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Evaluation Report 650

Case IH 4900 Vibra Chisel

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

CASE IH 4900 VIBRA CHISEL

MANUFACTURER:
JI Case Company
450 Sherman Avenue
Hamilton, Ontario
L8N 4C4

DISTRIBUTOR:
JI Case Company
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Regina, Saskatchewan
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RETAIL PRICE:
$27,150.00 [February, 1991, f.o.b. Humboldt, Saskatchewan, 44.8 ft (13.7 m)width, with optional mounted harrows].

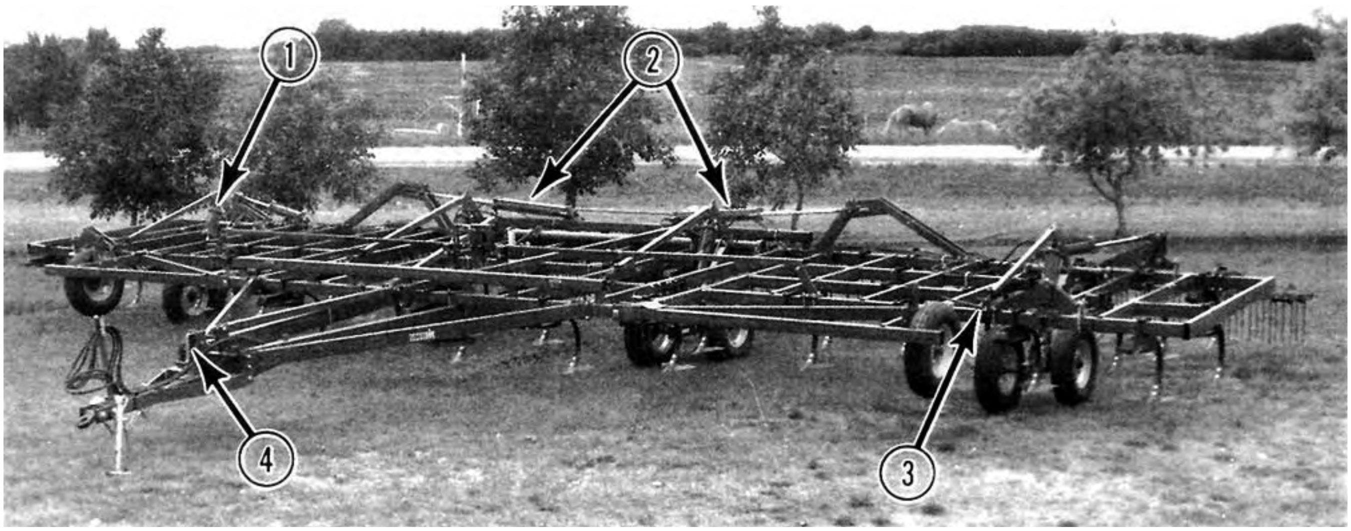

FIGURE 1. Case IH 4900 Vibra Chisel: (1) Depth Control Cylinders, (2) Wing Lift Cylinders, (3) Depth Control Cranks, (4) Fore-and-Aft Leveling Crank.

SUMMARY AND CONCLUSIONS

Quality of work: The Case IH 4900 was suitable for light primary and secondary tillage. Penetration was good with the 14 in (356 mm) sweeps. However, the cultivator did not penetrate well in hard or very dry primary tillage. Depth uniformity was good. Depth was very uniform in level terrain but varied in sharply rolling terrain. Furrow bottom ridging was excessive in heavy primary tillage with the 14 in (356 mm) sweeps. Narrower sweeps or chisel points should be used in hard or dry primary tillage conditions.

The maximum lift height of the shanks was 13 in (330 mm). This provided good stone protection; however, while tripping, several sweeps contacted the cultivator frame and wheels.

Trash clearance was good, and plugging only occurred at wheel locations in very heavy damp trash or weeds. The mounted harrows would fill with trash in moderate conditions. Surface finish was good in light trash.

The sweep pattern was symmetrical and skewing was not a problem on level ground. Like all cultivators, skewing occurred on steep hillsides resulting in weed misses. Weed kill was good when the mounted harrows were used in light trash.

Ease of Operation and Adjustment: Ease of hitching to the Case IH 4900 was very good. Hitch weight was positive in field and transport position. Ease of transport was good. It took less than 5 minutes, but installing the depth control transport locks required climbing on the cultivator frame. The locks for the wings in transport position were controlled from the tractor cab. Maneuverability was excellent. The hitch frame did not contact the tractor rear wheels in sharp turns.

Ease of setting tillage depth was very good. It took less than 5 minutes; however, the hand cranks for the wing wheel depth adjustment would rotate while transporting. Ease of leveling the frame was very good. Lateral and fore-and-aft leveling was easily accomplished with the hand cranks provided. Ease of adjusting the harrows was poor. No tine angle adjustment was provided. The harrow sections were very heavy and required a jack for lifting.

Ease of service and maintenance was very good. Clear instructions were provided. Sweeps were easily removed as there was no thread damage on the bolts. The shank mechanism had to be removed from the frame to replace a bent shank.

Power Requirements: In secondary tillage at a 3 in (75 mm) depth, and at 5 mph (8 km/h), a tractor with 192 hp (143 kW) is required. At the same depth and speed in primary tillage, a 215 hp (160 kW) tractor is required.

Operator Safety: The Case IH 4900 required caution in transport. Transport locks, hitch safety chain, and a bracket for a slow moving vehicle sign were provided. The main frame tires were overloaded in transport with the added weight of the mounted harrows.

Operator's Manual: The operator's manuals were very good. Separate manuals were provided for the cultivator and tine harrows. The manuals very simply supplied the required instructions.

Mechanical History: Only minor mechanical problems occurred during testing. However, shanks were relocated on the frame to provide better clearance at wheel locations before the start of the test.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Providing shanks that flex less under load to maintain a lower sweep pitch angle.
2. Modifying the mounted harrows so the tine angle can be adjusted for better trash clearance.
3. Providing more clearance between the mounted harrows at the hinge locations.
4. Providing transport locks for the main frame wheels that are easier to access.
5. Providing a lock system for the hand cranks of the depth adjustment.

6. Improving quality control on the wing transport locks.
7. Sizing the main frame tires in accordance to the Tire and Rim Association Guidelines.
8. Modifying the sweep pattern to improve frame and wheel clearance for the shanks.

Senior Engineer: J.D. Wassermann
Project Manager: C.A. Hanson
Project Technologist: A. R. Boyden

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. The Vibra Shanks and Vibra Chisel are for light primary and secondary tillage. Heavier shanks are available on the Case IH chisel plows. Also, Case IH has recently introduced a lower pitch cultivator sweep line.
2. A new adjustable coil tine mulcher is in production and has been available since fall, 1990. Also, the fore-and-aft distance was increased 4 in (102 mm) for additional trash clearance.
3. In connection with the new adjustable coil tine mulcher, the main frame section was increased in width, thus providing clearance at the hinge location.
4. A positive mechanical transport lockout is provided on the main frame. Future design will consider this recommendation.
5. Case IH will investigate the need of a wire bail lock on the hand cranks.
6. Recent quality improvements have been made to the wing transport locks.
7. Case IH is currently reviewing main frame tire requirements in accordance with the Tire and Rim Association Guidelines.
8. Case IH is currently reviewing the sweep pattern to improve wheel clearance for the shanks.

GENERAL DESCRIPTION

The Case IH 4900 is a trailing cultivator suitable for secondary and light primary tillage operations. It is available in seven widths ranging from 31 to 52 ft (9.4 to 15.8 m). The test machine was a 44.8 ft (13.7 m) wide model with a 15.2 ft (4.6 m) main frame, two 10.8 ft (3.3 m) primary wings, and two 4 ft (1.2 m) wing extensions.

The centre frame is supported by two tandem walking-beam wheel sets connected by a rock shaft. Each wing is supported by one tandem walking-beam wheel set and a stabilizer wheel. Four hydraulic cylinders are used to control tillage depth. Tillage depth is adjusted at each wheel set by hand cranks at the front of the machine. The test machine had a 10 in (250 mm) shank spacing. The cushion spring shanks were arranged in four rows on each wing and five rows on the main frame.

The wings fold into transport position with four hydraulic cylinders. The wing extensions fold to reduce transport height.

The test machine was equipped with optional Case IH three bar tine harrows. A tractor with dual remote hydraulic controls is required to operate the Case IH 4900 cultivator. Detailed specifications are given in APPENDIX I. FIGURE 1 shows the locations of major components.

TABLE 1. Operating Conditions.

FIELD CONDITIONS	HOURS	FIELD AREA	
		ac	ha
Operation			
- primary	64	1460	591
- secondary	47	1050	425
TOTAL	111	2510	1016
Soil Type			
- light loam	21	480	194
- loam	47	1040	421
- silty loam	28	600	243
- clay	15	390	158
TOTAL	111	2510	1016
Stony Phase			
- stone free	15	340	138
- occasional stones	34	740	300
- moderately stony	39	920	372
- very stony	23	510	206
TOTAL	111	2510	1016

SCOPE OF TEST

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

The Case IH 4900 cultivator was operated in the field conditions shown in TABLE 1 for 111 hours while cultivating 2510 ac (1016 ha). It was evaluated for quality of work, ease of operation and adjustment, power requirements, safety, and suitability of the operator's manual. The intent of this test was to evaluate functional performance. Durability tests were not conducted; however, a record of mechanical failures that occurred during the test is provided.

RESULTS AND DISCUSSION

QUALITY OF WORK

Penetration: Penetration was good with the 14 in (356 mm) sweeps.

The cultivator was able to penetrate in secondary or light primary tillage conditions.

Penetration in heavy primary tillage was not adequate with the 14 in (350 mm) sweeps. The machine's weight was not sufficient for penetration with the sweeps in hard soil. Changing to narrower sweeps or chisel points would improve penetration in these conditions.

Depth Uniformity: Depth uniformity of the Case IH 4900 cultivator was good in light primary and secondary tillage operations.

Flexibility of the cultivator is one factor that affects uniformity. The width of sections and their linkage designs determine how well the cultivator follows the contours of the field. Tillage depth was very uniform in level terrain, provided all depth stops were used and properly set. In gently rolling terrain, depth was also uniform. However, depth varied in sharply rolling terrain such as when crossing gullies or sharp hill crests.

Sweep pitch (FIGURE 2) during operating is another factor that affects depth uniformity. PAMI has selected 70 as the maximum sweep pitch that will produce an acceptable furrow bottom for most operations. Excessive sweep pitch will result in furrow bottom ridging, rapid sweep tip wear and increased draft. The sweep pitch during operation can be determined by the sweep pitch characteristics of the shank assembly (FIGURE 3) and the soil forces encountered by the sweep.

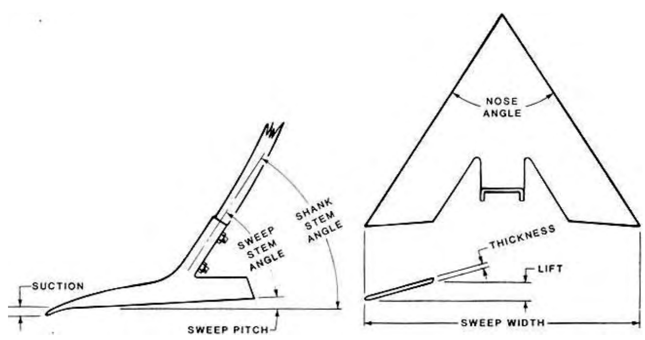

FIGURE 2. Shank and Sweep Terminology.

The no-load sweep pitch was 3°. FIGURE 3 shows that as force is applied to the sweep, the pitch increases due to shank flexing (lower sloped line). At a horizontal force of 305 lb (1.4 kN), the shank begins to trip as the spring preload is overcome. This is the point on the graph when the steep upper curve begins.

The soil forces encountered by sweeps and other soil tools on the front row of a cultivator operating in typical prairie conditions are given in APPENDIX II. This chart shows that although the sweep pitch will be relatively high, the shank assemblies would not trip in most secondary and light primary tillage. The sweep pitch when operating in secondary or light primary tillage conditions would usually exceed the recommended angle of 7° from shank flexing. These characteristics were confirmed in the field. In light primary tillage, the furrow bottom ridges (FIGURE 4) were 3/4 in (19 mm) high although no weed misses occurred. It is recommended that the manufacturer consider providing shanks that flex less under load to maintain a lower sweep pitch angle.

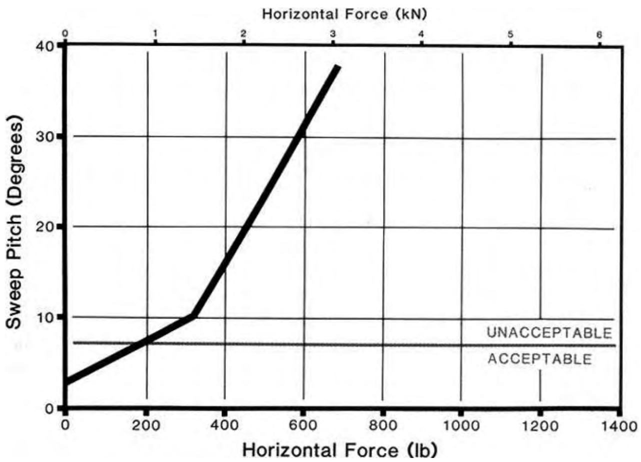

FIGURE 3. Sweep Pitch for the Case IH 4900 Vibra Chisel Shank.

For heavy primary tillage, such as a depth of 4 in (100 mm), the soil force of about 340 lb (1.5 kN) would cause some tripping of the shanks. In primary tillage, furrow bottom ridges were excessive and weed misses occurred. Changing to narrower sweeps or spikes should be considered if wanting to use this cultivator in heavy draft conditions to provide adequate penetration and to reduce shank assembly wear. Performance in other conditions with different soil tools can be determined using FIGURE 3 and APPENDIX II.

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 soil depth.

Stone Protection: Stone protection was good.

Very little damage occurred while operating in rocky conditions.

The maximum lift height of the Case IH 4900 cultivator shanks was 13 in (330 mm), when equipped with the 14 in (350 mm) sweeps (FIGURE 5). This trip height would normally prevent shank and sweep damage in fields with many large rocks. However, at several locations, the sweep wings would hit the cultivator frame while lifting over rocks. Also, one tire was punctured by a sweep that was forced sideways while clearing a rock. It is recommended that the manufacturer modify the sweep pattern to improve frame and wheel clearance for the shanks.

FIGURE 4. Furrow Bottom Ridging.

Trash Clearance: Trash clearance was good.

Large amounts of dry straw easily cleared through the shanks. However, plugging usually occurred at wheel locations in very heavy damp trash or green weeds that were encountered in low lying areas.

The mounted harrows would fill with straw in moderate trash conditions. The harrows were normally raised in primary tillage to where they only slightly touched the ground, in order to prevent leaving bunches of straw on the field surface. No tine angle adjustment was provided. Trash clearance through the harrows may have improved if the harrow tine angle could have been adjusted to a steeper angle. It is recommended that the manufacturer consider modifying the mounted harrows so tine angle can be adjusted for better trash clearance.

Surface Finish: Field surface finish was good.

In light trash conditions, the harrows were effective in distributing trash and leveling the ridges left by the cultivator for a smooth seedbed (FIGURE 6).

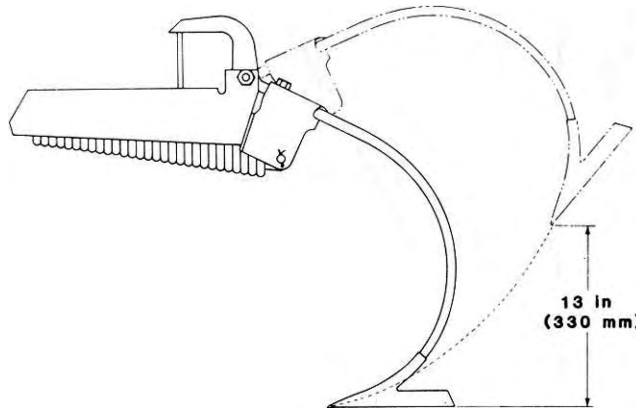

FIGURE 5. Shank Mechanism.

FIGURE 6. Typical Seedbed Preparation.

In heavy trash, the harrows left bunches on the field surface (FIGURE 7). When the harrows were raised slightly to clear the trash, the ridges left by the cultivator shanks were not completely levelled.

FIGURE 7. Typical Field Surface in Heavy Trash Conditions.

Skewing and Stability: The Case IH 4900 was stable and did not skew in typical field conditions. The sweep pattern of the Case IH 4900 (FIGURE 8) was symmetrical and did not impose side forces on the cultivator when operated on level ground. Skewing did

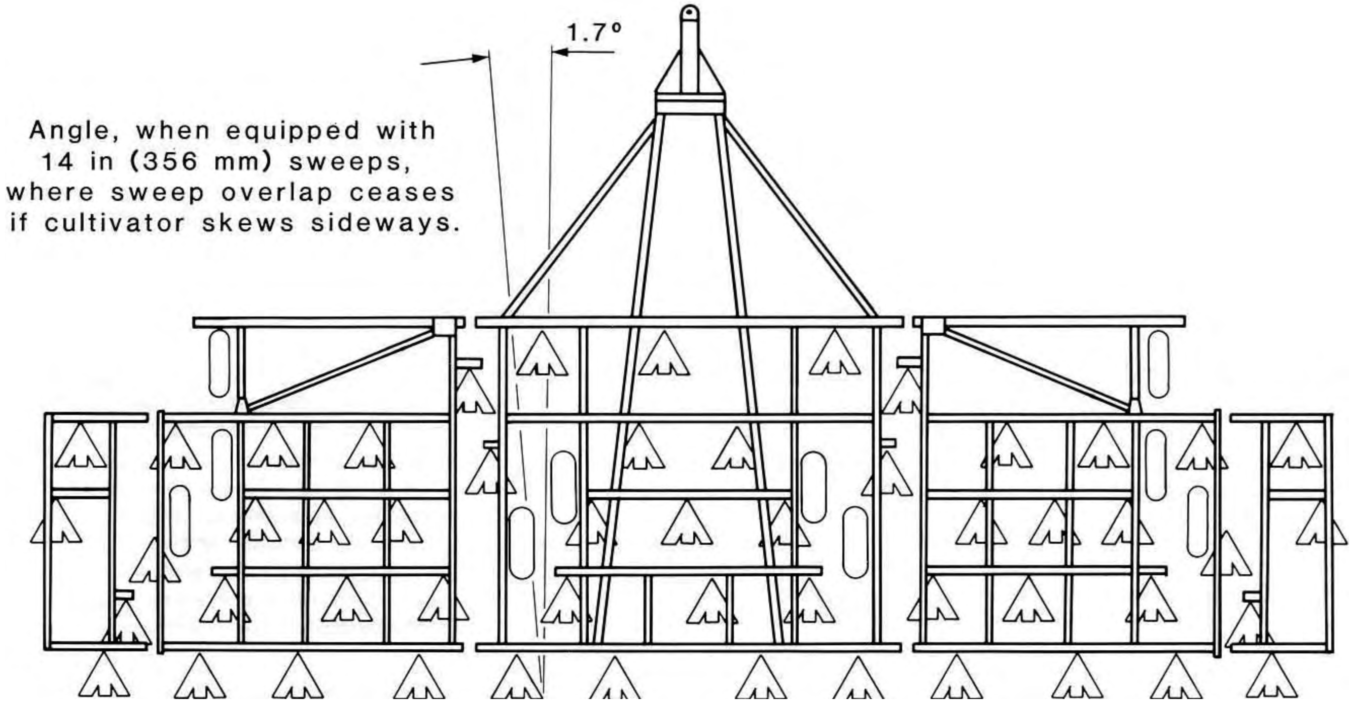

FIGURE 8. Sweep Pattern.

occur on steep hillsides or where soil hardness varied across the width of the machine. Like all cultivators, weed misses did occur on hillsides when the cultivator skewed. Care must be taken to work up and down the hillsides to ensure adequate weed kill.

Weed Kill: Weed kill was good with the 14 in (350 mm) sweeps and the 10 in (250 mm) shank spacing.

All cultivators have a tendency to bury a portion of the weeds uprooted by the shanks. The harrows aided in killing weeds by bringing many of the weeds to the surface. In heavy trash, the harrows had to be raised slightly and did not aid weed kill.

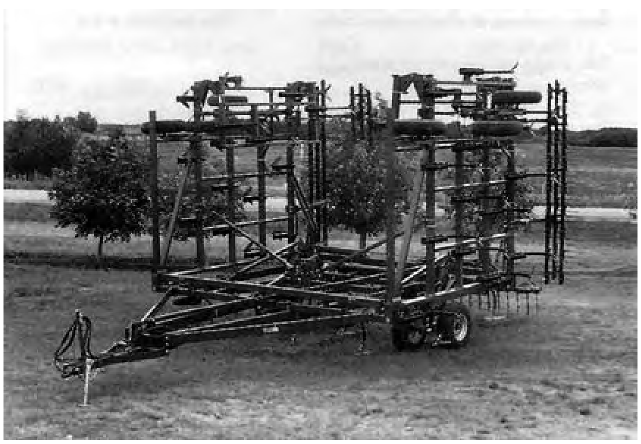

FIGURE 9. Transport Position.

EASE OF OPERATION AND ADJUSTMENT

Hitching: Ease of hitching was very good.

The hitch jack lifting range was adequate. Hitch weight was positive in both field and transport position.

When unhitched in transport position, the cultivator could be made less prone to rearward upset by adjusting the ratchet jack at the hitch for fore-and-aft leveling. This transferred more weight to the hitch jack.

Transporting: Ease of transporting was good. The cultivator was placed into transport by one person in less than five minutes (FIGURE 9).

Transport locks were provided for the wings and main frame wheels. The wing locks were conveniently controlled hydraulically from the cab. They should always be checked to ensure the pins are properly engaged before transport. Installing the transport locks on the main frame wheel required climbing on the cultivator frame. It is recommended that the manufacturer provide transport locks for the main frame wheels that are easier to access.

The Case IH harrows could not be in the raised position when folding the cultivator wings otherwise the wing harrows could contact and damage the main frame harrow. It is recommended that the manufacturer consider providing more clearance between the harrows at the hinge locations.

Transport height of the 44.8 ft (13.7 m) wide five section model was 14.8 ft (4.5 m). The wheel tread of 12.3 ft (3.7 m) provided adequate stability for transport. The maximum ground clearance of 13 in (330 m) was also adequate.

Maneuverability: Maneuverability of the Case IH 4900 was excellent. The cultivator could be turned around sharply to the opposite direction without the hitch contacting the tractor's rear wheels. Depth Adjustment: Ease of setting tillage depth was very good, and usually took less than 5 minutes.

The hydraulic cylinders were always fully retracted at the set tillage depth. The depth was set by hand cranks located at the front of the frame for each set of wheels. Tillage depth was very repeatable; however, the hand cranks for the wing wheels would rotate while in transport, causing non-uniform depth across the cultivator at the start of the next field unless they were readjusted. It is recommended that the manufacturer consider providing a lock system for the hand cranks of the depth adjustment.

Frame Leveling: Ease of leveling the frame was very good.

The same hand cranks for tillage depth adjustment were also used to level the cultivator from side-to-side. The hand cranks on the hitch frame adjusted hitch height and provided fore-and-aft leveling of the main frame. Since the hitch height adjustment was linked to the depth control system, hitch height varied with the set depth to keep the main frame level. The gauge wheels in front of the wings were also adjustable for fore-and-aft leveling of the wing sections. The gauge wheels were adjusted by repositioning pins when working depth changed.

Harrow Adjustment: Ease of adjusting the harrows was poor.

Harrow spring preload and harrow height were adjustable. The harrows were very heavy and required a jack to lift the harrow sections to adjust the threaded anchors of the springs. Adjustment was provided for fore-and-aft leveling of the harrow sections. However, no tine angle adjustment was provided. Adjusting the tines to a steeper angle usually aids trash clearance. A recommendation has been made.

Maintenance: Ease of service and maintenance was very good.

The operator's manual provided clear instructions for servicing.

The 28 grease fittings required grease every 30 hours or every three days, depending on which came first. The wheel hubs required grease at the start and end of each season.

The sweeps were easily removed. The bolts were double nutted and prevented damage to the threads. This made the bolts easy to remove.

The shank mechanism had to be removed from the frame to replace a bent shank. A special tool is supplied as standard equipment with the cultivator to make shank mechanism mounting easier.

Power Requirements: PAMI has measured power requirements on several cultivators in various 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. The tractor sizes (TABLE 2) have been adjusted to include tractive efficiency and represent a tractor operating at 80% 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 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 power requirements were 4.8 hp/ft (11.7 kW/m). Therefore, the tractor PTO power recommended to pull the 44.8 ft (13.7 m) Case IH 4900 cultivator for the same depths and speed would be 192 hp (143 kW) in secondary conditions and 215 hp (160 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)] to Pull a Typical 44.8 ft (13.7 m) Cultivator.

OPERATION	DEPTH in (mm)	SPEED - mph (km/h)	
		5.0 (8.0)	6.0 (9.7)
PRIMARY	3.0 (75)	215 (160)	260 (194)
	4.0 (100)	273 (204)	332 (248)
SECONDARY	3.0 (75)	192 (143)	233 (174)
	4.0 (100)	254 (187)	304 (227)

OPERATOR SAFETY

The Case IH 4900 was 14.8 ft (4.5 m) high in transport position. The double folded wings in transport provided a reasonable height which is low enough to clear most power lines. Most available widths were under 15 ft (4.6 m) high in transport. However, a 41 ft (12.5 m) single fold wing model has a transport height of 16 ft (4.9 m). This would require considerable caution when passing under power lines. The responsibility of safe passage always rests with the machinery Operator. All provinces have regulations governing maximum permissible equipment height and widths on various types of public roads. The operator should contact the provincial authorities for the laws governing the safe transport of farm machinery for their area.

The test machine was 21.3 ft (6.5 m) wide in transport, and required caution in transport. A hitch safety chain and a bracket for a slow moving vehicle sign were provided.

Transport locks were provided for the depth control wheels of the cultivator main frame. Installing these locks required climbing on the cultivator frame. A recommendation has been made.

Transport locks were provided for the wings in transport position. The locks were hydraulically controlled from the cab and should always be checked to ensure the pins are properly engaged for transport. On the test machine, the pins did not fully engage. It appeared that the receiving tongue was not properly located during manufacturing. Since it appeared that the pins may disengage, PAMI used a safety chain between the two upright wings for long transport distances. It is recommended that the manufacturer consider improving quality control on the wing transport locks.

The wheels of the main frame were overloaded by 16% when in transport with the added weight of the mounted harrows. It is recommended that the manufacturer consider sizing the main frame tires in accordance to the Tire and Rim Association Guidelines.

OPERATOR'S MANUAL

The operator's manuals were very good.

Separate manuals were provided for the cultivator and the tine harrows. The harrow manual provided mostly installation instructions. Both manuals very simply supplied the required instructions on maintenance, adjustment and safety. It is essential that the operator read the manuals for safe and reliable use of the machine.

MECHANICAL HISTORY

TABLE 3 outlines the mechanical history of the Case IH 4900 cultivator during 111 hours of field operation. The intent of the test was functional performance evaluation. Extended durability testing was not conducted.

Shanks: Originally six sweeps had to be trimmed to prevent contact with the wheels. Shanks were relocated on the frame by the manufacturer before testing to provide better clearance at six wheel locations. However, sweep overlap at a location on each wing was still marginal. The shanks were moved to improve overlap and to prevent possible weed misses.

A tire was deflated after it was hit by a sweep. The shank was forced sideways and upward when it was tripping over a rock. The shanks of the Case IH 4900 cultivator are very flexible and require a lot of clearance vertically and horizontally. It is recommended that the manufacturer consider modifying the sweep pattern to provide better clearance around the wheel locations and frame members.

Harrows: One harrow section was bent when the harrows collided as the cultivator was folded into transport position. The harrows had been placed in a raised position to prevent trash plugging. The adjacent harrows were so close at the cultivator hinge locations, that the harrows would collide if in a raised position while folding the wings. Operating the cultivator in rolling terrain could also result in the harrows hitting each other at the hinge locations. A recommendation regarding this has been made.

TABLE 3. Mechanical History

ITEM	OPERATING HOURS	EQUIVALENT FIELD AREA ac	(ha)
-Repositioned 10 shanks to provide better clearance at wheel locations before	The beginning of test		
-Two shanks were moved to provide better sweep overlap at	30	690	(279)
-One harrow section was bent at	78	1810	(733)
-A tire was deflated after it was hit by a sweep when it tripped at	96	2130	(863)

APPENDIX I

SPECIFICATIONS

MAKE:	Case IH	
MODEL:	4900 Vibra Chisel	
SERIAL NUMBER:	JAG0065317	
MANUFACTURER:	JI Case 450 Serman Avenue Hamilton, Ontario L8N 4C4	
DIMENSIONS:	**FIELD POSITION**	**TRANSPORT POSITION**
-width	44.8 ft (13.7 m)	21.3 ft (6.5 m)
-length (without mounted harrows)	25.1 ft (7.7 m)	25.1 ft (7.7 m)
-height	5.0 ft (1.5 m)	14.8 ft (4.5 m)
-maximum ground clearance1	3 in (330 mm)	13 in (330 mm)
-maximum wheel tread	35.8 ft (10.9 m)	12.3 ft (3.7 m)
SHANKS:		
-number	53	
-lateral spacing	10 in (250 mm)	
-trash clearance	23 in (584 mm)	
-number of shank rows		
-centre	5	
-wings	4	
-distance between rows	31.5 in (800 mm)	
-cross section	1.75 x 0.75 in (44 x 19 mm)	
-shank stem angle	50°	
-sweep hole spacing	2.25 in (57 mm)	
-sweep bolt size	7/16 in x 2 in	
HITCH:		
-height range	30 in (750 mm)	
DEPTH CONTROL:		
-main frame	2 hydraulic cylinders connected in parallel on a common rock shaft	
-wings	1 cylinder on each wing connected in series with each main frame cylinder	
-depth stops tillage	hand cranks at each pair of wheels set depth	

FRAME:
-cross section — 4 x 3 in (100 x 75 mm) rectangular tubing

TIRES:
-centre section — 4, 9.5L - 15, 8 ply
-wing sections — 6, 7.60 - 15, 4 ply

LUBRICATION:
-number of grease fittings — 28 (require grease every 30 hours)
-grease fittings on wheels — 10 (require grease annually)

HYDRAULIC CYLINDERS:
-depth control — two, 4 x 8 in (102 x 203 mm) two, 3.75 x 8 in (95 x 203 mm)
-wing lift — two, 4 x 34 in (102 x 864 mm) two, 3 x 16 in (76 x 406 mm)

WEIGHTS: (without harrows)	**FIELD POSITION**	**TRANSPORT POSITION**
-right wheels	2160 lb (980 kg)	
-right centre wheels	2730 lb (1240 kg)	4660 lb (2110 kg)
-left centre wheels	2690 lb (1220 kg)	4585 lb (2080 kg)
-left wheels	2255 lb (1020 kg)	
-hitch	4201b (190 kg)	1010 lb (460 kg)
TOTAL	10,255 lb (4650 kg)	10,255 lb (4650 kg)

WEIGHTS: (with harrows)	**FIELD POSITION**	**TRANSPORT POSITION**
-right wheels	2610 lb (1185 kg)	
-right centre wheels	3180 lb (1440 kg)	5625 lb (2550 kg)
-left centre wheels	3150 lb (1430 kg)	5605 lb (2540 kg)
-left wheels	2615 lb (1185 kg)	
-hitch	245 lb (110kg)	570 lb (260 kg)
TOTAL	11,800 lb (5350 kg)	11,800 lb (5350 kg)

OPTIONAL EQUIPMENT AVAILABLE:
-7 width options from 31 to 52 ft (9.4 to 15.8 m)
-8 or 9 in (200 or 225 mm) shank spacing
-clearance lights
-mounted harrows

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) soil force.

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

DEPTH	SWEEPS			SPIKE	BANDING KNIFE
	FIELD CULT	HEAVY DUTY CULT			
	11 in (275 mm)	12 in (305 mm)	16 in (406 mm)	2 in (50 mm)	1 in (25 mm)
in (mm)	lb (kN)	lb (kN)	lb (kN)	lb (kN)	lb (kN)
2 (50)	110 (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	BANDING KNIFE
	FIELD CULT	HEAVY DUTY CULT			
	11 in (275 mm)	12 in (305 mm)	16 in (406 mm)	2 in (50 mm)	1 in (25 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 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, 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 44.8 ft (13.7 m) cultivator in those conditions, 273 PTO hp (204 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 (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)		
in (mm)	4.0 (6.4)	5.0 (8.0)	6.0 (9.7)
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

The following rating scale is used in PAMI Evaluation Reports:

Excellent	Fair
Very Good	Poor
Good	Unsatisfactory

SUMMARY CHART

CASE IH 4900 VIBRA CHISEL

RETAIL PRICE	$ 27,150.00 [February, 1991, f.o.b. Humboldt ,Saskatchewan, 44.8 ft (13.7 m)width, with optional mounted harrows].
QUALITY OF WORK	
Penetration	**Good;** acceptable in light primary and secondary tillage; reduced in heavy primary conditions
Depth Uniformity	**Good;** acceptable in light primary and secondary tillage; reduced in heavy primary conditions, operating sweep pitch exceeded 7° in many conditions
Stone Protection	**Good;** trip height was 13 in (330 mm) but sweeps occasionally contacted cultivator frame while tripping
Trash Clearance	**Good;** plugging only occurred at wheel locations in heavy or damp conditions
Surface Finish	**Good;** harrows effective in light trash conditions
Skewing and Stability	Stable in typical field conditions
Weed Kill	**Good;** suitable in typical conditions but reduced in heavy primary conditions
EASE OF OPERATION AND ADJUSTMENT	
Hitching	**Very Good;** hitch weight positive
Transporting	**Good;** placed into transport in less than 5 minutes
Maneuverability	**Excellent;** could turn sharply without contacting tractor wheels
Depth Adjustment	**Very Good;** less than 5 minutes
Frame Leveling	**Very Good;** easily accomplished with hand cranks
Harrow Adjustment	**Poor;** very heavy with limited adjustment
Maintenance	**Very Good;** greasing every 30 hours and sweeps easily removed
POWER REQUIREMENTS	
Secondary Tillage	192 hp (143 kW) at 3 in (75 mm) and 5 mph (8 km/h)
Primary Tillage	215 hp (160 kW) at 3 in (75 mm) and 5 mph (8 km/h)
OPERATOR SAFETY	Transport locks, hitch safety chain, and slow moving vehicle sign were provided
OPERATOR'S MANUAL	**Very Good;** supplied required instructions on maintenance, adjustments and safety
MECHANICAL HISTORY	Only minor mechanical problems occurred

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