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Evaluation Report 225

Allis-Chalmers Gleaner N-6 Self-Propelled Combine

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

ALLIS-CHALMERS GLEANERS N-6 SELF-PROPELLED COMBINE

MANUFACTURER:
Allis-Chalmers Corporation – Combine Division
627 South Cottage Street
Independence, Missouri 64051

DISTRIBUTOR:
Allis-Chalmers, Rumely Ltd.
515 Dewdney Avenue
Regina, Saskatchewan
S4P 3A1

RETAIL PRICE:
$116,317.34 (June 1981, f.o.b. Humboldt, with 4.6 m header, 3.2 m Melroe 378 pickup, loss monitor, air conditioner, auxiliary warning system, unloading auger options, acre estimator, automatic pickup speed control, 30.5 L x 32 front tires and 12.4 x 24 rear tires).

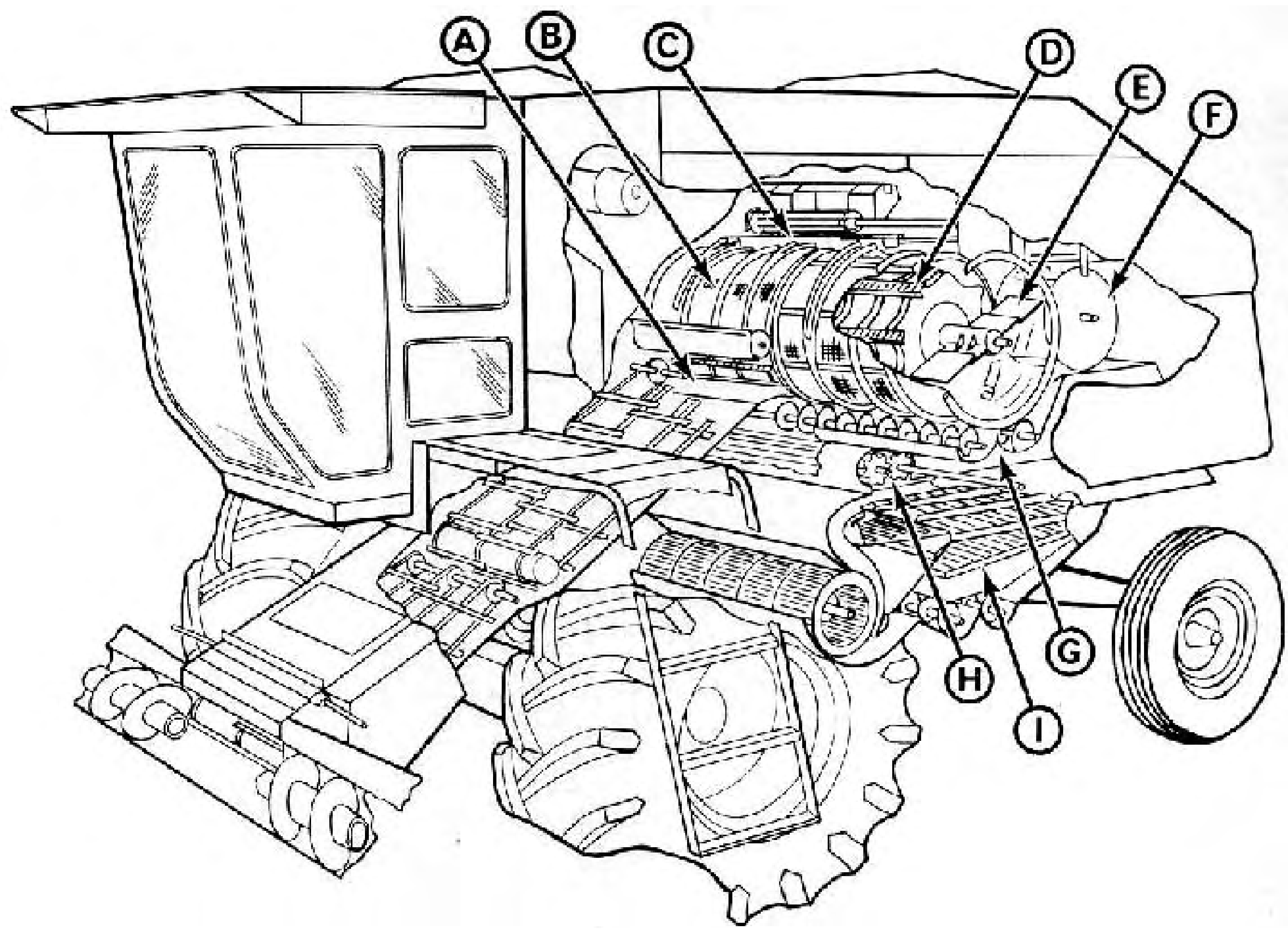

FIGURE 1. Allis-Chalmers Gleaner N-6: (A) Concave, (B) Cage. (C) Cage Sweeps, (D) Rotor, (E) Discharge Paddles, (F) Discharge Beater, (G) Distribution Augers, (H) Accelerator Roils, (I) Shoe.

SUMMARY AND CONCLUSIONS

Functional performance of the Allis-Chalmers Gleaner N-6 self-propelled combine was very good in dry grain and oilseed crops, good in tough grain crops and fair in tough oilseed crops.

The MOG feedrate* at 3% total grain loss varied from 18.3 t/h (670 lb/min) in 2.7 t/ha (40 bu/ac) Neepawa wheat to 16 t/h (587 lb/min) in 3.3 t/ha (61 bu/ac) Hector barley.

For similar total grain loss, capacity of the Gleaner N-6 was much greater than the capacity of the PAMI reference combine. Rotor loss limited capacity in barley while in wheat total loss was about 3% of yield when operating at the engine power limit. Cylinder and shoe losses were low over the full operating range. Engine power was well matched with combine loss characteristics. Fuel consumption varied from 27 to 36 L/h (6 to 8 gal/h).

The Gleaner N-6 was convenient to operate. Forward and side visibility was very good while rear visibility was restricted. Steering and brakes were very responsive, making the combine very maneuverable both in the eld and during transport. Lighting for nighttime operation was very good. Most instruments and controls were conveniently located, easy to use and responsive. The air conditioner and heater provided comfortable cab temperatures in all conditions. The cab was relatively dust free. Operator station sound level was about 81 dBA.

The Gleaner N-6 was easy to set and adjust. Rotor speed, pickup speed and fan blast were adjusted from within the cab. The return tailings could not be sampled.

The pickup fed evenly and uniformly in all crops. The table auger and feeder performed well in uniform windrows, but plugged frequently in bunchy windrows. Unplugging the table auger was dif cult. The rotor plugged occasionally in tough windrows. A plugged rotor was easily cleared by power unplugging. The concave thresher door effectively stopped most roots and stones from entering the rotor. The unloading auger had ample reach and clearance for unloading on-the-go.

Most lubrication points were easy to service. The rotor drive

*The MOG Feedrate (Material-Other-than-Grain Feedrate) is the mass of straw and chaff passing through a combine per unit time.

was dif cult to grease. Accessibility for cleaning or repair was fair.

The Gleaner N-6 was safe to operate as long as manufacturer's safety instructions were followed. The operator's manual was well illustrated, clearly written and contained much useful information. The rotor drive spline wore and had to be replaced during the test.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Improving the ease of shifting the transmission.
2. Modi cations to provide smoother and more accurate header height control.
3. Protecting the unloading auger swing control switch to prevent accidental engagement.
4. Including a warning buzzer for rotor speed reduction.
5. Relocating the digital component speed monitor to the lower instrument console.
6. Improving the lighting for the upper and lower instrument and control consoles.
7. Modi cations to improve pickup speed change responsiveness, to increase maximum pickup speed and to improve operation of the optional automatic pickup speed control.
8. Modi cations to improve ease of removing stone strap ef uent from the fan inlet panel.
9. Supplying eight springs on the table auger slip clutch as standard equipment for windrow operation and supplying a wrench and hub to facilitate table auger unplugging.
10. Improving the ease of lubrication of the rotor drive spline.
11. 11. Supplying a safe, convenient method for sampling return tailings.
12. Including a method of zeroing and levelling the concave in the operator manual.
13. Reducing the fan settings suggested in the operator manual for wheat, barley and rapeseed.
14. Providing the modi ed unloading auger drive as standard equipment.
15. Modifying the clean grain drive idler tensioning track to eliminate slot deformation.
16. Modi cations to improve rotor drive hub spline durability.
17. Modifying the left rotor support assembly to facilitate quicker rotor removal.

Chief Engineer -- E. O. Nyborg
Senior Engineer -- J. D. MacAulay
Project Technologist -- L. G. Hill

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Ease of shifting the transmission has been improved on 1981 models with the addition of a hydraulic clutch pedal that relieves the hydraulic pressure when the clutch is depressed for shifting. In addition, to further enhance ease of shifting, the shift couplings within the mechanical transmission have been changed by pointing or nosing the gear teeth for easier engagement.
2. Smoother operation can be obtained with the optional hydraulic accumulator.
3. Protecting the unloading auger swing control switch will be evaluated on future models.
4. An engine speed alarm is provided to indicate overload conditions, which, if no drive slippage occurs, indirectly warns of rotor speed reduction. The recommended additional alarm will be investigated.
5. The digital tachometer has been grouped in the overhead console along with all other electronic modules to simplify wiring and reduce dust for improved service and reliability. Priority has been given to minimizing the size of the lower right hand console to achieve maximum right hand visibility. Our market research indicates customer satisfaction at the current location.
6. Improved lighting for both the upper and lower consoles will be investigated.
7. Drive con gurations vary with the pickup manufacturer selected. Improvements in the pickup drive and automatic speed control are being investigated.
8. The fan inlet screen will be redesigned to improve ease of removing crop material on future models.
9. A higher torque, auger slip clutch will be standard on future models. Means to facilitate auger unplugging is being evaluated.
10. The grease tting for lubricating the rotor drive spline coupler has been relocated for easy access on all N-series combines including both current and prior models.
11. Methods for sampling the return tailings are being investigated.
12. Procedure for zeroing and levelling the concave is included in the service manual and will be added to the operator's manual for 1982 models.
13. Suggested fan settings in the operator's manual will be reviewed for best overall average settings.
14. The modi ed unloading auger drive is standard on all 1981 model combines and is available for prior models.
15. Deformation of the clean grain drive idler tensioning slot will be corrected on future models.
16. The rotor drive coupling has been redesigned for improved durability and supplied for all N-series combines.
17. A eld installed optional quick removal left hand rotor support assembly is available for all N-series combines and will be standard on future models.

GENERAL DISCRIPTION

The Allis-Chalmers Gleaner N-6 is a self-propelled combine with a transverse-mounted rotor, single segment threshing concave, 360 degree separating cage, accelerator rolls and cleaning shoe. Initial threshing and separation occur at the concave while nal separation of grain from straw takes place in the cage. Initial cleaning is accomplished by an air blast through the grain as it passes from the accelerator rolls to the shoe. Tailings are returned to the accelerator rolls.

The test machine was equipped with a 164 kW (220 hp) turbocharged and inter-cooled 6 cylinder diesel engine, a 4.6 m (15 ft) header, a 3.2 m (126 in) Melroe 378 pickup, straw spreader and optional accessories as listed on page 2.

The Allis-Chalmers Gleaner N-6 has a pressurized operator's cab, power steering, hydraulic wheel brakes, and a hydrostatic traction drive. Electrical switches, in the cab, control separator, header and unloading auger drive engagement, header height, unloading auger swing, pickup speed and rotor speed. Fan inlet opening is adjusted from the cab while concave clearance is externally adjusted. There is no provision to safely and conveniently sample the return tailings. Most component speeds and harvest functions are displayed on electronic monitors.

Detailed speci cations are given in APPENDIX I.

SCOPE OF TEST

The Allis-Chalmers Gleaner N-6 was operated in the conditions shown in TABLES 1 and 2 for 176 hours while harvesting about 613 ha (1515 ac). It was evaluated for ease of operation, ease of adjustment, rate of work, grain loss characteristics, operator safety, and suitability of operator's manual. Throughout the tests comparisons were made to the PAMI reference combine.

RESULTS AND DISCUSSION

EASE OF OPERATION

Operator Location: The cab was positioned ahead of the grain tank, centered on the combine body, while the feeder house was offset to the right. Visibility forward and to both sides was very good; rear visibility was restricted. Two rear view mirrors were provided, but caution was needed when operating in con ned areas. Header visibility was very good (FIGURE 2). The grain level was visible through the rear window until the tank was nearly full.

The seat and steering column were adjustable, providing a comfortable combination for most operators. Incoming air was effectively ltered while fans pressurized the cab to reduce dust leaks. The heater and air conditioner provided suitable cab temperatures.

Operator station sound level was about 81 dBA.

TABLE 1. Operating Conditions

Crop	Variety	Average Yield t/ha	Swath Width m	Hours	Field Area ha
Barley	Betzes	2.7	6.1	10.5	28
Barley	Hector	3.1	6.1 to 12.2	12.5	22
Barley	Klages	3.5	6.1	1.0	2
Barley	Melvin	2.4	6.1 to 12.2	10.0	27
Flax	Dufferin	1.1	6.1 to 7.6	10.0	38
Rapeseed	Altex	1.8	6.1 to 7.3	20.5	68
Rapeseed	Candle	1.5	6.1	8.0	21
Rapeseed	Midas	1.5	7.3	3.0	6
Rapeseed	Regent	1.5	6.1	8.5	23
Rapeseed	Torch	1.5	6.1	2.0	6
Rye	Puma	1.1	6.1 to 12.2	26.5	133
Wheat	Neepwa	3.0	6.1 to 12.2	61.0	231
Wheat	Sinton	2.1	6.1 to 12.2	2.5	8
Total				176	613

TABLE 2. Operation in Stony Fields

Field Condition	Hours	Field Area (ha)
Stone Free	42	138
Occasional Stones	118	424
Moderately Stony	16	51
Total	176	613

(a)

(b)

FIGURE 2. View of Incoming Windrow (a) Normal Seated Position (b) Leaning Right.

Controls: The control arrangement is shown in FIGURE 3. The controls were conveniently located and most were easy to use.

The gear selector lever was very difficult to shift. The hydrostatic speed control lever usually had to be momentarily activated to enable shifting. It is recommended that the manufacturer consider improving the ease of shifting the transmission.

When adjusted for suitable full range raise and drop rate, header response was abrupt when making small height adjustments. It is recommended that the manufacturer consider modifications to provide smoother, more accurate header height control.

The unloading auger swing switch was very sensitive and if accidentally bumped while in the automatic mode, the auger swung out undetected. It is recommended that the manufacturer consider protecting the unloading auger swing switch to prevent accidental engagement.

Instruments: The instruments were located on two consoles, one to the right of the operator and one above the windshield. The lower console (FIGURE 3) had gauges for engine oil pressure, coolant temperature, battery voltage and turbocharger boost pressure. The upper console (FIGURE 4) had a grain loss monitor, engine and separator hour meters, an acre estimator, and readout for fuel level, rotor speed, engine speed and ground speed as well as a series of warning indicators. As standard equipment, warning indicators were provided for stone trap door opening, oil, air and fuel filter restrictions, parking brake engagement, hydraulic oil temperature, coolant level, transmission oil pressure and reduced speeds of major combine drives. It is recommended that the manufacturer consider including a warning for rotor speed reduction. Optional equipment on the test machine included warning devices for battery voltage, engine oil pressure, grain tank level, coolant temperature and unloading auger position. All warning indicators were displayed with a warning light and most were accompanied with a four-second audio alarm.

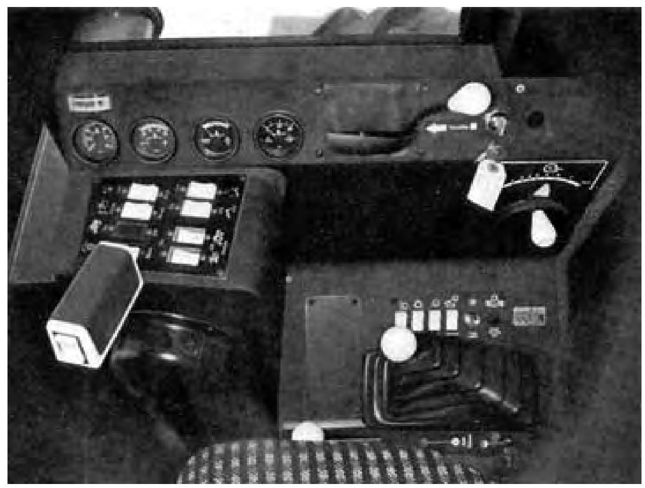

FIGURE 3. Controls and Lower Instrument Console.

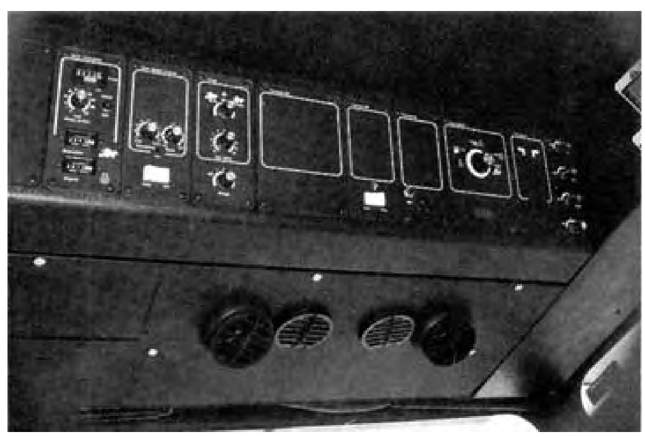

FIGURE 4. Upper Instrument Console.

The acre estimator, and separator and engine hour meters worked well aiding the operator in assessing field performance. The loss monitor indicated changes in mechanical loss over the shoe, but not airborne loss. The rotor loss sensor did not provide a representative enough signal to be beneficial. Warning systems using both the audio alarm and light were useful and effective, while those using only the light were not as effective. The digital component speed monitor was very useful, but was inconvenient to read or switch while harvesting. It is recommended that the manufacturer consider relocating the digital display to the lower instrument console.

Lights: Lighting was very good for nighttime harvesting. There were eight front lights, a grain tank light, an unloading auger light and an engine compartment light. Control and instrumentation lighting was unsatisfactory. It is recommended that the manufacturer consider improving lighting of the lower and upper consoles.

The warning lights and taillights were adequate for safe road transport.

Engine: The engine started easily. It had adequate power for average crop conditions, but operated near its power limit in hard-to-thresh and tough crops, or in hilly elds.
Average fuel consumption varied from 27 to 36 L/h (6 to 8 gal/h). Oil consumption was insigni cant. The fuel tank was located 2.7 m (8.8 ft) above ground level, which made lling from average height gravity fuel tanks dif cult.

The rotary radiator screen plugged occasionally when operating with heavy tail winds (FIGURE 5), however it prevented any major radiator plugging. The engine air intake used a screened pre-cleaner, an aspirated pre-cleaner and two dry lters. Periodic cleaning of the outer dry element was needed.

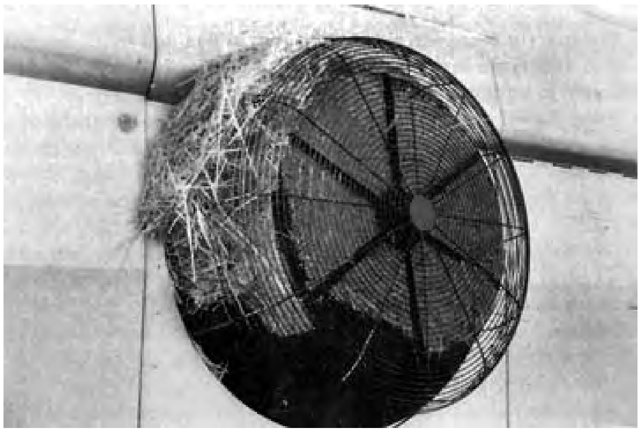

FIGURE 5. Plugged Rotary Inlet Screen.

Maneuverability: The Gleaner N-6 was very maneuverable. The steering was smooth and responsive, and the wheel brakes positive. The turning radius was about 6 m (20 ft) making it unnecessary to use the wheel brakes for picking around most corners. The hydrostatic drive made backing up easy on dif cult-to-pick corners.

Stability: The Gleaner N-6 was very stable in the eld even with
a full grain tank. Normal caution was needed on hillsides. The combine transported well at speeds up to 38 km/h (24 mph), but over-steering at this speed could cause loss of control.

Grain Tank: The grain tank volume was 8.6 m³ (237 bu). The tank lled evenly in all crops. The operator could observe the grain level through the rear cab window until the tank was nearly full. A light and four-second audio alarm indicated a full grain tank.

The unloading auger had ample reach and clearance for easy unloading on-the-go (FIGURE 6). Unloading a full tank of dry wheat took about 135 seconds.

Pickup: The Gleaner N-6 was equipped with a 3215 mm (126 in) Melroe 378 two roller draper pickup with steel teeth, an intermediate transfer draper and windguard. Picking height was controlled by castor wheel adjustment while picking angle was determined by adjustable support chains and the header height setting.

FIGURE 6. Unloading Auger Clearance.

The pickup performed well at speeds up to 10 km/h (6 mph). It fed evenly and uniformly in all crops. In rapeseed, the windguard had to be removed to prevent bunching add excessive shelling.

The pickup was hydrostatically driven. Draper speed was regulated by an electric ow control valve. The speed control was adequate in uniform windrows, but was not responsive enough in varying windrows. Maximum draper speed was too slow in light windrows. The test machine was also equipped with an optional automatic pickup speed control, which automatically changed pickup speed as ground speed changed. Performance of the automatic speed control was erratic and uncertain throughout the test. It is recommended that the manufacturer improve the pickup speed change responsiveness, increase maximum pickup speed and improve the operation of the optional automatic pickup speed control.

Stone Protection: The Gleaner N-6 was equipped with a thresher concave door, which tripped open as a stone or object entered the rotor. The trip system was effective in preventing rotor or concave damage. Whenever the concave door tripped open, straw and chaff fell onto the screen panel below the cleaning fan inlet. Removal of this straw and chaff was dif cult and dirty. It is recommended that the manufacturer consider modi cations to improve the ease of removing stone trap ef uent from the fan inlet panel.

Straw Spreader: The combine was equipped with a single four bat straw spreader. Spreading width was up to 4 m (13 ft) in calm conditions (FIGURE 7). Wind greatly reduced spreading effectiveness. The spreader was easily removed to permit windrowing the straw. As is common with most rotary combines, the rotor broke the straw into short lengths and a straw chopper was not needed. As a result, the straw usually was unsuitable for baling.

FIGURE 7. Straw Spreader Operation.

Plugging: Feeding was even and non-restricted in uniform windrows. The table auger plugged occasionally in bunchy windrows or when cornering. Feeding off-centre had no affect on threshing or separation, but increased table auger plugging. Two additional springs were added to the table auger slip clutch, greatly improving table auger capacity. Unplugging the table auger was inconvenient and dif cult. It is recommended that the manufacturer consider supplying eight springs on the table auger slip clutch as standard equipment for windrow operation and supplying a wrench and hub to facilitate 1able auger unplugging.

The lower feeder conveyor plugged frequently in heavy windrows. A new slip clutch was installed, but the conveyor continued to plug frequently until the slip clutch spring tension was increased beyond the manufacturer's recommended setting. Unplugging the lower feeder was usually accomplished by reversing the table auger by hand.

The rotor plugged occasionally in tough windrows. Unplugging was convenient and easy. In all cases the slug could be powered out by shifting the rotor gearbox into low, lowering the concave and engaging the separator.

The cage sweep plugged frequently in wheat and rapeseed if the optional cage covers were not used. Cage covers eliminated the problem. Cage covers were not necessary in barley or rye.

Machine Cleaning: Cleaning the Gleaner N-6 for combining seed grain was laborious and time consuming. The grain tank had many braces and support members, which made cleaning inconvenient. The rotor cage housing had many cavities, which retained seeds, dust and chaff. It was dif cult to clean around the cage and the distribution augers. A large amount of grain accumulated ahead of the shoe beneath the accelerator rolls, requiring entry onto the chaffer for cleaning. The chaffer and sieve had to be removed to clean the grain and tailings cross augers. Removal was easy, but required two people. The exterior of the combine was easily cleaned.

Lubrication: Ease of lubrication was good. Most lubrication points were accessible. The Gleaner N-6 had sixty-one pressure grease ttings. Nine needed greasing every 10 hours, fty every 50 hours and two seasonally. Access to the grease tting for the rotor drive spline was extremely dif cult. It is recommended that the manufacturer consider improving the ease of lubrication of the rotor drive spline.

EASE OF ADJUSTMENT

Field Adjustment: The Gleaner N-6 was easy to adjust and could be set by one person. Rotor speed and fan inlet opening were adjusted from the cab while concave clearance and chaffer and sieve openings were adjusted on the machine. Return tailings could not be inspected. A method of sampling return tailings would be bene cial in setting the combine. It is recommended that the manufacturer consider supplying a safe, convenient method for sampling the return tailings.

Concave Adjustment: The Gleaner N-6 had a single segment adjustable threshing and separating concave (FIGURE 8) and a 360 degree stationary separating cage (FIGURE 9).

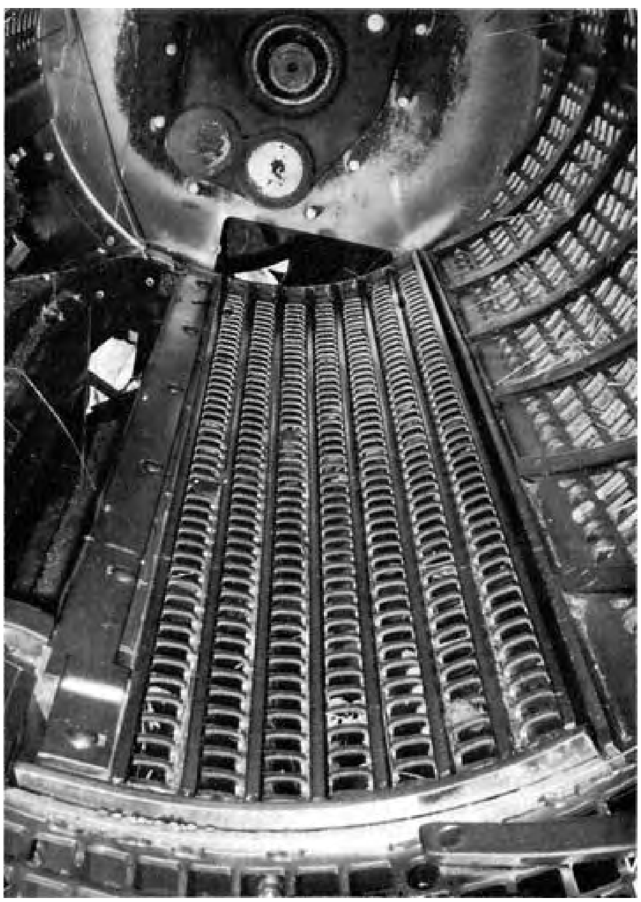

FIGURE 8. Adjustable Concave.

A method of levelling and zeroing the concave was not included in the operator's manual. To obtain access to the concave for levelling, a segment of the cage behind the concave had to be removed. Two eyebolts were provided at the rear of the concave for making initial settings, while the front adjusting cams could be repositioned for setting the front. For test purposes, the concave clearance indicator was set at zero with a 2 mm (0.08 in) concave clearance, front and rear. It is recommended that a method for initial zeroing and levelling the concave be provided in the operator manual.

FIGURE 9. Rotor Cage.

Threshing clearances were easily set with an adjusting ratchet on the right of the combine. Front concave clearance could be varied from 2 to 36 mm (0.08 to 1.42 in) while the rear concave clearance ranged from 2 to 18 mm (0.08 to 0.71 in).

Suitable concave indicator settings for harvesting were 0 in ax, 0 to 1/4 in hard-to-thresh wheat, 1/4 to 1/2 in fall rye and easy-to-thresh wheat, 1/2 to 1 in barley and 1 to 1-1/4 in rapeseed.

The separating cage was not adjustable. It contained raised spiral bars to direct the crop through the rotor cage. Optional retarder ngers were available, but were not tested.

Rotor Adjustment: The rotor was driven through a two speed gearbox and a variable speed belt. Rotor speed could be adjusted with an electro-hydraulic control and monitored from the cab. The drive provided rotor speeds from 210 to 510 rpm in low range and from 450 to 1070 rpm in high range. These speed ranges were adequate.

Suitable rotor speeds were 1050 rpm in ax and tough wheat, 950 to 1000 rpm in dry wheat, 850 to 950 rpm in fall rye, 700 to 850 rpm in barley and 650 to 700 rpm in rapeseed.

Shoe Adjustment: Shoe adjustment was convenient and the shoe was easy to set. Chaffer and chaffer extension, and clean grain sieve openings were adjusted with levers at the rear of the shoe while fan inlet opening was controlled with a crank located in the cab.

The shoe used a two stage cleaning system. Initial cleaning was by air blast through the stream of grain and chaff coming from the accelerator rolls. Final cleaning was accomplished at the chaffer and sieve. Since air velocities were very high and the fan shutter adjustment was sensitive, care had to be taken in setting the shoe to prevent airborne losses, especially in rapeseed and ax.

The shoe performed well in all crops. Foreign material in the grain tank varied from 0.3 to 0.8%.

Header Adjustment: The Gleaner N-6 was tested only with the pickup attachment for windrowed, crops. The table, which was equipped with standard quick release locks, could be removed by one person in about 15 minutes.

Adjustments were provided for header raise and drop rate, header levelling, feeder chain tension and table auger clearance.

Slip Clutches: Individual slip clutches protected the table auger, lower feed conveyor, return tailings elevator and cage sweep drives.

RATE OF WORK

Average Workrates: TABLE 3 presents average workrates for the Gleaner N-6 in all the crops harvested during the test. As average workrates are affected by crop conditions, windrow quality, eld conditions and availability of grain handling equipment, they should not be used to compare combines tested in different years. Average workrates varied from 11.4 t/ha (418 bu/hr) in 3.0 t/ha (44 bu/ac) Neepawa wheat to 3.8 t/ha (167 bu/hr) in 1.9 t/ha (34 bu/ac) Midas rapeseed.

Maximum Feedrate: The workrates in TABLE 3 represent average workrates at acceptable loss levels. In most crops much higher feedrates could be attained when operating near the engine power limit. The maximum acceptable feedrate was limited by either grain loss or engine power while the maximum feedrate was limited by engine power in average to heavy crops and by pickup performance in light crops.

TABLE 3. Average Workrates.

Crop	Variety	Average Yield t/ha	Average Speed km/h	Average Workrate	
				ha/h	t/h
Barley	Betzes	2.7	5.5	2.7	7.3
Barley	Hector	3.1	5.5 & 3.0	1.8	6.6
Barley	Klages	3.5	5.5	2.0	7.0
Barley	Melvin	2.4	5.5 & 3.0	2.7	6.5
Flax	Dufferin	1.1	9.5	3.8	4.2
Rapeseed	Altex	1.8	6.0	3.3	5.9
Rapeseed	Candle	1.5	6.5	2.6	3.9
Rapeseed	Midas	1.9	4.0	2.0	3.8
Rapeseed	Regent	1.5	6.5	2.7	4.1
Rapeseed	Torch	1.5	46.5	3.0	4.5
Rye	Puma	1.1	10 & 8.0	5.0	5.5
Wheat	Neepwa	3.0	9 & 4.0	3.8	11.4
Wheat	Sinton	2.1	10 & 6.0	3.2	6.7

Throughput was reduced in tough cereal crops and greatly reduced in tough rapeseed crops.

Capacity: Combine capacity is the maximum rate at which a combine, adjusted for optimum performance, can harvest a crop at a speci ed total loss level. Many crop variables affect combine capacity. Crop type and variety, grain and straw yield and moisture content, local climatic conditions and windrow quality cause capacity variations.

MOG Feedrate, MOG/G Ratio and Percent Loss: When determining combine capacity, combine performance and crop condition must be expressed in a meaningful way. The loss characteristics of a combine depend mainly on two factors, the quantity of the straw and chaff being processed and the quantity of grain being processed. The mass of the straw and chaff passing through a combine per unit time is called MOG Feedrate. MOG is an abbreviation for "Material-Other-than-Grain" and represents the mass of all plant material passing through the combine except for the grain or seed.

The mass of grain or seed passing through the combine per unit time is called Grain Feedrate. The ratio of the MOG Feedrate to Grain Feedrate, abbreviated as MOG/G, indicates how dif cult a crop is to separate. For example, if a combine is used in two wheat elds of identical yield, one with long straw and one with short straw, the combine will have better separation ability in the short crop and will be able to operate faster. This crop variable is expressed as the MOG/G ratio. MOG/G ratios for prairie wheat crops vary from about 0.5 to 1.5.

Grain losses from a combine are of two main types, unthreshed grain or seed still in the head and threshed grain or seed, which is discharged with the straw and chaff. Unthreshed grain is called cylinder loss. Free grain in the straw and chaff is called separator loss and consists of shoe and walker (or rotor) loss. Losses are expressed as a percent of total grain passing through the combine. Combine capacity is expressed as the maximum MOG Feedrate at which total grain loss (cylinder loss plus separator loss) is 3% of the total grain yield.

Capacity of the Gleaner N-6: TABLE 4 presents capacity results for the Allis-Chalmers Gleaner N-6 in four different crops. MOG Feedrates at 3% total grain loss varied from 18.3 t/h (670 lb/min) in 2.7 t/ha (40 bu/ac) Neepawa wheat to 16.0 t/h (587 lb/min) in 3.3 t/ha (61 bu/ac) Hector barley.

GRAIN LOSS CHARACTERISTICS

The grain loss characteristics for the Gleaner N-6 in the four crops described in TABLE 4 are presented in FIGURES 10 to 13.

Rotor Loss: Rotor loss was low over the operating range in wheat, but became signi cant at higher feedrates in barley.

Harvesting double windrows had no affect on combine capacity.

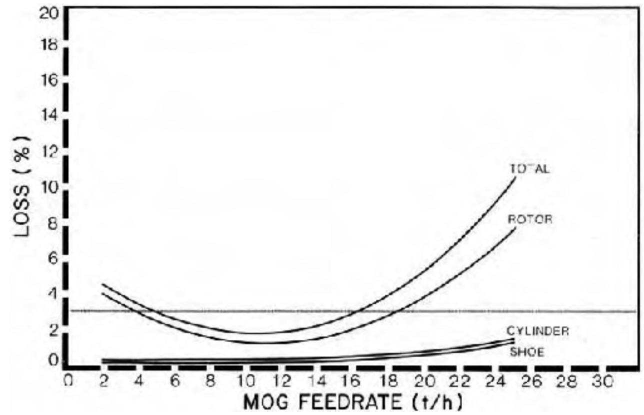

FIGURE 10. Grain Loss in Hector Barley (Field A - Double Windrow).

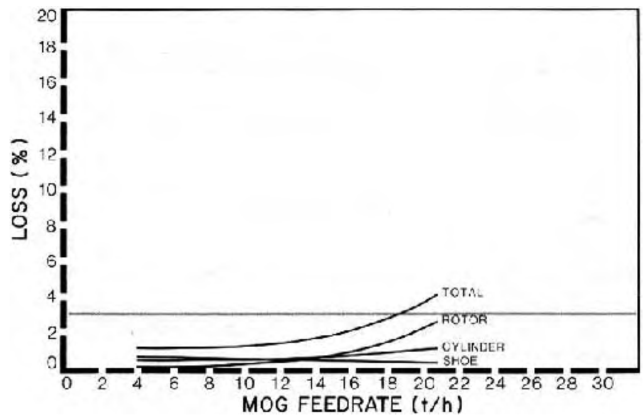

FIGURE 11. Grain Loss in Neepawa Wheat (Field C - Double Windrow).

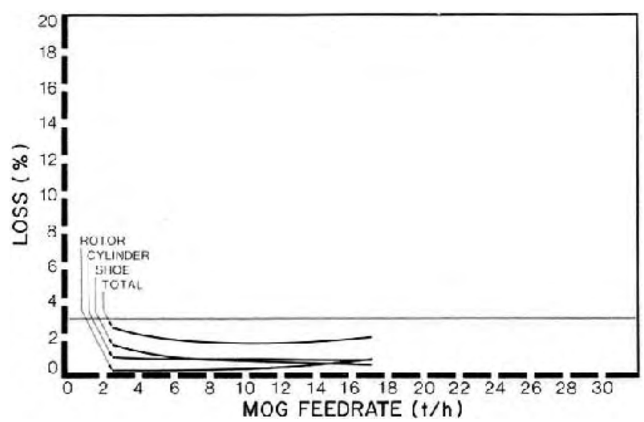

FIGURE 12. Grain Loss in Neepawa Wheat (Field D - Single Windrow).

Shoe Loss: Shoe loss was low and did not limit combine capacity. The pre-cleaning air blast prevented chaffer overloading at high feedrates or when operating on side slopes. At optimum shoe settings, losses increased when the combine was not adequately loaded.

Cylinder Loss and Grain Damage: Cylinder loss was low in dry, mature crops. Grain cracks varied from about 0.5% in Hector barley to 2% in Neepawa wheat (FIGURE 14). In most crops, the Gleaner N-6 had lower cylinder loss and less grain damage than the reference combine.

TABLE 4. Capacity at a Total Loss of 3% of Yield.

Crop Conditions							Capacity Results			
Crop	Variety	Width of Cut m	Crop Yield t/ha	Grain Moisture		MOG/G	MOG Feedrate t/h	Grain Feedrate t/h	Ground Speed km/h	Loss Curve
				Straw %	Grain %					
Barley (A)	Hector[1]	12.2	3.25	13.9	16.0	0.69	16.0	23.2	5.8	Fig. 10
Wheat (C)	Neepawa[1]	12.2	2.70	8.1	12.9	0.84	18.3	21.8	6.6	Fig. 11
Wheat (D)	Neepawa	6.1	2.85	6.4	11.6	0.95	17.1	18.0	10.4	Fig. 12
Wheat (D)	Neepawa[1]	12.2	3.00	5.9	11.1	0.97	17.7	18.2	5.0	Fig. 13

[1]Side by Side Double Windrow

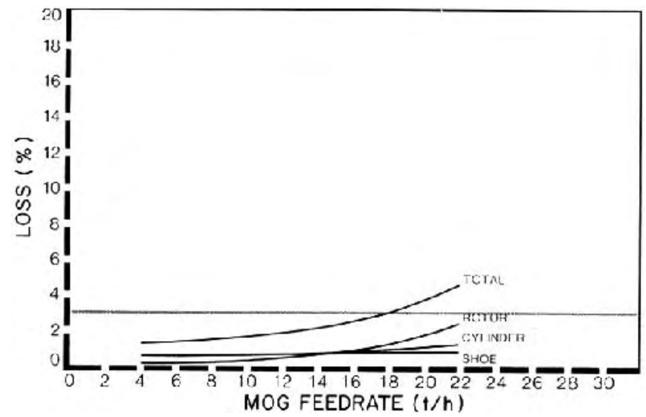

FIGURE 13. Grain Loss in Neepawa Wheat (Field D - Double Windrow).

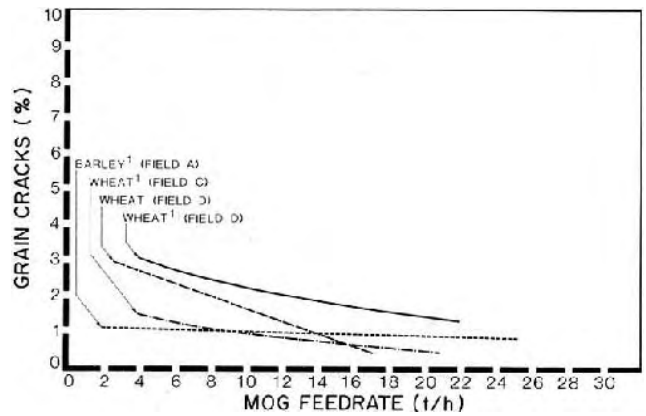

FIGURE 14. Grain Damage.

Body Loss: Leakage of grain from the combine body was negligible in both grain and oilseeds.

Comparison to Reference Combine: Comparing combine capacities is complex because crop and growing conditions affect combine performance with the result that slightly different capacity characteristics can be expected every year. As an aid in determining relative combine capacities, PAMI uses a reference combine. This combine is operated alongside test combines whenever capacity measurements are made. This permits the comparison of loss characteristics of every test combine to those of the reference combine, independent of crop conditions. The reference combine used by PAMI is commonly accepted in the prairie provinces and is described in PAMI evaluation report E0576C. See APPENDIX III for PAMI reference combine capacity results.

FIGURES 15 to 18 compare the total grain losses of the Gleaner N-6 and the PAMI reference combine in the four crops described in TABLE 4. The shaded areas on the gures are 95% con dence belts. If the shaded areas overlap, the loss characteristics of the two combines are not signi cantly different whereas if the shaded areas do not overlap, losses are signi cantly different. The capacity of the Gleaner N-6 was much greater than the reference combine capacity in wheat and barley.

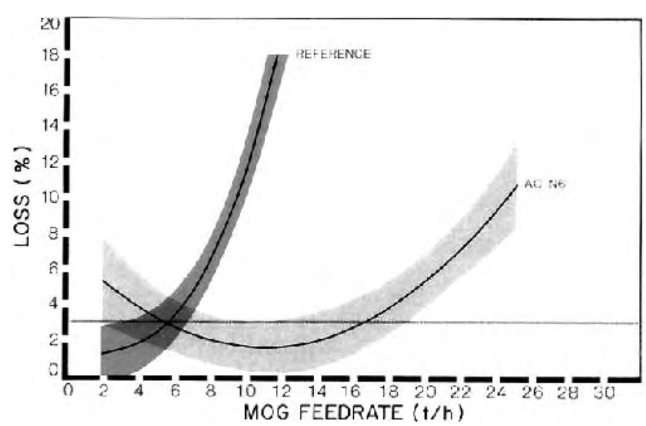

FIGURE 15. Total Grain Loss in Hector Barley (Field A - Double Windrow).

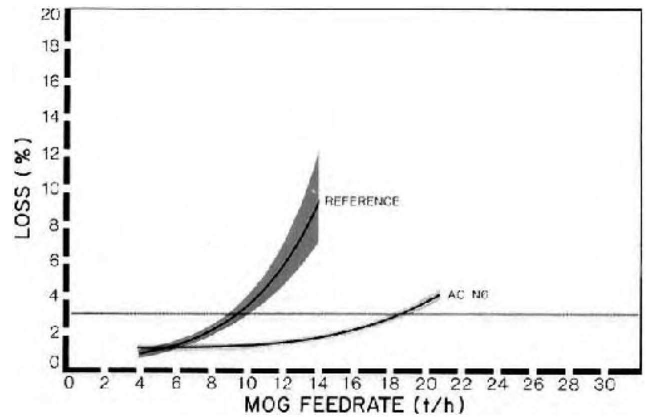

FIGURE 16. Total Grain Loss in Neepawa Wheat (Field C - Double Windrow). Page 8

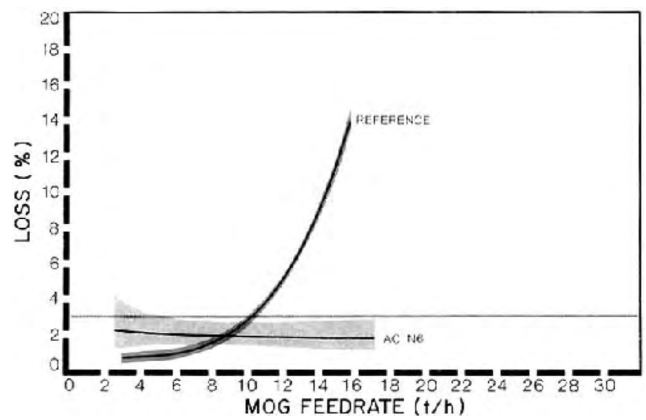

FIGURE 17. Total Grain Loss in Neepawa Wheat (Field D -Single Windrow).

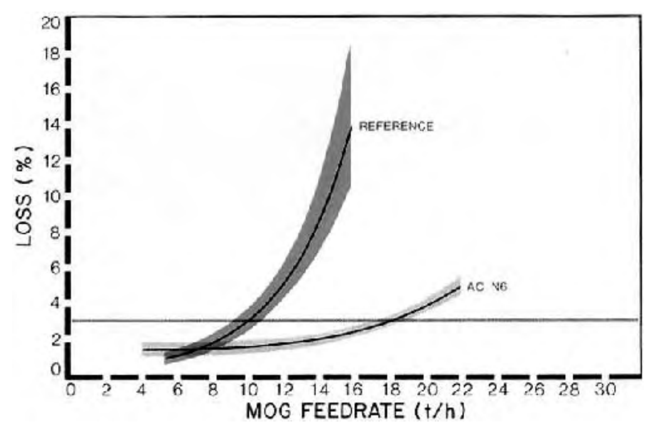

FIGURE 18. Total Grain Loss in Neepawa Wheat (Field D - Double Windrow).

OPERATOR SAFETY

The operator's manual emphasized operator safety. The Gleaner N-6 had adequate warning decals to warn of dangerous areas and shields to provide good protection from moving parts. Most shields were hinged to allow easy access.

The combine was equipped with a slow-moving vehicle sign, warning lights, taillights, signal lights and rear view mirrors for safe road transport.

A header lock was provided and it should be used when working near the header or when the combine is left unattended.

A rocking wrench and hub were not provided for unplugging the table auger, which invites an operator to work in a potentially dangerous area. All clutches should be disengaged and the engine shut off before attempting to clear obstructions.

Most machine adjustments could be made safely, however, when adjusting the shoe, the over center catches fastening the sieve access door snapped open with considerable force, often striking a painful blow. The operator, when stepping up from the cab to the ladder platform, often struck his head on the top of the door opening.

A re extinguisher (class ABC) should be carried on the combine at all times.

OPERATOR'S MANUAL

The operator's manual was clearly written and well illustrated. It contained much useful information on safe operation, controls, adjustments, crop setting, servicing and trouble shooting.

Fan settings suggested in the operator's manual for wheat, barley and rapeseed were too high causing excessive grain loss over the shoe. It is recommended that the manufacturer consider reducing the fan setting suggested for wheat, barley and rapeseed.

DURABILITY RESULTS

T ABLE 5 outlines the mechanical history of the Gleaner N-6 during 176 hours of eld operation while harvesting about 613 ha (1515 ac). The intent of the test was functional performance evaluation. Extended durability testing was not conducted.

TABLE 5. MECHANICAL HISTORY

Item	Operating Hours	Field Area ha
Drives		
-Oil leaked from between the two halves of the lower variable speed cylinder drive sheave. The sheave was removed and the back up ring straightened at	20	100
-The engine power take-off support bolts broke and were replaced at	80	280
-The unloading drive slipped intermittently until a manufacturer's modified drive was installed at	114	415
-The pickup pump drive chain wore out and was replaced at	130	465
-The female spline on the rotor drive stripped. The rotor was removed and a new spline housing installed at	145	516
-The adjustment slot for the clean grain drive idler deformed, preventing proper drive tensioning. The slot was reinforced at	145	516
-The lock collars on the input shaft of the cage sweep drive loosened, preventing the angle drive gear from meshing. The gears were realigned and the shaft locked to the bearings at	160	576
Miscellaneous		
-The speed wheel on the pickup for the automatic speed control interfered with the top pickup roller shaft. The pickup was shimmed at the mounting bracket to provide clearance at	start of test	
-The cab heater valve stuck open at	74	250

DISCUSSION OF MECHANICAL HISTORY

Unloading Auger Drive: Drive slip occurred frequently until a manufacturer's modi ed drive was installed. It is recommended that the manufacturer provide the modi ed drive as standard equipment.

Clean Grain Drive: The adjustment slot for the clean grain drive deformed when the idler bolt was tightened, preventing proper drive tensioning. It is recommended that the manufacturer consider modifying the clean grain idler tensioning track to eliminate slot deformation.

Rotor Drive Hub: The female drive spline on the rotor hub, stripped with no damage to the male spline on the gearbox. Replacing the hub required rotor removal. Removal was time consuming. It is recommended that the manufacturer consider modi cations to improve spline durability and modifying the left rotor support assembly to facilitate quicker rotor removal.

APPENDIX I
SPECIFICATIONS

MAKE:	Allis-Chalmers Self-Propelled Combine
MODEL:	Gleaner N-6
SERIAL NUMBER:	Header N-P02112H Body N6G020201180 Engine 70-08671
MANUFACTURER:	Allis-Chalmers Corporation-Combine Division 627 South Cottage Street Independence, Missouri 64051 U.S.A.
WINDROW PICKUP:	
--make and model	Melroe 378
--type	rubber draper with rubber transfer draper
--pickup width	3215 mm
--number of belts	7
--teeth per belt	70
--type of teeth	spring steel
--number of rollers	4
--height control	castor wheels
--speed control	hydrostatic
--speed range	0 to 2.3 m/s
HEADER:	
--type	centre feed
--width 4940 mm	
--auger diameter	610 mm
--feeder conveyor	2 stage, 3 roller chains, under-shot slatted conveyor
--conveyor speed	
-upper conveyor	2.45 m/s
-lower conveyor	2.35 m/s
--range of picking height	-135 to 1215 mm
--number of lift cylinders	2
--raising time	adjustable
--lowering time	adjustable
--options	corn and straight-cut headers
STONE PROTECTION:	
--type	spring loaded latch on door in front of concave
--ejection	automatic with manual reset
ROTOR:	
--crop ow	axial
--number of rotors	1
--type	rasp bar with discharge paddles
--diameter	640 mm
--length	
-feeding and threshing	2015 mm
-discharge	175 mm
-total	2190 mm
--drive	variable pitch belt and 2 speed gearbox
--speeds	
-low range	210 to 510 rpm
-high range	450 to 1070 rpm
CONCAVE (THRESHING):	
--number	1
--type	bars separated by formed metal
--number of bars	8
--con guration	7 intervals with 6.5 mm spacers and 16 by 24 mm openings
--area total	0.401 m²
--area open	0.129 m²
--wrap	50 degrees
--grain delivery to shoe	distribution augers and accelerator rolls
CONCAVE (SEPARATING):	
--number	1
--type	perforated formed metal
--area total	3.943 m²
--area open	1.610 m²
--wrap	360 degrees
--grain	delivery to shoe distribution augers and accelerator rolls
THRESHING AND SEPARATING CHAMBER:	
--number of spirals	12
--pitch of spirals	8 at 47 degrees and 4 at 22 degrees
DISCHARGE BEATER:	
--type	4 paddle
--diameter	560 mm
--width	280 mm
--speed	780 rpm
SHOE:	
--type	single action
--speed	280 rpm
--chaffer sieve	adjustable lip, 1.66 m² with 38.5 mm throw
--chaffer extension sieve	adjustable lip. 0.33 m²
--clean grain sieve	adjustable lip, 1.68 m² with 38.5 mm throw
--options	perforated elevator boot covers, sieve panel and shoe bottom

ACCELERATOR ROLLS:
--number 2
--type timed, rubber cogged rollers
--width 1570 mm
--speed 1075 rpm

CLEANING FAN:
--type squirrel cage cross-flow
--diameter 295 mm
--width 1590 mm
--control variable inlet

ELEVATORS:
--type roller chain with rubber flights, top delivery
--clean grain (top drive) 230 x 260 mm
--tailings (top drive) 143 x 220 mm

GRAIN TANK:
--capacity 8.62 m^3
--unloading time 135 s
--option perforated section for unloader tube

STRAW SPREADER:
--number of spreaders 1
--type steel hub with 4 rubber bats
--speed 255 rpm

ENGINE:
--make and model Allis-Chalmers 670 HI
--type 4 stroke, turbocharged and intercooled diesel
--number of cylinders 6
--displacement 6.98 L
--governed speed (full throttle) 2835 rpm
--manufacturer's rating 164 kW @ 2600 rpm
--fuel tank capacity 568 L

CLUTCHES:
--separator electro-hydraulic
--header electro-magnetic
--unloading auger electro-hydraulic v-belt tightener

NUMBER OF CHAIN DRIVES: 4

NUMBER OF BELT DRIVES: 20

NUMBER OF GEARBOXES: 1

NUMBER OF PRELUBRICATED BEARINGS: 76

LUBRICATION POINTS:
--10 hr lubrication 9
--50 hr lubrication 50
--200 hr lubrication 2

TIRES:
--front 2, 30.5 L x 32
--rear 2, 124 x 24

TRACTION DRIVE:
--type hydrostatic
--speed ranges
-1st gear 0 to 4.7 km/h
-2nd gear 0 to 9.3 km/h
-3rd gear 0 to 18.7 km/h
-4th gear 0 to 37.8 km/h

OVERALL DIMENSIONS:
--wheel tread (front) 3135 mm
--wheel tread (rear) 3070 mm
--wheel base 3425 mm
--transport height 3420 mm
--transport length 8925 mm
--transport width 4940 mm
--field height 3620 mm
--field length 8460 mm
--field width 4940 mm
--unloader discharge height 3335 mm
--unloader clearance height 2930 mm
--unloader reach 3175 mm
--turning radius
-left 6 375 mm
-right 5985 mm

MASS: (with empty grain tank):
--right front wheel 4100 kg
--left front wheel 3985 kg
--right rear wheel 1460 kg
--left rear wheel 1435 kg
TOTAL 10980 kg

APPENDIX II
REGRESSION EQUATIONS FOR CAPACITY RESULTS

Regression equations for the capacity results shown in FIGURES 10 to 13 are represented in TABLE 6. In the regressions, C = cylinder loss in percent of yield, S = shoe loss in percent of yield, R = rotor loss in percent of yield, F = the MOG feedrate in t/h, while $\ln$ is the natural logarithm. Sample size refers to the number of loss collections. Limits of the regressions may be obtained from FIGURES 10 to 13 while crop conditions are presented in TABLE 4.

TABLE 6. Regression Equations

Crop - Variety	Fig. No.	Regression Equations	Simple Correlation Coefficient	Variance Ratio	Sample Size
Barley - Hector	15	$C = 0.30 + 3.0 \times 10^{-6}F^4$ $S = 0.19 + 3.0 \times 10^{-6}F^4$ $R = 5.3 - 0.72 + 0.03F^2$	0.88 0.80 0.92	27.25[2] 14.57[2] 18.89[2]	10
Wheat - Neepawa	16	$\ln C = -1.15 + 0.06F$ $S = 0.72 - 0.02F$ $R = 0.07 + 1.4 \times 10^{-5}F^4$	0.94 0.79 0.99	55.10[2] 11.76 345.00[2]	9
Wheat - Neepawa	17	$\ln C = -0.08 - 0.07\ln F$ $\ln S = 1.01 - 0.61\ln F$ $\ln R = -2.63 + 0.14F$	0.20 0.90 0.98	0.21 22.05[2] 108.76[2]	7
Wheat - Neepawa	18	$\ln C = -0.87 + 0.05F$ $S = 0.52 + 0.02F$ $\ln R = -2.68 + 0.16F$	0.97 0.22 0.99	88.74[2] 0.25[2] 394.01[2]	7

[1]Significant at $P \leq 0.05$
[2]Significant at $P \leq 0.01$

APPENDIX III
PAMI REFERENCE COMBINE CAPACITY RESULTS

TABLE 7 and FIGURES 19 and 20 present the capacity results for the PAMI reference combine in wheat and barley crops harvested from 1976 to 1980.

FIGURE 19 shows capacity differences in Neepawa wheat for the ve years. Most 1980 Neepawa wheat crops shown in TABLE 7 were of average straw yield and better than average grain yield. Most of the crops were average-to-thresh while the grain moisture content was slightly lower than other years and the straw moisture content was average to lower than normal.

FIGURE 20 shows capacity differences in six-row Bonanza barley for 1976 to 1978, two-row Fergus barley for 1979 and two-row Hector barley for 1980. The 1980 Hector barley crops shown in TABLE 7 were of average straw yield, easy-to-thresh, and average straw and grain moisture content.

Results show that the reference combine is important in determining the effect of crop variables and in comparing capacity results of combines evaluated in different growing seasons.

TABLE 7. Capacity of the PAMI Reference Combine at a Total Grain Loss of 3% of Yield.

	Crop Conditions							Capacity Results			
			Width of Cut	Crop Yield	Grain Moisture			MOG Feedrate	Grain Feedrate	Ground Speed	
Year	Crop	Variety	m	t/ha	Straw %	Grain %	MOG/G	t/h	t/h	km/h	Loss Curve
1980	Barley (A)	Hector	6.1	3.48	13.8	14.5	0.69	5.5	8.0	3.8	Fig. 21
	Barley (B)	Hector	6.1	3.16	13.4	14.4	0.68	5.8	8.5	4.4	
	Wheat (C)	Neepawa[1]	12.2	2.87	7.2	13.2	0.88	9.4	10.6	3.0	
	Wheat (D)	Neepawa[1]	6.1	3.12	6.0	11.4	0.98	10.1	10.3	5.4	Fig. 20
	Wheat (D)	Neepawa[1]	12.2	3.09	3.2	12.2	1.02	10.2	10.0	2.7	
	Wheat (E)	Neepawa	6.1	3.00	4.9	10.8	0.91	10.3	11.3	6.2	
1979	Barley	Klages	6.1	3.67	dry	11.7	0.64	6.8	10.6	4.7	
	Wheat	Neepawa	7.3	2.77	dry	14.1	1.21	9.5	7.8	3.9	
	Wheat	Neepawa	6.1	2.67	dry	14.3	1.09	9.7	8.9	5.4	Fig. 20
	Barley	Fergus	7.3	3.46	dry	12.5	0.77	7.3	9.5	3.7	Fig. 21
1978	Wheat	Canuck	7.3	2.54	7.1	12.1	1.15	11.8	10.3	5.6	
	Wheat	Lemhi[1]	11.0	2.13	6.6	12.0	0.75	10.9	14.5	6.2	
	Wheat	Neepawa	6.1	4.37	10.4	15.9	1.04	9.3	8.9	4.5	Fig. 20
	Barley	Bonanza	6.1	4.06	7.7	13.5	0.68	6.1	9.0	3.6	Fig. 21
1977	Wheat	Neepawa	6.1	3.97	13.4	14.6	0.79	11.1	14.1	5.8	Fig. 20
	Barley	Bonanza	7.3	4.74	25.7	14.6	0.84	7.9	9.4	2.7	Fig 21
1976	Wheat	Neepawa	5.5	2.78	dry to tough	14.7	1.29	7.1	5.5	3.6	Fig. 20
	Barley	Bonanza	7.3	3.18	dry to tough	14.6	0.96	4.8	5.0	2.2	Fig 21

[1]Side by Side Double Windrow

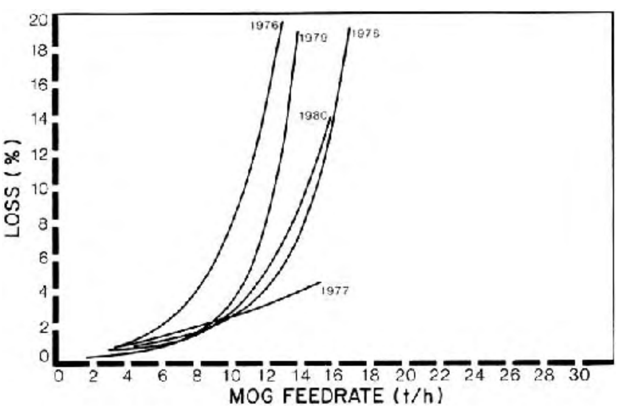

FIGURE 19. Total Grain Loss for the PAMI Reference Combine in Neepawa Wheat.

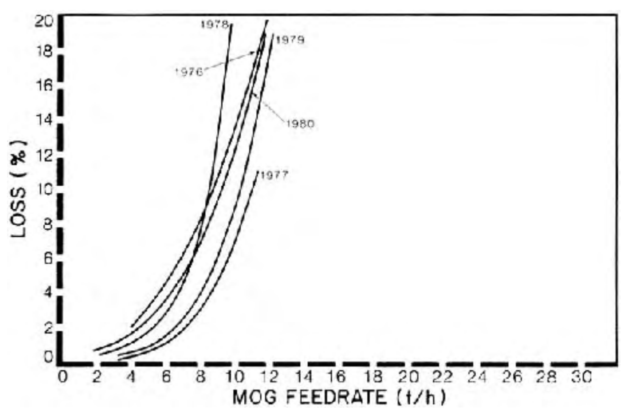

FIGURE 20. Total Grain Loss for the PAMI Reference Combine in Barley.

APPENDIX IV
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

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

APPENDIX V
CONVERSION TABLE

1 kilometre/hour (km/h) = 0.06 miles/hour (mph)
1 hectare (ha) = 2.5 acres (ac)
1 kilogram (kg) = 2.2 pounds mass (lb)
1 tonne (t) = 2200 pounds mass (lb)
1 tonne/hectare (t/ha) = 0.5 ton/acre (ton/ac)
1 tonne/hour (t/h) = 37 pounds/minute (lb/min)
1 kilowatt (kW) = 1.3 horsepower (hp)
1 litre/hour (L/h) = 0.2 Imperial gallons/hour (gal/h)
1 metre (m) = 3.3 feet (ft)
1 millimetre (mm) = 0.04 inches (in)

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