
Senior Engineer - J.D. MacAulay
Project Engineer - D.K. Garman

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. We are expanding the operator's manual to include detailed information on operations and adjustments.
2. We are working on modifications to reduce the cyclic load fluctuations.
3. The grease fittings are being changed to the bottom of the rockshaft bearing in the next production run. The grease fittings are recessed to protect them from rocks.
4. The rock deflectors will be changed to a better material with plies of reinforcing for more strength and tear resistance.

NOTE: This report has been prepared using SI units of measurement. A conversion TABLE is given in APPENDIX III.

GENERAL DESCRIPTION

The Degelman LC14 is a power take-off driven, pull-type rock windrower with a 4.3 m (14 ft) raking width. It is designed for use in conjunction with a rock picker.

The rake drum, which may be set at a 14, 18 or 22° rake angle, delivers rocks to the right. It consists of a cylinder with two rows of teeth arranged in spirals. The teeth are bolted to brackets, which are welded to the drum surface. The drum assembly is mounted on a rock shaft permitting it to move independently from the rake frame. Flotation and penetration are controlled by two adjustable springs and a single hydraulic cylinder.

The windrower may be equipped with gearbox and power input shaft to suit either 540 or 1000 rpm tractor power take-off speeds. The drum is chain driven from the gearbox with a slip clutch provided on the power input shaft. The test machine was equipped with a 540 rpm power take-off drive.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Degelman LC14 was operated in the conditions shown in TABLE 1 for 104 hours, while raking about 170 ha (420 ac). It was evaluated for rate of work, quality of work, ease of operation and adjustment, power requirements, safety and suitability of the operator's manual.

TABLE 1. Operating Conditions

Rock Size	Hours
Less than 200 mm (8 in)	20
200 to 300 mm (8 to 12 in)	62
Greater than 300 mm (12 in)	22
Total	104
Rock Concentration	Hours
Light	18
Medium	58
Heavy	26
Total	104

RESULTS AND DISCUSSIONS

RATE OF WORK

Suitable field speeds ranged from 3 to 7 km/h (2 to 4.5 mph). Average workrates varied from 1.2 to 2.7 ha/h (3 to 6.6 ac/h). Appropriate ground speeds depended on both the size and concentration of rocks in the field. In heavy concentrations, speeds had to be below 4 km/h (2.5 mph) to reduce misses; at higher speeds, some small rocks were missed. Low ground speeds also had to be used in large rocks of over 300 mm (12 in) size, to minimize possible damage to the rake teeth. Dense, uniform windrows were produced at speeds below 5 km/h (3 mph) while scattered windrows were formed at higher speeds.

QUALITY OF WORK

Raking Characteristics: The Degelman LC14 performed well in most field conditions. Although the rake angle could be set at 14°, 18° or 22°, an 18° rake angle was used throughout the test. High rake angles resulted in more aggressive raking action and more soil disturbance. At standard 540 rpm power take-off speed, the rake drum operated at 143 rpm. This speed, combined with an 18° rake angle gave adequate raking action and rock movement in most field conditions.

In fields with a heavy concentration of small rocks a number of rocks were missed by being thrown back over the drum. The optional small rock deflector attachment effectively prevented carry over of small rocks in these conditions (FIGURE 2). The small rock deflector attachment should not be used in fields infested with rocks larger than 375 mm (15 in). If large rocks are caught and thrown over the drum, as occasionally happens, the small rock deflector can be damaged (FIGURE 3).

FIGURE 2. Typical Raking Performance in a Field Heavily Concentrated with Small Rocks. Optional Small Rock Deflector Attachment Used.

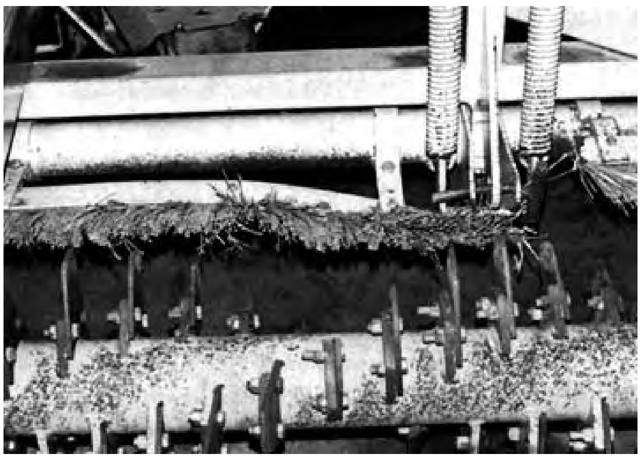

FIGURE 3. Small Rock Deflector Damaged by Large Rocks.

To effectively windrow surface rocks and to minimize soil retention in the windrow, forward speed had to be selected to suit field conditions. When set at an 18° rake angle best performance was achieved with a tooth index[1] of about 1.5 in fields with light rock concentrations, about 2 in fields with medium rock concentration and about 3 in fields with heavy rock concentrations. Since the rake drum speed was fixed at 143 rpm, corresponding ground speeds were about 8, 6 and 4 km/h (5, 3.7 and 2.5 mph) in light, medium and heavy concentration, respectively. FIGURE 4 shows the effect of ground speed on raking effectiveness in a field with medium rock concentration.

Windrow Formation: As is shown in FIGURE 4, windrow formation depended on ground speed. At speeds below 5 km/h (3 mph) dense, uniform windrows were formed in most conditions. High speeds resulted in scattered windrows.

Operating Depth: Performance was best with the rake teeth operating about 25 mm (1 in) below the soil surface. Deeper operation caused considerable soil to be windrowed with the rocks. In fields with subsurface rocks, deeper or faster operation also resulted in rake drum bounce, causing some surface rocks to be missed. If tooth penetration were less than 25 mm (1 in), small surface rocks were missed.

It was important to select the proper soil condition for optimum performance. For example, penetration usually was inadequate in fields with a hard surface crust. If the surface soil was very loose, operating depth had to be greater than 25 mm (1 in) to prevent misses. This produced windrows containing excessive soil.

[1]The tooth index is the ratio of the tangential tooth tip speed to the forward speed. A high tooth index gives aggressive raking action.

A

B

C

FIGURE 4. Typical Performance in a Field with Medium Rock Concentration (A) Before Windrowing, (B) Windrowed at 5 km/h, (C) Windrowed at 7 km/h.

Trashy Conditions: Surface trash caused few problems. The use of a rod weeder, prior to raking was desirable since this placed small rocks on the surface, and gave a relatively firm working base.

Soil Pulverization: The windrower caused considerable soil pulverization, especially at low ground speeds. Pulverization decreased with increased ground speeds. Raking levelled the field surface and broke most surface lumps, creating a condition susceptible to wind erosion. In dry fields, operation was very dusty (FIGURE 5), often causing the windrower to be completely obscured. At times the operator was unable to see where the rake had passed on the previous round. Because of the dust problem, a tractor equipped with a cab was desirable.

Stability: The Degelman LC14 was very stable. The spring loaded floating rake drum lifted to clear solid subsurface rocks without causing the windrower to skew sideways. Since the drum was spring loaded, the raking force could be adjusted to suit subsurface rock conditions. Ground speed had to be selected to suit field conditions. In fields with heavy subsurface rock concentrations, ground speed usually had to be below 6 km/h (3.7 mph). At higher speeds, the drum sometimes began to bounce, leaving a wavy surface, missing a large number of rocks.

The windrower was relatively stable on hillsides. Skewing was never severe enough to affect operation.

FIGURE 5. Typical Dust Conditions.

Rock Size: The Degelman LC14 could effectively windrow rocks ranging in size from 40 to 400 mm (1.6 to 16 in). Although it could also handle rocks ranging from 400 to 500 mm (16 to 20 in) such rocks had to be windrowed with caution due to severe shock loads on the rake teeth. A number of rake teeth and tooth mounting bolts broke during the test when operating in rocks of this size. Tooth failures were negligible when windrowing rocks less than 400 mm (16 in) in diameter.

Performance was best in fields having a maximum rock size less than 300 mm (12 in). In fields with a large number of rocks ranging from 300 to 400 mm (12 to 16 in) lower ground speed usually had to be used to reduce shock loading. Rocks greater than 500 mm (20 in) in diameter should be removed from the field before windrowing.

EASE OF OPERATION AND ADJUSTMENT

Transporting: The Degelman LC 14 was easily transported. It towed well at speeds up to 40 km/h (25 mph). The 180 mm (7 in) transport clearance was adequate. The transport lock was convenient to use.

Slip Clutch: The slip clutch on the power input shaft performed well when properly adjusted. Clutch adjustment had to be checked regularly. Proper clutch adjustment was about one turn of the adjustment nut, past snug, on a new clutch. This increased to one and one half turns on a worn clutch. If clutch slippage is noticed during normal operation, the clutch should be tightened only one-quarter turn at a time until slippage stops. This allows the clutch to be loose enough to protect drive components from overload.

Hitching: The windrower was easily hitched to a tractor. The hitch jack was inconvenient, and the hitch clevis was fixed allowing one man hook-up. Both the hitch clevis and the wheels were adjustable vertically to permit frame levelling and power take-off shaft alignment. When initially hitching to a tractor, the hitch clevis is adjusted to obtain power take-off shaft alignment. The wheels are then positioned to level the frame.

During the test, the hitch jack seized due to extreme dust conditions.

Ease of Servicing: The windrower was easy to service. All lubrication points, the drive chain and the slip clutch were accessible. As the grease fittings on the rock shaft assembly (FIGURE 6) were recessed into the support frame, the hole surrounding the fittings filled with soil and had to be cleaned before each lubrication. It is recommended that the rock shaft grease fittings be modified to eliminate this problem.

Rake Angle Adjustment: To change the raking angle, two bolts must be removed and the rake drum swung either forward or backward. When the two bolts on the right side are removed, the rake drum assembly drops and must be supported to allow the rake drum to be swung to the new raking angle.

Small Rock Deflector: The best performance of the optional small rock deflector attachment was obtained by positioning the brushes to point directly at the centre of the rake drum. When operating in larger rocks, the deflector had to be removed to prevent damage. The deflector could be removed in less than 15 minutes.

FIGURE 6. Soil Accumulation in Rock Shaft Grease Fittings.

Maneuverability: The Degelman LC14 was quite maneuverable. Its turning radius was short enough for easy operation, however, normal care had to be taken to prevent interference between the tractor tire and frame on sharp turns. As with most power take-off driven machinery, short turns caused high stresses in the driveline universal joints. Since many sharp turns are needed in normal rock windrowing operation, this condition cannot be avoided.

POWER REQUIREMENTS

A tractor with 35 kW (47 hp) maximum power take-off rating had sufficient power reserve to operate the Degelman LC14 in most conditions. Average power take-off demands were about 15 kW (20 hp), however, this fluctuated widely. Power fluctuations were caused by impact loading of the rake teeth as well as by the arrangement of the universal joints on the secondary drive shaft.

SAFETY

The Degelman L C 14 was safe to operate as long as normal safety practices were observed. Shielding provided adequate protection from driveline components. The windrower was equipped with a slow moving vehicle sign and a transport safety lock for the depth control cylinder.

OPERATOR'S MANUAL

The operator's manual contained a parts list, detailed assembly instructions, a list of safety precautions and some information on machine adjustments. It is recommended that the operator's manual be expanded to include detailed information on windrower operation and adjustment.

DURABILITY RESULTS

TABLE 2 outlines the mechanical history of the Degelman LC14 during 104 hours of field operation. The intent of the test was a functional evaluation. The following mechanical problems are those, which occurred during the functional testing. An extended durability test was not conducted.

TABLE 2. Mechanical History

Item	Hours
-The fabric rock deflectors tore off, requiring replacement at	22, 68
-The slip clutch pressure plate broke, seizing the slip clutch and damaging the secondary drive shaft. The pressure plate and secondary drive shaft were replaced at	16
-The hitch jack seized due to dust at	End of test
-Eighteen rake teeth broke and were replaced	During the test
-Fifty-nine rake tooth attaching bolts broke and were replaced	During the test
-The key on the slip clutch output stub shaft sheared and was replaced at	44
-The slip clutch output stub shaft slid out of the slip clutch, interfered with the universal joint and was repositioned at	32, 44
-The small rock deflector attachment was bent by large stones and straightened at	12
-A universal joint on the primary drive shaft broke and was replaced at	End of test

DISCUSSION OF MECHANICAL PROBLEMS

Slip Clutch: Breakage of the pressure plate was due to a defective plate in the original slip clutch assembly. This resulted in overload and damage to the secondary drive shaft. No further problems occurred after the pressure plate was replaced.

Sliding of the slip clutch output stub shaft and shearing of the key, were probably caused by the cyclic loading of the drive train due to the operating orientation of the universal joint in the secondary drive line. It is recommended that the manufacturer consider modifications to reduce the cyclic load fluctuations caused by the orientation of the universal joints.

Rock Deflectors: The rock deflectors, which were constructed of a rubberized fabric, tore easily during normal operation (FIGURE 7). It is recommended that the manufacturer consider modifications to improve durability of the rock deflectors.

Rock Teeth: Breakage of rake teeth and rake teeth attaching bolts occurred mainly when windrowing rocks greater than 400 mm (16 in) in size. Tooth breakage was insignificant in smaller rocks.

FIGURE 7. Tom Rock Deflector.

APPENDIX I
SPECIFICATIONS

MAKE:	Degelman Rock Rake
MODEL:	LC14
SERIAL NUMBER:	1690
WEIGHT:	
-- left rear wheel	440 kg
-- right rear wheel	440 kg
-- hitch	678 kg
Total	1558 kg
TIRES:	2, 9.5L x 15
0VERALL DIMENSIONS:	
-- width	5080 mm
-- height	920 mm
-- length	4150 mm
-- ground clearance	180 mm
DRUM:	
-- width	4300 mm
-- diameter	170 mm
-- tooth length	160 mm
-- lateral tooth spacing	95 mm
-- operating speed	143 rpm
NUMBER OF GEARBOXES:	1
NUMBER OF CHAIN DRIVES:	1
NUMBER OF LUBRICATION POINTS:	17
OPTIONAL EQUIPMENT:	
-- small rock deflector	

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

(a) excellent	(d) fair
(b) very good	(e) poor
(c) good	(f) unsatisfactory

APPENDIX III
CONVERSION TABLE

1 hectare (ha)	= 2.5 acres (ac)
1 kilometre/hour (km/h)	= 0.6 miles/hour (mph)
1 metre (m)	= 3.3 feet (ft)
1 millimetre (mm)	= 0.04 inches (in)
1 kilowatt (kW)	= 1.3 horsepower (hp)
1 kilogram (kg)	= 2.2 pounds mass (lb)

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