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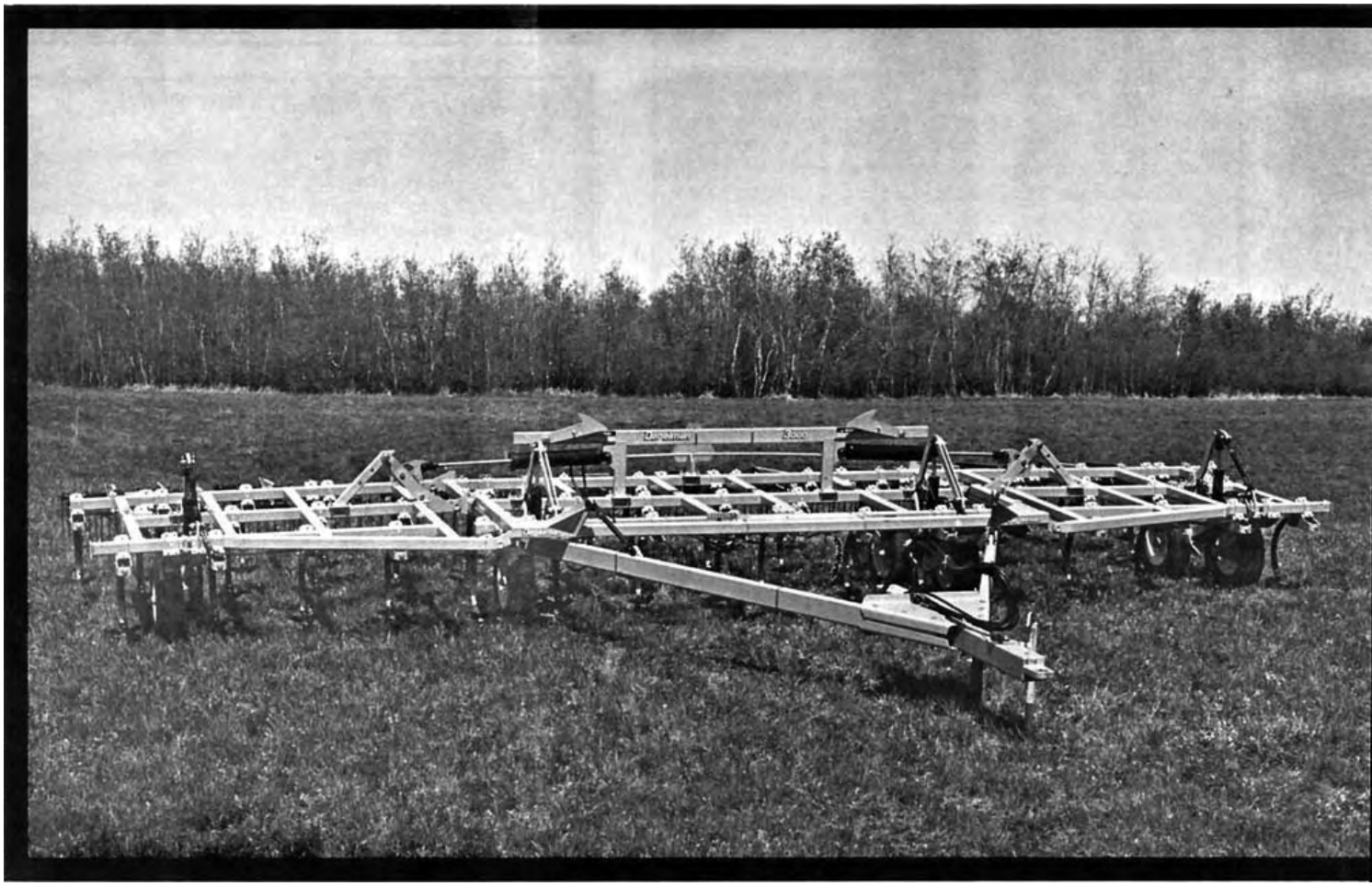
Evaluation Report 342



Degelman 3000 (35.4 ft) Cultivator

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

DEGELMAN 3000 CULTIVATOR

MANUFACTURER AND DISTRIBUTOR:

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

RETAIL PRICE:

$18,750.00 (February, 1984, f.o.b. Humboldt, 35.4 ft (10.8 m) width, with optional harrows and mud scrapers).

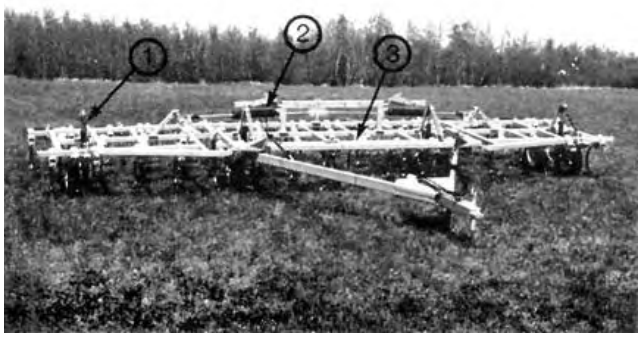


FIGURE 1. Degelman 3000 (1) Depth Control Cylinders, (2) Wing Lift Cylinders, (3) Hydraulic Flow Divider.

SUMMARY AND CONCLUSIONS

Functional Performance: The overall functional performance of the Degelman 3000 was good for secondary tillage such as seedbed preparation and herbicide incorporation, provided nishing harrows were used. Its performance in light to intermediate primary tillage was good in moderate trash conditions. Performance was reduced in rocky conditions, and it was unsuitable for heavy primary tillage or very heavy trash.

Quality of Work: The spring cushioned shanks could lift 14 in (356 mm) to clear stones. Shank lift was much less at the four shanks located near the inside wheels. When equipped with 47 degree sweeps, sweep pitch ranged from 5 to 7 degrees over the normal range of secondary tillage draft. Shank cushion spring preload was exceeded at drafts greater than 398 lb/ft (5.8 kN/m), well below the limit of the primary tillage draft range. This indicates that the Degelman 3000 is suitable for secondary tillage and light primary tillage, but not for heavy primary tillage.

Penetration was very good in all secondary and light primary tillage conditions. Excessive furrow bottom ridging occurred as the shank spring preload was exceeded in heavy primary tillage. Tillage depth was uniform across the width of the cultivator. Plugging occurred in heavy damp trash. The four row tine harrows did not clear large amounts of damp loose trash. The Degelman 3000 buried less trash than most heavy duty cultivators. Skewing only occurred on hillsides or where soil hardness varied across the machine width. Weed kill was good except in heavy trash conditions where the harrows were less effective.

Ease of Operation and Adjustment: The Degelman 3000 could be easily placed into transport in less than ve minutes. Because of its large transport width and height, transporting on public roads required caution. The 7.5 in (190 mm) sweep-to-ground clearance was adequate for normal transport.

One man hitching was easy. The hitch length was adjustable and no tractor wheel interference occurred with the hitch during normal turns.

Adequate adjustment was provided for fore-and-aft frame levelling and lateral levelling of the wings. No adjustment was provided for laterally levelling the main frame. Tillage depth could be easily set by adjusting the hydraulic stop valve on the ow divider or the stop collars on each depth control cylinder.

Power Requirements: In light secondary tillage, at 6 mph (9.7 km/h) and 3 in (75 mm) depth, a tractor with 113 hp (84kW) maximum power take-off rating will have suf cient power reserve to operate the 35.4 ft (10.8 m) wide Degelman 3000. in heavy secondary or light primary tillage at the same depth and speed, a 167 hp (124 kW) tractor is required.

Safety: The Degelman 3000 was equipped with depth control and wing transport locks. In transport, the tires of the centre section were overloaded with the added weight of the mounted harrows. A slow moving vehicle sign was provided.

Operator Manual: The operator manual provided useful information and was well written and clearly illustrated.

Mechanical History: Some mechanical problems occurred during eld testing. Abnormal wear occurred at the shank pivot assembly. A shank broke as a result of frame interference. Other minor mechanical problems did not greatly affect the cultivator performance.

RECOMMENDATIONS

It is recommended the manufacturer consider:

1. Modifying the shank pivot assembly to prevent abnormal wear.
2. Modi cations to allow more shank trip clearance at the wheel locations.
3. Modifying the harrow control arm straps to prevent bending.

Senior Engineer: G.E. Frehlich

Project Technologist: A.R. Boyden

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Modi cations have been made to the shank pivot to provide a grease pocket to ensure lubrication of the bushing. A higher grade ne thread bolt, that is 55% stronger, is now used to hold the bushing in place more securely. The shank curvature has been changed to provide for a 0 to 2 degree sweep pitch under no load conditions.
2. On all new 1984 machines, the walking axle has been redesigned to provide better trip clearance and to prevent trash build-up around the tires.
3. The harrow control arm has already been redesigned using stronger material.

GENERAL DESCRIPTION

The Degelman 3000 is a trailing, exible, three section intermediate cultivator suitable for light primary tillage such as rst operation summerfallow, or secondary tillage such as seedbed preparation, herbicide incorporation, and heavy secondary summerfallow. It is not intended for heavy primary tillage.

It is available in widths from 27 ft (8.2 m) to 40 ft (12.2 m), with a shank spacing of 9 in (230 mm). The test machine was 35.4 ft (10.8 m) wide with a 15.8 ft (4.8 m) wide centre frame and two 9.8 ft (3 m) wide wings.

The centre frame is carried by four wheels, while each wing is supported by two wheels. A hydraulic ow divider and four hydraulic cylinders control tillage depth. The wings fold into transport position with two hydraulic cylinders connected in parallel. A tractor with dual remote hydraulic controls is needed to operate the Degelman 3000.

The test machine was equipped with four row tine harrows; three row tine harrows are also available. Detailed speci cations are given in APPENDIX I, and FIGURE 1 shows the location of major components.

SCOPE OF TEST

The Degelman 3000 was operated in the eld conditions shown in TABLE 1 for 126 hours while cultivating about 2725 ac (1104 ha). It was evaluated for quality of work, ease of operation and adjustment, power requirements, safety, and suitability of the operator manual.

RESULTS AND DISCUSSION

QUALITY OF WORK

Shank Characteristics: There is a large variation in shank and sweep stern angles (FIGURE 2) on cultivators from different manufacturers. Sweeps and shanks must be matched to obtain suf cient sweep pitch to achieve and maintain penetration. Usually manufacturers recommend sweeps with a stem angle from 0 to

5 degrees less than the shank stern angle to result in a slightly positive no-load sweep pitch.

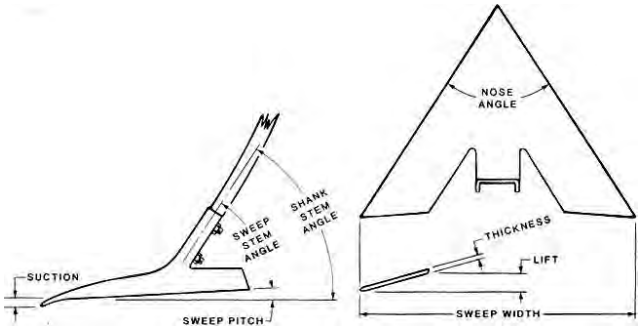


FIGURE 2. Shank and Sweep Terminology.

TABLE 1. Operating Conditions

FIELD CONDITIONS	HOURS	FIELD AREA (ha)	
		ac	ha
Soil Type			
- sand	11	221	90
- light loam	3	65	26
- loam	90	1934	783
- clay	22	505	205
TOTAL	126	2725	1104
Stony Phase			
- stone free	37	783	317
- occasional stones	42	913	370
- moderately stony	33	743	301
- very stony	14	286	116
TOTAL	126	2725	1104

Sweep pitch increases in proportion to draft due to shank exing and, depending on shank stiffness and cushion-spring preload, may become excessive on some cultivators in normal tillage. A slightly positive sweep pitch results in uniform tillage depth and a smooth furrow bottom while excessive sweep pitch causes furrow bottom ridging, rapid sweep tip wear, and increased draft. Shanks which maintain a low, relatively constant sweep pitch over the normal range of tillage forces, are desirable. The Degelman 3000 was equipped with spring-cushioned shank holders, spaced at 9 in (230 mm). Spring tension was adjustable. The Degelman 3000 was used with 12 in (305 mm) sweeps with a 47 degree stem angle, giving a no-load sweep pitch of 5 degrees.

FIGURE 3 shows pitch characteristics of the shank assemblies on the Degelman 3000. The lower sloped line results from shank exing, while the steeper upper line occurs when draft is large enough to overcome cushion-spring preload. Over the normal secondary tillage draft range, sweep pitch varied 2 degrees at the manufacturer's recommended setting. With the 47 degree sweeps this represents a working sweep pitch range from 5 to 7 degrees in secondary tillage. Shank cushion-spring preload was exceeded at a draft of 398 lb/ft (5.8 kN/m), well below the upper limit of the primary tillage draft range. This shows that the Degelman 3000 is suitable for both secondary and light primary tillage, but not for heavy primary tillage.

FIGURE 4 shows the lifting pattern when shanks encountered stones or eld obstructions. Maximum lift height was 14 in (356 mm). Maximum lift height was much less at four shanks located near the inside wheels. Abnormal wear occurred at the shank pivots (see "Durability Results").

Penetration: Penetration was very good in all secondary and light primary tillage conditions. The Degelman 3000 is not suitable for heavy primary tillage.

Penetration was uniform across the cultivator width provided the frame was properly levelled. The frame remained level in secondary and light primary tillage with little twisting of the wing frames.

The Degelman 3000 followed gently rolling eld contours well, maintaining uniform depth across its width. As with most wing cultivators, large variations in tillage depth occurred in elds with abrupt contour changes.

Furrow Bottom Ridging: The spring-cushioned shanks of the Degelman 3000 held the sweeps level resulting in an even furrow bottom in secondary tillage. Furrow bottom ridging became excessive in heavy primary tillage as the draft exceeded the shank cushion-spring preload causing excessive sweep pitch.

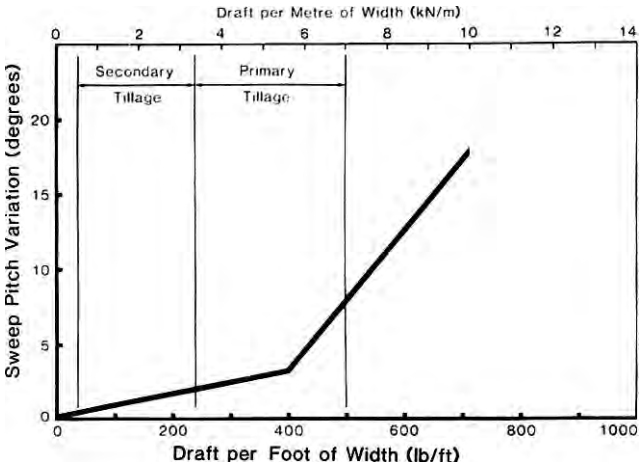


FIGURE 3. Sweep Pitch Variation over a Normal Range of Draft (9 in (230 mm) Shank Spacing).

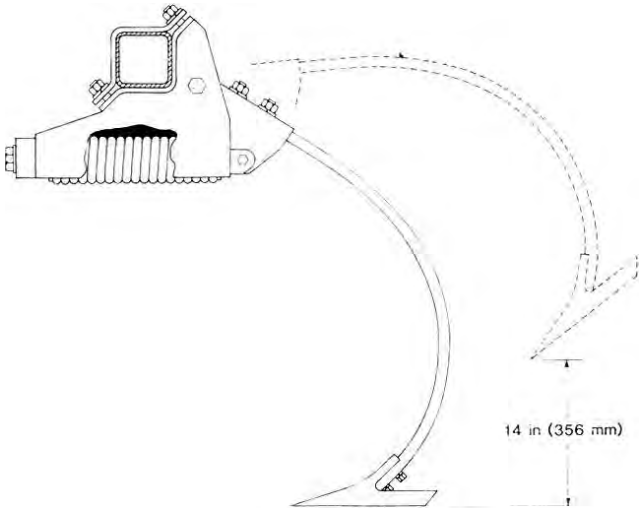


FIGURE 4. Shank Lifting Pattern.

Trash Clearance: The 9 in (230 mm) lateral shank spacing and 27.3 in (690 mm) sweep-to-frame clearance was suitable for clearing large amounts of dry trash. In heavy damp trash, plugging usually occurred at the wheel locations.

Trash Burial and Field Surface: The Degelman 3000 buried less trash than most heavy duty cultivators. In moderate trash conditions the harrows were effective in distributing the trash evenly. In heavy trash the harrows left bunches on the eld surface (FIGURE 5). In light trash the harrows were effective in levelling the ridges left by the cultivator to produce a uniform seedbed (FIGURE 6).

FIGURE 5. Typical Field Surface in Heavy Trash Conditions.

FIGURE 6. Typical Seedbed Preparation.

Skewing and Stability: The Degelman 3000 was stable and did not skew sideways in normal eld conditions. The sweep pattern (FIGURE 7) was symmetrical and did not impose any side forces on the cultivator during normal tillage. As with most cultivators, skewing occurred only on hillsides or when soil hardness varied across the machine width. With the 12 in (305 mm) sweeps, the cultivator had to skew more than 2.2 degrees for weed misses to Occur.

Weed Kill: Weed kill was good with the 12 in (305 mm) sweeps and 9 in (230 mm) shank spacing. The nishing harrows were effective in exposing weeds in light trash conditions. The harrows were less effective in exposing weeds in heavy trash conditions.

EASE OF OPERATION AND ADJUSTMENT

Transporting: The Degelman 3000 was easily placed in transport position (FIGURE 8) by one person in less than ve minutes. Locks were provided for the wings and the depth control wheels. The transport locks were easily positioned without climbing on the cultivator frame by using the long rod supplied.

Transport width of the test machine was 21.6 ft (6.6 m) while transport height was 13.2 ft (4.0 m). Care was needed when transporting on public roads, through gates, over bridges, and beneath power lines.

The Degelman 3000 towed well without sway at normal transport speeds. Sweep-to-ground clearance of 7.5 in (190 mm) and a wheel tread of 12.1 ft (3.7 m) provided adequate ground clearance.

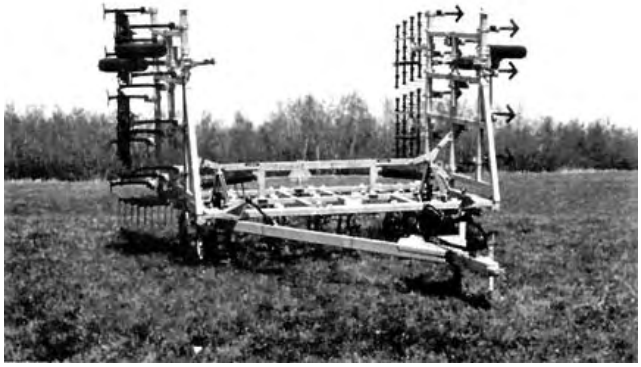


FIGURE 8. Transport Position.

Hitching: The hitch jack and rigid hitch link made one-man hitching easy. Hitch weight was positive in transport and eld position with mounted harrows.

Maneuverability: The hitch length of the Degelman 3000 was adjustable over an 8 ft (2.4 m) range. Tractor wheels did not interfere with the hitch during normal turns. There were a suf cient number of sweeps beyond the wing wheels to allow moderate overlap without running a wheel on the cultivated ground. Running all wheels on

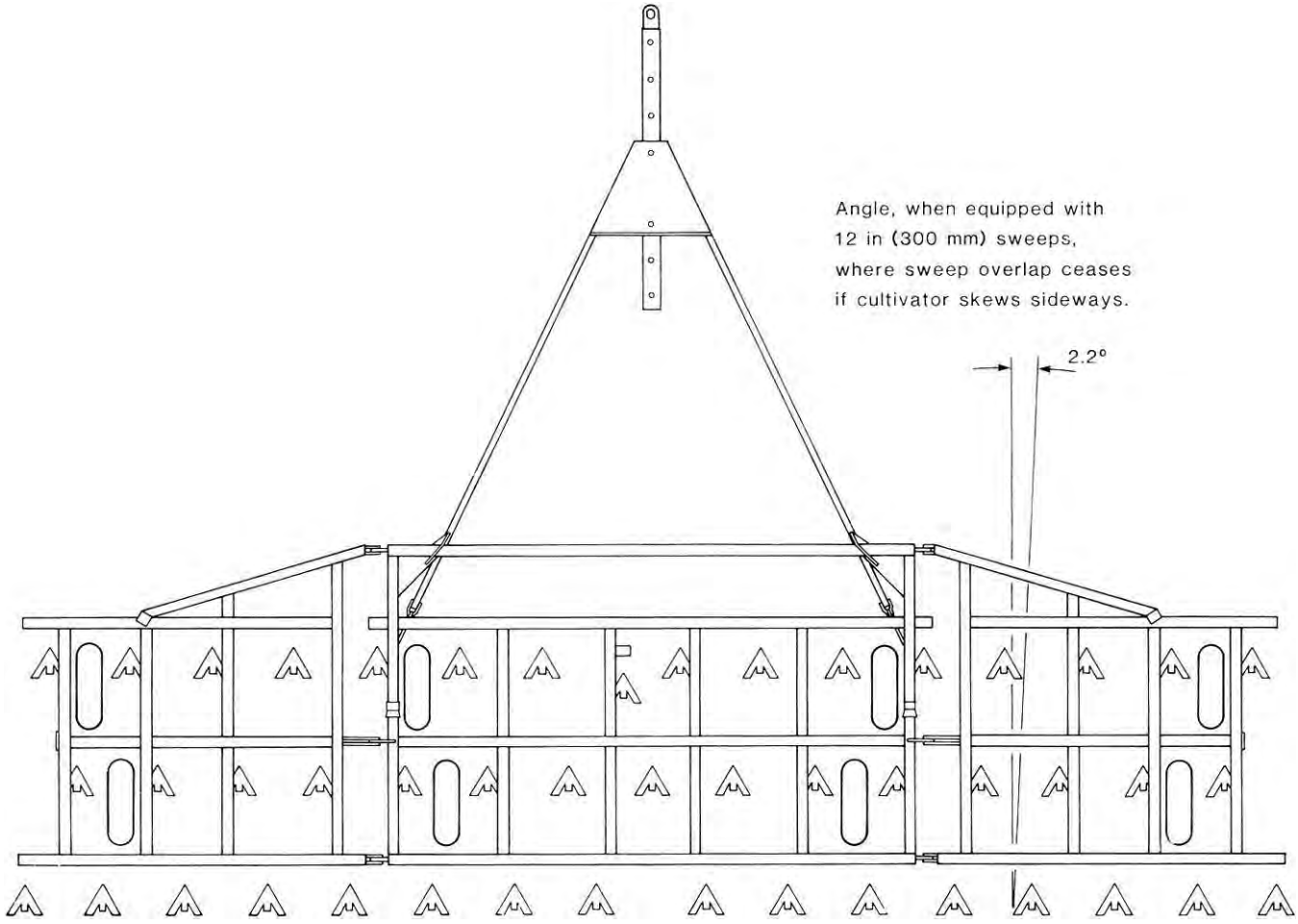


FIGURE 7. Sweep Pattern (9 in (230 mm) Shank Spacing).

similar untilled soil maintains proper otation and aids in uniform tillage depth.

Frame Levelling: Turnbuckles provided adequate lateral levelling adjustment at the depth control wheels of the wing sections. No lateral levelling adjustment was provided for the centre section depth control wheels.

The hitch height adjustment was adequate for all tractors. A large wrench was required to loosen the lock nuts when adjusting the turnbuckles for fore-and-aft or lateral levelling (FIGURE 9).

FIGURE 9. Hitch Height Adjustment.

Tillage Depth: Tillage depth was controlled by a four chamber hydraulic ow divider (FIGURE 10) and four hydraulic cylinders. A hydraulic stop valve on the ow divider could be adjusted to set tillage depth. To ensure uniform tillage depth, the hydraulic cylinders could be synchronized by completely extending them to a fully raised position. Stop collars on each cylinder could also be adjusted to set the depth.

Sweep Installation: It took one person about 2-1/2 hours to replace the 47 sweeps on the Degelman 3000. Thread damage to the sweep bolts from soil abrasion was only slight and did not hamper the removal of the bolts.

Shank Installation: A shank could be replaced in about 15 minutes. The spring tension had to be released and the spring removed from the shank holder before removing the two shank bolts.

POWER REQUIREMENTS

Draft Characteristics: FIGURE 11 shows draft requirements for cultivators in typical primary and secondary tillage at a speed of 5 mph (8 km/h). This gure gives average requirements based on tests of 25 cultivators and 53 different eld conditions. Attempting to compare draft requirements of different makes of cultivators usually is unrealistic. Draft requirements for the same cultivator, in the same eld, may vary by as much as 30% in two different years, due to changes in soil conditions. Variations in soil conditions affect draft much more than variations in machine make, usually making it impossible to measure any signi cant draft differences between makes of cultivators.

In light secondary tillage, such as seedbed preparation and herbicide incorporation, average draft at 8 km/h (5 mph) varied from 55 lb/ft (0.8 kN/m) at 1.6 in (40 mm) depth to 150 lb/ft (2.2 kN/m) at 4 in (100 mm) depth. For the 35.4 ft (10.8 m) wide test machine, this corresponds to a total draft ranging from 1930 to 5350 lb (8.6 kN to 23.8 kN).

In heavy secondary and light primary tillage, average draft varied from 90 lb/ft (1.3 kN/m) at 1.6 in (40 mm) depth to 250 lb/ft (3.7 kN/m) at 5 in (125 mm), corresponding to a total draft ranging from 3150 to 8990 lb (14.0 to 40.0 kN) for the 35.4 ft (10.8 m) wide test machine.

Increasing speed by 1.0 mph increased draft by 10 lb/ft (90 kN/m draft increase for each 1.0 km/h speed increase). This represents a total draft increase of 350 lbs for a 1.0 mph speed increase (1.0 kN for a 1.0 km/h speed increase) for the test machine.

Tractor Size: TABLES 2 and 3 show tractor size needed to operate the 35.4 ft (10.8 m) wide Degelman 3000 in light secondary tillage as well as in heavy secondary or light primary tillage. The Degelman 3000 is not intended for heavy primary tillage operations.

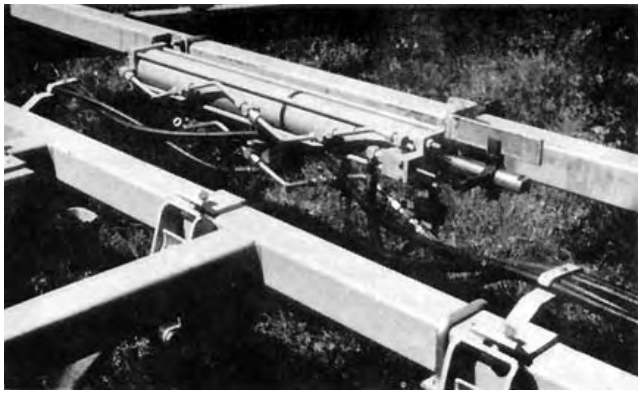


FIGURE 10. Hydraulic Flow Divider.

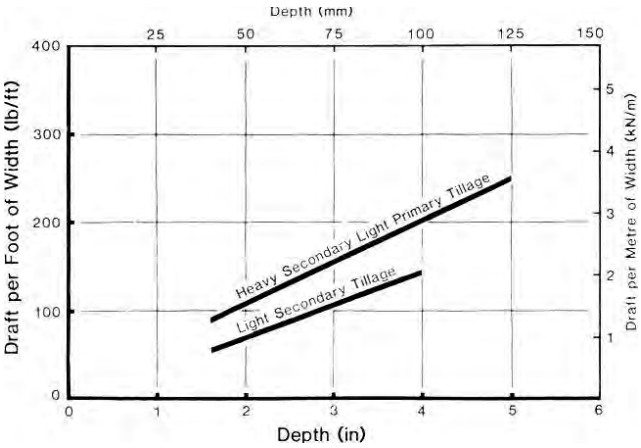


FIGURE 11. Average Draft Requirements for Intermediate Cultivators at 5 mph (8 km/h).

Tractor sizes have been adjusted to include tractive efficiency and represent a tractor operating at 80% of maximum power on a level field. The sizes presented in the tables are the maximum power take-off rating, as determined by Nebraska tests or as presented by the tractor manufacturer. Selected tractor sizes will have ample power reserve to operate the Degelman 3000 in the stated conditions.

Tractor size may be determined by selecting the desired tillage depth and speed from the appropriate table. For example, in light secondary tillage at 3 in (75 mm) depth and 6 mph (9.7 km/h) a 113 hp (84 kW) tractor is needed to operate the Degelman 3000. In heavy secondary or light primary tillage at the same depth and speed, a 167 hp (124 kW) tractor is required.

TABLE 2. Tractor Size: Maximum Power Take-Off Rating hp (kW) Required to Pull the 35.4 ft (10.8 m) Degelman 3000 in Light Secondary Tillage.

DEPTH in (mm)		SPEED mph (km/h)					
in	(mm)	5	(8)	6	(9.7)	7	(11.3)
2	(50)	55	41	73	55	93	69
3	(75)	88	65	113	84	139	104
4	(100)	121	90	153	114	185	138

TABLE 3. Tractor Size: Maximum Power Take-Off Rating hp (kW) Required to Pull the 35.4 ft (10.8 m) Degelman 3000 in Heavy, Secondary or Light Primary Tillage.

DEPTH in (mm)		SPEED mph (km/h)					
in	(mm)	5	(8)	6	(9.7)	7	(11.3)
2	(50)	91	68	121	91	153	114
3	(75)	129	96	167	124	206	154
4	(100)	166	123	212	158	259	193
5	(125)	203	152	257	192	318	233

OPERATOR SAFETY

Extreme caution is needed in transporting most folding cultivators to avoid contacting power lines. Minimum power line heights over

farmland or secondary roads vary in the three prairie provinces. In Alberta and Manitoba, lines over roads may be as low as 16 ft (4.8 m). In Saskatchewan, they may be as low as 17 ft (5.2 m). In all three provinces, lines in farmyards may be as low as15 ft (4.6 m).

Transport height of the 35.4 ft (10.8 m) wide three section machine was 13.2 ft (4.0 m) permitting safe transport under prairie power lines. The legal responsibility for safe passage under utility lines rests with the machinery operator and not with the power utility or machinery manufacturer. All provinces have regulations governing maximum permissible equipment heights on various types of public roads. If height limits are exceeded, the operator must contact power and telephone utilities before moving.

The test machine was 21.6 ft (6.6 m) wide in transport position and required caution when transporting. A slow moving vehicle sign was supplied as standard equipment.

Locks for the depth control and the wings were provided. Access to the locks was safe and easy when using the long metal rod provided.

The rigid hitch link allowed safe hitching by one person.

The tires of the cultivator without mounted harrows were adequate for transport speeds of 20 mph (32 km/h). The load on the centre section tires exceeded the Tire and Rim Association maximum load ratings by 20% when the cultivator was fitted with mounted harrows. No damage occurred to the wheels during testing.

STANDARDIZATION

Hydraulics: During the test, considerable difficulty was encountered due to differences in hydraulic couplers on various tractors. The difficulty was in the lack of standardization both in couplers and in hose threads. More standardization is needed in this area.

Sweep Bolt Holes: The bolt hole size and spacing on cultivator sweeps and shanks, as well as stem angles, should similarly be standardized to provide some degree of interchangeability of sweeps.

OPERATOR MANUAL

The operator manual supplied instructions on setup, operation, lubrication, maintenance, and safety. It also provided a complete parts listing. It was well written and clearly illustrated.

DURABILITY RESULTS

TABLE 4 outlines the mechanical history of the Degelman 3000 during 126 hours of field operation while tilling 2725 ac (1104 ha). The intent of the test was evaluation of functional performance. The following mechanical problems occurred during functional testing. An extended durability test was not conducted.

TABLE 4. Mechanical History

ITEM	OPERATING HOURS	EQUIVALENT FIELD AREA ac	(ha)
Shank and Holder:			
-Two shanks bent when tripping over a rock and were replaced\	During the test		
-One shank broke and was replaced at	126	2725	(1104)
-Four shank holders would not take grease at	53	1105	(442)
-Four shank pivot spacers were abnormally worn and replaced at	70	1478	(591)
-Shank mechanism mounting bolts required tightening at	112	2439	(976)
Hydraulic System:			
-One hydraulic cylinder leaked and was replaced a	t 27	555	(222)
Wheels: During the test			
-One bearing cap was lost at	115	2504	(1002)
and all were damaged by rocks	During the test		
Harrows:			
-Three harrow control arm straps bent at	27	555	(222)

DISCUSSION OF MECHANICAL PROBLEMS

Shank and Holder: The inside metal pivot spacers came loose and turned on the bolt, causing abnormal bolt wear. The metal spacers were oversized and prevented grease from entering between the nylon bushings and spacers. This lack of grease and sideways tripping of the shank caused the spacers to loosen. It is recommended that the manufacturer consider modifications to the shank pivot assembly to prevent abnormal wear.

A shank jammed against the depth control wheel arm, and broke when the cultivator was raised. Clearance for tripping is much less at the inside wheel locations (FIGURE 12). It is recommended that the manufacturer consider modifications to increase trip clearance at these wheel locations.

Two shanks were bent while working in very stony conditions. This does not represent a serious problem. Hydraulic System: One depth control cylinder developed an external leak at the outer seal and was replaced.

Harrows: The harrow control arm straps of the four bar harrows bent. It is recommended that the manufacturer modify these straps to prevent bending.

FIGURE 12. Reduced Shank Clearance at Wheel Locations.

APPENDIX I

SPECIFICATIONS
MAKE: Degelman
MODEL: 3015
SERIAL NUMBER: 3126
MANUFACTURER: Degelman Industries Ltd.
P.O. Box 830
Regina, Saskatchewan S4P 3R1

OVERALL DIMENSIONS:	**FIELD POSITION**	**TRANSPORT POSITION**
- width	35.4 ft (10.8 m)	21.6 ft (6.6 m)
- maximum length		
- with mounted harrows	33.2 ft (10.1 m)	33.2 ft (10.1 m)
- height	5.4 ft (1.6 m)	13.2 ft (4.0 m)
- maximum ground clearance	7.5 in (190 mm)	7.5 in (190 mm)
- wheel tread	29.5 ft (9.0 m)	12.1 ft (3.7 m)

SHANKS:	
-number	47
-lateral spacing	9 in (230 mm)
-trash clearance (frame to sweep tip)	27.3 in (690 mm)
-number of shank rows	
-centre section	3
-wings	3
-distance between rows	39 in (990 mm)
-shank cross section	0.75 x 2 in (19 x 51 mm)
-shank stem angle	520
-sweep hole spacing	1.75 in (44 mm)
-sweep bolt size	7/16 x 11/2 in
HITCH:	
-length adjustment range	8 ft (2.4 m)
-vertical adjustment range	sufficient
DEPTH CONTROL:	hydraulic
FRAME:	
-cross section	3.5 in (89 mm) square tubing, 0.19 in (4.8 mm) thick
TIRES:	
-centre section	4, 7.60 x 15, 8 ply
-wing sections	4, 7.60 x 15, 6 ply
NUMBER OF LUBRICATION POINTS:	
-grease fittings	
-wheel bearings	
HYDRAULIC CYLINDERS:	
-depth control	4, 3 x 8 in (76 x 203 mm)
-wing lift	2, 5 x 24 in (127 x 610 mm)

WEIGHTS: (WITHOUT HARROWS)	**FIELD POSITION**	**TRANSPORT POSITION**
-right wheels	1141 lb (655 kg)	
-right centre wheels	2662 lb (1210 kg)	4103 lb (1865 kg)
-left centre wheels2	629 lb (1195 kg)	4092 lb (1860 kg)
-left wheels	1463 lb (665 kg)	
-hitch	715 lb (325 kg)	715 lb (325 kg)
TOTAL	8910lb (4050kg)	8910lb (4050kg)

WEIGHTS: (WITH MOUNTED HARROWS)	**FIELD POSITION**	**TRANSPORT POSITION**
-right wheels	1650 lb (750 kg)	
-right centre wheels	3344 lb (1520 kg)	5071 lb (2305 kg)
-left centre wheels	3311 lb (1505 kg)	5027 lb (2285 kg)
-left wheels	1628 lb (740 kg)	
-hitch	330 lb (150 kg)	165 lb (75 kg)
TOTAL	10263 lb (4665 kg)	10263 lb (4665 kg)

OPTIONAL REQUIPMENT:
-mounted finishing harrows (four or three row)
-wheel and scrapers
-11 width options from 27 to 40 ft (8.2 to 12.2 m)

APPENDIX II

MACHINE RATINGS
The following rating scale is used in Machinery Institute Evaluation Reports:

excellent	fair
very good	poor
good	unsatisfactory

APPENDIX III

CONVERSION TABLE

IMPERIAL UNITS	MULTIPLY BY:	S.I. UNITS
Acres (ac)	0.405	Hectares (ha)
Feet (ft)	0.305	Metres (m)
Inches (in)	25.4	Millimetres (mm)
Horsepower (hp)	0.746	Kilowatts (kW)
Miles/Hour (mph)	1.61	Kilometres/Hour (km/h)
Pounds Force (lb)	4.45	Newtons (N)
Pounds Force/Foot (lb/ft)	14.6	Newtons/Metre (N/m)
Pounds Mass (lb)	0.454	Kilograms (kg)

SUMMARY CHART

DEGELMAN 3000 CULTIVATOR

RETAIL PRICE: $18,750.00 (February, 1984, f.o.b. Humboldt,
35.4 ft (10.8 m) width, with optional harrows and mud scrapers).

QUALITY OF WORK	EVALUATION	COMMENTS
- Shank Characteristics		
- trip clearance	14 in (356 mm)	- restricted at wheel locations
- spring preload	398 lb/ft	
exceeded	(5.8 kN/m)	-not suitable for heavy primary tillage
- working sweep pitch	5 to 7 degrees	-over normal range of secondary tillage
- Penetration		
-ability	**Very Good**	- in secondary and light primary soil conditions
- uniformity	**Very Good**	- less uniform in primary tillage
- Furrow Bottom Ridging	**Good**	- became excessive in heavy primary tillage
- Trash Clearance	**Good**	- plugged at wheel locations in heavy trash
- Trash Burial and Field Surface	**Good**	- harrows left bunches of straw in heavy trash
- Weed Kill	**Good**	- harrows were less effective in heavy trash
EASE OF OPERATION AND ADJUSTMENT		
- Hitching	**Excellent**	- hitch weight was always positive
- Frame Levelling	**Very Good**	
- Tillage Depth	**Excellent**	- a hydraulic stop valve and cylinder stop collars were provided
- Maneuverability	**Excellent**	- hitch length was adjustable
- Transporting	**Very Good**	- locks were easily installed
- Sweep Installation	**Very Good**	
- Shank Installation	**Good**	- approximately 15 minutes required
OPERATOR SAFETY	**Very Good**	- climbing on the frame to remove locks was not required
OPERATOR MANUAL	**Very Good**	- well written and clearly illustrated
POWER REQUIREMENTS		
- At 3 in (75 mm) depth and 6 mph (9.7 km/h) in		
- light secondary tillage	113 hp (84 kW)	
- heavy secondary or light primary tillage	167 hp (124 kW)	

CAUTION

This summary chart is not intended to represent the final conclusions of the evaluation reports. The relevance of the ratings is secondary to the information provided in the full text of the report. It is not recommended that a purchase decision be based only on the summary chart.

ALBERTA FARM MACHINERY RESEARCH CENTRE

3000 College Drive South
Lethbridge, Alberta, Canada T1K 1L6
Telephone: (403) 329-1212
FAX: (403) 329-5562
http://www.agric.gov.ab.ca/navigation/engineering/afmrc/index.html

Prairie Agricultural Machinery Institute
Head Office: P.O. Box 1900, Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-2555

Test Stations:
P.O. Box 1060
Portage la Prairie, Manitoba, Canada R1N 3C5
Telephone: (204) 239-5445
Fax: (204) 239-7124

P.O. Box 1150
Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-5033
Fax: (306) 682-5080

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