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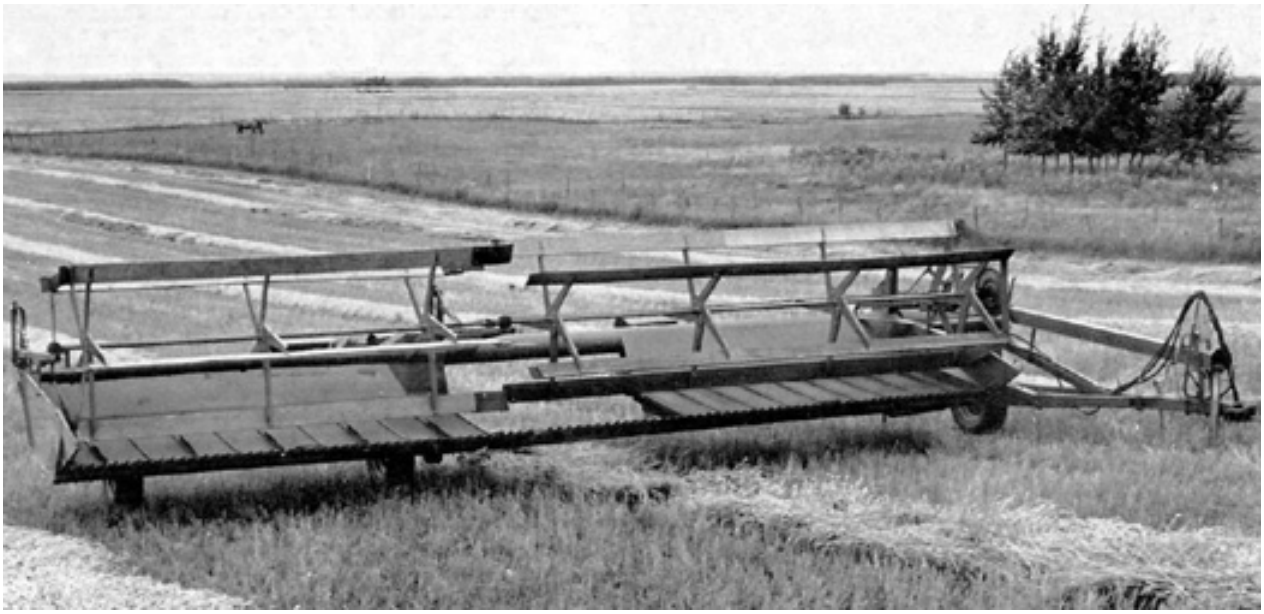
Evaluation Report 151



Co-op Implements 660 Pull-Type Windrower

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

CO-OP IMPLEMENTS 660 PULL-TYPE WINDROWER

MANUFACTURER AND DISTRIBUTOR

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

RETAIL PRICE:

$6,488.00 (March, 1979, f.o.b. Humboldt, Saskatchewan with 7.3 m cutter bar).

SUMMARY AND CONCLUSIONS

Overall functional performance of the Co-op Implements 660 windrower was *very good* in all grain crops and was good in flax and rapeseed. Performance in hay crops, with the 7.3 m (24 ft) cutter bar, was *good*.

Cutting ability was *excellent* in most standing grain and hay crops. Feeding problems occurred in lodged crops. Table flotation was *fair*.

Windrow formation and quality varied from *fair* to *very good* depending on crop type and stand. Parallel and angled parallel windrow patterns were predominant in hay and grain crops. Fan-tail patterns occurred in most heavy grain crops while herringbone patterns occurred in light crops. The narrow windrow opening setting was inadequate in heavy grain and hay crops, while the wide setting was adequate in all crops.

The automatic side draft eliminator was effective in reducing sideways skewing on hillsides and in soft fields. Its performance was *very good* in firm fields and *good* in soft fields.

Peak power take-off requirements were about 10 kW (13 hp). A 35 kW (47 hp) tractor would have ample power reserve to operate the Co-op 660 in most field conditions. Suitable speeds were from 3 to 10 km/h (2 to 6 mph) in average grain crops and from 3 to 5 km/h (2 to 3 mph)in average hay crops.

Reel and table height were easily controlled with the tractor hydraulics. Daily maintenance took from 25 to 30 minutes.

No serious safety hazards were apparent, when the windrower was operated according to normal recommended procedures.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Up-grading assembly standards to eliminate poorly fitting components and faulty drive alignment.
2. Modifying the knife actuator assembly to improve lubricant distribution and to reduce the frequency of adjustment.
3. Modifications to eliminate the loose guard problem.
4. Modifying the side-draft eliminator drive shield to reduce interference with windrow formation.
5. Supplying a heavier hitch jack to facilitate jacking at the centre wheel location
6. Supplying a slow moving vehicle sign.

Chief Engineer -- E.O. Nyborg
Senior Engineer -- L.G. Smith
Project Technologist -- G.G. Burton

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. This recommendation is accepted and action has been taken.
2. The assembly will be examined for improvement for the next production.
3. The problem will be investigated and resolved.
4. The shield will be improved for the next production.
5. The rated capacity of the jack is 2270 kg while the load at the jack is 1044 kg. We accept that some users will prefer an easier turning crank, therefore an improvement will be developed for the next production.
6. A bracket and slow moving vehicle sign will be provided for the next production.

MANUFACTURER'S ADDITIONAL COMMENT

Regarding the field problem with the left hand draper drive belt, clearance between the belt and frame can be achieved by adjusting the driven pulley and belt idlers.

GENERAL DESCRIPTION

The Co-op Implements 660 is a pull-type, power-take-off driven windrower. The hinged, two-piece cutting platform has dual drapers and a central, adjustable, windrow opening. The twin knives are actuated through sway bars by belt driven pitmans. A right angle gear box transmits power from the power take-off shaft through a lateral drive shaft to the reel, drapers, pitmans and side-draft eliminator.

The test machine was equipped with the 7.3 m cutter bar. Cutter bar height and reel height were controlled by the tractor hydraulics.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The CI 660 was operated in the conditions shown in TABLES 1 and 2 for 76 hours while cutting about 268 ha. It was evaluated in forage, cereal grain and oil seed crops for windrow formation, cutting ability, ease of operation and adjustment, power requirements, operator safety, and suitability of the operator's manual.

TABLE 1. Operating Conditions

CROP	SOIL TEXTURE	HOURS	FIELD AREA ha
Alfalfa	sandy loam	2	5
Bromegrass/Alfalfa	sandy loam	5	14
Mixed Hay	light loam	8	29
Fall Rye	loam	12	26
Barley	loam	7	23
Wheat	loam to silty clay loam	18	80
Oats	loam	4	14
Rapeseed	loam to silty clay loam	11	38
Barley/Oats	loam	2	7
Barley/Clover	silty clay loam	4	18
Flax	loam	3	14
TOTAL		76	268

TABLE 2. Oparation in Stony Fields

FIELD CONDITION	HOURS	FIELD AREA ha
Stone free	51	177
Moderately stony	25	91
TOTAL	76	268

RESULTS AND DISCUSSION

WINDROW FORMATION

Windrow Types: Windrows may be classified into four general patterns (FIGURE 1) although many combinations and variations exist. The CI 660 produced parallel and angled parallel windrows in most hay and grain crops. Herringbone windrows occurred in very light crops while fantail windrows occurred in heavy crops. TABLE 3 describes the types of windrows produced by the CI 660 in various crops while FIGURES 2 to 9 illustrate typical windrows.

In general, good quality windrows have an even distribution of heads across the width of the windrow and a loose structure with heads near the top to assure proper curing. Windrows of mixed patterns seem to weather best in extended wet periods.

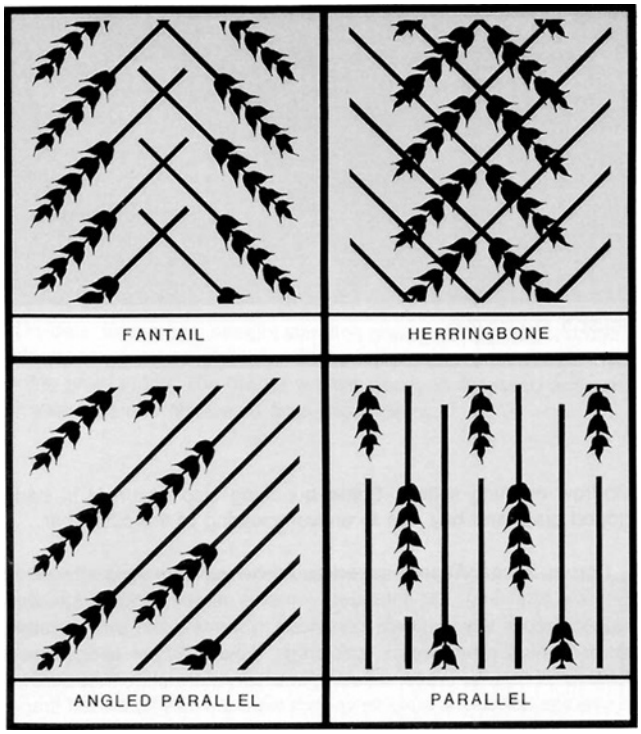


FIGURE 1. Windrow Types.

FIGURE 2. Alfalfa (3.1 t/ha).

TABLE 3. Windrow Formation in Various Crops

CROP	RANGE t/ha	CUT CROP LENGTH mm	SPEED km/h	WINDROW TYPE	FIGURE NO.
Alfalfa	3.1	300 to 600	3 to 5	Parallel and Herringbone	2
Bromegrass/ Alfalfa	1.7	300 to 900	3 to 5	Parallel and Herringbone	3
Mixed Hay	1.5	400 to 800	5 to 5.5	Parallel and Herringbone	
Fall Rye	1.9	600 to 800	6 to 9.5	Parallel and Fantail; Herringbone where light	4
Barley	2.6	200 to 700	4 to 8	Herringbone	5
Wheat	1.9 to 3.7	300 to 1000	4 to 10	Parallel and Herringbone	6
Oats	2.2	400 to 800	6 to 6.5	Herringbone	7
Rapeseed	1.0 to 1.8	400 to 800	2.5 to 8	Parallel and Fantail	8
Barley/Oats	3.7	300 to 700	3 to 6.5	Parallel and Herringbone; Fantail where heavy	
Barley/Clover	3.4	300 to 800	5 to 10	Herringbone	
Flax	1.3	500 to 600	9 to 9.5	Parallel and Fantail	9

FIGURE 3. Bromegrass/Alfalfa (1.7 t/ha).

FIGURE 4. Fall Rye (1.9 t/ha).

FIGURE 5. Barley (2.6 t/ha).

FIGURE 6. Wheat (3.4 t/ha).

FIGURE 7. Oats (2.2 t/ha).

FIGURE 8. Rapeseed (1.8 t/ha).

FIGURE 9. Flax (1.3 t/ha).

Leaning Crops: The direction of cut affected windrow formation when windrowing lodged or leaning crops. Cutting parallel to the direction of lean resulted in parallel windrows while cutting at an angle to the direction of lean generally resulted in angled parallel windrows.

Poor feeding occurred when cutting in the direction of lean, while crop hairpinned on the dividers when cutting at an angle to the direction of lean.

Uniformity: Windrows were uniform in most crops. In light, short hay crops, hay sometimes collected on the cutter bar causing slight bunching. Bunching was more prevalent when using the narrow windrow opening setting. Some bunching also occurred in badly lodged grain and hay due to uneven clearing of the cutter bar.

Draper Speed: Draper speed could be varied from 1.40 to 2.58 m/s by adjusting the threaded variable speed draper sheaves. Higher draper speeds were beneficial in forming denser, narrower, easier-to-pick windrows in light crops. Lower draper speeds were suitable for heavier crops, resulting in wider, more uniform windrows. In average conditions suitable speeds were 1.4 m/s for the left draper and 1.6 m/s for tile right draper.

Forward Speed: Forward speed had little effect on windrow formation. Speed was usually limited by field roughness or cutting performance. In very heavy crops, forward speed was limited by windrow clearance when using the narrow windrow opening. Windrow clearance did not limit forward speed in any crops when using the wide opening setting.

Windrow Opening: The windrow opening could be set at two different widths. Some plugging occurred in heavy hay and grain crops at the narrow setting, while no plugging occurred in any crops at the wide setting. The side-draft eliminator shield sometimes caught the side of the windrow turning it upwards. It is recommended that the side-draft eliminator shield be modified to reduce windrow interference.

Cornering: The corners produced by the centre delivery design were not continuous, as shown in FIGURE 10. It was not necessary to drive on the preceding windrow when cornering.

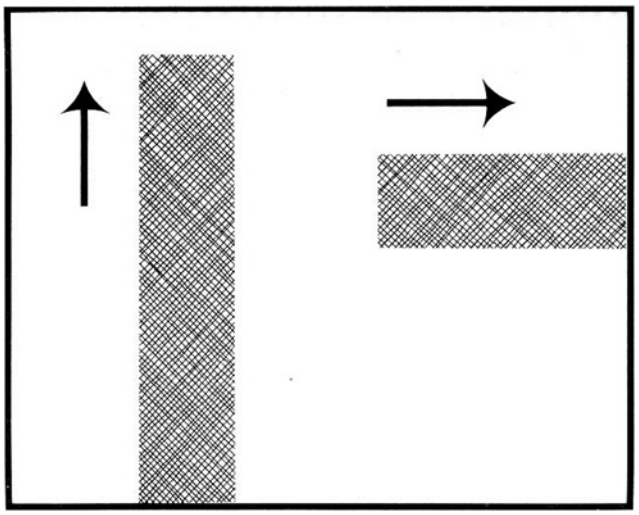


FIGURE 10. Typical Corner Formation.

CUTTING ABILITY

Cutter Bar: All field work was conducted with underserrated knife sections. Cutting ability was excellent in most hay and grain crops. In badly lodged crops, uneven feeding occurred due to poor cleaning of the cutter bar. Cutter bar hammering was not a problem, even in damp or very heavy crops, when the knife actuators were properly adjusted.

Stubble: The types of stubble formed by a windrower may be divided into three types; ideal, undulating, and irregular as shown in FIGURE 11. The CI 660 generally produced ideal stubble in all grain and hay crops at speeds up to 9 km/h.

Dividers: In average, straight standing grain and hay crops, divider performance was satisfactory. Slight hairpinning occurred in tall, leaning grain crops. The divider worked poorly in rapeseed and was replaced with one fabricated from sheet metal.

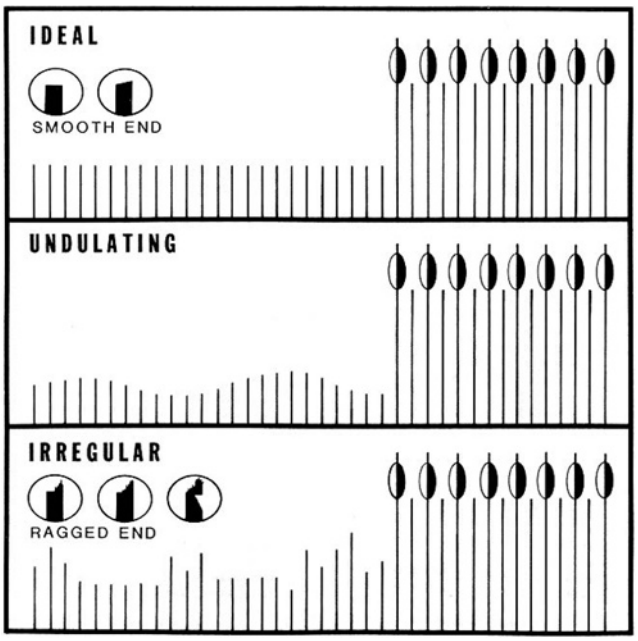


FIGURE 11. Types of Stubble.

Reel: Reel performance was adequate in most crops. Clearing of material in lodged crops was fair. The range of vertical and horizontal adjustment was good in all crops. Reel drive belt slippage was not a problem.

Reel speed was variable from 30 to 50 rpm by adjusting the belt drive sheave. For optimum performance it is best to have a reel index* from 1.1 to 1.2. The optimum reel index was obtained at forward speeds ranging from 6.2 to 10.3 km/h. Operation at lower speeds was often necessary due to surface roughness and crop conditions.

Table Flotation: The CI 660 was equipped with a table flotation system, supplied as standard equipment (FIGURE 12). Table flotation was fair. The degree of flotation could not be adjusted.

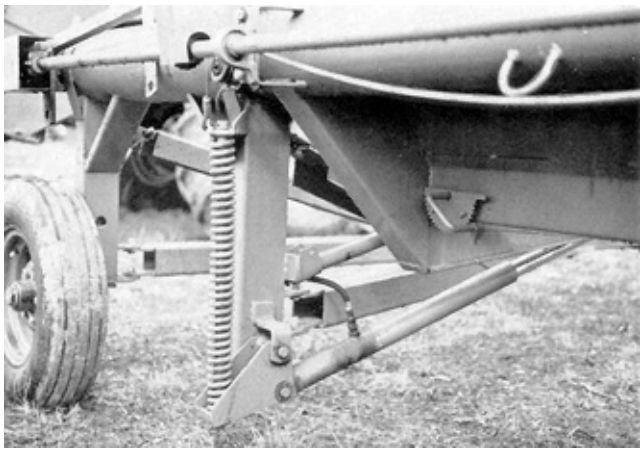


FIGURE 12. Table Flotation System.

EASE OF OPERATION

Controls: The test machine was equipped with tractor operated hydraulics. Raising and lowering speeds of both the reel and table were satisfactory. The combination reel and wing lift cylinder, must be supplied by the owner.

Side-Draft Efiminator: The CI 660 was equipped with a side-draft eliminator to reduce skew on hillsides and in soft fields and to assist in making left turns. A control switch (FIGURE 13), mounted on the hitch tongue, is activated by a tractor mounted paddle. This switch engages an electromagnetic clutch which applies power to the centre wheel of the windrower. It was important that the paddle not be set too close to the switch as continuous on-off operation could damage the drive belts and overheat the clutch.

Functional performance of the side-draft eliminator was good in soft fields and very good in firm fields.

Transporting: The CI 660 has two transport positions. In semi-transport position, the wing is lifted to provide a narrower tracking width. In full transport, the hitch and wheel positions are changed and the wing is raised permitting the windrower to be pulled from the right end (FIGURE 14). Rearward visibility was poor when transporting with a small tractor.

It took one man about five minutes to change to semi-transport position and about thirty minutes to change to full transport position. The large machine weight made the hitch jack difficult to adjust when changing the centre wheel into transport position. It is recommended that a heavier jack be provided to facilitate jacking at the centre wheel location.

**Reel index is the ratio of reel tip speed to travel speed.*

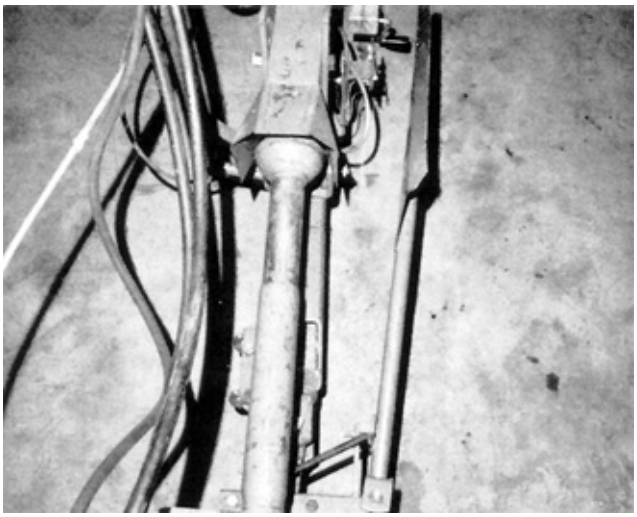


FIGURE 13. Side-Draft Eliminator Control.

FIGURE 14. Full Transport Position.

Adjustments: Reel and draper speeds were varied by loosening set screws and adjusting the size of the threaded sheaves. The horizontal position of the reel was adjusted by removing two bolts at each of the three mountings and repositioning the wooden boxings. Drive belt tensions had to be reset after adjustment.

Changing from the narrow to the wide windrow opening took from 10 to 15 minutes. The knife actuators required adjustment after every six hours of operation. It is recommended that the knife actuator assemblies be modified to improve lubricant distribution within the actuators and to reduce the frequency of adjustment.

Servicing: Daily lubrication on the CI 660 took from 20 to 25 minutes. Twenty six pressure grease fittings needed daily service. A grease gun with a flexible hose was needed for greasing the universal joints and several other fittings.

POWER REQUIREMENTS

A 35 kW tractor had ample power to operate the CI 660 in most field conditions. A maximum of 10 kW was needed to drive the power take-off.

OPERATOR SAFETY

No safety hazards were apparent, if proper safety procedures were followed during servicing and operation.

OPERATOR'S MANUAL

The operator's manual contained useful information on operation, adjustment and servicing.

DURABILITY RESULTS

TABLE 4 outlines the mechanical history of the CI 660 during 76 hours of operation while windrowing about 268 ha. The following failures represent those which occurred during functional testing. An extended durability evaluation was not conducted.

TABLE 4. Mechanical History

ITEM	OPERATING HOURS	EQUIVALENT AREA (ha)
The main reel and wing lift cable broke and was replaced at	0	0
A nut and washer were missing from the central pivot bolt. They were installed at	7	19
The left sickle actuator block loosened and several bolts sheared. New bolts were installed at	7	19
The right pitman drive belt tightener was realigned to prevent belt damage at	7	19
The left draper drive tightener was replaced at	27	74
The small left draper drive shield was modified at	27	74
The wing wheel lock bolt broke loose and was replaced at	34	97
The left draper drive belt broke and was replaced at	36, 51, 73	104, 171, 254
The left knife actuator broke and was replaced at	52	174
The left pitman crank bolt broke and was replaced at	56	187
The centre reel support bent sideways and was straightened at	68	237
The left sickle actuator block shield broke and was replaced at	73	254

DISCUSSION OF MECHANICAL PROBLEMS

The wing latch was improperly aligned and the cable broke while attempting automatic latching.

Draper drive belt failures were the result of interference between the belt and the windrower frame.

Knife actuator failure and pitman crank bolt failure were both the result of fatigue. Sickle to guard interference, due to loose guard bolts, appeared to have been the problem. The guard bolts refused to remain tight and required repeated tightening. It is recommended that modifications be made to eliminate the loose guard problem.

APPENDIX I

SPECIFICATIONS

MAKE: Co-op Implements Puli-Type Windrower

MODEL: 660

SERIAL NUMBER: 1977-14958

MANUFACTURER: Canadian Co-operative Implements Limited
770 Pandora Ave. East
Winnipeg, Manitoba
R2C 3N1

HEADER:

-- width of cut (divider points)	7280 mm
-- effective cut (inside divider)	7225 mm
-- range of cutting height	0 to 1025 mm
-- guard spacing	76 mm
-- length of knife section (underserrated)	76 mm
-- knife stroke	81 mm
-- knife speed	540 cycles/min
-- platform angle	
-- fully raised	9.5° above horizontal
-- fully lowered	34° below horizontal
-- number of drapers	3
-- draper width	1045 mm
-- draper speed range	1.40 to 2.58 m/s
-- draper roller diameter	64 mm
-- height of windrow opening	910mm
-- width of windrow opening	
-- between wind board	1050 mm or 1550 mm
-- between rollers	1060 mm or 1525 mm
-- between roller shields	980 mm or 1400 mm
-- raising time	2.8s
-- lowering time	2.6s

REEL:

-- number of bats	5
-- number of reel arms per bat	4 inner table 3 outer table
-- diameter	1252 mm
-- speed range	30 to 50 rpm
-- range of adjustment	
-- fore and aft	228 mm
-- height above cutter bar	690 mm
-- raising time	3.3s
-- lowering time	3.5s

HYDRAULIC SYSTEM:	tractor hydraulics
NUMBER OF CHAIN DRIVES:	2
NUMBER OF V-BELT DRIVES:	
-- single V	5
-- double V	1
NUMBER OF LUBRICATION POINTS:	
-- pressure grease	26
NUMBER OF PRE-LUBRICATED BEARINGS:	43

OVERALL DIMENSIONS:	FIELD POSITION	TRANSPORT POSITION
-- length	3924 mm	10312mm
-- width	8827 mm	3621 mm
-- wheel tread	518mm	3600 mm (5461 in semi-transport)
-- wheel base		5385 mm

TIRES:

-- *left*	1, 7.60 x 15, 6 ply rating
-- centre	1, 7.60 x 15, 6 ply rating
-- right	1, 7.60 x 15, 6 ply rating

WEIGHT:

-- hitch pin	322 kg
-- left wheel	400 kg
-- centre power wheel	560 kg
-- right wheel	344 kg
Total	1626 kg

OPTIONS AVAILABLE:
-- high speed gear box for 1000 rpm power take-oft

APPENDIX II

MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

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

APPENDIX III

METRIC UNITS

In keeping with the Canadian metric conversion program this report has been prepared in SI Units. For comparative purposes, the following conversions may be used.

1 hectare (ha)	=	2.47 acres (ac)
1 kilometre/hour (km/h)	=	0.62 miles/hour (mph)
1 tonne/hectare (t/ha)	=	0.45 ton/acre (ton/ac)
1000 millimetres (mm) = 1 metre (m)	=	39.37 inches (in)
1 kilowatt (kW)	=	1.34 horsepower (hp)
1 kilogram (kg)	=	2.20 pounds mass (lb)

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

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

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

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