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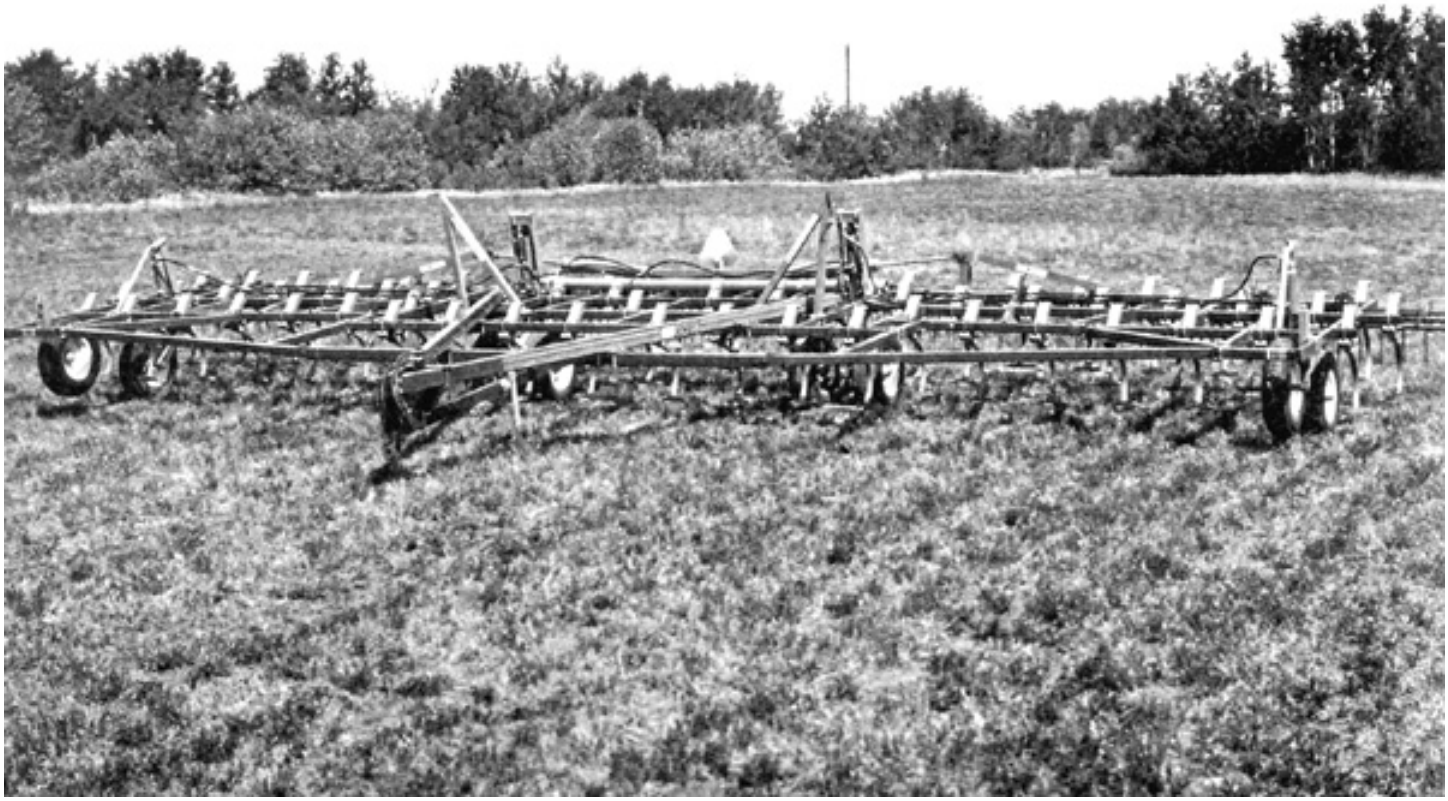

Co-op Implements 279 (12.6 m) Field Cultivator

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

CO-OP IMPLEMENTS 279 FIELD CULTIVATOR

MANUFACTURER AND DISTRIBUTOR:

Co-op Implements Limited
770 Pandora Avenue East
Winnipeg, Manitoba
R2C 3N1

RETAIL PRICE:

$14,613.00 (December, 1981, f.o.b. Humboldt, 12.6 m width, with 200 mm shank spacing, and optional mounted harrows).

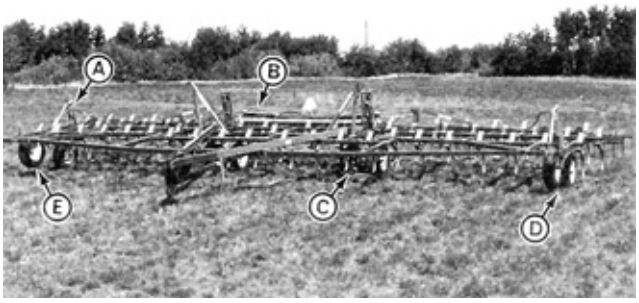

FIGURE 1. CI 279: (A) Depth Control Cylinders, (B) Wing Lift Cylinders, (C) Centre Wheels, (D) Wing Wheels, (E) Stabilizer Wheels.

SUMMARY AND CONCLUSIONS

Overall functional performance of the CI 279 field cultivator was very good for seedbed preparation, second operation summerfallow and most herbicide incorporation, providing mounted finishing harrows were used. Weed kill was very good with 250 mm (10 in) sweeps. Penetration was reduced in heavy secondary tillage. As with most light duty field cultivators the CI 279 was unsuitable for primary tillage and heavy trash conditions.

The spring cushioned shanks could lift 280 mm (11 in) to clear stones. As with most field cultivators the shanks were quite flexible. When equipped with the recommended 47 degree sweeps, sweep pitch varied from 0 to 4 degrees over the normal secondary tillage draft range. With the 200 mm (8 in) shank spacing, the shank cushioning springs began to deflect at a draft greater than 3.9 kN/m (267 lb/ft). This occurred above the secondary tillage draft range, indicating that the CI 279 shanks are suited for secondary tillage operations and not intended for primary tillage.

Penetration was very good in normal secondary tillage, but was inadequate in fields with a hard subsurface layer.

The CI 279 could clear moderately heavy trash, normally found in secondary tillage operations. The CI 279 buried less trash than most heavy duty cultivators. Skewing occurred only on hillsides or where soil hardness varied across the machine width. Weed kill was good and the mounted harrows were effective in exposing loosened weeds.

The CI 279 could be easily placed into transport position in less than five minutes. The 250 mm (10 in) sweep-to-ground clearance was adequate for normal transport. Because of its large transport width and height, transporting on public roads had to be done with extreme caution. The CI 279 was stable and towed well at normal transport speeds. The tires of the centre section were adequate to support the cultivator with mounted harrows, while transporting up to speeds of 32 km/h (20 mph). The 12.6 m (41.3 ft) wide test machine was 5.2 m (17 ft) high in transport, which is high enough to contact many prairie power lines.

The hitch jack and the swivel hitch clevis that was easily supported in a horizontal position made one man hitching convenient. Adequate adjustment was provided for both fore-and-aft and lateral levelling. Tillage depth was usually level across the cultivator width. Thenarrow hitch permitted normal turns.

Average draft for the 12.6 m (41.3 ft) wide test machine in light secondary tillage at 8 km/h (5 mph), varied from 10.1 kN (2270 lb) at 40 mm (1.5 in) depth to 27.7 kN (6227 lb) at 100 mm (4 in) depth. In heavy secondary tillage, at 6 km/h (5 mph), average draft varied from 16.4 to 36.5 kN (3687 to 8206 lb) over the same depth range.

In light secondary tillage at 10 km/h (6.2 mph) and 75 mm (3 in) depth, a tractor with 108 kW (140 hp) maximum power take-off rating will have sufficient power reserve to operate the 12.6 m (41.3 ft) wide CI 279. In heavy secondary tillage at the same depth and speed, a 148 kW (192 hp) tractor is needed.

The CI 279 was equipped with wing and depth control transport locks. The depth control locks would not stay in place for transport unless the hydraulic cylinders were slightly retracted. A slow moving vehicle sign was provided to aid in transport safety. The operator's manual was well written and clearly illustrated.

A few mechanical problems occurred during the 131 hours of field operation. Two spring guides bent, a hydraulic wing lift cylinder leaked, harrow adjustment levers failed, eight shanks bent, and twelve sweeps broke.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifying the centre section wheels to eliminate frame interference.
2. Modifying the mounted harrows tine angle adjustment to prevent bending and weld failures.
3. Working with the agricultural equipment industry to standardize hydraulic quick couplers and hydraulic hose fitting threads.
4. Working with the agricultural equipment industry to standardize shank and sweep stem angles, and sweep fastener spacings and sizes.

Senior Engineer: G. E. Frehlich
Pro/ect Technologist: A. R. Boyden

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. We will take this recommendation under advisement. Our pivot design permits an exceptional range of flexibility for passing over obstacles. We feel that the smooth frame surface the tire momentarily contacts when this range is exceeded, will not cause any damage.
2. Action has been taken to strengthen the adjustment lever welds and the adjustment arm.
3. We would welcome and will work with industry to obtain standards for quick couplers and hose threads. We presently follow all standards wherever possible.
4. We will work with industry to standardize shank and sweep stem angles. We believe our models 179, 279 and 379 meet current ASAE standards for ground working tools.

NOTE: This report has been prepared using SI units of measurement. A conversion table isgiven in APPENDIX III.

GENERAL DESCRIPTION

The CI 279 is a trailing, flexible, three section field cultivator suitable for light tillage such as seedbed preparation, herbicide incorporation and secondary summerfallow. It is available in widths ranging from 9.3 to 12.6 m (30.3 to 41.3 ft), with shank spacings of 200 mm (8 in) or 250 mm (10 in). The test machine was 12.6 m (41.3 ft) wide with a 200 mm (8 in) shank spacing. The centre section was 4.4 m (14.4 ft) wide and the wing sections were 4.1 m (13.5 ft) wide. It was equipped with 63 spring cushioned shanks arranged in four rows on the centre section and three rows on the wing sections.

The centre frame is supported by two sets of dual wheels. Each wing frame is supported by one wheel and a stabilizer wheel mounted at the front of the wing frame. Four hydraulic cylinders, connected in series, 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 CI 279.

Detailed specifications are given in APPENDIX I while FIGURE 1 shows the location of major components.

SCOPE OF TEST

The CI 279 was operated in field conditions shown in TABLE 1 for 131 hours, while cultivating about 1314 ha (3285 ac). It was evaluated for quality of work, ease of operation and adjustment, power requirements, safety, and suitability of the operator's manual.

Optional attached finishing harrows were used during the test.

TABLE 1. Operating Conditions

FIELD CONDITION	HOURS	FIELD AREA (ha)
Soil Type		
— loam	89	864
— clay	15	157
— heavy clay	27	293
TOTAL	131	1 314
Stony Phase		
— stone free	22	248
— occasional stones	64	659
— moderately stony	24	209
— very stony	21	198
TOTAL	131	1 314

RESULTS AND DISCUSSION

QUALITY OF WORK

Shank Characteristics: There is a large variation in shank and sweep stem angles (FIGURE 2) on cultivators from different manufacturers. Sweeps and shanks must be matched to obtain sufficient sweep pitch to achieve and maintain penetration. Usually manufacturers recommend sweeps with a stem angle from 0 to 5 degrees less than the shank stem angle to result in a slightly positive no-load sweep pitch.

Sweep pitch increases in proportion to draft due to shank flexing 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 CI 279 was equipped with spring cushioned shank holders. Spring tension was not adjustable. The CI 279 was used with 250 mm (10 in) Co-op Implement sweeps with a 47 degree stem angle giving a no-load sweep pitch of 0 degrees.

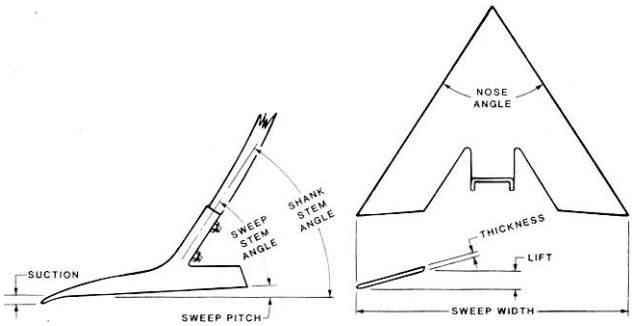

FIGURE 2. Shank and Sweep Terminology.

FIGURE 3 shows pitch characteristics of the shank assemblies on the CI 279. The low end of the pitch curve results from shank flexing, while the steeper upper part is due to cushion-spring deflection. Sweep pitch varied 4 degrees over the normal secondary tillage draft range. When equipped with the 47 degree sweeps, sweep pitch varied from 0 to 4 degrees over this draft range. The cushioning springs began to deflect at drafts greater than 3.9 kN/m (267 lb/ft). This occurred above the secondary tillage draft range, indicating that the CI 279 shanks are well suited for secondary tillage.

FIGURE 4 shows the lifting pattern when shanks encounter stones or field obstructions. Maximum lift height was 280 mm (11 in). Eight shanks bent and twelve sweeps broke during testing.

Penetration: Penetration was very good in normal secondary tillage. The CI 279 was not intended for primary tillage, and penetration was inadequate in fields with a hard subsurface layer. Penetration was uniform across the cultivator width provided the frame was properly levelled and the depth control cylinders were kept synchronized. Tires were adequately sized and positioned to provide good flotation in normal conditions. The centre section tires interfered with the frame when the wheels encountered large rocks.

Depth differences between the front and the rear row of shanks were slight, once the frame had been properly levelled. In all conditions, the frame remained relatively level with very little twisting of the wing frames.

The CI 279 followed gently rolling field contours well, maintaining a uniform depth across its width. As with most wing cultivators, large variations in tillage depth occurred in fields with abrupt contour changes.

Plugging: The 200 mm (8 in) lateral shank spacing and 620 mm (24 in) sweep to frame clearance was suitable for moderately heavy trash conditions normally found in secondary tillage operations. Plugging occurred in most areas of the cultivator in heavy trash conditions.

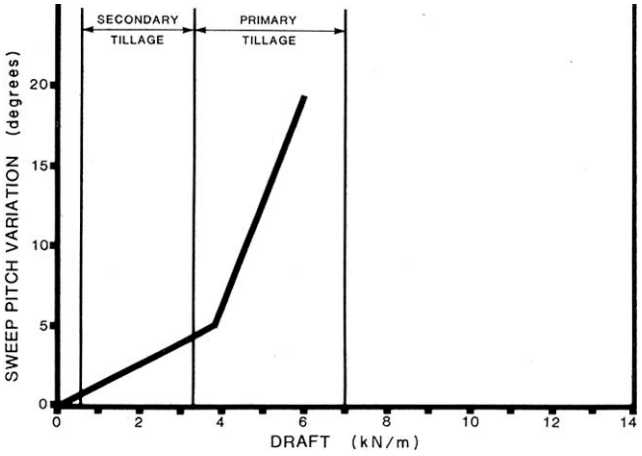

FIGURE 3. Sweep Pitch Variation over a Normal Range of Draft (200 mm Shank Spacing).

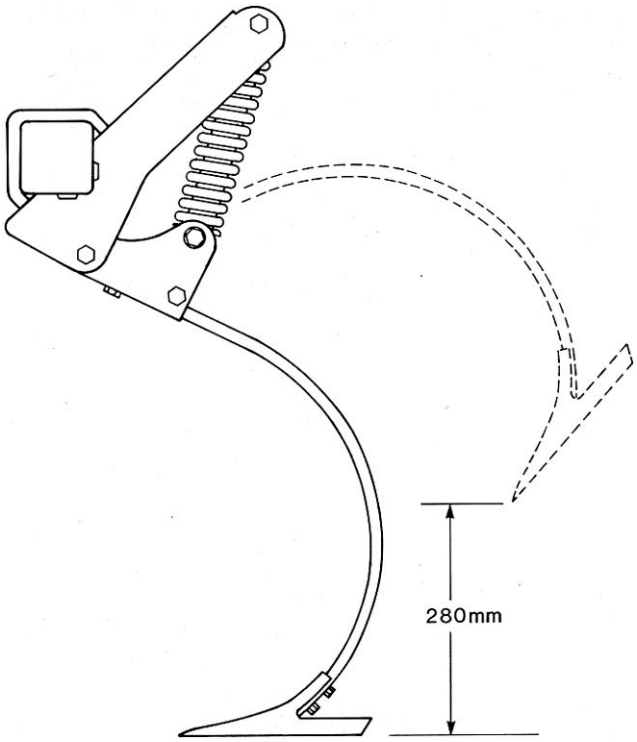

FIGURE 4. Shank Lifting Pattern.

The mounted finishing harrows could clear large amounts of trash.

Trash Burial and Field Surface: As with most field cultivators, the CI 279 buried less trash than most heavy duty cultivators. The mounted harrows levelled the slight ridges left by the cultivator, and smoothed the soil surface resulting in a uniform seedbed (FIGURE 5).

Furrow Bottom Ridging: Shank and spring cushion stiffness were sufficient to hold the sweeps very level. Furrow bottom ridging was never excessive because the sweeps failed to penetrate in heavy secondary tillage or soils with a hard subsurface layer.

Skewing and Stability: The CI 279 was stable and did not skew sideways in normal field conditions. The sweep pattern (FIGURE 6) was symmetrical and did not impose any side forces on the cultivator during normal tillage. As with most field cultivators, skewing occurred only on hillsides or where soil hardness varied across the machine width. With the 250 mm (10 in) sweeps, the cultivafor had to skew more than 1.4 degrees for weed misses to occur.

Weed Kill: Weed kill was good with the 250 mm (10 in) sweeps and the 200 mm (8 in) spacing. Sweeps were located behind the wheels to uproot weeds in the tracks. Mounted harrows increased weed kill by exposing the loosened weeds, breaking lumps, and distributing heavy trash.

EASE OF OPERATION AND ADJUSTMENT

Transporting: The CI 279 was easily placed into transport position (FIGURE 7) by one person in less than five minutes. The wing sections moved very rapidly when being placed in transport or field position. The manufacturer had failed to include orifices in the wing lift hydraulic system during assembly. The orifices are provided as standard equipment to slow wing movement and prevent possible damage to the cultivator.

Transport locks for the wings and depth control wheels were provided. Danger areas should be avoided when climbing on the machine to install these locks. The depth control locks did not stay in transport position when the hydraulic cylinders were fully extended. Slightly retracting the hydraulic cylinders to rest the cultivator weight on the transport locks prevented them from moving.

Transport width of the test machine was 5.5 m (18 ft) while transport height was 5.2 m (17 ft). Extreme care was needed when transporting on public roads, through gates, over bridges, and beneath power and telephone lines.

FIGURE 5. Typical Seedbed Preparation.

The CI 279 towed well without sway at normal transport speeds. Sweep-to-ground clearance of 250 mm (10 in) and a wheel tread of 3.2 m (10.5 ft) gave good transport ground clearance on slopes and rough terrain.

Hitching: The hitch jack permitted easy hitching of the cultivator in transport and field position with finishing harrows attached. The hitch clevis was easily supported in a horizontal position by inserting a screw driver in the.tube provided under the hitch clevis, (FIGURE 8).

The hitch height could be adjusted 240 mm (9.4 in)in five increments by removing one pin. This range was adequate to allow fore-and-aft frame levelling with all tractors used during testing.

Maneuverability: The hitch frame of the CI 279 was narrow, permitting normal turns without tractor wheel interference. There was a sufficient number of sweeps beyond the wing wheels to allow moderate overlap without running a wheel on cultivated ground. Running all wheels on similar untilled soil maintains proper flotation and aids in uniform tillage depth.

Frame Levelling: Adequate lateral levelling adjustments were provided for the depth control wheels of the centre and wing sections. The centre frame was levelled by inserting shim plates between the cylinder mounts. Wing frames were levelled by adjusting the threaded hydraulic cylinder mounts.

Tillage Depth: Tillage depth was controlled with four hydraulic cylinders connected in series. A hydraulic stop valve on one cylinder could be .adjusted to set tillage depth. As is common with series hydraulic systems, to maintain the centre and wing frames at the same depth, periodic synchronization of the cylinders by completely extending them to the fully raised position was necessary.

Sweep Installation: It took one person about three and one-half hours to change the 63 sweeps on the CI 279. The sweep bolts were short enough to have their threaded ends completely covered by the retaining nuts, preventing thread damage during tillage. Sweep-to-ground clearance of 250 mm (10 in) was adequate for easy sweep removal.

Shank Installation: A shank could be replaced in less than ten minutes by loosening one bolt and removing another.

POWER REQUIREMENTS

Draft Characteristics: FIGURE 9 shows draft requirements for field cultivators in typical secondary tillage, at a speed of 8 km/h (5 mph). This figure gives average requirements based on tests of seven makes of field cultivators in three seasons and 14 different field conditions. Attempting to compare draft requirements of different makes of field cultivators usually is unrealistic. 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. Variation in soil conditions affect draft much more than variation in machine make, usually making it impossible to measure any significant draft differences between different makes of field cultivators.

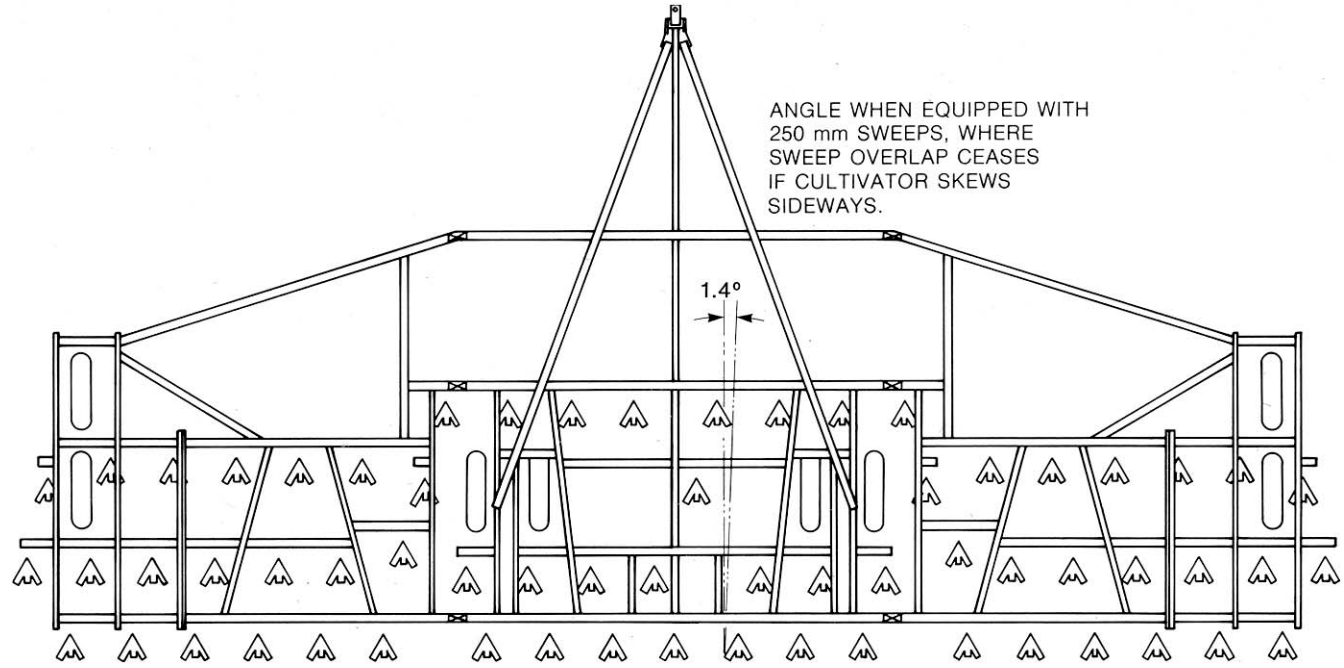

FIGURE 6. Sweep Patterns (200 mm Shank Spacing).

FIGURE 7. Transport Position.

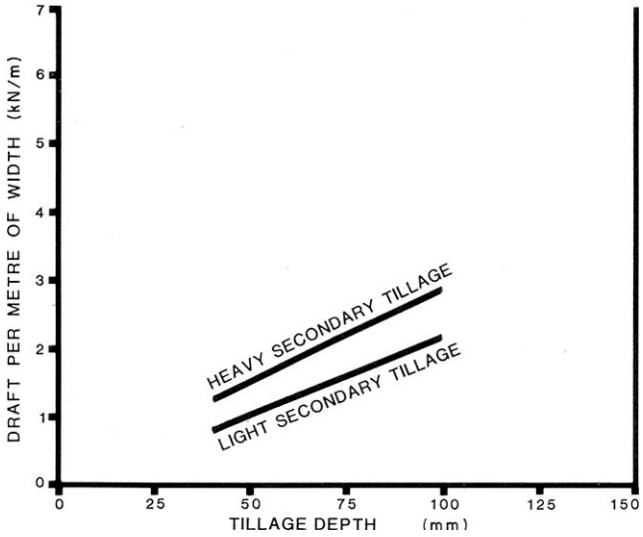

FIGURE 9. Average Draft Requirements for Field Cultivators at 8 km/h.

FIGURE 8. Hitch Clevis Supported in Horizontal Position.

In light secondary tillage, such as herbicide incorporation or seedbed preparation, average draft per metre of width, at 8 km/h (5 mph), varied from 0.8 kN/m (55 lb/ft) at 40 mm (1.5 in) depth to 2.2 kN/m (151 lb/ft) at 100 mm (4 in) depth. For the 12.6 m (41.3 ft) wide test machine, this corresponds to a total draft ranging from about 10.1 to 27.7 kN (2270 to 6227 lb).

In heavy secondary tillage, such as firm summerfallow, average draft per metre of width, at 8 km/h (5 mph), varied from 1.3 kN/m (89 lb/ft) at 40 mm (1.5 in) depth to 2.9 kN/m (198 lb/ft) at 100 mm (4 in) depth, corresponding to a total variation from about 16.4 to 36.5 kN (3687 to 8206 lb) for the 12.6 m (41.3 ft) test machine.

Increasing speed by 1 km/h (0.6 mph) increased draft by 90 N/m (6 lb/ft). For the 12.6 m (41.3 ft) wide test machine, this represents a draft increase of about 1.1 kN (255 lb) for a 1 km/h (0.6 mph) speed increase.

Tractor Size: TABLES 2 and 3 show tractor sizes needed to operate the 12.6 m (41.3 ft) wide CI 279 in light and heavy secondary tillage. Tractor sizes have been adjusted to include tractive efficiency in loose soils 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 CI 279 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 75 mm (3 in) depth and 10 km/h (6 mph), a 108 kW (140 hp) tractor is needed to operate the CI 279. In heavy secondary tillage at the same depth and speed, a 148 kW (192 hp) tractor is needed.

TABLE 2. Tractor Size (Maximum Power Take-off Rating, kW) to Operate the 12.6 m Wide CI 279 in Light Secondary Tillage.

DEPTH (mm)	SPEED km/h 7	8	9	10	11	12
40	31	39	49	59	70	82
50	41	51	61	73	85	99
75	65	78	92	108	124	141
100	89	106	124	142	162	179

TABLE 3. Tractor Size (Maximum Power Take-off Rating, kW) to Operate the 12.6 m Wide CI 279 in Heavy Secondary Tillage.

DEPTH (mm)	SPEED km/h 7	8	9	10	11	12
40	53	65	78	92	107	124
50	64	78	92	108	125	143
75	92	110	128	148	169	191
100	120	142	165	189	213	239

OPERATOR SAFETY

Extreme caution is needed in transporting most folding cultivators, to avoid contacting power lines. Minimum power line heights vary in the three prairie provinces. In Saskatchewan, the energized line may be as low as 5.2 m (17 ft) over farm land or over secondary roads. In Alberta and Manitoba, the neutral ground wire may be as low as 4.8 m (16 ft) over farm land. In all three provinces, power lines in farmyards may be as low as 4.6 m (15 ft).

Transport height of the 12.6 m (41.3 ft) wide test machine was 5.2 m (17 ft) which is high enough to contact many prairie power lines. The legal responsibility for safe passage under utility lines rests with the machinery operator and not with the power utility or the 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 5.5 m (18 ft) wide in transport position, necessitating caution when transporting. A slow moving vehicle sign was provided.

Locks for the wings and depth control were provided for safe transport. Danger areas should be avoided when climbing on the machine to install these locks.

The test machine could be safely hitched to a tractor by one person by inserting a screw driver into the tube provided under the hitch clevis.

The four tires supporting the main frame were adequately sized for transporting the cultivator with mounted harrows, at speeds up to 32 km/h (20 mph).

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'S MANUAL

The operator's manual supplied instructions on set up, operation, maintenance, and safety. It was well written and clearly illustrated.

DURABILITY RESULTS

TABLE 4 outlines the mechanical history of the CI 279 during 131 hours of field operation while tilling about 1314 ha (3285 ac). The intent of the test was evaluation of functional performance. The following mechanical problems represent those which occurred during functional testing. An extended durability evaluation was not conducted.

TABLE 4. Mechanical History

ITEM	OPERATING HOURS	EQUIVALENT FIELD AREA (ha)
Shank and Holder:		
Two spring guides were bent and replaced at	28	311
Eight shanks were bent while tripping over rocks at	67, 81, 84, 91	722, 856, 883, 944
Twelve sweeps broke while tripping over rocks and were replaced at	73, 81, 84	775, 856, 883
Depth Control System:		
Centre section wheels rubbed against the frame		during the test
Pivot mounting bolts on the wing depth control wheel loosened and were retightened at	71	763
The depth control adjustment clamp failed at	47	518
Miscellaneous:		
A wing lift hydraulic cylinder began-leaking at	98	1021
One harrow adjustment arm bent at	34	375
Adjustment lever welds on six harrows failed at	124	1251

DISCUSSION OF MECHANICAL HISTORY

SHANK AND HOLDER

Spring Guides: Two spring guides were bent when they hit the wing frames while tripping over rocks. The cultivator was being operated with the wings in transport position.

Shanks: Eight shanks were bent while working in very stony conditions, when large rocks were brought to the surface.

Sweeps: Twelve sweeps broke across the lower bolt hole while tripping over rocks. Since the sweeps were very worn, these failures do not represent a serious problem.

DEPTH CONTROL SYSTEM

Wheels: The centre section wheels would rub against the frame when they encountered large rocks on the field surface. Modifications to eliminate frame interference are recommended.

Wheel Pivot Mounting Bolts: The wing wheel pivot moved out of the wheel pivot bearings when the mounting bolts came loose. No serious damage occurred.

Depth Control Stop Clamp: A retainer on the depth control stop clamp failed making it necessary to use two wrenches instead of one to set the depth.

MISCELLANEOUS

Hydraulic Cylinder: The outer seal on a hydraulic wing lift cylinder began to leak. The leak was caused by improper installation of the oil seal backup ring during assembly.

Mounted Harrows: A harrow adjustment arm (FIGURE 10) bent when the harrows were operated in the most vertical position. The adjustment lever welds on the six harrows failed during testing. Modifications to prevent adjustment lever bending and weld failures are recommended.

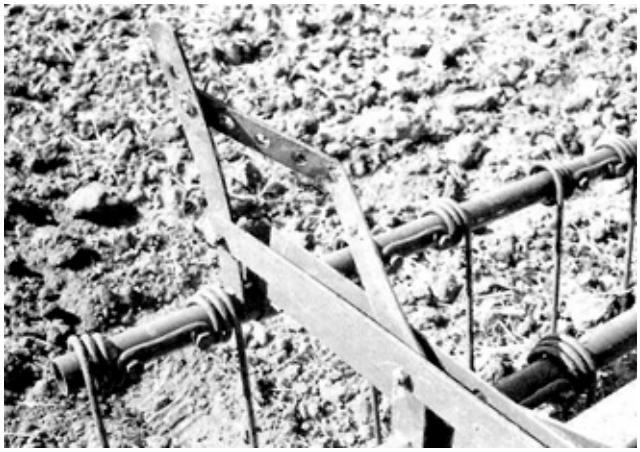

FIGURE 10. Bent Harrow Adjustment Arm.

APPENDIX I

SPECIFICATIONS

MAKE: Co-op Implements Field Cultivator
MODEL: 279
SERIAL NUMBER: 22636
MANUFACTURER: Co-op Implements
770 Pandora Avenu.e East
Winnipeg, Manitoba
R2C 3N1

	FIELD POSITION	TRANSPORT POSITION
DIMENSIONS:		
-- width	12,650 mm	480 mm
-- length - with mounted harrows	7320 mm	7320 mm
-- height - with mounted harrows	1950 mm	5230 mm
-- maximum ground clearance	250 mm	250 mm
-- wheel tread	11,360 mm	3200mm
SHANKS:		
-- number	63	
-- lateral spacing	200 mm	
-- trash clearance (frame to sweep tip)	620 mm	
-- number of shank rows		
-- centre section	4	
-- wings	3	
-- distance between rows	Centre Section	Wing Section
-- first to second	735 mm	960 mm
-- second to third	845 mm	725 mm
-- third to fourth	635 mm	
-- shank cross section	14 x 45 mm	
-- shank stem angle	47°	
-- sweep hole spacing	45 mm	
-- sweep bolt size	3/8 x 1-1/4 in	

HITCH:	
-- vertical adjustment range	242 mm
DEPTH CONTROL:	hydraulic
FRAME:	
-- centre section	75 mm, square tubing, 8 mm thick
-- wings	75 mm, square tubing, 6 mm thick
TIRES:	
-- centre section	4, 9.5L x 15, 6 ply
-- wings	4, 7.60 x 15, 4 ply
NUMBER OF LUBRICATION POINTS:	
	-- 12 grease fittings, daily service
	-- 8 wheel bearings, yearly service
	-- 2 axle bearings, yearly service
HYDRAULIC CYLINDERS:	
-- depth control	1,108 x 203 mm
	1,102 x 203 mm
	1, 95 x 203 mm
	1, 89 x 203 mm
-- wing lift	2, 102 x 711 mm

		FIELD POSITION	TRANSPORT POSITION
WEIGHTS:			
(Without Harrows)			
-- right wheel		555 kg	
-- right centre wheels		965 kg	1515 kg
-- left centre wheels		940 kg	1520 kg
-- left wheel		545 kg	
-- hitch		305 kg	275 kg
	TOTAL	3310 kg	3310 kg

		FIELD POSITION	TRANSPORT POSITION
WEIGHTS:			
(With Mounted Harrows)			
-- rightwheel		670 kg	
-- right centre wheels		1225 kg	1865 kg
-- left centre wheels		1230 kg	1875 kg
-- left wheel		665 kg	
-- hitch		30 kg	80 kg
	TOTAL	3820 kg	3820 kg

OPTIONAL EQUIPMENT:
-- 9 width options from 9.4 to 12.6 m with 200 mm shank spacing
-- 6 width options from 9.3 to 12.3 m with 250 mm shank spacings
-- mounted finishing harrows

APPENDIX II

MACHINE RATINGS

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

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

APPENDIX III

CONVERSION TABLE

1 hectare (ha)	= 2.5 acre (ac)
1 kilometre/hour (km/h)	= 0.6 miles/hour (mph)
1 millimetre (mm)	= 0.04 inches (in)
1 metre (m)	= 3.3 feet (ft)
1 kilowatt (kW)	= 1.3 horsepower (hp)
1 kilogram (kg)	= 2.2 pounds mass (lb)
1 kilonewton (kN)	= 220 pounds force (lb)
1 kilonewton/metre (kN/m)	= 70 pounds force/foot (lb/ft)

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