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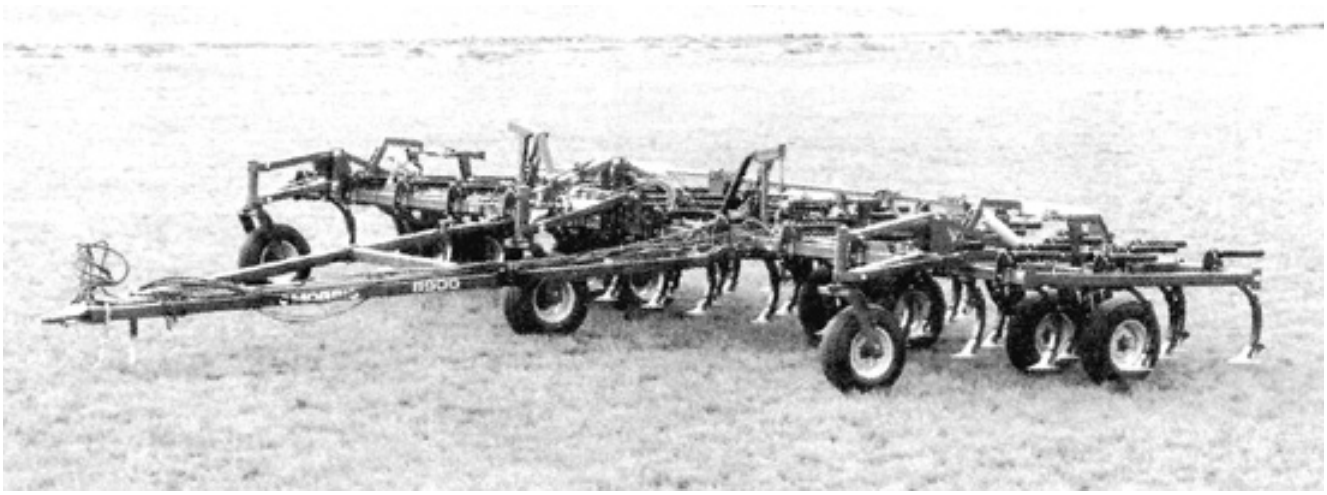

Morris 8900 Floating Hitch Cultivator

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

MORRIS 8900 FLOATING HITCH CULTIVATOR

MANUFACTURER AND DISTRIBUTOR:

Morris Industries Ltd.
85 York Road
Yorkton, Saskatchewan
S3N 2X2
Phone: (306) 783-8585

RETAIL PRICE: $32,872.00 [June 22, 1992, f.o.b. Lethbridge, Alberta, 37 ft (11.3 m) wide machine complete with 49 regular duty shanks spaced at 9 in (229 mm), set-up not included].

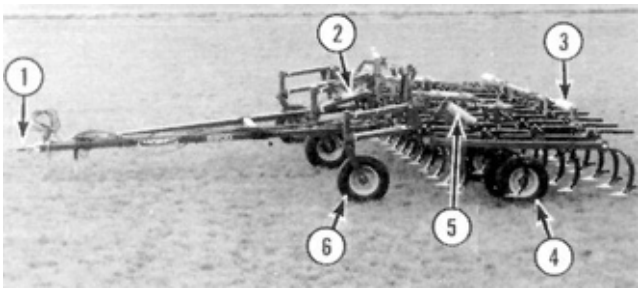

FIGURE 1. Morris 8900 Floating Hitch Cultivator: (1) Floating Hitch, (2) Flow Divider Cylinders, (3) Wing Lift Cylinders, (4) Dual Axle Wheel Set, (5) Depth Cylinders, and (6) Gauge Wheels.

SUMMARY

QUAUTY OF WORK

The Morris 8900 floating hitch cultivator was suitable for primary and secondary tillage. Penetration was very good with 12 in (305 mm) sweeps. Uneven penetration occurred in dry, hard primary tillage. Depth uniformity was very good in secondary and moist primary tillage. Uniformity was reduced when working in dry, hard primary soil or in sharply rolling terrain. Laboratory and field testing of the regular duty shank assembly showed the shank would maintain uniform tillage depth in both primary and secondary field conditions.

The maximum lift height of the shank assembly was 10 in (254 ram) when equipped with 12 in (305 mm) sweeps. The lift height provided very good stone protection.

The 27 in (686 mm) sweep-to-frame clearance and 9 in (229 mm) shank spacing allowed for very good trash clearance. In moist primary tillage the surface was left level with the majority of the straw on the surface. Soil ridging occurred in secondary tillage with heavy trash coverage.

The Morris 8900 was stable and did not skew sideways in typical field conditions. The symmetrical sweep pattern required skewing greater than 2 degrees before tillage misses occurred.

EASE OF OPERATION AND ADJUSTMENT

Maintenance of the cultivator was very good with easy access to all lubrication points. One person could replace the 49 sweeps in 3.5 hours. The two wing cultivator sweeps adjacent to the outside main frame wheels were trimmed to prevent tire damage. Ease of hitching was good. The hitch jack required the use of a block when hitching.

Transporting the 8900 cultivator was very good. The cultivator was placed into transport position in five minutes. Ease of levelling the frame was good. The control rods and gauge wheel adjustment rods on the wing frame were difficult to adjust. The floating hitch eliminated the need to level the hitch.

Ease of setting the tiliage depth was very good. A depth control rod plunger engaged the depth stop valves at the cotrect depth.

POWER REOUIREMENTS

In secondary tillage at a 3 in (75 mm) depth and a 5 mph (8 km/h) speed, a tractor with 159 PTO hp (119 kW) was required. At the same depth and speed in primary tillage, a 178 PTO hp (133 kW) tractor was required.

OPERATOR SAFETY

Operation of the Morris 8900 floating hitch cultivator was safe provided normal safety procedures were observed. A slow moving vehicle sign, safety reflectors and hitch safety chain were provided as standard equipment. Pressure relief check valves were located in the wing lift and depth control hydraulic systems.

OPERATOR'S MANUAL

The operator's manual was very good, containing useful information on safety, specifications, operation, maintenance and trouble shooting. No assembly or parts list manuals were included.

MECHANICAL HISTORY

No mechanical problems were encountered during the test.

RECOMMENDATIONS

The AFMRC recommends that the manufacturer consider:

1. Providing a longer hitch jack.
2. Improving access to the double nuts on the wing frame control rod assembly to allow for easier setting of the rod.
3. Improving access to the adjustment rod interior nuts to allow for easier setting of the rod length.

Manager: R.R Atkins

Project Engineer: L.W. Papworth
Field Technologist: G.A. Magyar

THE MANUFACTURER STATES THAT:

With regards to recommendation number:

1. This recommendation has been implemented.
2. This recommendation will be considered for future machines.
3. This recommendation has been implemented.

GENERAL DESCRIPTION

The Morris 8900 is a trailing, floating hitch cultivator suitable for primary and secondary tillage operations. The cultivator is available in three section units with widths ranging from 25 to 41 ft (7.6 to 12.5 m) and five section units with widths ranging from 43 to 59 ft (13.1 to 18.0 m). A shank spacing of 9 or 12 in (229 or 305 mm) is available. The 9 in (229 mm) shank spacing comes in a four row frame while the 12 in (305 mm) shank spacing is available in a three or four row frame.

The centre frame is supported by two dual axle wheel sets and one gauge wheel. Each wing frame is supported by one castering gauge wheel and either a single or dual axle wheel set. Hydraulic cylinders connected in series, control the tillage depth. Tillage depth is set by adjusting the depth control rod length. Adjustment of the main and wing frame control rods and each gauge wheel adjustment rod level the cultivator.

Hydraulic cylinders connected in parallel fold the wings into transport position. A tractor with dual remote hydraulic controls is needed to operate the Morris 8900 floating hitch cultivator.

The test machine was a three section 37 ft (11.3 m) wide model with a 13.6 ft (4.1 m) main frame and two 11.7 ft (3.6 m) wing frames. The unit was equipped with 49 shanks spaced at a 9 in (229 mm) interval. The wing frames were equipped with dual axle wheel sets.

An optional ground driven hex-rod was attached. FIGURE 1 shows the location of major components while detailed specifications are given in Appendix I.

SCOPE OF TEST

The Morris 8900 floating hitch cultivator was operated in the conditions shown in TABLE 1 for 160 hours while cultivating 3450 ac (1397 ha). The cultivator was evaluated for quality of work, ease of operation and adjustment, power requirements, operator safety and suitability of the operator's manual.

The machine evaluated by the Alberta Farm Machinery Research Centre (AFMRC) was configured as described in the General Description, FIGURE 1 and the Specifications section in Appendix I of this report. The manufacturer may have built different configurations of this machine before and after AFMRC tests. Therefore, when using this report, be sure to first check that the machine under consideration is the same as the one reported here. If differences exist, assistance can be obtained from AFMRC or the manufacturer to determine changes in performance.

TABLE 1. Operating Conditions.

FIELD CONDITIONS	HOURS	FIELD AREA ac (ha)	
Operation:			
—Primary	60.0	1300	(526)
—Secondary	100.0	2150	(871)
TOTAL	**160.0**	**3450**	**(1397)**
Soil Type:			
—Loam	23.5	500	(202)
—Silt Loam	102.0	2200	(891)
—Sandy Loam	14.5	320	(130)
—Sandy Clay Loam	20.0	430	(174)
TOTAL	**160.0**	**3450**	**(1397)**
Stony Phase:			
—Stone Free	62.0	1330	(539)
—Occasional Stones	70.0	1500	(607)
—Moderately Stony	28.0	620	(251)
TOTAL	**160.0**	**3450**	**(1397)**

RESULTS AND DISCUSSION

QUALITY OF WORK

Penetration: Penetrating ability of the Morris 8900 floating hitch cultivator equipped with 12 in (305 mm) sweeps was very good. Uneven penetration resulted when working in dry, hard primary tillage.

Uniform penetration across the width of the cultivator required proper setting of the gauge wheels and the main and wing frame dual axle wheel sets. The wing gauge wheels minimized twisting of the wing frames. The floating hitch and wings enabled the cultivator to maintain penetration when working in gently to moderately rolling field conditions.

Maintaining uniform penetration required checking and making appropriate cultivator adjustments when changing fields.

Depth Uniformity: Depth uniformity of the Morris 8900 floating hitch cultivator was very good in secondary and moist primary tillage. Depth uniformity was reduced when working in dry, hard primary tillage. Tillage depth was very uniform in level and gently rolling terrain provided all adjustment and control rods were properly set. There was depth variation in sharply rolling terrain such as when crossing gullies or sharp hill crests.

The sweep pattern allowed for sufficient overlap without running the outside wheel on cultivated soil. Running all wheels on untilled soil helped maintain uniform tillage depth.

Flexibility of the cultivator frame and shank characteristics (FIGURE 2) determine depth uniformity of the sweeps. Width of the centre and wing frames and how they are linked together determine how well the unit follows the contours of the field. Shank stiffness and cushion spring preload determine the sweep pitch over a varying range of tillage forces. Excessive sweep pitch can result in furrow bottom ridging, rapid sweep tip wear and increased draft. A shank should maintain a low, relatively constant sweep pitch over the normal range of tillage forces. AFMRC has selected 7 degrees as a maximum operating sweep pitch that will produce an acceptable furrow bottom for most operations. The sweep pitch during operation can be determined by the sweep pitch characteristics of the shank assembly and the soil forces encountered by the sweep.

The sweep pitch characteristics of the Morris regular duty trip shank are shown in FIGURE 3. The no-load sweep pitch was 2 degrees. The lower portion of the line shows that as force is applied to the sweep, the pitch increases due to shank flexing. At a horizontal force of 750 lb (3.3 kN) the shank began to trip as the spring-trip preload was overcome. The point on the curve where the sweep pitch exceeded 7 degrees was at 550 lb (2.4 kN). The curve above the 7 degree line showed the shank force decreased as the shank tripped over an obstacle.

The forces encountered by soil tools on the front row of a cultivator operating at different depths are given in Appendix II. The Morris 8900 shank force at the 7 degree sweep pitch was greater than all shown soil forces. The 12 in (305 mm) sweeps would maintain uniform tillage or seed depth while operating in primary or secondary tillage. The Morris 8900 cultivator would also maintain 16 in (406 mm) sweeps, 2 in (51 mm) spikes and banding knives at uniform tillage or seeding depths.

The 750 lb (3.3 kN) shank trip force minimized assembly wear as there was no partial tripping or continuous movement of the shank assemblies.

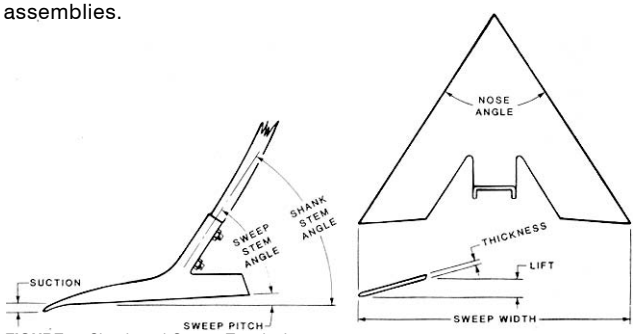

FIGURE 2. Shank and Sweep Terminology.

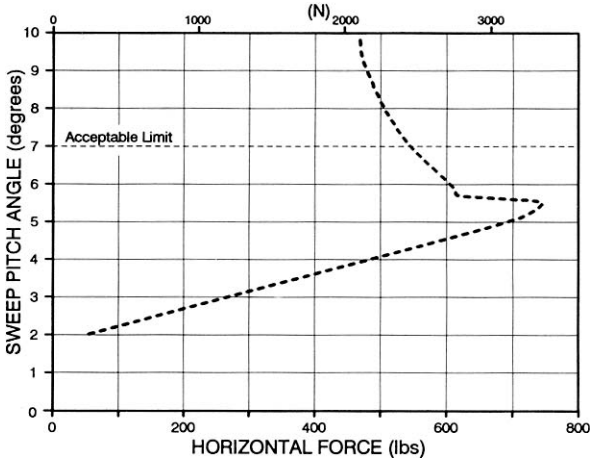

FIGURE 3. Sweep Pitch for Morris 8900 Shank.

Stone Protection: Stone protection was very good. The lifting pattern for the regular duty trip shank is shown in FIGURE 4. The maximum lift height of the Morris 8900 shank assembly was 10 in (254 mm) when equipped with 12 in (305 mm) McKay sweeps. There was no shank damage during the test period.

Trash Clearance: The Morris 8900 floating hitch cultivator was very good in clearing large amounts of trash. The four row, 27 in (686 mm) sweep-to-frame clearance and 9 in (229 mm) shank spacing allowed large amounts of trash to clear the cultivator.

Soil Surface: When working in moist primary soil conditions, the Morris 8900 left a level soil surface with the majority of the straw left on the surface. Working in dry soil conditions the soil surface was left lumpy with most of the straw buried. Working in secondary soil conditions with light to moderate trash coverage, there was minimal soil ridging with the majority of the trash left on the soil surface. When working in heavy secondary trash conditions, trash would wrap around

the cultivator shanks causing soil ridging. Lumps of trash were also left on the soil surface.

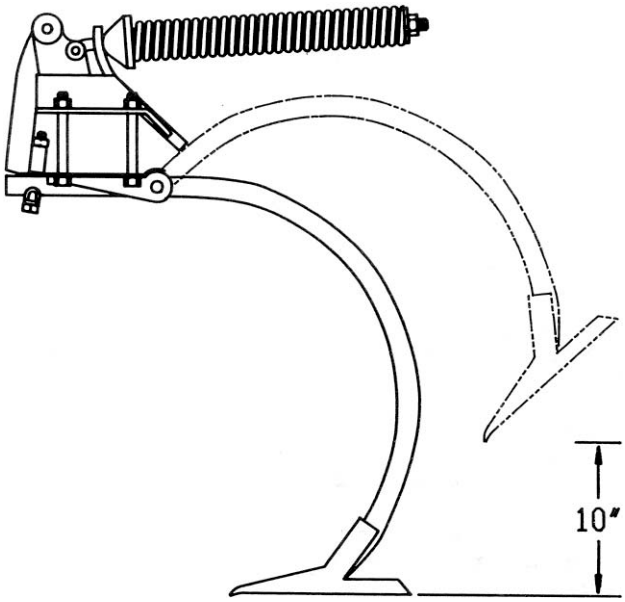

FIGURE 4. Morris 8900 Regular Duty Shank Mechanism.

Skewing and Stability: The Morris 8900 was stable and did not skew sideways in typical field conditions. Skewing occurred when working in dry, hard primary soil conditions and in hilly terrain. The sweep pattern (FIGURE 5) was symmetrical and did not impose any side forces on the cultivator during tillage. With 12 in (305 mm) sweeps the cultivator must skew more than 2 degrees before tillage misses to occur.

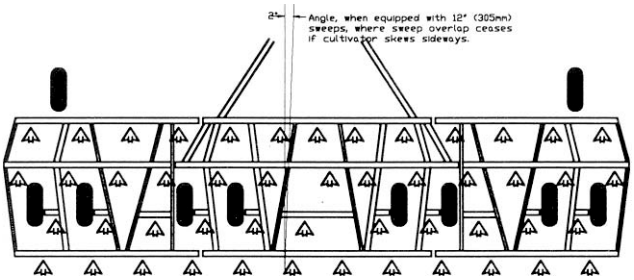

FIGURE 5. Sweep Pattern for 9 in (229 mm) Shank Spacing.

EASE OF OPERATION AND ADJUSTMENT

Maintenance: Ease of performing routine maintenance was very good. Grease fittings were provided for all wheel hubs, axle pivot bearings, lower trip rocker pins and gauge wheel bushings. The wheel hubs and axle pivot bearings were greased every 10 hours. The lower trip rocker pins were greased every 50 hours and the gauge wheel bushings every 100 hours. The manufacturer recommended the shank trip adjustment be checked after 40 hours. A detailed maintenance schedule was provided.

The manufacturer specified trimming the sweeps on the wing frame adjacent to the outside main frame wheels which prevented wheel damage. One person could replace the 49 sweeps in 3.5 hours. The replacement of one shank assembly required 10 minutes.

Hitching: Ease of hitching to the Morris 8900 cultivator was good. The hitch jack and solid hitch link made one man hitching easy. The hitch jack required the use of a block when hitching to the test tractor. AFMRC recommends the manufacturer consider providing a longer hitch jack.

Hitching required the connection of the safety chain. Hitch weight was positive in transport and field position.

Transporting: Ease of transporting the Morris 8900 cultivator was very good. The cultivator was placed into transport position (FIGURE 6) in 5 minutes. The wings were secured in transport position with locks situated near the front of the cultivator. The main frame was secured by transport lock brackets on the frame depth cylinders. A lock was provided to secure the flow divider cylinders on the main gauge wheel. The gauge wheel was also pinned to prevent castering.

Transport width of the test machine was 20.9 ft (6.4 m), while transport height was 14.8 ft (4.5 m). Care was needed when transporting on public roads, through gates, over bridges and beneath power lines.

Sufficient clearance between the tractor rear tires and the cultivator allowed for sharp turns in both field and transport position.

The 8900 cultivator towed well without sway or bounce at a tractor speed of 20 mph (32 km/h). A sweep-to-ground clearance of 8.25 in (210 mm) provided for safe ground clearance.

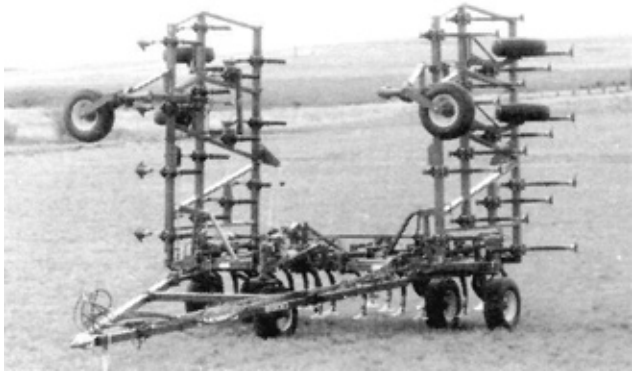

FIGURE 6. Transport Position.

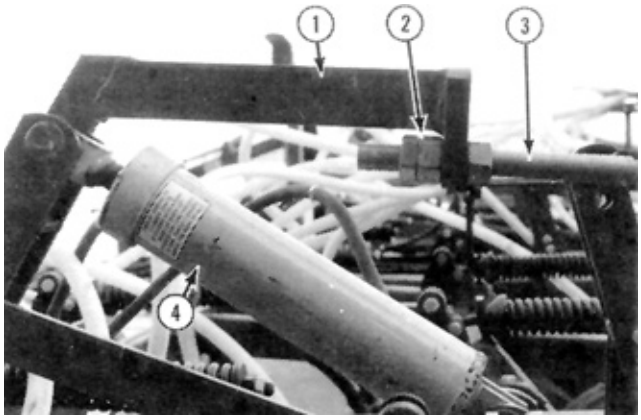

FIGURE 7. Wing Frame Control Rod: (1) Control Rod, (2) Locking Nuts, (3) Depth Cylinder and (4) Rod Bracket.

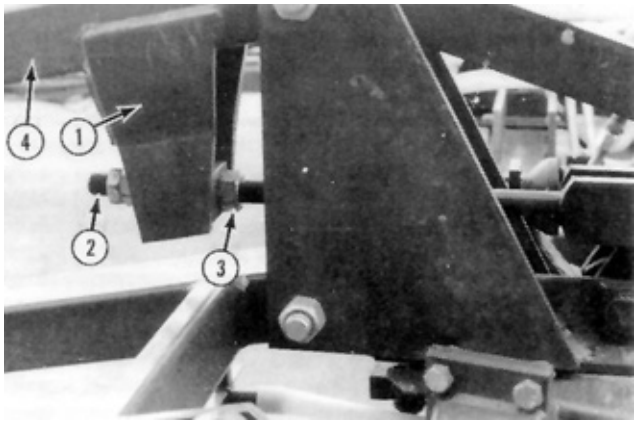

FIGURE 8. Wing Gauge Wheel Adjustment Rod: (1) Rod Bracket, (2) Adjusting Rod, (3) Interior Nut and (4) Gauge Wheel Arm.

Frame Levelling: Ease of levelling the frame was good. Initial level settings were supplied for the control and adjustment rods. Final adjustments were done in the field. The spring rod adjustment was set to 2 in (51 mm). The main frame control rods were adjusted to level the frame. The wing frame control rod adjusted lateral levelling of the wing. The wing frame gauge wheel adjustment rod levelled the wing front to back. Narrow clearance between the double nuts on the wing frame control rod (FIGURE 7) and rod bracket made rod adjustment difficult. AFMRC recommends the manufacturer

consider improving access to the double nuts on the wing frame control rod assembly to allow for easier setting of the rod. Interference from the adjustment rod bracket on the wing frame gauge wheel (FIGURE 8) made access to the adjustment rod interior nuts difficult. AFMRC recommends the manufacturer consider improving access to the adjustment rod interior nuts to allow for easier setting of the rod.

The floating hitch eliminated the need to adjust hitch height.

Depth Adjustment: Ease of setting tillage depth was very good. Tillage depth was controlled by six hydraulic cylinders connected in series. Two hydraulic cylinders (flow divider cylinders) were located on the main frame gauge wheel, with one cylinder on each main and wing frame axle. The depth adjustment system (FIGURE 9) was located by the left main frame axle. The depth control rod plunger engaged the depth stop valves at the correct depth.

The depth control cylinders were rephased by maintaining hydraulic pressure for four seconds with the cultivator in a raised position. Keeping the cylinders phased helped maintain uniform tillage depth.

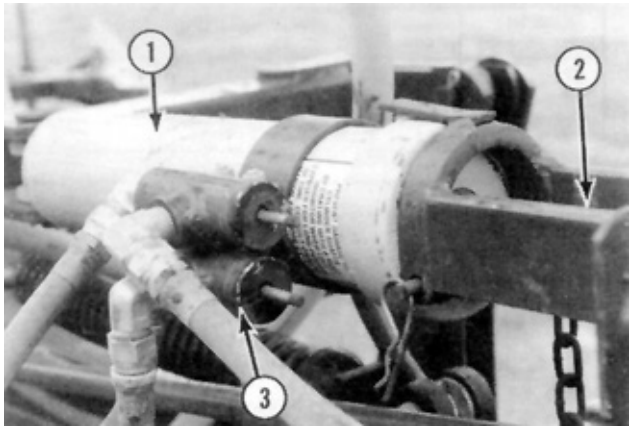

FIGURE 9. Depth Control Components: (1) Depth Control Cylinder, (2) Plunger and (3) Depth Stop Valves.

POWER REQUIREMENTS

AFMRC has measured power requirements on several cultivators in various field conditions as explained in Appendix II1. From these field measurements, average power requirements have been determined to assist farmers in matching tractor and cultivator sizes. The tractor sizes (TABLE 2) have been adjusted to include tractive efficiency and represent a tractor operating at 80 per cent of maximum power take-off rating.

In typical secondary tillage conditions at a speed of 5 mph (8 km/h) and a depth of 3 in (75 mm), average cultivator PTO power requirements were 4.3 hp/ft (10.5 kW/m) (Appendix III). In typical primary tillage conditions at the same speed and depth, average PTO power requirements were 4.8 hp/ft (11.7 kW/m). Tractor PTO horsepower recommended to pull a 37 ft (11.3 m) Morris 8900 floating hitch cultivator would be 159 hp (119 kW) in secondary conditions and 178 hp (133 kW) in primary conditions. Additional power will be required when tilling deeper or working in hilly terrain.

TABLE 2. Tractor Size: PTO Power [hp (kW)] Required to Operate a Typical 37 ft (11.3 m) Floating Hitch Cultivator.

OPERATION	DEPTH		SPEED — MPH (km/h)			
	in	(mm)	5.0	(8.0)	6.0	(9.7)
Primary	2.0	(50)	126	(94)	152	(113)
	3.0	(75)	178	(133)	215	(160)
	4.0	(100)	226	(169)	274	(204)
Secondary	2.0	(75)	111	(83)	133	(99)
	3.0	(75)	159	(119)	192	(143)
	4.0	(100)	207	(154)	252	(188)

OPERATOR SAFETY

The Morris 8900 floating hitch cultivator was 20.9 ft (6.4 m) wide in transport, which necessitated caution when towing on public roads, over bridges, through gates and under power lines. A slow moving vehicle sign, safety reflectors and hitch safety chain were provided as standard equipment.

The test machine hydraulic wing lift and depth control systems were equipped with a pressure relief check valve. The check valves allowed oil to flow back to the tractor when the transport or wing lift pins were not removed before lowering the machine or wings.

Caution was required when servicing the shank mechanism for access to the lower trip rocker pins required climbing onto or crawling underneath the cultivator.

The centre section tires did not exceed The Tire and Rim Association's maximum load rating in transport position.

OPERATOR'S MANUAL

The operator's manual was very good. The manual for the Morris 8900 floating hitch cultivator contained useful information on safety, specifications, operation, maintenance and trouble shooting. No assembly or parts list manuals were included.

MECHANICAL HISTORY

No mechanical problems were encountered during 160 hours of field operation. The intent of the test was evaluation of functional performance. An extended durability evaluation was not conducted.

APPENDIX I

SPECIFICATIONS

MAKE:	Morris	
MODEL:	8900 Floating Hitch Cultivator	
SERIAL NUMBER:	9081	
MANUFACTURER:	Morris Industries Ltd. 85 York Road Yorkton, Saskatchewan S3N 2X2 Phone: (306) 783-8585	
DIMENSIONS OF SINGLE UNIT:	**FIELD POSITION**	**TRANSPORT POSITION**
--width	37.6 ft (11.5 m)	20.9 ft (6.4 m)
--length	28.7 ft (8.7m)	28.7 ft (8.7 m)
--height	6.0 ft (1.8 m)	14.8 ft (4.5 m)
--maximum ground clearance	8.25 in	(210 mm)
--maximum wheel tread	33.5 ft (10.2 m)	15.6 ft (4.8m)
SHANKS:		
--number	49	
--lateral spacing	9 in (229 mm)	
--trash clearance	27 in (686 mm)	
--number of shank rows		
--centre	4	
--wings	4	
--distance between rows	32 in (813 mm), 34.5 in (876 mm), 29.75 in (756 mm)	
--cross section	1.25 x 2.0 in (32 x 51 mm)	
--stem angle	52 degrees	
--sweep hole spacing	2.25 in (57 mm)	
--sweep bolt size	0.5 in (13 mm)	
HITCH:		
--floating	eliminates hitch height adjustment	
DEPTH CONTROL:	Series Hydraulic, Double Depth Stop Valve located at left Main Frame Cylinder	
FRAME:		
--main cross section	4 x 4 in (102 x 102 mm)	
--wing cross section	4 x 4 in (102 x 102 mm)	
TIRES:		
--centre section	4 - 11 x 15LT, 6 Ply	
--wing sections	4 - 9.5L x 15, 6 Ply	
--centre gauge wheel	1 - 12.5L x 15, 8 Ply	
--wing gauge wheels	2 - 9.5L x 15, 6 Ply	

NUMBER OF LUBRICATION POINTS:	49 on Shanks, 16 on Main and Wing Frame Dual Axles, 7 on each Wing Caster Wheel, and 8 on Centre Caster Wheel		
HYDRAULIC CYLINDERS:			
--flow divider	2 - 4 x 12 in (102 x 305 mm)		
--depth control	4 - 3.5 x 12 in (89 x 305 mm)		
--wing lift	2 - 5 x 28 in (127 x 711 mm)		
WEIGHTS:	**FIELD POSITION**	**TRANSPORT POSITION**	
--hitch	230 lb (104 kg)	230 lb (104 kg)	
--right gauge wheel	950 lb (431 kg)		
--right wing axle	1700 lb (771 kg)		
--right centre axle	3100 lb (1407 kg)	5100 lb (2314 kg)	
--centre gauge wheel	1600 lb (726 kg)	2880 lb (1307 kg)	
--left centre axle	3200 lb (1452 kg)	5100 lb (2314 kg)	
--left wing axle	1700 lb (771 kg)		
--left gauge wheel	830 lb (377 kg)		
TOTAL	13,310 lb (6039 kg)	13,310 lb (6039 kg)	
OTHER AVAILABLE OPTIONS:	three section units with widths ranging from 25 to 41 ft (7.6 to 12.5 m)		
	five section units with widths ranging from 43 to 59 ft (13.1 to 18.0 m)		
	shank spacing of 9 or 12 in (229 or 305 mm), 1250 lb (5.6 kN) heavy duty trip shank, 3 or 4 row on 12 in (304 mm) shank spacing		

APPENDIX II

SOIL FORCES TABLE

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. 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 seven degree sweep pitch.

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

DEPTH in (mm)	SWEEPS			SPIKE 2 in (50 mm) lb (kN)	BANDING KNIFE 1 in (25 mm) lb (kN)
	FIELD CULTIVATOR 11 in (275 mm) lb (kN)	HEAVY DUTY CULTIVATOR 12 in (305 mm) lb (kN)	HEAVY DUTY CULTIVATOR 16 in (406 mm) 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

DEPTH in (mm)	SWEEPS			SPIKE 2 in (50 mm) lb (kN)	BANDING KNIFE 1 in (25 mm) lb (kN)
	FIELD CULTIVATOR 11 in (275 mm) lb (kN)	HEAVY DUTY CULTIVATOR 12 in (305 mm) lb (kN)	HEAVY DUTY CULTIVATOR 16 in (406 mm) 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)	250 (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 various 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 per cent 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 differences between machines, AFMRC has averaged the results obtained over the years and has used these to determine tractor size requirements.

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 per cent in primary and 70 per cent in secondary tillage and represent a tractor operating at 80 per cent 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, OECD 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 37 ft (11.3 m) cultivator in those conditions, 226 PTO hp (169 kW) is recommended.

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

DEPTH		SPEED — mph (km/h)					
in	(mm)	4.0	(6.4)	5.0	(8.0)	6.0	(9.7)
2	(050)	2.7	(6.6)	3.4	(8.3)	4.1	(10.0)
3	(075)	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)					
in	(mm)	4.0	(6.4)	5.0	(8.0)	6.0	(9.7)
2	(050)	2.3	(5.6)	3.0	(8.3)	4.1	(10.0)
3	(075)	3.4	(8.3)	4.3	(11.7)	5.8	(14.2)
4	(100)	4.5	(11.0)	5.6	(13.7)	6.8	(16.6)
5	(125)	5.5	(13.5)	7.0	(17.0)	8.4	(20.6)

APPENDIX II

MACHINE RATINGS

The following rating scale is used in AFMRC Evaluation Reports:

--Excellent
--Very Good
--Good
--Fair
--Poor
--Unsatisfactory

SUMMARY CHART
MORRIS 8900 FLOATING HITCH CULTIVATOR

RETAIL PRICE:	$32,872.00 [June 22, 1992, f.o.b. Lethbridge, Alberta, 37 ft (11.3 m) wide machine complete with 49 regular duty shanks spaced at 9 in (229 mm), set-up not included].
QUALITY OF WORK:	
--Penetration:	**very good;** uneven in dry, hard primary tillage
--Depth Uniformity:	**very good;** reduced in dry, hard primary tillage
--Stone Protection:	**very good;** trip height of 10 in (254 mm)
--Trash Clearance:	**very good**
--Surface Finish:	level in moist primary soil conditions
--Skewing and Stability:	stable
EASE OF OPERATION AND ADJUSTMENT:	
--Maintenance:	**very good;** easy access to all lubrication points
--Hitching:	**good;** hitch jack required use of a block
--Transporting:	**very good;** ready for transport in five minutes
--Frame Levelling:	**good;** wing frame control rods and adjustment rods were difficult to adjust
--Depth Adjustment:	**very good;** set by adjusting depth control rod
POWER REQUIREMENTS:	
--Secondary Tillage:	159 PTO hp at 3 in (75 mm) and 5 mph (8 km/h)
--Primary Tillage:	178 PTO hp at 3 in (75 mm) and 5 mph (8 km/h)
OPERATOR SAFETY:	slow moving vehicle sign, hitch safety chain, pressure relief check valves and safety reflectors were provided
OPERATOR'S MANUAL:	**very good;** supplied instructions on safety, operation, maintenance and adjustment
MECHANICAL HISTORY:	no mechanical problems were encountered during the test

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