Evaluation Report No. E3079B
Printed: May, 1980
Tested at: Humboldt
ISSN 0383-3445

Evaluation Report 191

Massey Ferguson 751 Pull-Type Combine

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI

PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

MASSEY FERGUSON 751 PULL-TYPE COMBINE

MANUFACTURER:
Massey Ferguson Industries Ltd.
915 King Street West
Toronto, Ontario
M6K 1E3

DISTRIBUTOR:
Massey Ferguson Industries Ltd.
Box 1340, Station T
Calgary, Alberta
T2C 1G3

RETAIL PRICE:
$36,402.00, February, 1980, f.o.b. Humboldt, with 3.89 m header, 3.39 m Massey Ferguson Model 67 pickup, straw chopper, wide spaced concave, 3 filler bars, 8 mm round hole screen, risers, tool box and table elevator paddle shields.

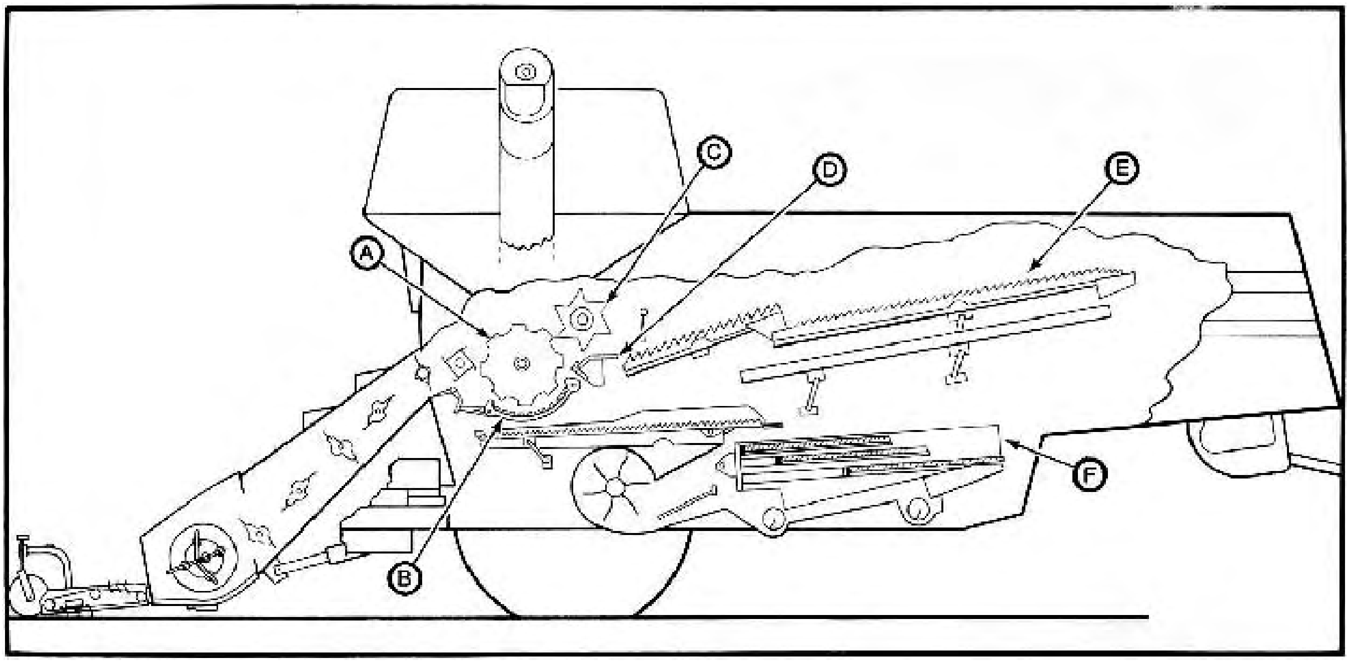

FIGURE 1. Massey Ferguson 751: (A) cylinder, (B) concave, (C) back beater, (D) beater grate, (E) straw walkers, (F) shoe.

SUMMARY AND CONCLUSIONS

Functional performance of the Massey Ferguson 751 pull-type combine was good in dry and tough grain and oilseed crops.

The MOG Feedrate* at 3% total grain loss varied from 12.1 t/h (445 lb/min) in a field of 3.4 t/ha (51 bu/ac) Neepawa wheat to 7.9 t/h (290 lb/min) in 3.3 t/ha (61 bu/ac) Fergus barley.

The capacity of the Massey Ferguson 751 was somewhat greater than the capacity of the PAMI reference combine for a similar total grain loss. Straw walker or shoe loss limited capacity in most crops. A reduction in grain loss over the straw walkers and shoe would have permitted higher combining rates. Cylinder losses were insignificant in most crops. In dry crops with high straw break-up, high shoe losses resulted from an erratic fan blast caused by fan speed variation. In crops with low straw break-up, sieve loading was not as severe and shoe losses were acceptable.

At a 3% total grain loss, average power requirements were 35 kW (47 hp) in wheat and 25 kW (34 hp) in barley. Although the manufacturer recommends a 75 kW (100 hp) tractor, a 100 kW (135 hp) tractor was required when combining in hilly fields.

The Massey Ferguson 751 was fairly maneuverable. Changing from transport to field position required caution. Header visibility, ease of handling and control convenience depended on the tractor used. Feedrate control depended upon the range of ground speeds provided by the tractor.

Grain level visibility was good. Combine lighting provided good night visibility when supplemented by tractor lights. The unloading auger was too short for easy unloading on-the-go, although vertical clearance between the auger and most truck boxes was sufficient. The combine was not equipped with full speed monitoring equipment, although the rethresher and straw chopper were protected with a warning horn.

The Massey Ferguson 751 was fairly easy to adjust, for specific field conditions. Pickup speed could not be adjusted on-the-go. Cylinder speed, concave fan and shoe adjustments were located on the combine. The shoe was difficult to set as fan speed variation caused a pulsating air blast. There was no provision to safely and quickly inspect the return tailings.

Ease of servicing was very good as most grease fittings were accessible and located in lubrication banks.

The table auger and feeder had good capacity in dry cereal and oilseed crops. Auger backfeeding often occurred due to auger out-of-round. Cylinder plugging seldom occurred. Cylinder access was fair.

The stone trap stopped most stones and roots before they entered the cylinder. The stone trap was convenient to service.

The pickup had poor feeding characteristics in most crops, and many problems were experienced with the pickup throughout the test.

The Massey Ferguson 751 transported well at speeds up to 30 km/h (20 mph). Transport width was narrow enough for easy movement on most roads, but the right side of the table protruded far over the shoulder and caution was required. Rear visibility was restricted.

Some safety hazards were encountered during operation. The operator's manual was well written and clearly illustrated, providing much useful information on operation and adjustment. Several minor durability problems occurred during the test.

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

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Supplying a hitch safety chain.
2. Modifications to strengthen the hitch assembly.
3. Modifications to reduce grain damage by the grain tank levelling auger drive chain.
4. Modifications to the unloading auger to increase reach and to eliminate leakage between the spout and auger tube.
5. Modifications to the pickup to improve feeding characteristics, to reduce plugging, and to provide on-the-go speed variation over a more suitable range.
6. Modifications to the header to facilitate inline feeding of windrows.
7. Modifications to improve table auger concentricity.
8. Modifications to the hitch to improve the ease and safety of drawpole positioning.
9. Modifications to improve ease of concave filler bar installation.
10. Modifications to the shoe to eliminate spearing of straw through the sieves.
11. Modifications to strengthen the fan drive variable speed idler support post to improve fan blast uniformity.
12. Modifications to provide for easy and safe sampling of return tailings.
13. Modifications to prevent the back beater curtain from lifting and wedging against the straw walker housing.
14. Modifications to simplify shield removal and replacement.
15. Revising the operator's manual to provide initial concave settings and revised rapeseed settings.
16. Modifications to keep the pickup support chains secured in their retainers.
17. Modifications to the pickup drive shield to reduce damage from ground contact.

Chief Engineer -- E. O. Nyborg
Senior Engineer -- J. D. MacAulay
Project Engineer -- P. D. Wrubleski

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Hitch safety chains are already available as tractor accessory part 10054A91, which will be cross referenced in future operator's manuals. Two safety chains are recommended.
2. A field rework program is in progress. Improvements have been released for next production.
3. The levelling auger drive chain shield was extended commencing machine serial No. 1001.
4. The unloading auger was extended 914 mm (3 ft) commencing machine serial No. 1001.
5. No modifications are planned as the Massey Ferguson Model 67 Pickup has been discontinued from our product line.
6. No modifications are planned as centre feeding is not possible without substantially increasing side draft.
7. This is a quality control matter, and is being drawn to factory attention for close inspection.
8. This recommendation will be further investigated.
9. Access is reasonable if the grain pan front sections are removed, so no modifications are planned.
10. No modifications are planned as Massey Ferguson does not consider this a problem.
11. This recommendation will be further investigated.
12. Sampling can be safely accomplished by using a container under the elevator cleanout door, so no modifications are planned.
13. No modifications are currently planned.
14. No modifications are currently planned.
15. The operator's manual will be reviewed and revised for the next issuance.
16. The pickup has been discontinued so no modifications are planned.
17. The pickup has been discontinued so no modifications are planned.

NOTE: This report has been prepared using SI units of measurement. A conversion table is given in APPENDIX V.

GENERAL DESCRIPTION

The Massey Ferguson 751 is a power take-off driven pull-type combine with a transverse-mounted, tangential threshing cylinder, straw walkers and a cleaning shoe. Threshing and initial separation occur at the cylinder and concave while the straw walkers accomplish final separation of grain from straw. Grain is cleaned at the shoe and the tailings delivered to a rethresher.

The test machine was equipped with a straw chopper and a 3390 mm (133 in) three-roller belt pickup mounted on a 3890 mm (12.8 ft) off-set header.

The separator drive is controlled by the tractor power take-off clutch. The header and unloading auger drives are controlled by electromagnetic clutches, while header height is controlled by the tractor hydraulics.

Concave clearance is adjusted with a special wrench while cylinder and fan speeds are controlled with hand cranks which adjust variable belt drives. Fan blast is directed with an adjustable windboard. The sieves are adjusted with levers at the rear of the shoe. There is no provision to safely and quickly sample the return tailings.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Massey Ferguson 751 was operated in a variety of Saskatchewan crops (TABLES 1 and 2) for 112 hours while harvesting about 206 ha (509 acres). It was evaluated for ease of operation, ease of adjustment, rate of work, grain loss characteristics, power requirements, operator safety and suitability of the operator's manual. Throughout the test, comparisons were made to the PAMI reference combine.

TABLE 1. Operating Conditions

Crop	Variety	Average Yield t/ha	Swath Width m	Hours	Field Area ha
Barley	Fergus	2.3	7.2	12	19
Barley	Klages	2.0	5.9 to 7.5	2	4
Flax	Dufferin	1.5	5.8 to 6.1	6	10
Rapeseed	Candle	1.8	5.1	4	6
Rapeseed	Torch	1.1	5.9 to 6.2	21	47
Rye	Cougar	1.2	4.4 to 11.9	25	51
Wheat	Neepawa	3.2	5.7 to 7.3	42	69
Total				112	206

TABLE 2. Operation in Stony Fields

Field Condition	Hours	Field Area (ha)
Stone Free	13	21
Occasional Stones	86	151
Moderately Stony	13	34
Total	112	206

RESULTS AND DISCUSSION

EASE OF OPERATION

Hitching: A tractor with a standard 35 mm (1.38 in) spline, 1000 rpm power take-off and 12 volt negative ground electrical system was required to power the Massey Ferguson 751 combine. The following adjustments were needed before attaching the tractor to the combine: The control box had to be suitably located in the tractor cab, and the control cables routed out of the cab. The tractor drawbar had to be pinned in line with the tractor power take-off shaft, providing a standard 406 mm (16 in) distance between the end of the tractor power take-off and the hitch pin centre. The drawpole had to be levelled by adjusting the drawpole clevis. The tractor had to be hitched to the combine using a suitable drawpin which locked in place. The combine power take-off shaft, the header hydraulic hose, and the electrical connectors had to be coupled to the tractor. Finally, the tire bumpers had to be positioned to prevent drawpole damage during tight turns.

No hitch safety chain was supplied and it is recommended that the manufacturer consider supplying a safety chain.

Operator Location: With a pull-type combine, operator comfort and visibility depends mainly on the tractor used. Grain level was easily viewed through a window in the front of the grain tank. Typical of pull-type combines, the operator had less “feel” for combine performance and had to rely more heavily on the monitoring equipment.

Controls: The separator drive was controlled with the tractor power take-off clutch, while header height was controlled by the tractor hydraulics. The combine control box (FIGURE 2) contained a cylinder tachometer, warning lights and switches for engaging the header drive and the grain unloading auger, as well as a switch for the combine lights. A visual and audible warning system was supplied for the rethresher and straw chopper. The warning horn was very loud and annoying to the operator. The range of ground speeds available depended upon the tractor transmission.

FIGURE 2. Tractor Mounted Control Box.

Lights: The Massey Ferguson 751 was equipped with two field lights, one for the grain tank and one for the unloading auger. Tractor field lights were adequate for satisfactory header lighting. Warning lights and taillights were adequate for safe road transport.

Stability: The Massey Ferguson 751 was fairly stable when the grain tank was less than three-quarters full. With a full grain tank, or when combining rough fields, or when changing ground speed, the combine rocked severely about a line between the right wheel and the hitch point, causing the draw pole to flex noticeably. It is recommended that the manufacturer consider modifications to strengthen the hitch assembly.

The centre of gravity with the grain tank three-quarters full of wheat was 1840 mm (73 in) above ground, 310 mm (12 in) ahead of the axle and 70 mm (3 in) to the right of the combine centre-line. With the grain tank three-quarters full, the hitch load became negative when travelling up slopes greater than 15 degrees. Care was needed when turning corners on hillsides. Adequate tractor ballast was required in hilly fields.

Maneuverability: The Massey Ferguson 751 was quite maneuverable and picked satisfactorily around most windrowed corners. The pickup, header and drawpole position did not allow fluffy or non-uniform windrows to be fed directly in line with the feeder housing opening (FIGURE 3). Shifting the header to the left and extending the drawpole would greatly improve direct feeding.

The minimum windrow width to permit passing between windrows was 4875 mm (16 ft) when combining fluffy windrows with a 2440 mm (96 in) tractor width (FIGURE 4).

Grain Tank: Grain tank volume was 5.1 m³ (140 bu). When the levelling auger was correctly adjusted, the grain tank filled completely in all crops. When the grain tank was nearly full, the levelling auger drive chain became immersed in the grain and crushed about 2 L (0.4 gal) of grain as the tank was being topped. It is recommended that the manufacturer consider modifications to reduce grain damage by the levelling auger drive chain.

The unloading auger could be placed in field position by one person if the drive pin and drive dowel were both placed in the vertical position before engagement. The auger was held in place with an over-centre lock.

The unloading auger drive was noisy and vibrated excessively when operating empty. Although auger clearance was satisfactory when unloading into trucks with high boxes or box extensions (FIGURE 5), the unloading auger had insufficient lateral reach for easy unloading. The auger delivered a concentrated stream of grain and unloaded the 5.1 m³ (140 bu) tank of dry wheat in 78 seconds. Some grain leaked from between the spout and the unloading auger tube as the spout did not fit tightly against the tube. This was eliminated by wrapping tape around the auger tube at the spout connection. It is recommended that the manufacturer consider modifications to the unloading auger to increase reach and to eliminate leakage between the spout and auger tube.

FIGURE 3. Feeding of Windrow.

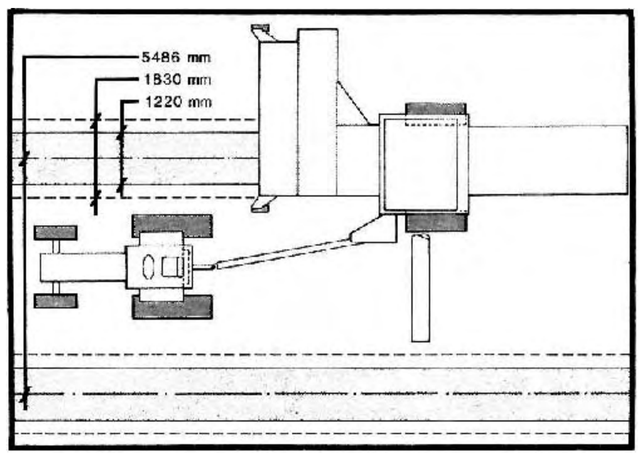

FIGURE 4. Tractor Wheel and Windrow Spacing Needed for In-Line Feeding.

FIGURE 5. Unloading Auger Clearance.

Pickup: The Massey Ferguson 751 was equipped with a Massey Ferguson Model 67 3390 mm (133 in) three roller belt pickup. Picking height was controlled by the pickup castor wheels while pickup angle was determined by header height and pickup support chain position. Pickup speed could be varied manually by changing shims in the drive sheaves.

Picking was satisfactory in all crops, but feeding characteristics were poor. Attempting to centre-feed wide windrows caused bunching on the left pickup wheel support. At higher pickup speeds or at higher pickup positions the windrow usually fed into the middle or over top of the table auger. In fall rye, barley and wild oat infested crops severe plugging often occurred between the rear pickup roller and stripper bar and no combination of rear roller position or pickup speed prevented this plugging. The outside roller ends also wrapped severely in buckwheat, causing belt separation. Pickup apron speed, which ranged from 1.3 to 1.8 m/s (255 to 355 ft/min), was too high, as even the slowest speed caused shelling in rapeseed and poor feeding in many crops. It is recommended that the manufacturer consider modifications to the pickup to improve feeding characteristics, to reduce plugging and to provide on-the-go speed variation over a more suitable range.

Stone Trap: The stone trap, located in front of the cylinder, trapped most stones and roots before they entered the cylinder. The stone trap was easy to operate (FIGURE 6), and emptied completely when tripped.

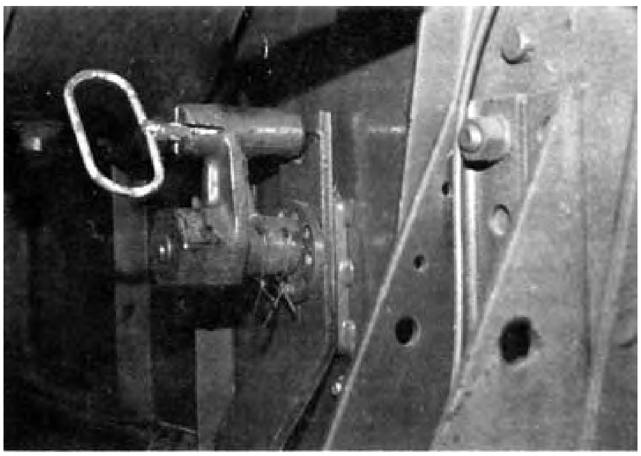

FIGURE 6. Stone Trap Release.

Straw Chopper: The optional straw chopper attachment performed satisfactorily in all crops. The length of cut could be varied by adjusting knife protrusion into the chopper housing. The width of spread could be changed by adjusting the deflector fins and the tail plate. Maximum spreading width varied from 3 to 5 m (10 to 16 ft) depending on straw and wind conditions. Spreading was inadequate for swath widths greater than 5 m (16 ft). The chopper could easily be moved rearward on railings to permit the unchopped straw to be dropped in a windrow.

Plugging: The table auger was quite aggressive in dry crops. In heavy, bunchy windrows, choking and plugging of the table auger occurred more frequently. When feeding on the right of the pickup, such as when going around corners, the table auger plugged frequently. When feeding into the centre of the feeder housing, the crop often bunched on the left pickup wheel support causing plugging. The wind guard hampered unplugging, but the feeder rocking hub and wrench greatly aided in unplugging the table auger and feeder. It is recommended that the manufacturer consider modifications to the header to facilitate in-line feeding of windrows.

Optimum feeding in most crops was obtained by removing two of the three auger flight extensions. Auger back feeding and consequent plugging occurred often as the table auger was 7 mm (0.3 in) out of round, preventing proper adjustment of the table auger stripper bar. It is recommended that the manufacturer consider modifications to improve table auger concentricity.

Although the paddle feeder (FIGURE 7) had high capacity in most crops, plugging occurred more frequently in flax, rapeseed and wild oat infested crops.

Unplugging the paddle feeder was very difficult, taking from 20 to 30 minutes, as every second paddle depressed the crop against the feeder housing bottom. Since the table auger and feeder housing slip clutches were in parallel rather than in series as on most combines, plugging was more severe. If the feeder housing plugged first, the table auger force-fed the feeder housing, while the combine was being stopped, usually causing the auger to plug. If the two clutches were installed in series, the severity of plugging would likely be reduced.

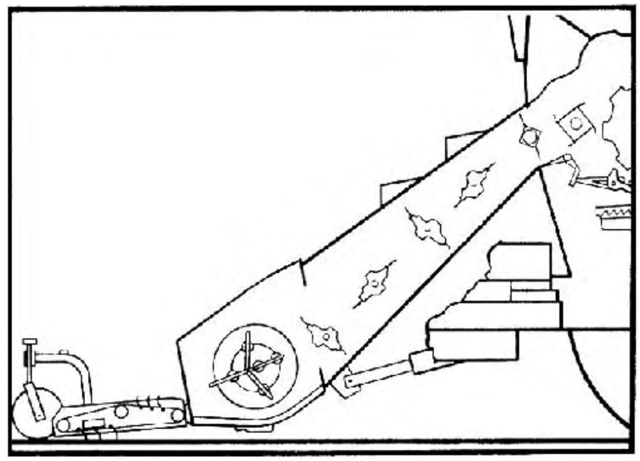

FIGURE 7. Paddle Feeder.

The cylinder was very aggressive and seldom plugged. The cylinder could usually be unplugged in 15 minutes by lowering the rear of the concave using the special eccentric provided, switching the cylinder gear box to low gear and power unplugging. Cylinder access, which was through a door ahead of the grain tank, was very inconvenient. Cylinder backfeeding often occurred in bunchy rapeseed windrows and in wads of wild oat straw.

Machine Cleaning: As with most combines, complete cleaning of the Massey Ferguson 751 was laborious and time consuming. The stone trap was easy to clean, but the grain pan was very difficult to clean. The sieves were easy to remove for cleaning of the tailings and clean grain augers. The grain tank was quite accessible and convenient to clean.

Transporting: Caution was needed when pinning the drawpole in transport or field position. The pin, located inside the cradle was difficult and unsafe to remove and install, as the operator had to reach into a severe pinch point (FIGURE 8). It is recommended that the manufacturer consider modifications to improve the ease and safety of drawpole positioning.

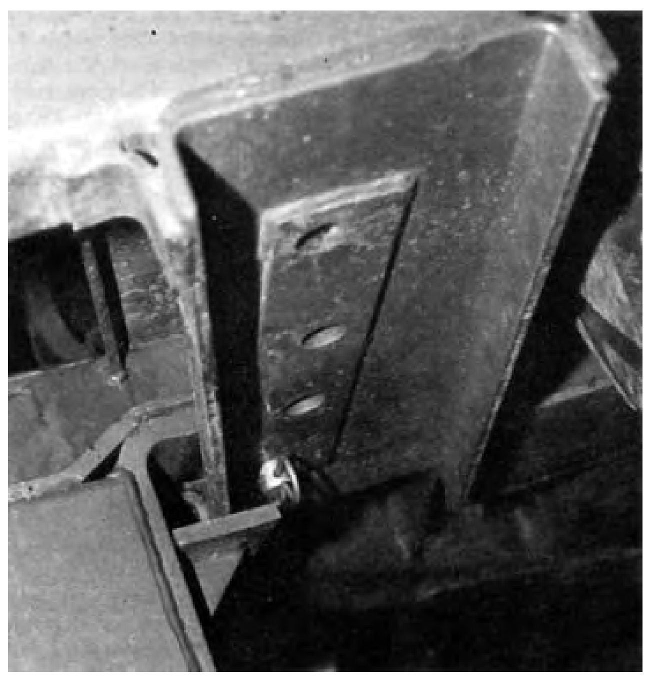

FIGURE 8. Drawpole Pivot.

The Massey Ferguson 751 transported well at speeds up to 30 km/h (20 mph). Caution was needed at higher speeds, as the combine swayed noticeably especially on rough roads. Transport width was narrow enough for easy movement on most roads, however, care had to be taken as the table extended far to the right. Rear visibility was good. The combine was adequately equipped with warning lights and a slow moving vehicle sign for safe transport on public roads.

Lubrication: The Massey Ferguson 751 had 22 pressure grease fittings. Fifteen needed greasing every 10 hours, three every 50 hours, three every 100 hours and one required greasing annually. Lubrication banks improved ease of servicing. The two gear boxes required 100 hour checks and the wheel bearings required seasonal checks. Two grease fittings, at the front power take-off telescopic section, and at the grain pan drive crank, were hard to reach.

EASE OF ADJUSTMENT

Field Adjustments: The Massey Ferguson 751 was fairly easy to adjust. As with all pull-type combines, having a second person available enabled faster setting.

Concave Adjustment: The Massey Ferguson 751 had a single segment concave. The concave could be levelled with two draw bolts at the rear and a single levelling eccentric at the front. Front and rear concave clearances could be gauged through side inspection holes. Access to the rear left inspection hole was difficult. The operator should periodically check initial concave clearances over the width of the concave as clearances at the outside edges of the cylinder bars may be smaller, giving erroneous settings. Suitable initial concave settings, with the concave set in the number three bottom position, were 8 mm (0.3 in) at the leading bar and from 0 to 3 mm (0 to 0.1 in) at the trailing bar.

Once the concave had been initially set, threshing clearances were set with a cam assembly (FIGURE 9). Adjustment was inconvenient, requiring both a hand wrench and the cylinder rocking wrench. The control linkage was designed so that the leading concave bar opened faster than the trailing bar. Leading bar clearances could be varied from 2 to 20 mm (0.1 to 0.8 in) while trailing bar clearances could be varied from 0 to 6 mm (0 to 0.25 in).

FIGURE 9. Concave Clearance Adjustment.

Suitable concave settings were number 5-top in spring wheat, number 4-bottom in barley and fall rye, number 5-bottom in rapeseed. In flax, rear clearances was reduced to zero while front clearance was 4 mm (0.2 in).

The test machine was equipped with the wide spaced concave. Filler bars were installed in the first three concave openings in flax. This was an extremely difficult job and took two men three hours. It is recommended that the manufacturer consider modifications to improve ease of concave filler bar installation.

Cylinder Adjustment: The cylinder was equipped with a tachometer, located in the combine control box, a crank operated variable speed drive and a two-speed gear box (FIGURE 10). The variable drive provided speeds from 360 to 720 rpm in low range and from 570 to 1145 rpm in high range. This range was adequate for all crops encountered during the test.

Suitable cylinder speeds were from 850 to 1050 rpm in spring wheat, 800 to 950 rpm in fall rye, 700 to 900 rpm in barley and 350 to 600 rpm in rapeseed, and 1050 rpm in flax.

Shoe Adjustment: The shoe was convenient to adjust. Fan blast was varied with a crank operated variable speed drive and was directed with a windboard (FIGURE 11). The windboard was most effective in positions 5 or 6, directing air to the front of the shoe.

The triple cascade shoe (FIGURE 12) had five adjustable sieves and one 8 mm (0.3 in) round hole sieve. The five adjustable sieves were readily accessible from the rear of the combine. Return tailings were delivered to the rethresher (FIGURE 13), which discharged to the straw walker grain pan. The rethresher concave packed with soil and plant residue during normal operation and required frequent cleaning. In addition, stone damage caused concave channel deformation.

FIGURE 10. Cylinder Speed Adjustment.

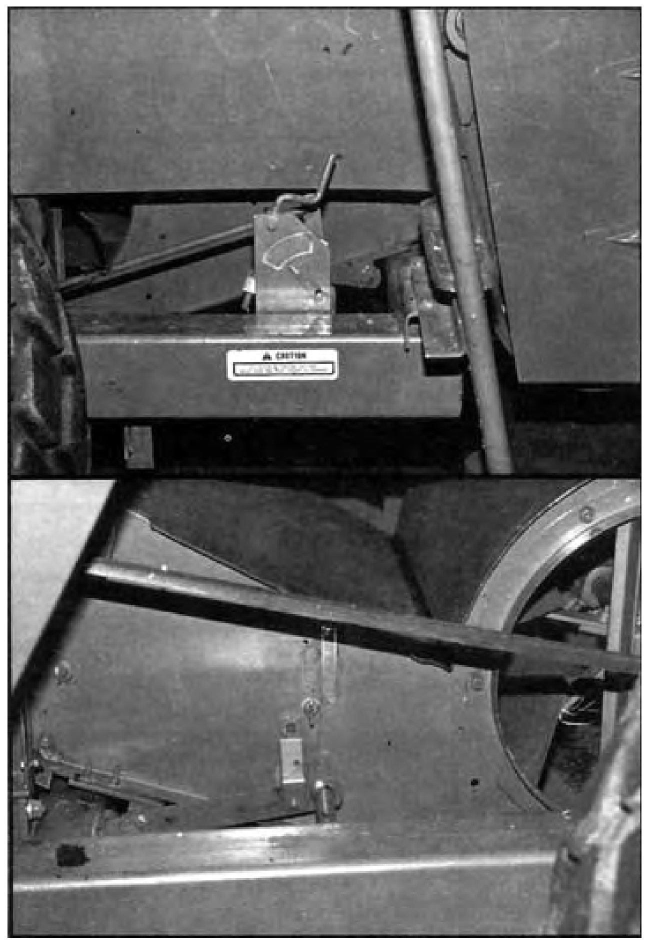

FIGURE 11. Shoe Adjustments (Top) Fan Speed, (Bottom) Windboard.

Spearing of straw through the adjustable sieves occurred frequently in fall rye and spring wheat. Partial heads also lodged in the holes of the round hole sieve, reducing cleaning area. It is recommended that the manufacturer consider modifications to the shoe to eliminate spearing.

The shoe was difficult to set in most crops. The fan variable speed idler support post (FIGURE 14) flexed under load, causing the drive belt to move up and down within the fan sheave. Consequently, the fan speed varied about 125 rpm at each setting, resulting in a pulsating air blast, increasing the difficulty of setting the shoe. It is recommended that the manufacturer consider modifications to strengthen the fan variable speed idler support post.

Foreign material in the tank sample varied from 0.3 to 3.3% when the shoe was properly adjusted.

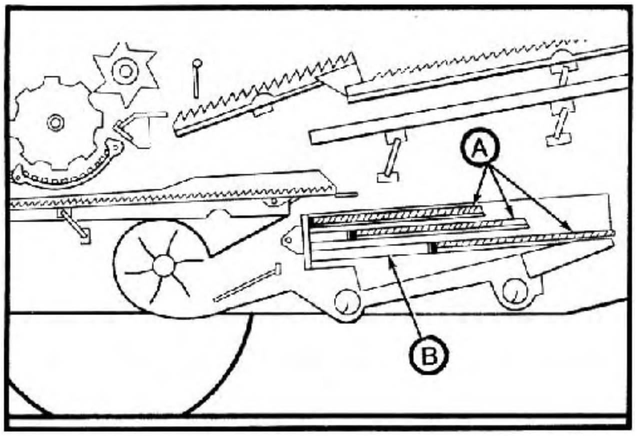

FIGURE 12. Triple Cascade Shoe (A) Adjustable Sieves, (B) 8 mm (0.3 In) Round Hole Sieve.

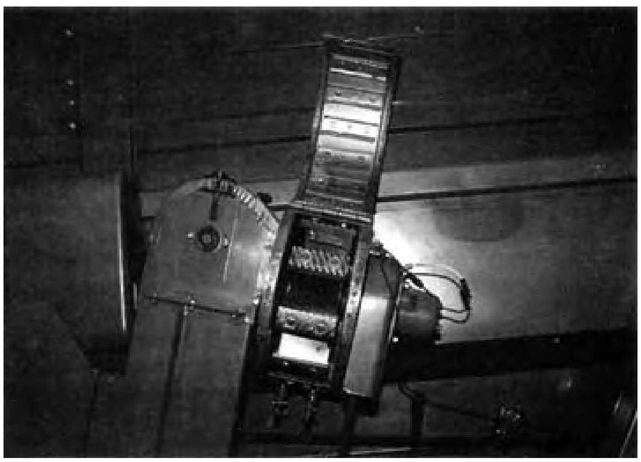

FIGURE 13. Rethresher.

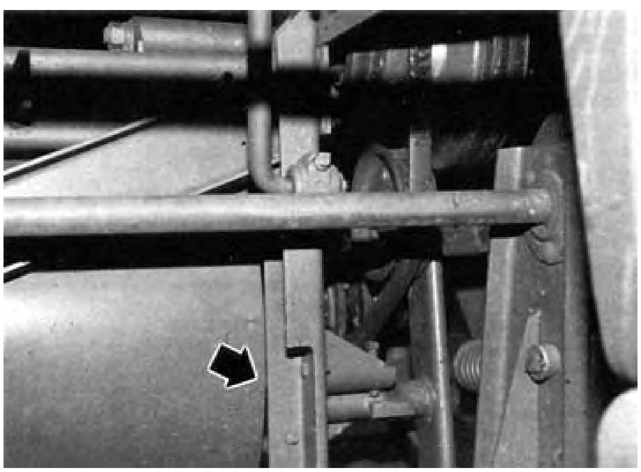

FIGURE 14. Fan Idler Support Post.

It was important to feed the windrow centred on the feeder housing and to load the full cylinder width to ensure uniform shoe loading. This was difficult, as off-centre feeding usually was required to prevent plugging at the left side of the combine header. As with most combines shoe loss increased noticeably when combining on side slopes greater than 5 degrees, due to non-uniform shoe loading.

There was no provision to safely and quickly examine return tailings. It is recommended that the manufacturer consider modifications to provide easy return sampling.

Header Adjustments: The Massey Ferguson 751 was tested only with the windrow pickup header. The header platform could be removed by one man in about 30 minutes. Removal of the complete header and feeder assembly took two men about 45 minutes.

The table auger was easy to adjust both vertically and horizontally, although adjustment was seldom required.

Slip Clutches: Individual slip clutches protected the table auger, paddle feeder conveyor and tailings return elevator.

RATE OF WORK

Average Workrates: TABLE 3 presents average workrates for the Massey Ferguson 751 in all crops harvested during the test. Average workrates are affected by crop conditions in a specific year and should not be used to compare combines tested in different years. In some crops, workrates were reduced by bunched or sunken windrows, rough ground, irregularly shaped fields and insufficient grain handling equipment. During the 1979 harvest, average workrates varied from 5.2 t/h (191 bu/h) in 3.2 t/ha (48 bu/ac) Neepawa wheat to 2.4 t/h (106 bu/h) in 1.8 t/ha (32 bu/ac) Candle rapeseed.

TABLE 3. Average Workrates

Crop	Variety	Average Yield t/ha	Average Speed km/h	Average Workrate	
				ha/h	t/h
Barley	Fergus	2.3	3.8	1.6	3.8
Barley	Klages	2.0	3.2	2.2	4.3
Flax	Dufferin	1.5	3.8	1.7	2.4
Rapeseed	Candle	1.8	2.4	1.4	2.4
Rapeseed	Torch	1.1	4.5	2.3	2.6
Rye	Cougar	1.2	5.7	2.0	2.5
Wheat	Neepawa	3.2	3.2	1.8	5.2

Maximum Feedrate: The workrates given in TABLE 3 represent average workrates at acceptable loss levels. The tractor used had ample power to achieve much higher workrates in all crops. In most crops the maximum acceptable feedrate was limited by grain loss, while in light crops, the maximum feedrate was limited by pickup performance. In heavy, bunchy crops, the feedrate was limited by feeder and table auger plugging.

Capacity: Combine capacity is the maximum rate at which a combine can harvest a certain crop, at a specified total loss level, when adjusted for optimum performance. Many crop variables affect combine capacity. Crop type and variety, grain and straw yield and moisture content, and local climatic conditions during the growing season all affect the threshing and separating ability of a combine.

MOG Feedrate, MOG/G Ratio, and Percent Loss: When determining combine capacity, combine performance and crop conditions must be expressed in a meaningful way. The loss characteristics of the combine in a certain crop depend mainly on two factors, the quantity of the straw and chaff being processed and the quantity of grain being processed. The weight of 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 weight of all plant material passing through the combine except for the grain or seed.

The weight of grain or seed passing through the combine per unit time is called Grain Feedrate. The ratio of the MOG Feedrate to the Grain Feedrate, which is abbreviated as MOG/G, gives an indication of how difficult a certain crop is to separate. For example, if a certain combine is used in two wheat fields of identical yield, but 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 with the MOG/G ratio when determining combine capacity. 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 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 loss and walker 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 Massey Ferguson 751: TABLE 4 presents capacity results from the Massey Ferguson 751 in four different crops. MOG Feedrates for a 3% total grain loss varied from 12.1 t/h (445 lb/min) in a field of 3.4 t/ha (51 bu/ac) Neepawa wheat to 7.9 t/h (290 lb/min) in 3.3 t/ha (61 bu/ac) Fergus barley.

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	Straw Breakup	Grain Moisture %	MOG/G	MOG Feedrate t/h	Grain Feedrate t/h	Ground Speed km/h	Loss Curve
Wheat (B)	Neepawa-	7.3	2.96	high	12.7	1.00	11.2	11.2	5.2	Fig. 15 & 21
Wheat (C)	Neepawa	6.1	2.60	high	13.9	1.14	10.7	9.4	5.9	Fig. 16 & 22
Wheat (D)	Neepawa	7.3	3.41	low	11.2	1.19	12.1	10.2	4.1	Fig. 17
Barley	Fergus	7.3	3.26	medium	12.4	0.75	7.9	10.5	4.4	Fig. 18 & 23

GRAIN LOSS CHARACTERISTICS

The grain loss characteristics of the Massey Ferguson 751 in the four crops described in TABLE 4 are presented in FIGURES 15 to 18.

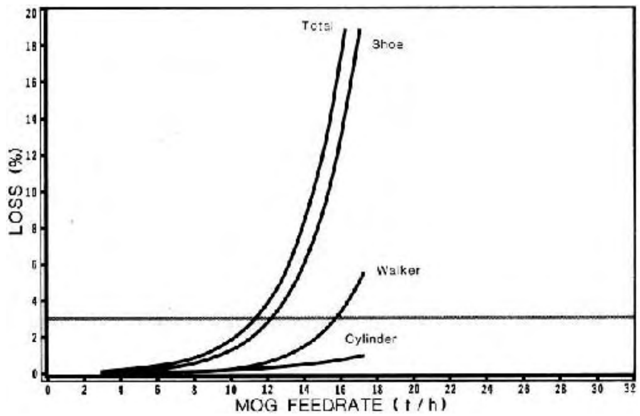

FIGURE 15. Grain Loss in Neepawa Wheat (Field S).

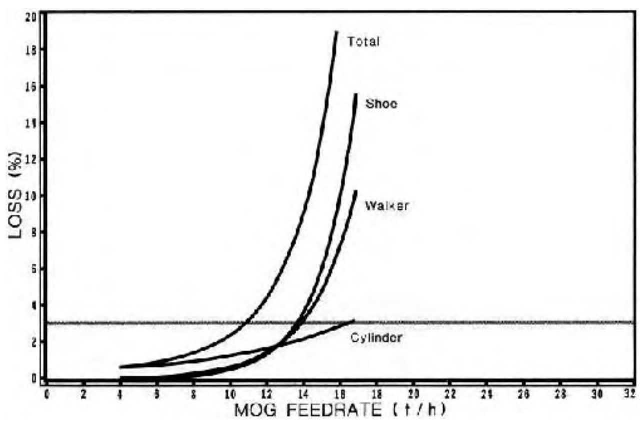

FIGURE 16. Grain Loss in Neepawa Wheat (Field C).

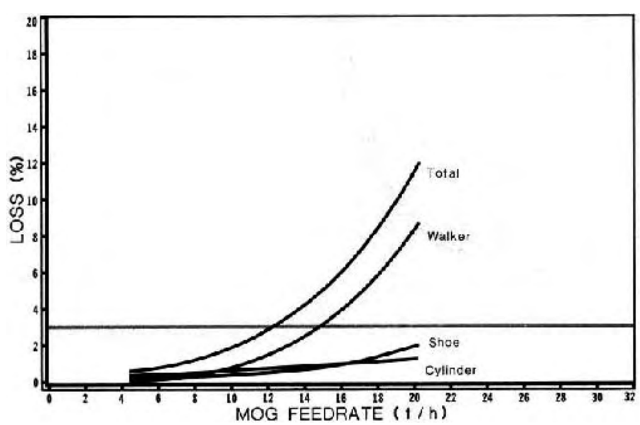

FIGURE 17. Grain Loss in Neepawa Wheat (Field D).

Walker Loss: Walker loss usually was the most significant factor limiting capacity, however in very dry wheat crops, shoe loss sometimes exceeded walker loss. A reduction in free grain loss over the straw walkers would have enabled higher combining rates especially in difficult-to-separate crops such as barley.

On numerous occasions, the back beater curtain wedged against the top of the straw walker housing, increasing straw walker loss. TABLE 5 and FIGURE 19 show that a 23% reduction in capacity occurred in Neepawa wheat when the curtain wedged, due to the straw and grain being discharged further back on the walkers. A rod was installed by PAMI to prevent the curtain from wedging. It is recommended that the manufacturer consider modifications to prevent the back beater curtain from lifting and wedging against the straw walker housing.

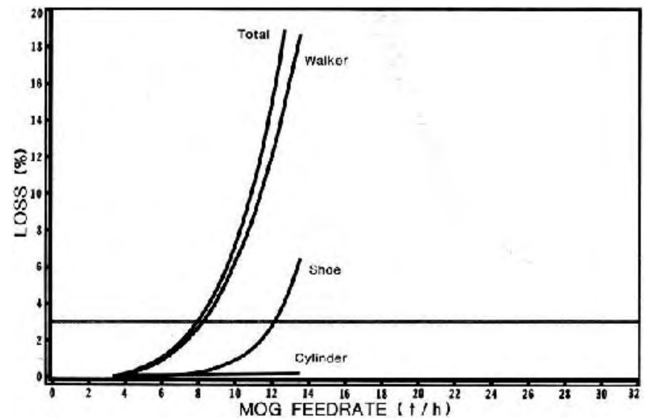

FIGURE 18. Grain Loss in Fergus Barley.

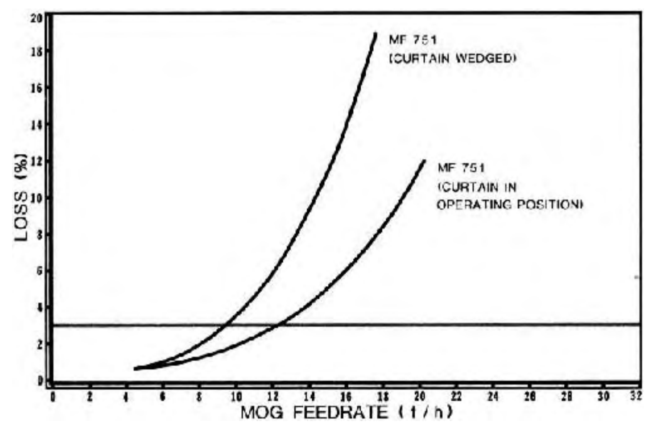

FIGURE 19. Total Losses with Back Beater Curtain Wedged Open and With Curtain In Normal Operating Position.

Shoe Loss: When operating in cereal grains, the shoe loss of a conventional combine is usually low in comparison to walker loss. In crops with high straw break-up, shoe loss of the Massey Ferguson 751 formed a significant part of the total loss, increasing rapidly with increased MOG Feedrate. In crops with low straw break-up, the load on the sieve was not as severe and losses were acceptable. Shoe losses were affected by the erratic fan blast caused by approximately a 125 rpm variation in fan speed. The fan speed variation made optimum shoe adjustment unattainable, and therefore shoe capacity was reduced. As mentioned previously, strengthening the idler support post would eliminate fan speed variation.

Cylinder Loss and Grain damage: Cylinder loss was usually low in most crops. In Fergus barley (FIGURE 18) when cylinder losses were negligible, grain cracks (FIGURE 20) varied from 2.5 to 3%. Neepawa wheat in fields B and C (FIGURES 15 & 16) was relatively easy-to-thresh and while cylinder loss ranged from 0 to 3%, grain cracks varied from 1 to 2%.

In difficult-to-thresh crops such as Neepawa wheat in field D (FIGURE 17), final cylinder and concave adjustments were a

TABLE 5. Capacity at a Total Loss of 3% of Yield

Crop Conditions							Capacity Results			
Crop	Variety	Width of Cut m	Crop Yield t/ha	Straw Breakup	Grain Moisture %	MOG/G	MOG Feedrate t/h	Grain Feedrate t/h	Ground Speed km/h	Loss Curve
Wheat	Neepawa	7.3	3.72	low	11.6	1.16	9.3	7.9	2.9	Fig. 19
Wheat	Neepawa	7.3	3.41	low	11.2	1.19	12.1	10.2	4.1	Fig. 19

[1]Back Beater Curtain Wedged Open
[2]Back Beater Curtain in Operating Position

compromise between cylinder loss and grain damage. While cylinder loss ranged from 0.5 to 1%, grain cracks varied from 6 to 6.5%.

Body Loss: Slight grain leakage occurred from the elevator and unloading auger doors, and from the rethresher inspection door. Losses were very low and most were eliminated by adding a suitable packing material.

Comparison to Reference Combine: Comparing combine capacities is complex because crop and growing conditions influence 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.

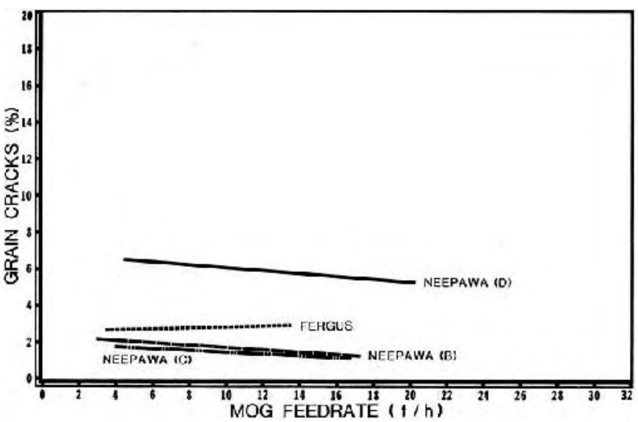

FIGURE 20. Grain Damage.

FIGURES 21 to 23 compare the total grain losses of the Massey Ferguson 751 and the PAMI reference combine in three of the crops described in TABLE 4. The shaded areas on the figures are the 95% confidence belts. If the shaded areas overlap, the loss characteristics of the two combines are not significantly different whereas if the shaded areas do not overlap, losses are significantly different. The capacity of the Massey Ferguson 751 was somewhat greater than the capacity of the reference combine and the Massey Ferguson 751 usually had lower grain losses than the reference combine when operating at the same feedrate.

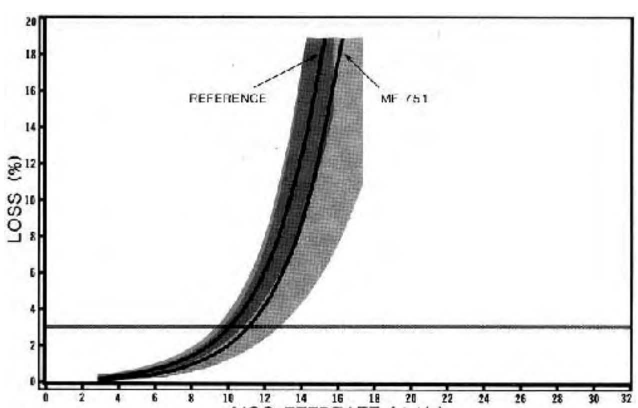

FIGURE 21. Total Grain Losses in Neepawa Wheat (Field B).

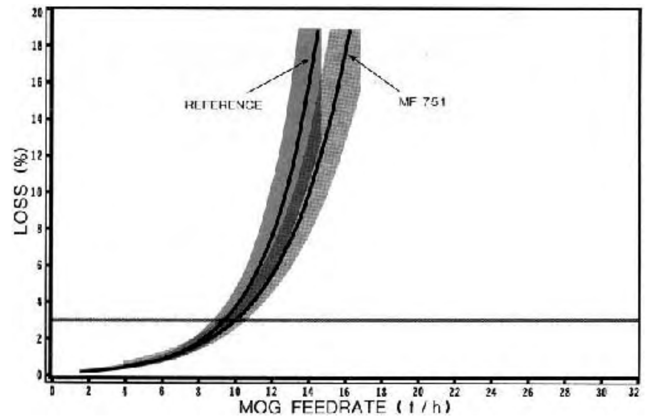

FIGURE 22. Total Grain Losses in Neepawa Wheat (Field C).

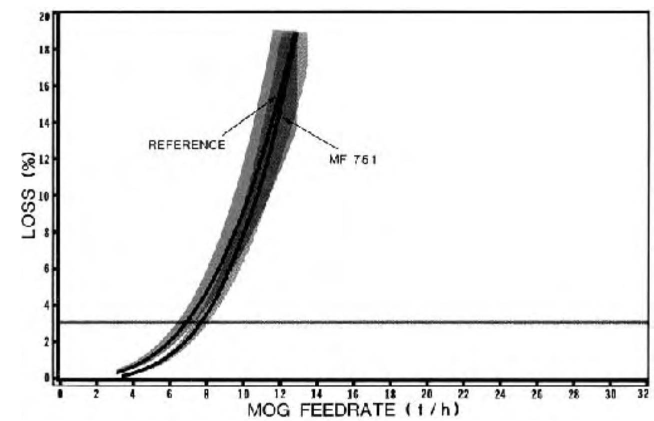

FIGURE 23. Total Grain Losses in Fergus Barley.

POWER REQUIREMENTS

Power Consumption: The manufacturer recommended a minimum tractor size of 75 kW (100 hp). This tractor size was suitable for average conditions, however, when operating in hilly fields, a tractor size of about 100 kW (135 hp) was needed.

Power take-off input (FIGURE 24) was measured in wheat and barley. When operating at a 3% total grain loss, power input was 35 kW (47 hp) in wheat and 25 kW (34 hp) in barley.

Specific Capacity: Specific Capacity is a measure of how efficiently a combine uses energy. It is the MOG Feedrate divided by the power take-off input, when operating at a 3% loss level. A high specific capacity indicates efficient energy use, while a low specific capacity indicates less efficient operation. Average specific capacity for the Massey Ferguson 751 was 0.32 t/kW-h as compared to 0.32 t/kW-h for the reference combine.

OPERATOR SAFETY

The operator's manual emphasized operator safety.

The Massey Ferguson 751 had adequate warning decals, but larger decals might increase operator awareness. It was also equipped with a slow moving vehicle sign and warning lights.

The combine was well shielded, giving good protection from moving parts, but most of the shields were inconvenient to remove and difficult to reattach. Many shields were designed with closed bottoms, which retained large amounts of chaff, making lubrication difficult and creating a potential fire hazard. It is recommended that the manufacturer consider modifications to simplify shield removal and replacement.

The combine was equipped with a header lock and its proper use was emphasized in the operator's manual. The header lock must be used when working beneath or around the header.

A rocking wrench and hub were provided for unplugging the feeder housing and feeder auger. This enabled unplugging of the table auger without entering the header.

Caution was needed when moving the unloading auger to field or transport position.

No attempt should be made to sample the tailings from the inspection holes, as these are hazardous pinch points and serious hand injury could result.

When using the slug wrench to unplug the cylinder, or when unplugging the table auger or feeder housing, all clutches should be disengaged and the tractor shut off.

The operator is cautioned about loaded springs used for tensioning drive tighteners and variable speed sheaves. Caution is also needed when moving around the rear of the combine, as sharp edges on the straw chopper rails could cause injury.

Caution was needed when pinning the drawpole in transport or field position, as the pin was located inside a severe pinch point area.

The hitch jack was safe and easy to use. The operator is cautioned to place the hitch jack at the rear of the combine before removing the header to prevent the combine from tipping rearward.

A fire extinguisher should be carried on the combine at all times.

OPERATOR'S MANUAL

The operator's manual was clearly written and well illustrated. It contained useful information on safe operation, adjustments, settings, service and lubrication.

While concave levelling and adjustment procedures were clearly outlined, no initial concave settings were provided in the operator's manual. Initial suggested concave clearances for rapeseed were too small and suggested cylinder speeds too high. It is recommended that the operator's manual be revised to include an initial concave adjustment procedure as well as revised initial rapeseed settings.

DURABILITY RESULTS

TABLE 6 outlines the mechanical history of the Massey-Ferguson 751 during 112 hours of operation while combining about 206 ha. The intent of the text was evaluation of functional performance. The following failures represent those which occurred during functional testing. An extending durability evaluation was not conducted.

TABLE 6. Mechanical History

Item	Operating Hours	Field Area ha
Power Shaft		
-The intermediate drive shaft universal joint moved and was repositioned at	9	24
Drives		
-The header drive chain idler was improperly installed and was realigned at	29	54
-The pickup front roller sprocket was lost and replaced at	33	64
-The separator drive belt failed and was replaced at	49	101
-The grain tank levelling auger drive chain broke and was repaired at	73	143
Miscellaneous		
The pickup drive shield was damaged when striking the ground and was replaced at	4	12
-The right and left pickup draper belts tore when buckwheat wrapped around the rollers. The belts were repaired at	51	106
-The right front roller pickup bearing failed and was replaced at	104	192
-The pickup support chains slipped from their retainers	many times during test	

DISCUSSION OF MECHANICAL PROBLEMS

Separator Drive Belt: The separator drive belt began cracking and slipping after 30 hours of operation. It was replaced at 49 hours with an improved belt supplied by the manufacturer.

Pickup: The pickup support chains often slipped from their retainers, necessitating pickup height readjustment. It is recommended that the manufacturer consider modifications to keep the pickup support chains secured.

The pickup drive shield could be easily damaged when picking short crops, due to limited ground clearance. It is recommended that the manufacturer consider modifying the shield to reduce damage from ground contact.

APPENDIX I
SPECIFICATIONS

MAKE:	Massey Ferguson Puli-Type Combine
MODEL:	751
SERIAL NUMBER:	2019 00643
MANUFACTURER:	Massey Ferguson Industries Ltd. 915 King Street West Toronto, Ontario M6K 1E3
WINDROW PICKUP:	
--make and model	Massey Ferguson 67
--type	belt
--width	3390 mm
--number of belts	6
--teeth per belt	70
--type of teeth	nylon
--number of rollers	3
--height control	castor wheels and support chains
--speed control	manually adjusted variable pitch sheaves
--apron speed range	1.3 to 1.8 m/sec
HEADER:	
--type	off-set
--width	3890 mm
--auger diameter	512 mm
--feeder	5 fabric belted paddles
--paddle speed	280 rpm
--range of height	-450 to 1300 mm
--number of lift cylinders	1
--options	auger flight extensions, paddle shields
FEEDER BEATER:	
--type	four blade integral
--diameter	157 mm
--speed	745 rpm
CYLINDER:	
--type	rasp bar
--number of bars	8
--diameter	555 mm
--width	1270 mm
--drive	crank controlled variable pitch belt
--speed range	
-low gear	340 to 760 rpm
-high gear	550 to 1210 rpm
--stripper	bar steel
CYLINDER BEATER:	
--type	drum with 6 triangular bats
--diameter	374 mm
--speed 7	10 rpm
CONCAVE:	
--type	bar and wire
--number of bars	11
--configuration	10 intervals with 8 mm wires and 13.5 mm spaces
--area total	0.654 m²
--area open	0.271 m²
--transition grate area total	0.279 m²
--transition grate area open	0.183 m²
--wrap	106°
--grain delivery to shoe	grain pan
--options	stone trap cover, filler bars, narrow spaced concave, grain pan screen
STRAW WALKERS:	
--type	rotary, formed metal
--number	6
--length	3015 mm
--walker housing width	1550 mm
--separating area	4.616 m²
--crank throw	102 mm
--speed	202 rpm
--grain delivery to shoe	grain pan
--options	risers
SHOE:	
--type	single action, triple sieve
--speed	330 rpm
--top sieve	adjustable lip, 1.081 m2 with 39 mm throw
--middle sieve	adjustable lip, 1.081 m² with 39 mm throw
--bottom sieve	
-front	8 mm fixed round hole 0.811 m² with 40 mm throw
-rear	adjustable lip, 1.316 m² with 40 mm throw
--options	miscellaneous screens
RETHRESHER:	
--type	rasp bar cylinder with closed concave
--cumber of bars	8
--diameter	337 mm
--width	114 mm
--speed	840 rpm

CLEANING FAN:
--type: 6 blade undershot dual fans
--diameter: 480 mm
--width: 1142 mm
--drive: crank controlled variable pitch belt
--speed range: 625 to 1000 rpm
--options: small seed kit

ELEVATORS:
--type: roller chain with rubber flights, top delivery
--clean grain (bottom drive): 125 mm x 250 mm
--tailings (bottom drive): 100 mm x 255 mm

GRAIN TANK:
--capacity: 5.1 m^3
--unloading time: 78 s

STRAW CHOPPER:
--type: rotor with 35 freely swinging hammers
--speed: 3000 rpm
--options: straw spreader

CLUTCHES:
--header: electromagnetic
--unloading auger: electromagnetic

NUMBER OF CHAIN DRIVES: 12

NUMBER OF BELT DRIVES: 10

NUMBER OF GEARBOXES: 2

NUMBER OF PRELUBRICATED BEARINGS: 81

LUBRICATION POINTS:
--10 h lubrication: 15
--50 h lubrication: 3
--100 h lubrication: 3
--annual: 1

TIRES: 2, 18.4 x 26, 12-ply

OVERALL DIMENSIONS:
--wheel tread: 2580 mm
--transport height: 3490 mm
--transport length: 10060 mm
--transport width: 4900 mm
--field height: 3530 mm
--field length: 9910 mm
--field width: 7430 mm
--unloading discharge height: 2900 mm
--unloader clearance height: 2890 mm
--unloader reach: 1790 mm

WEIGHT: (with empty grain tank and hitch in field position)
--right wheel: 3410 kg
--left wheel: 2360 kg
--hitch: 370 kg
TOTAL: 6140 kg

APPENDIX II
REGRESSION EQUATIONS FOR CAPACITY RESULTS

Regression equations, for the capacity results shown in FIGURES 15 to 18 are presented in TABLE 8. In the regressions, C = cylinder loss in percent of yield, S = shoe loss in percent of yield, W = straw walker 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 15 to 18 while crop conditions are presented in TABLE 4.

TABLE 7. Regression Equations

Crop - Variety	Fig. No.	Regression Equations	Simple Correlation Coefficient	Variance Ratio	Sample Size
Wheat - Neepawa (Field B)	15	$\ln C = -3.29291 + 0.19594F$ $\ln S = -3.48312 + 0.37829F$ $\ln W = -5.13065 + 0.39776F$	0.98 0.93 0.98	116.50[2] 39.31[2] 156.62[2]	8
Wheat - Neepawa (Field C)	16	$\ln C = -1.07752 + 0.13257F$ $\ln S = -4.53925 + 0.40834F$ $\ln W = -5.74606 + 0.50495F$	0.98 0.94 0.99	206.96[2] 55.81[2] 356.17[2]	9
Wheat - Neepawa (Field D)	17	$C = -0.13221 + 0.05683F$ $\ln S = -2.43725 + 0.15443F$ $\ln W = -7.8724 + 3.33895 \ln F$	0.71 0.74 0.86	6.91[1] 8.83[1] 21.00[2]	9
Barley - Fergus	18	$C = -0.06979 + 0.01969F$ $\ln S = -5.57219 + 0.55056F$ $\ln W = -6.53339 + 3.6334 \ln F$	0.87 0.97 0.98	24.04[2] 126.30[2] 195.85[2]	10

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

APPENDIX III
PAMI REFERENCE COMBINE CAPACITY RESULTS

TABLE 8 and FIGURES 25 and 28 present capacity results for the PAMI reference combine in wheat and barley crops harvested from 1976 to 1979.

FIGURE 25 shows capacity differences in Neepawa wheat for the four years, Most 1979 Neepawa wheat crops shown In TABLE 4 were of average-to-heavy straw yield, easier-to-thresh than normal and most had high straw break-up, FIGURE 26 also shows differences in capacities in six-row Bonanza barley for 1976 to 1978, and in two-row Fergus barley for 1979. The 1979 Fergus barley crop shown in TABLE 4 was of average straw yield, and easy-to-thresh. 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 8. Capacity of the PAMI Reference Combine at a Total Grain Loss of 3% of Yield.

Crop Conditions								Capacity Results			
					Grain Moisture			MOG Feedrate	Grain Feedrate	Ground Speed	
Year	Crop	Variety	Width of Cut m	Crop Yield t/ha	Straw %	Grain %	MOG/G	t/h	t/h	km/h	Loss Curve
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. 25
	Barley	Fergus	7.3	3.46	dry	12.5	0.77	7.3	9.5	3.7	Fig. 26
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. 25
	Barley	Bonanza	6.1	4.06	7.7	13.5	0.68	6.1	9.0	3.6	Fig. 26
1977	Wheat	Neepawa	6.1	3.97	13.4	14.6	0.79	11.1	14.1	5.8	Fig. 25
	Barley	Bonanza	7.3	4.74	25.7	14.6	0.84	7.9	9.4	2.7	Fig 26
1976	Wheat	Neepawa	5.5	2.78	dry to tough	14.7	1.29	7.1	5.5	3.6	Fig. 25
	Barley	Bonanza	7.3	3.18	dry to tough	14.6	0.96	4.8	5.0	2.2	Fig 26

[1]Side by Side Double Windrow

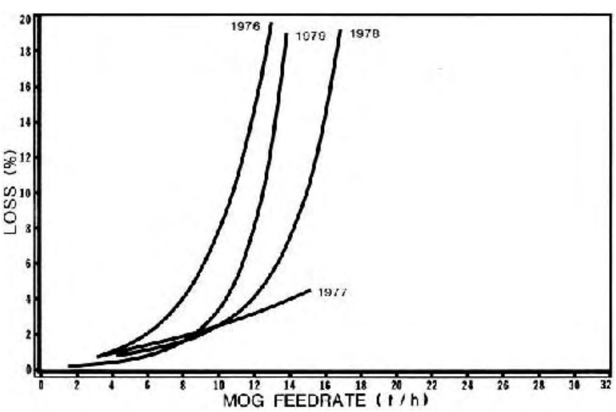

FIGURE 25. Total Grain Loss for the PAMI Reference Combine In Neepawa Wheat.

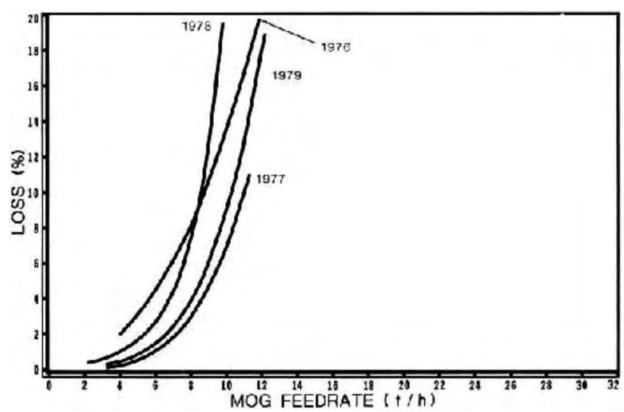

FIGURE 26. Total Grain Losses for the PAMI Reference Combine in Barley.

APPENDIX IV
MACHINE RATINGS

The following rating scale if used in PAMI Evaluation Reports:

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

APPENDIX V
CONVERSION TABLE

1 kilometre/hour (km/h)	= 0.6 miles/hour (mph)
1 hectare (ha)	= 2.5 acres (ac)
1 kilogram (kg)	= 2.2 pounds mass (lb)
1 tonne (t)	= 2 200 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)

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

This report is published under the authority of the minister of Agriculture for the Provinces of Alberta, Saskatchewan and Manitoba and may not be reproduced in whole or in part without the prior approval of the Alberta Farm Machinery Research Centre or The Prairie Agricultural Machinery Institute.