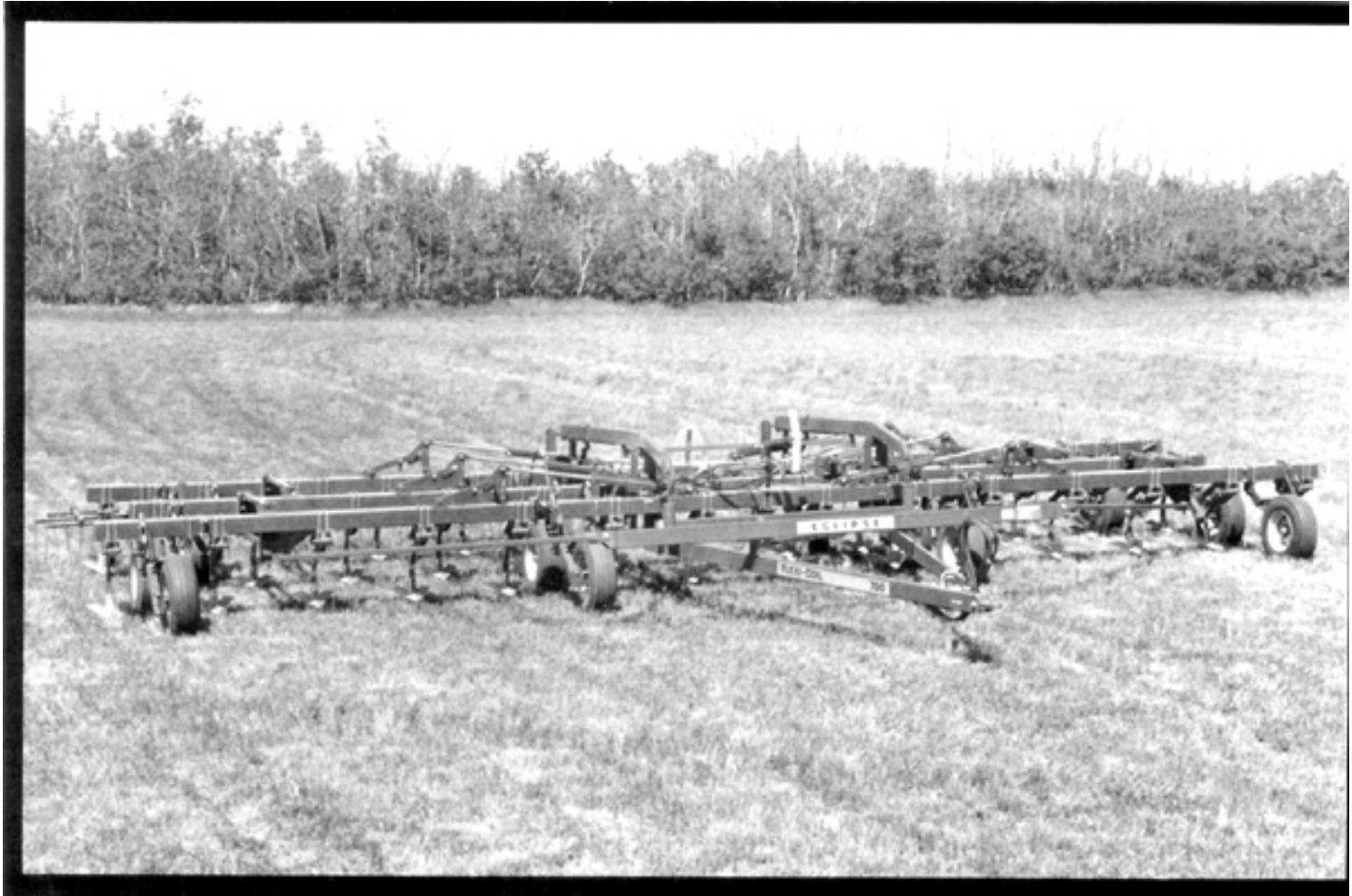


Evaluation Report

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Flexi-coil 700 Eclipse Cultivator

A Co-operative Program Between



ALBERTA
FARM
MACHINERY
RESEARCH
CENTRE



PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

FLEXI-COIL 700 ECLIPSE CULTIVATOR

MANUFACTURER AND DISTRIBUTOR:

Flexi-coil Ltd.
P.O. Box 1928
Saskatoon, Saskatchewan
S7K 3S5
(306) 934-3500

RETAIL PRICE:

\$31,075.00 (12.0 in. (305 mm) shank spacing)
\$33,435.00 (9.3 in. (237 mm) shank spacing)
(September, 1987, f.o.b. Humboldt, Saskatchewan, 41.3 ft.
(12.6 m) width, with optional harrows and McKay sweeps.)

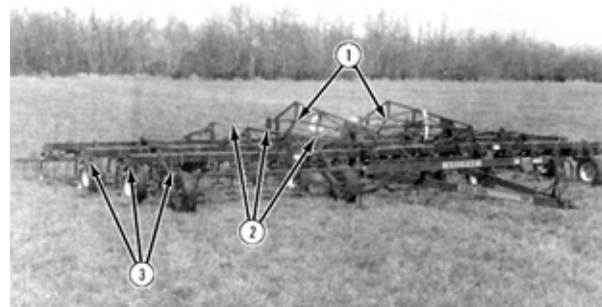


FIGURE 1. Flexi-coil 700 Eclipse: (1) Shank Beam Rotation Cylinders, (2) Wing Lift Cylinders, (3) Depth Control Cams

SUMMARY AND CONCLUSIONS

Quality of Work: The Flexi-coil 700 Eclipse cultivator was suitable for all primary and secondary tillage. Penetration of the Flexi-coil 700 was very good in all conditions. Uniformity of the tillage depth was excellent in all secondary and primary tillage. The hinged hitch and the flexibility between individual shank mounting beams allowed the Flexi-coil 700 Eclipse to follow rolling field contours extremely well. Shank force at trip point was 530 lb (2.3 kN) and, at the sweep pitch limit of 7° was 600 lb (2.7 kN). Common sweeps at normal depths were held in position and resulted in a smooth furrow bottom.

The trip height of 8.5 in (216 mm) provided fair stone protection.

Trash clearance was very good on the 12 in (305 mm) spacing machine. Trash clearance was good with the 9.3 in (237 mm) spacing machine as some plugging occurred when large amounts of damp trash were encountered. When using tine harrows, the surface finish left by the Flexi-coil 700 was good with the 12 in (305 mm) spacing machine and very good with the 9.3 in (237 mm) spacing machine. Narrower spacing machines leave smoother surface finishes. The harrows left bunches, typical of all mounted harrows, on the field surface in heavy trash.

The 12 in (305 mm) spacing machine was stable. However, the 9.3 in (237 mm) spacing machine had a different frame configuration and skewed on hillsides. Weed kill with the 12 in (305 mm) spacing machine was good as is typical of most cultivators. Weed kill was reduced to fair with the 9.3 in (237 mm) spacing machine, due to the cultivator skewing on rolling land.

Ease of Operation and Adjustment: Ease of hitching to the Flexi-coil 700 was good. The rigid hitch link and hitch jack made one-man hitching easy, but the hitch would rise if unhitched with the shanks rotated into some positions. Ease of transporting the Flexi-coil 700 was good. The Flexi-coil 700 was easily placed in transport, but it was 20.3 ft (6.2 m) wide and up to 17.3 ft (5.3 m) high. Maneuverability was good. The hitch did not contact the tractor tires on turns, but special care was required when turning sharp or backing up.

Ease of adjusting depth was good. A hydraulic depth stop was provided, but resetting the cams on the wheels took about 10 minutes. Ease of adjusting sweep pitch was very good, as it was adjusted hydraulically. Ease of frame levelling and harrow adjustment were very good. Ease of installing sweeps and shanks was good. Soil abrasion to the bottom sweep mounting bolts was slight. Shank replacement was easy.

Power Requirements: In secondary tillage at 3 in (75 mm) and 6 mph (9.7 km/h), a tractor with 215 hp (160 kW) PTO horsepower is suggested for a 41.3 ft (12.6 m) wide cultivator. In primary tillage at 4 in (100 mm) and 5 mph (8.0 km/h), a tractor with 250 hp (185 kW) is suggested.

Operator Safety: The transport height of the Flexi-coil 700 Eclipse was up to 17.3 ft (5.3 m). The operator did not have to climb onto the frame to position the centre frame and wing transport locks. In transport, the tires were not overloaded.

Operator's Manual: The operator's manual was excellent and included cultivator specifications, operation and assembly instructions, maintenance schedule, safety instructions and a complete parts list.

Mechanical History: Three harrow pivot bolts came out. A hydraulic depth cylinder was replaced three times. Eighteen shanks bent and three broke. Some other minor mechanical problems occurred during the test.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to reduce shank damage when operating in rocky conditions.
2. Modifications to the 9.3 in (237 mm) spacing machine to reduce skewing.
3. Supplying a hitch safety chain.
4. Modifications to prevent the harrow pivot bolts from loosening.
5. Modifications to reduce hydraulic cylinder leaks.

Senior Engineer: J.D. Wassermann

Project Engineer: H.D. Kydd

Project Technologist: M.J. Bennett

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. The original 700 trips were redesigned and replaced on all machines. The current trips and shanks, which were reported on in this test, have not been a field service problem.
2. We recommend the 12 in (305 mm) spaced machine only for hillsides. The 9.3 in (237 mm) spaced machine is not recommended where skewing may be a problem.
3. It has not been industry practice to supply a hitch safety chain. However, this will be considered for new designs.
4. The harrow pivot bolt has been locked to prevent loosening on harrows manufactured since the summer of 1987.
5. The hydraulic cylinder seals have been improved to reduce leaks.

GENERAL DESCRIPTION

The Flexi-coil 700 Eclipse is a trailing, three section cultivator suitable for primary and secondary tillage operations. It is available in six widths from 33.4 to 41.3 ft (10.2 to 12.6 m). The test machines are 41.3 ft (12.6 m) wide with a 15.1 ft (4.6 m) centre section, and two 13.1 ft (4.0 m) wing sections.

The spring trip shanks are arranged in three rows. The 12 in (305 mm) shank spacing machine has a 4.4 ft (1.3 m) row spacing. The 9.3 in (237 mm) shank spacing machine has a 5.3 ft (1.6 m) row spacing. There are 41 shanks on the 12 in (305 mm) spacing machine, and 53 shanks on the 9.3 in (237 mm) spacing machine.

The frame consists of three lateral shank mounting beams connected by parallel bars. Each centre beam is supported by two wheels. Wing frame beams are each supported by a single wheel. Two hydraulic cylinders connected in parallel rotate the shank mounting beams to raise or lower the sweeps. The lower positions of these two cylinders and the manually adjusted cams on each wheel are used to set tillage depth and sweep pitch. The wings fold into transport with six hydraulic cylinders connected in parallel. A tractor with dual remote hydraulic controls is needed to operate the Flexi-coil 700 Eclipse cultivator. The test machines are equipped with optional three row tine harrows.

Detailed specifications and differences between test machines are given in APPENDIX I. FIGURE 1 shows the location of special components.

SCOPE OF TESTS

The Flexi-coil 700 Eclipse cultivators were operated in the field conditions shown in TABLE 1 for 119 hours while cultivating 2305 ac (933 ha). They were evaluated for quality of work, ease of operation and adjustment, power requirements, safety, and suitability of the operator's manual. Machines with shank spacings of 12.0 and 9.3 in (305 and 237 mm) were both tested. Extended durability testing was not conducted. Mechanical failures were recorded.

TABLE 1. Operating Conditions.

FIELD CONDITIONS	HOURS	FIELD AREA	
		ac	(ha)
Operation:			
— Primary	62	1090	(441)
— Secondary	57	1215	(492)
TOTAL	119	2305	(933)
Soil Type:			
— Sand	19	340	(137)
— Light Loam	39	800	(324)
— Loam	58	1130	(458)
— Clay	3	35	(14)
TOTAL	119	2305	(933)
Stony Phase:			
— Stone Free	5	75	(30)
— Occasional Stones	59	1190	(482)
— Moderately Stony	32	590	(239)
— Very Stony	23	450	(182)
TOTAL	119	2305	(933)
Shank Spacing:			
— 12 in (305 mm)	45	755	(306)
— 9.3 in (237 mm)	74	1550	(627)
TOTAL	119	2305	(933)

RESULTS AND DISCUSSION

QUALITY OF WORK

Penetration: Penetrating ability of the Flexi-coil 700 Eclipse was very good in all the field conditions.

Machine weight and sweep pitch both affect penetration. A slightly positive no-load sweep pitch is required to maintain proper penetration. Manufacturers use many combinations of shank and sweep stem angles to obtain the desired sweep pitch (FIGURE 2).

The manufacturer recommended no-load sweep pitch was 3°. No-load sweep pitch could be increased up to 10° to aid penetration in very hard or compacted soils. Adjustable sweep pitch was useful to optimize penetration in all conditions.

Depth Uniformity: Depth uniformity of the Flexi-coil 700 Eclipse was excellent in both primary and secondary tillage.

A uniform tillage depth is very important when a cultivator is used for seeding or seedbed preparation. It is also important for other operations such as incorporating chemicals, deep banding fertilizer and killing weeds. Tillage depth uniformity depends on a cultivator's ability to follow changing ground contours and to maintain a low sweep pitch. If sweep pitch is too high, furrow bottom ridging occurs and results in an uneven tillage depth. In addition, it causes rapid sweep tip wear and higher draft. PAMI has selected 7° as the maximum sweep pitch that will produce an acceptable furrow bottom for most operations.

The Flexi-coil 700 followed rolling contours extremely well, maintaining uniform depth across its width. Even with sudden contour changes in a field, depth remained very uniform due to the flexibility between the shank mounting beams.

The sweep pitch characteristics of the Flexi-coil 700 are shown in FIGURE 3. The no-load sweep pitch was 3°. The lower sloped line shows how an increase in force gradually flexed the shank as indicated by a slight increase in sweep pitch. At a horizontal force of 530 lb (2.3 kN), the shank began to trip as the cushion spring preload was overcome. This is the point on the curve where the steep upper curve begins. At a horizontal trip force of 600 lb (2.7 kN), the sweep pitch curve exceeded 7°. This is the point where the steep curve crosses the shaded grey horizontal line. The maximum sweep pitch of 7° is recommended by PAMI to maintain an acceptable furrow bottom. If a cultivator is operated in conditions where soil forces exceed that value, a non-uniform furrow bottom will result. The curve above the shaded grey line shows how shank force increases as the shank trips over an obstacle.

Performance of the Flexi-coil 700 Eclipse can be determined by comparing its sweep pitch characteristics to the actual horizontal force that the shanks will encounter in the field. Research has been conducted to determine the typical prairie soil forces acting on soil tools located in the front row of a cultivator while operating at different depths in primary and secondary tillage (APPENDIX II). The position and subsequent performance of the soil tools

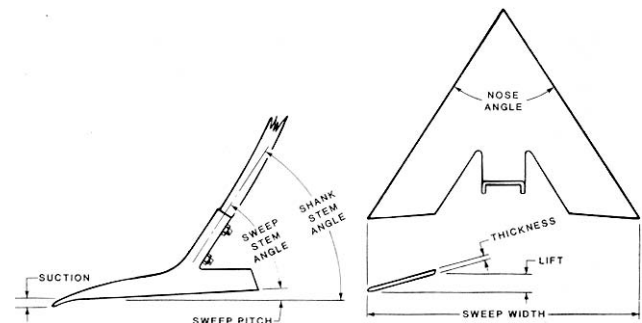


FIGURE 2. Shank and Sweep Terminology.

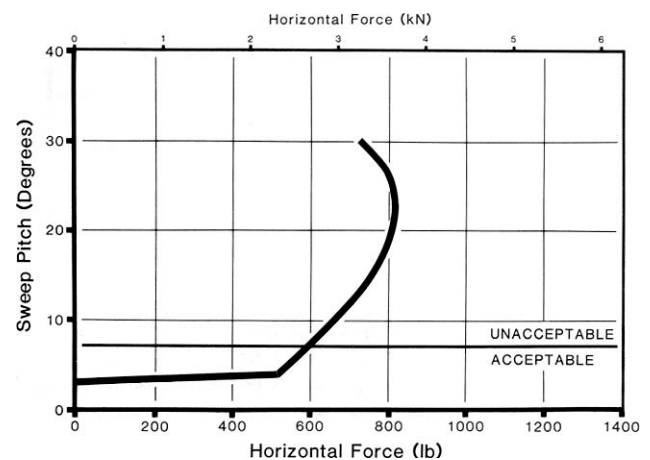


FIGURE 3. Sweep Pitch for Flexi-coil 700.

can be predicted by comparing the researched soil forces to the counteracting shank force (FIGURE 3) developed by the shank assembly.

The Flexi-coil 700 shank force at a 7° sweep pitch was greater than all shown soil forces. This indicates that the 12 and 16 in (305 and 406 mm) sweeps will maintain a uniform tillage or seeding depth while operating in primary and secondary tillage. The Flexi-coil 700 would also maintain 2 in (50 mm) spikes and banding knives at a uniform working depth in primary and secondary conditions.

Soil forces would not even exceed the spring preload of 530 lb (2.3 kN), except when deep banding 6 in (150 mm) deep. This would minimize shank assembly wear as the soil forces would not be causing partial tripping or continuous movement of the assembly.

There were enough sweeps beyond the outer wheel to allow moderate overlap without running the wheel on cultivated soil. Running all wheels on untilled soil helps maintain a uniform tillage depth.

Stone Protection: Stone protection was fair.

FIGURE 4 shows the lifting pattern when shanks on the Flexi-coil 700 encounter stones or field obstructions. A lift height of 12 in (305 mm) normally prevents shank and sweep damage in fields with many large rocks. The maximum lift height for the Flexi-coil 700 was only 8.5 in (216 mm) when equipped with 12 or 16 in (305 or 406 mm) McKay sweeps. The shank tripped when forces exceeded 530 lb (2.3 kN). Eighteen shanks bent and three shanks broke during the test (see Mechanical History). It is recommended that the manufacturer consider modifications to reduce shank damage when operating in rocky conditions.

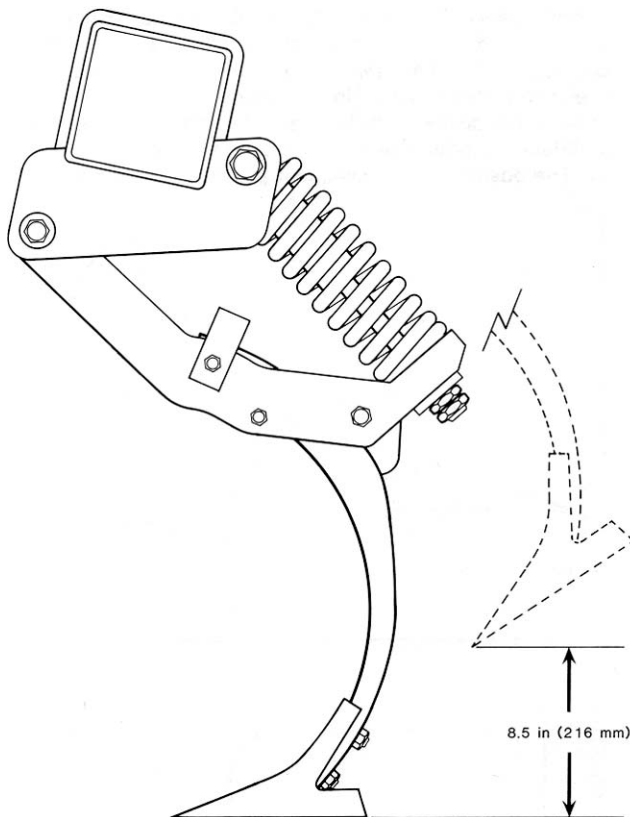


FIGURE 4. Shank Lifting Pattern.

Trash Clearance: Trash clearance of the 12 in (305 mm) spacing machine was very good. The 9.3 in (237 mm) spacing machine had good trash clearance. The sweep-to-frame clearance was 30 in (762 mm) on both machines. No plugging occurred with the 12 in (305 mm) spacing machine. However, with the 9.3 in (237 mm) spacing machine, plugging occurred when large amounts of damp trash or green weeds were encountered in low lying areas.

Surface Finish: Field surface finish was good with the 12 in (305 mm) spacing machine and very good with the 9.3 in (237 mm) spacing machine.

A smooth field surface is required for proper seedbed preparation and improves operator comfort on the following operation. Cultivators with narrower spacings typically leave smoother fields than those with wider spacings.

In heavy trash, the harrows left bunches on the field surface (FIGURE 5), typical of all mounted harrows. In light trash, the harrows were effective in distributing trash and levelling the ridges left by the cultivator to produce a uniform seedbed (FIGURE 6).

Skewing and Stability: Skewing increases weed misses, variation in row spacing, and requires frequent operator steering corrections. The sweep pattern of the Flexi-coil 700 (FIGURE 7) was symmetrical so no side forces were imposed on the cultivator. The machine did not skew on flat land when depth settings were uniform across the machine width.

The 12 in (305 mm) spacing machine was stable and skewing was minimal, even on hillsides or where soil hardness varied across the machine width. However, the 9.3 in (237 mm) spacing machine had a different frame configuration. It skewed on hillsides and frequent weed misses occurred. It is recommended that the manufacturer consider modifications to the 9.3 in (237 mm) spacing machine to reduce skewing.

Weed Kill: Effective weed kill depends most on soil and moisture conditions. Weed kill with the 16 in (406 mm) sweeps on the 12 in (305 mm) spacing machine was good. With the 12 in (305 mm) sweeps on the 9.3 in (237 mm) spacing machine, the weed kill was reduced to fair. This was due to skewing on hillsides even though narrower spacing machines usually have better weed kill.

The finishing harrows were effective in exposing weeds in light trash conditions. The harrows were less effective in heavy trash conditions.



FIGURE 5. Typical Field Surface in Heavy Trash Conditions.



FIGURE 6. Typical Seedbed Preparation.

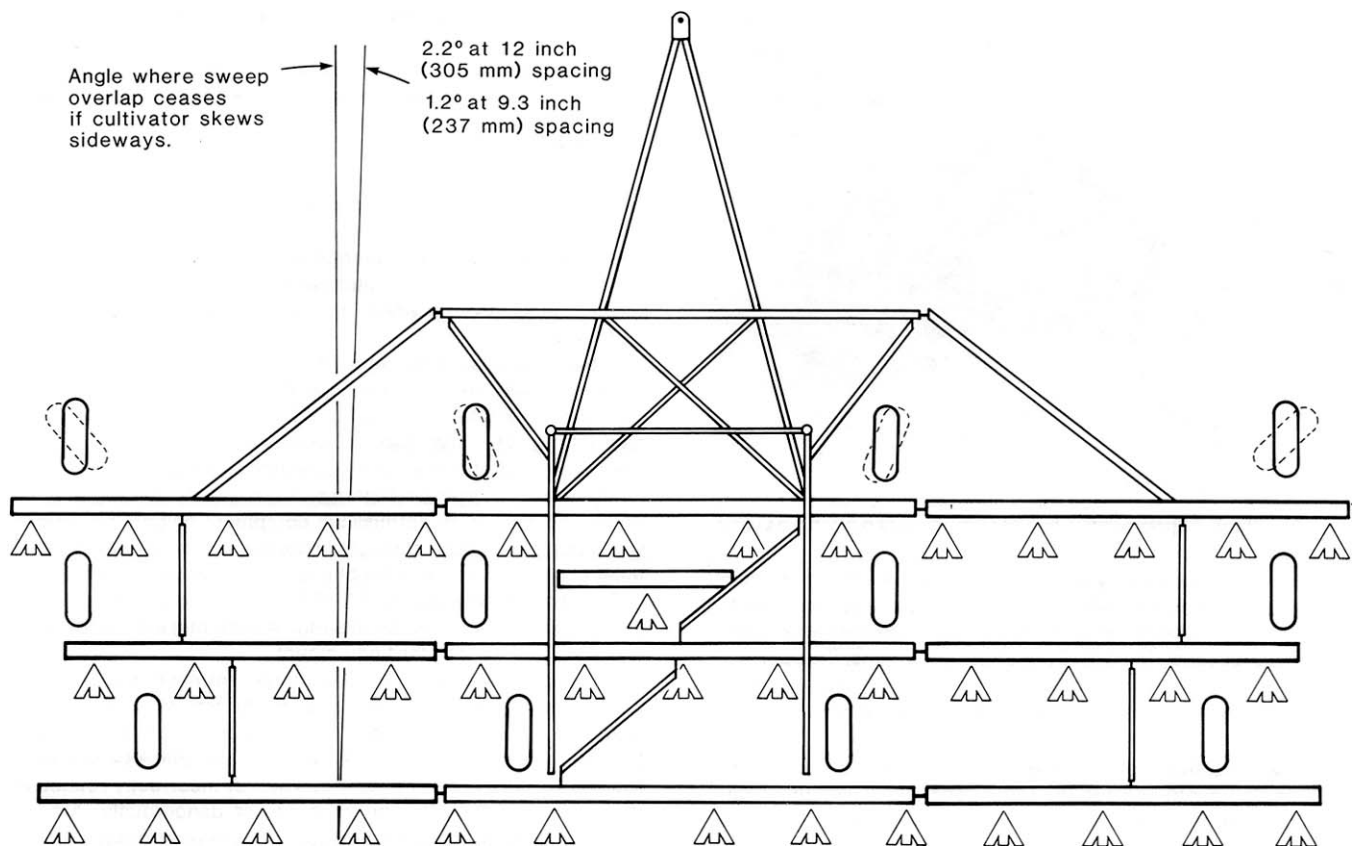


FIGURE 7. Sweep Pattern (12 in (305 mm) Spacing Machine Shown).

EASE OF OPERATION AND ADJUSTMENT

Hitching: Ease of hitching to the Flexi-coil 700 was very good.

The hitch jack and rigid hitch link made one-man hitching easy. Hitch weight was positive when the shanks were rotated into correct transport and field positions with mounted harrows. However, if the cultivator was incorrectly unhitched with the shank beams rotated into the high transport or reverse position, the hitch would rise. To re hitch, the hydraulics had to be connected first to rotate the beams and lower the hitch.

Transporting: Ease of transporting the Flexi-coil 700 was good.

It was easily placed in transport position (FIGURE 8) by one person in less than five minutes. Transport locks were provided for the centre frame wheels and the wings. The locks could be positioned without climbing on the cultivator frame.

The shank mounting beams had to be rotated into the transport position for transporting. If not, castor wheels could partially pivot and skid along at an angle when backing up or making sharp turns on a firm surface.



FIGURE 8. Transport Position.

Transport width of the test machine was 20.3 ft (6.2 m) when equipped with mounted harrows. Transport height varied from 16.8 to 17.3 ft (5.1 to 5.3 m) depending on the depth cam setting. Extreme caution was needed when transporting on public roads, through gates, over bridges and beneath power lines.

The Flexi-coil 700 towed very well without any sway or bounce at normal transport speeds. A wheel tread of 14 ft (4.3 m) provided sufficient stability in the transport position. Sweep-to-ground clearance ranged from 5 to 10 in (127 to 254 mm) depending on the depth cam setting.

Maneuverability: Maneuverability of the Flexi-coil 700 was good.

The rear tires of the four-wheel drive test tractor did not contact the hitch during turns. The front row wheels had a limited pivot angle while the center and rear row wheels did not pivot. The wheels normally castored properly. However, on sharp turns, some of the tires skidded. When backing up, the shank beams had to be properly rotated to prevent the front wheels from partially castoring and skidding.

Depth Adjustment: Ease of setting tillage depth was good.

Tillage depth depended on the depth cam adjustment at each wheel and the sweep pitch setting.

It took one man about 10 minutes to adjust the depth. The mounting beams were hydraulically rotated backwards until the wheels lifted off the ground. Each depth cam (FIGURE 9) was then rotated into the desired one of five possible settings and the hydraulic cylinder stop was repositioned. The operator had to crawl over the machine to get at some of the adjustments.

The available settings were adequate although the cams only adjusted depth in steps, intermediate depths could be easily obtained by varying sweep pitch slightly.

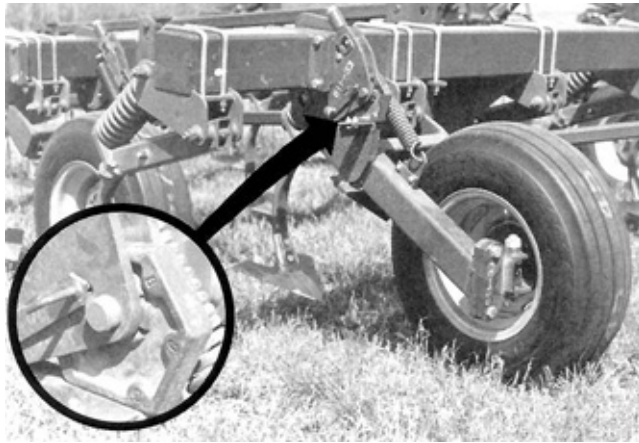


FIGURE 9. Manually Adjusted Depth Cam.

Sweep Pitch Adjustment: Ease of setting sweep pitch was very good.

Sweep pitch was set by two hydraulic cylinders connected in parallel that rotated the shank mounting beams. A hydraulic valve automatically stopped the cylinders when the preset sweep pitch angle was reached. In hard to penetrate conditions, the operator could increase sweep pitch by rotating the shank beams using the remote hydraulic controls, however, this would decrease depth unless the depth cams were reset.

Frame Levelling: Ease of levelling the frame was very good.

Setting all depth cams to the same position levelled the Flexi-coil 700 both laterally and front-to-back. In addition, shims could be inserted under the depth cams to compensate for differences due to cultivator wheels following in the tractor tracks.

Harrow Adjustment: Ease of adjusting the optional tine harrows was very good.

The harrow frame could be levelled by loosening two bolts. The tine angle could be adjusted to five different positions.

Adjustments for tine angle and harrow spring preload were adequate for most conditions.

Sweep and Shank Replacement: Ease of sweep and shank replacement was good.

Soil abrasion to the lower sweep nuts was slight and did not seriously hamper removal of the nuts. Shank replacement was easily accomplished in less than 5 min. Two easily accessed bolts had to be removed.

POWER REQUIREMENTS

PAMI has measured cultivator power requirements on several cultivators in many different field conditions as explained in APPENDIX III. From these field measurements, average power requirements have been determined to assist farmers in matching tractor and cultivator sizes. These tractor sizes (TABLE 2) have been adjusted to include tractive efficiency and represent a tractor operating at 80% of its maximum PTO rating.

TABLE 2. Tractor Size: PTO Power (hp (kW)) Required for Typical Operations with a 41.3 ft (12.6 m) Cultivator.

OPERATION	DEPTH		SPEED — mph (km/h)	
	in	(mm)	5.0 (8.0)	6.0 (9.7)
Primary	3	(75)	200 (150)	240 (180)
	4	(100)	250 (185)	305 (225)
Secondary	3	(75)	180 (135)	215 (160)
	4	(100)	230 (170)	280 (210)

In typical secondary tillage conditions of 6 mph (9.7 km/h) and a depth of 3 in (75 mm), average cultivator power requirements were 5.2 hp/ft (12.7 kW/m) (APPENDIX III). In typical primary tillage conditions of 5 mph (8.0 km/h) and a depth of 4 in (100 mm), average power requirements were 6.1 hp/ft (14.9 kW/m). Therefore, the tractor PTO horsepower recommended to pull the 41.3 ft (12.6 m) Flexi-coil 700 Eclipse cultivator in those conditions were 215 hp (160 kW) in secondary tillage and 250 hp (185 kW) in primary tillage.

More power will be required at greater depths, in hills, or in heavy soils known to have higher power requirements. Average cultivator power requirements per unit width for different conditions, depths, and speeds are given in APPENDIX III.

OPERATOR SAFETY

Extreme caution is needed when 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 as 15 ft (4.6 m).

Extreme caution was required when transporting the 41.3 ft (12.6 m) wide three section Flexi-coil 700 as transport height varied from 16.8 to 17.3 ft (5.1 to 5.3 m) depending on the depth cam setting. 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 20.3 ft (6.2 m) wide in transport position and required caution when moving. A slow moving vehicle sign was provided as standard equipment.

Transport locks were provided for the centre frame section and the wings. The locks were easily positioned without climbing onto the cultivator. The rigid hitch link and hitch jack allowed safe hitching by one person. However, if the shank beams were rotated into the high transport position or incorrectly rotated in the reverse position, the hitch could rise dangerously. A hitch safety chain for transporting on public roads was not supplied. A hitch safety chain standard has been adopted by the American Society of Agricultural Engineers (ASAE). It is therefore recommended that the manufacturer supply a hitch safety chain.

The load on the centre section tires did not exceed The Tire and Rim Association maximum load rating, even when in transport with mounted harrows.

OPERATOR'S MANUAL

The operator's manual was excellent. It supplied instructions on assembly, maintenance and safety. There was a complete list of operating instructions. It also provided a complete parts listing. It was well written and clearly illustrated.

MECHANICAL HISTORY

TABLE 3 outlines the mechanical history of the Flexi-coil 700 Eclipse during 119 hours of field operation while cultivating 2305 ac (933 ha).

The intent of the test was evaluation of functional performance. The following mechanical problems occurred during testing. An extended durability test was not conducted.

TABLE 3. Mechanical History.

ITEM	OPERATING HOURS	EQUIVALENT FIELD AREA ac (ha)
-- A hydraulic depth cylinder started to leak three times and was replaced at	38	740 (300)
	69	1430 (579)
	107	2145 (868)
-- A harrow pivot bolt came out and was replaced at	64	1330 (538)
	80	1650 (668)
	117	2285 (925)
-- The depth stop valve started to leak and was replaced at	102	2050 (830)
-- One shank mechanism was bent while turning with the cultivator in the ground at	105	2100 (850)
-- Three shanks broke and were replaced		During the test
-- Eighteen shanks were bent and replaced		During the test

Harrow Pivot Bolt: The pivot bolt on three sets of harrows came out. The bolts were replaced before damage to the harrows occurred. It is recommended that the manufacturer consider modifications to prevent the harrow pivot bolts from loosening.

Hydraulic Depth Cylinder: Three hydraulic depth cylinders leaked past the end cap and were replaced. It is recommended that the manufacturer consider modifications to prevent hydraulic cylinder leaks.

Shanks: Eighteen shanks bent and three shanks broke while operating in rocky field conditions. Insufficient lift height and the shank configuration were probable causes for the shank damage. Modifications have already been recommended.

Spring Guide: When the shank mechanism tripped over 4 in (102 mm), the compression spring bowed enough to push the rear of the spring guide up a bit and out of position. The spring guide would not always drop back to its proper position after the shank returned. With the spring guide out of place, the two spring seats were out of line, so the compression spring remained bowed. Although this appeared irregular, performance and durability of the shank assemblies were not affected.

APPENDIX I

SPECIFICATIONS

MAKE:	Flexi-coil	
MODEL:	700 Eclipse	
SERIAL NUMBER:	E700A00-G010706	
MANUFACTURER:	Flexi-coil Ltd. P.O. Box 1928 Saskatoon, Saskatchewan S7K 3S5	
OVERALL DIMENSIONS:	FIELD POSITION	TRANSPORT POSITION
- width	41.3 ft (12.6 m)	20.3 ft (6.2 m)
- length with mounted harrows		
- 12 in (305 mm) spacing machine	30.3 ft (9.2 m)	30.3 ft (9.2 m)
- 9.3 in (237 mm) spacing machine	32.1 ft (9.8 m)	32.1 ft (9.8 m)
- height	5.8 ft (1.8 m)	16.8 to 17.3 ft (5.1 to 5.3 m)
- maximum ground clearance	10.0 in (254 mm)	10.0 in (254 mm)
- maximum wheel tread	35.7 ft (10.9 m)	14.0 ft (4.3 m)
SHANKS:		
- number		
- 12 in (305 mm) spacing machine	41	
- 9.3 in (237 mm) spacing machine	53	
- lateral spacing	9.3 or 12.0 in (237 or 305 mm)	
- trash clearance (frame to sweep tip)	30 in (762 mm)	
- number of shank rows		
- centre section	3	
- wings	3	
- distance between rows		
- 12 in (305 mm) spacing machine	4.4 ft (1.3 m)	
- 9.3 (237 mm) spacing machine	5.3 ft (1.6 m)	
- shank cross section	2 x 1 in (50 x 25 mm) on the top reshaped to 1 x 2 in (25 x 50 mm) on the bottom adjustable	
- shank stem angle	adjustable	
- sweep hole spacing	2.25 in (57 mm)	
- sweep bolt size	1/2x2 in	
HITCH:		
- floating	eliminates need for hitch height adjustment	
DEPTH CONTROL:	12 manually adjusted cams and two hydraulic cylinders with a stop valve	
FRAME:		
- cross section	6 in (152 mm) square tubing	

TIRES:

- centre section	2, 11 - 15LT, 8 ply
	4, 9.5L - 15, 6 ply
- wing sections	6, 9.5L - 15, 6 ply

NUMBER OF LUBRICATION POINTS:

- grease fittings	
- 12 in (305 mm) spacing machine	127
- 9.3 in (237 mm) spacing machine	151
- wheel bearings	12

HYDRAULIC CYLINDERS:

- depth control	2, 4 x 16 in (100 x 406 mm)
- wing lift	6, 3 x 30 in (75 x 762 ram)

WEIGHTS (WITHOUT HARROWS):

12 in (305 mm) spacing machine	FIELD POSITION	TRANSPORT POSITION
	1730 lb (785 kg)	
- right wheels	4260 lb (1932 kg)	6005 lb (2724 kg)
- right centre wheels	4170 lb (1891 kg)	5925 lb (2687 kg)
- left centre wheels	1770 lb (803 kg)	
- left wheels	---	---
- hitch	---	---
TOTAL	11,930 lb (5411 kg)	11,930 lb (5411 kg)

9.3 in (237 mm) spacing machine

	FIELD POSITION	TRANSPORT POSITION
	2120 lb (964 kg)	
-right wheel:	4220 lb (1918 kg)	6405 lb (2911 kg)
-right centre wheel:	4170 lb (1895 kg)	6315 lb (2871 kg)
-left centre wheel:	2210 lb (1005 kg)	
-left wheel:	---	---
-hitch	---	---
TOTAL	12,720 lb (5782 kg)	12,720 lb (5782 kg)

WEIGHTS (WITH MOUNTED HARROWS):

12 in (305 mm) spacing machine	FIELD POSITION	TRANSPORT POSITION
	2105 lb (955 kg)	
- right wheels	4540 lb (2059 kg)	6660 lb (3021 kg)
- right centre wheels	4450 lb (2018 kg)	6580 lb (2984 kg)
- left centre wheels	2145 lb (973 kg)	
- left wheels	---	---
-hitch	---	---
TOTAL	13,240 lb (6005 kg)	13,240 lb (6005 kg)

9.3 in (237 mm) spacing machine

	FIELD POSITION	TRANSPORT POSITION
	2495 lb (1134 kg)	
- right wheels	4500 lb (2045 kg)	7045 lb (3202 kg)
- right centre wheels	4450 lb (2023 kg)	6985 lb (3175 kg)
- left centre wheels	2585 lb (1175 kg)	
- left wheels	---	---
-hitch	---	---
TOTAL	14,030 lb (6377 kg)	14,030 lb (6377 kg)

OPTIONAL EQUIPMENT INCLUDED:

- mounted finishing harrows (three row)

OPTIONAL EQUIPMENT AVAILABLE:

- 6 width options from 33.4 to 41.3 ft (10.2 to 12.6 m)
- mounted finishing harrows (four row)

APPENDIX II

SOIL FORCES TABLES

The following tables give typical horizontal forces acting on sweeps, spikes, and banding knives located in the front row of a cultivator while operating at different depths in primary and secondary tillage on the prairies. These values are relevant for 95% of all prairie conditions. Higher forces may be encountered in extremely heavy, dry, or compacted soils.

These values can be used to determine how well the shank assemblies are suited to the various operations. Comparing the sweep pitch curve of the assembly to these soil forces will indicate whether the assembly will hold the soil tool below the acceptable 7° sweep pitch.

For example, an assembly should be suitable for primary tillage with a 16 in (400 mm) sweep at 5 in (125 mm) depth if it will not exceed 7° sweep pitch below 500 lb (2.2 kN).

TABLE 4. Forces Required (lb (kN)) in Primary Tillage for Various Soil Tools.

DEPTH	SWEEPS			SPIKE 2 in (50 mm)	BANDING KNIFE 1 in (25 mm)
	FIELD CULTI- VATOR 11 in (275 mm)	HEAVY DUTY CULTIVATOR			
		12 in (305 mm)	16 in (406 mm)		
in (mm)	lb (kN)	lb (kN)	lb (kN)	lb (kN)	lb (kN)
2 (50)	120 (0.5)	190 (0.8)	220 (1.0)	—	—
3 (75)	140 (0.6)	230 (1.0)	280 (1.2)	150 (0.7)	—
4 (100)	180 (0.8)	310 (1.4)	370 (1.6)	190 (0.8)	320 (1.4)
5 (125)	—	420 (1.9)	500 (2.2)	260 (1.2)	390 (1.7)
6 (150)	—	—	—	360 (1.6)	540 (2.4)

TABLE 5. Forces Required (lb (kN)) in Secondary Tillage for Various Soil Tools.

DEPTH	SWEEPS			SPIKE 2 in (50 mm)	BANDING KNIFE 1 in (25 mm)
	FIELD CULTI- VATOR 11 in (275 mm)	HEAVY DUTY CULTIVATOR			
		12 in (305 mm)	16 in (406 mm)		
in (mm)	lb (kN)	lb (kN)	lb (kN)	lb (kN)	lb (kN)
2 (50)	110 (0.5)	170 (0.8)	200 (0.9)	—	—
3 (75)	140 (0.6)	220 (1.0)	270 (1.2)	130 (0.6)	—
4 (100)	170 (0.8)	280 (1.2)	340 (1.5)	180 (0.8)	290 (1.3)
5 (125)	—	370 (1.6)	450 (2.0)	290 (1.1)	380 (1.7)
6 (150)	—	—	—	320 (1.4)	490 (2.2)

APPENDIX III

POWER REQUIREMENTS

Draft Characteristics

Draft requirements have been measured on several cultivators in many different field conditions over the past years. Average draft requirements have been determined from these measurements.

Draft requirements for the same cultivator, in the same field, 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, making it difficult to measure any significant draft differences between makes of cultivators.

Since there is little or no draft difference between machines, PAMI has averaged the results obtained over the years and has used these to determine tractor size recommendations.

Recommended Tractor Size

The following tables show tractor PTO power required to pull cultivators in various conditions at the given depths and speeds. Tractor power requirements have been adjusted to include a tractive efficiency of 80% in primary and 70% in secondary tillage and represent a tractor operating at 80% of maximum PTO power on a level field. These power requirements can be used along with the maximum PTO ratings, as determined by Nebraska tests or as presented by the tractor manufacturer, to select the appropriate tractor. Higher power will be required in hills or in heavy soils. Cultivators with marked differences in spacing, number of rows, or configuration may require more or less power.

Recommended tractor size may be determined by selecting the required horsepower per foot from the appropriate table and multiplying by the width of cultivator. For example, in primary tillage at 4 in (100 mm) and 5 mph (8.0 km/h), 6.1 hp/ft (14.9 kW/m) is required. Therefore, for a 41.3 ft (12.6 m) cultivator in those conditions, 250 PTO hp (185 kW) is recommended.

TABLE 6. Tractor PTO Power Per Unit Width (hp/ft (kW/m)) Required in Primary Tillage.

DEPTH	SPEED — mph (km/h)		
	4.0 (6.4)	5.0 (8.0)	6.0 (9.7)
in (mm)			
2 (50)	2.7 (6.6)	3.4 (8.3)	4.1 (10.0)
3 (75)	3.8 (9.3)	4.8 (11.7)	5.8 (14.2)
4 (100)	4.9 (12.0)	6.1 (14.9)	7.4 (18.1)
5 (125)	6.0 (14.7)	7.5 (18.4)	9.0 (22.0)

TABLE 7. Tractor PTO Power Per Unit Width (hp/ft (kW/m)) Required in Secondary Tillage.

DEPTH	SPEED — mph (km/h)		
	4.0 (6.4)	5.0 (8.0)	6.0 (9.7)
in (mm)			
2 (50)	2.3 (5.6)	3.0 (7.3)	3.6 (8.8)
3 (75)	3.4 (8.3)	4.3 (10.5)	5.2 (12.7)
4 (100)	4.5 (11.0)	5.6 (13.7)	6.8 (16.6)
5 (125)	5.5 (13.5)	7.0 (17.1)	8.4 (20.6)

APPENDIX IV

MACHINE RATINGS

excellent	fair
very good	poor
good	unsatisfactory

SUMMARY CHART

Flexi-coil 700 ECLIPSE CULTIVATOR

RETAIL PRICE	
- 12 in (305 mm) spacing machine	\$31,075.00
- 9.3 in (237 mm) spacing machine	\$33,435.00 (October, 1987, f.o.b. Humboldt, 41.3 ft (12.6 m) width, optional harrows, and McKay sweeps.)
QUALITY OF WORK	
Penetration	Very Good ; sweep pitch could be adjusted for greater penetration
Depth Uniformity	Excellent in primary and secondary tillage; followed ground contours well, acceptable sweep pitch and smooth furrow bottom
Stone Protection	Fair ; trip height was only 8.5 in (216 ram)
Trash Clearance	
- 12 in (305 mm) spacing machine	Very Good
- 9.3 in (237 mm) spacing machine	Good ; plugging occurred in damp or heavy trash
Surface Finish	
- 12 in (305 mm) spacing machine	Good
- 9.3 in (237 mm) spacing machine	Very Good ; narrower spacing machines leave a smoother finish
Skewing and Stability	
- 12 in (305 mm) spacing machine	Stable
- 9.3 in (237 mm) spacing machine	Skewed on hillsides
Weed Kill	
- 12 in (305 mm) spacing machine	Good
- 9.3 in (237 mm) spacing machine	Fair ; reduced due to skewing
EASE OF OPERATION AND ADJUSTMENT	
Hitching	Good ; hitch could rise if unhooked incorrectly
Transporting	Good ; easily put in transport, but quite wide
Maneuverability	Good ; special care required to prevent wheels from skidding on turns and when backing up
Depth Adjustment	Good ; resetting took about 10 minutes
Sweep Pitch Adjustment	Very Good ; controlled hydraulically
Frame Levelling	Very Good
Harrow Adjustment	Very Good
Sweep and Shank Replacement	Good ; shanks changed easily
POWER REQUIREMENTS	
Secondary Tillage	215 hp (160 kW) at 3 in (75 mm) and 6 mph (9.7 km/h)
Primary Tillage	250 hp (185 kW) at 4 in (100 mm) and 5 mph (8.0 km/h)
OPERATOR SAFETY	High and wide in transport, operator did not have to climb on machine to position transport locks
OPERATOR'S MANUAL	Excellent ; well written, clearly illustrated and complete
MECHANICAL HISTORY	Eighteen shanks bent and three broke; several other mechanical failures occurred



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