Printed: February, 1990
Tested at: Humboldt
ISSN 0383-3445Group 4c

Evaluation Report 622

Massey Ferguson 8560 Self-Propelled Combine

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

MASSEY FERGUSON 8560 SELF-PROPELLED COMBINE

MANUFACTURER AND DISTRIBUTOR:

Massey Combines Corporation
3201 Massey House
171 Colborne Street
Brantford, Ontario
N3T 6E1
Phone: (519) 758-2000

RETAIL PRICE:

$139,204.00 [March, 1988, f.o.b. Humboldt, Sask., with a 13 ft (4.0 m) pickup header, 12 ft (3.7 m) Melroe model 388 pickup, automatic pickup speed control, sidehill package, concave blanks, grain loss monitor and straw chopper].

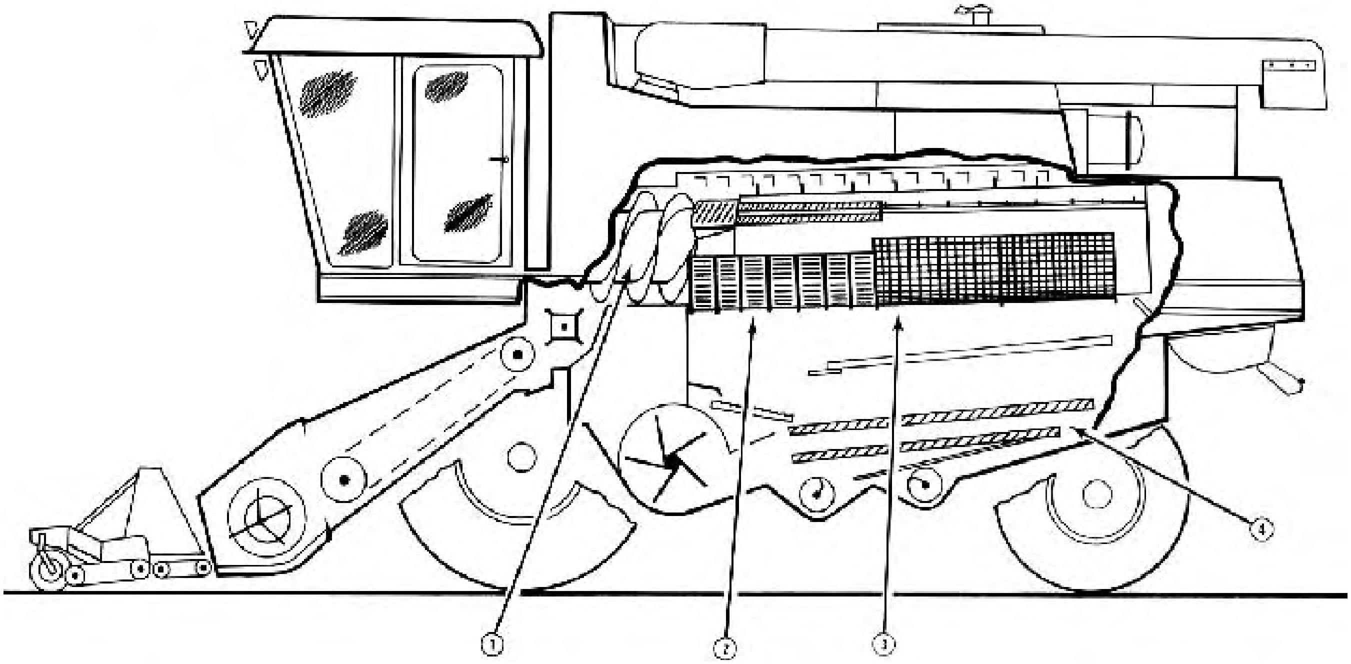

FIGURE 1. Massey Ferguson 8560 Self - Propelled Combine: (1) Rotor, (2) Threshing Concaves, (3) Separating Concaves, (4) Cleaning Shoe.

SUMMARY AND CONCLUSIONS

Capacity: In the capacity tests, the MOG feedrate* at engine power limit was 630 lb/min (17.2 t/h) in Argyle barley and 870 lb/min (23.5 t/ha) in Harrington barley. In three Katepwa wheat crops, combine capacity at power limit ranged from 530 to 915 lb/min (14.3 to 24.7 t/ha) MOG. Total loss did not reach 3% in any of the capacity tests.

The capacity of the Massey 8560 at power limit was 1.6 and 2.4 times the capacity of the PAMI Reference II combine at 3% loss in Argyle and Harrington barley, respectively. At power limit in wheat, the Massey 8560 had 1 to 1.4 times the capacity of the Reference II combine at 3% loss.

Quality of Work: Pickup performance was very good. In most crops it picked cleanly, and the automatic pickup speed control system was very convenient. Minor plugging occurred in some field conditions. Feeding was very good after the table auger slip clutch was modified. Crop fed smoothly under the table auger into the feeder. The feeder was aggressive and did not plug.

The stone trap provided good stone protection. Most stones and hard objects were trapped in the pocket below the front feed beater. A few small stones entered the rotor housing and caused minor concave damage.

Threshing was good. The Massey 8560 threshed smoothly in most crops, but a few crop conditions caused rotor "rumbling".

Unthreshed losses were low in easy-to-thresh crops, but somewhat higher in hard-to-thresh wheat. Grain damage was low in all crops.

Separation of grain from straw was very good. In most crops, rotor loss was low over the entire operating range. Rotor loss was highest in barley, but it did not limit capacity in any crop.

Cleaning shoe performance was very good. Shoe loss was very low over the entire operating range in wheat and barley, but limited capacity in oilseeds. The grain tank sample was clean in all crops.

Grain handling was very good. The 195 Imp bu (7.1 m³) grain tank filled evenly in all crops. The auger was convenient to position. Unloading was fast, taking about 116 seconds to unload a full tank.

Straw spreading was fair. The straw was spread up to 20 ft (6.1 m) and the distribution was somewhat uneven. The straw chopper conversion for dropping straw was inconvenient.

Ease of Operation and Adjustment: Operator comfort in the Massey 8560 was very good. The cab was quiet and relatively dust free. The heater and air conditioner provided comfortable cab temperatures. The seat could be adjusted to suit most operators, but the steering wheel adjustment was limited. The operator had a clear view forward and to the sides, and rear view mirrors provided rear visibility. View of the incoming swath was slightly obstructed by the steering wheel.

Instrumentation was good. The instruments monitored all important functions and had built-in warning systems. Most instruments were easy to observe but the rotor overload light was difficult to see in bright daylight. Controls were very good. Most of the controls were conveniently located, responsive, and easy to use.

Loss monitor performance was good. Only shoe loss could be monitored. The reading was meaningful only if compared to actual losses.

Lighting for nighttime harvesting was fair. Field lights provided adequate short to mid range forward lighting, but peripheral and long range forward lighting were inadequate.

Handling was very good. Steering was smooth and responsive, but occasional difficulty with transmission shifting was experienced. The combine was easy to maneuver and stable in the field and while transporting.

**MOG feedrate (material-other-than-grain feedrate) is the mass of straw and chaff passing through the combine per unit of time.*

Ease of adjusting combine components was good. Most components were easy to adjust, but changing between fan speed ranges was very inconvenient. Ease of setting the combine components to suit field conditions was good, although shoe and fan setting required some experimentation.

Ease of unplugging was fair. The Massey 8560 was not equipped with a slug wrench or header reverser. Rotor plugs could usually be cleared by lowering the concave and rocking the slug out with the hydrostatic rotor control.

Ease of cleaning the combine exterior was good, however, cleaning the inside was difficult and time consuming.

Ease of lubrication was very good. Daily lubrication was quick and easy. Gaining access to perform general maintenance and repair was generally good, but a few areas were inconvenient to access.

Engine and Fuel Consumption: The engine started easily and ran well. In most conditions, the engine was run at or near its power limit. Average fuel consumption for the year was 7.4 gal/h (33.6 L/ h). Oil consumption was insignificant.

Operator Safety: The operator's manual emphasized safety. All moving parts were well shielded. No safety hazards on the Massey 8560 were apparent. However, normal safety precautions were required and warnings had to be heeded.

Operator's Manual: The operator's manual was well written and contained much useful information on safety, servicing, setting, troubleshooting, and specifications.

Mechanical History: A few mechanical problems occurred during the test.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to the table auger slip clutch to permit more adjustment.
2. Modifications to prevent grain loss along the side walls at the rear of the shoe.
3. Modifications to the straw chopper mounting system to allow simpler conversion for windrowing straw, and to provide a larger opening for straw discharge.
4. Providing greater steering column tilt adjustment.
5. Modifications to the rotor overload indicator to make it more noticeable during daylight operation.
6. Providing grain loss sensors for the rotor.
7. Providing extra forward and peripheral lighting,
8. Modifications to permit easier shifting of the transmission.
9. Modifications to permit convenient full range fan speed adjustment from the operator's station.
10. Modifications to improve grain tank access from the operator's station.
11. Modifications to permit safe, convenient sampling of the return tailings while harvesting.
12. Modifications to permit quick, convenient header unplugging.
13. Modifications to permit easy access to and positive relatching of the stone trap door lever.
14. Modifying the tailings elevator chain tensioning system to simplify adjustment.
15. Modifications to the rotary screen to prevent radiator plugging.
16. Modifications to prevent steering return line failures and repetitive hydraulic oil loss.
17. Modifications to prevent dirt and chaff entry into the coolant reservoir.

Senior Engineer: J. D. Wassermann
Project Manager: L.G. Hill
Project Engineer: C.A. Hanson

THE MANUFACTURER STATES THAT

Western Combine Corporation acquired the technology and manufacturing rights to the Massey 8560 rotary combine, Although the 8560 wilt not be built, Western Combine Corporation plans to introduce an improved version for the 1990 harvest season to be marketed as a Massey - Ferguson 8570. This model will address many of the recommendations made for the 8560. The following replies outline these changes.

1. The table auger clutch will be set for average power requirements but may require adjustment to suit specific crops and conditions.
2. The 8570 will have improved shoe sealing.
3. A slide back chopper incorporating a number of improvements will be provided.
4. The 8570's steering column has been redesigned to increase tilt adjustment.
5. No changes to the rotor overload light are planned at this time.
6. A rotor loss monitor is under review, however, since rotor loss is usually low, the need for one is not critical.
7. Seven halogen lights wilt be used on the 8570 to provide superior night lighting.
8. The 8570 will be equipped with a 4 speed transmission with easier shifting characteristics.
9. We are currently reviewing the fan speed adjustments.
10. An easier method of retrieving a grain sample from the grain tank is being considered.
11. No immediate changes are planned.
12. The 8570 will have a hydraulically powered header reverser as standard equipment.
13. Alternate designs are currently under test.
14. This recommendation is under review.
15. Radiator fin spacing has been increased on the 8570 to minimize plugging even in adverse conditions.
16. The 8570 will have improvements to the hydraulic system to prevent similar failures.
17. Changes have been made to prevent dust entry into the coolant recovery bottle on the 8570.

MANUFACTURERS ADDITIONAL COMMENTS

In addition to improvements made with respect to the recommendations, the MF 8570 will also be equipped with a new engine rated at 220 hp (164 KW), and will have the maximum rotor speed increased to 1,000 rpm. These changes will make the 8570 even better in hard threshing conditions.

GENERAL DESCRIPTION

The Massey 8560 is a self-propelled combine. It has a single longitudinally mounted rotor, threshing and separating concaves, and a cleaning shoe. The closed-tube rotor has intake auger flighting, three initial threshing elements and three pairs of raspbars, three longitudinal separating fins and three rows of rotor knives (FIGURE 2). The threshing and separating concaves are typical bar and wire construction. The cleaning fan is a five blade, paddle fan. The adjustable lip chaffer sieve and cleaning sieve move in opposed motion.

Crop is fed to the rotor intake by a transverse mounted impeller, which also propels rocks and other hard objects into a stone trap below. The auger flighting at the rotor intake moves the crop back to the threshing elements.

Threshing begins upon contact with the initial threshing elements and continues along the length of the threshing concaves. The crop is spiralled rearward through the rotor cage by the angled rasp bar ribs and stationary vanes at the top of the rotor housing (FIGURE 3). The rotor knives break up the crop material. Separation of grain from straw occurs throughout the full length of the threshing and separating concaves. Grain and chaff passing through the concaves are conveyed to the front of the cleaning shoe by the grain pan. The grain is cleaned by a combination of pneumatic and sieving action. Tailings are returned to the intake of the rotor.

The test combine was equipped with a 190 hp (142 kW) turbo-charged six cylinder diesel engine, a 13 ft (4.0 m) pickup header, a 12 ft (3.7 m) Melroe model 388 pickup, straw chopper, and optional equipment as listed on page 2.

The Massey 8560 has a pressurized operator's cab, power steering, hydraulic wheel brake, and a three-speed transmission with hydrostatic traction drive.

The separator and header drives are electrically engaged, while the rotor is hydrostatically driven. Header height and unloading auger swing are controlled electro-hydraulically. The unloading auger drive is mechanically engaged. Hydraulic rotor speed and electronic pickup speed controls are located in the cab, while fan speed is varied electrically from the cab through each of three externally selected ranges. Concave clearance, and chaffer sieve and cleaning sieve openings are adjusted externally on the machine. There is no provision to safely and conveniently inspect the return tailings while operating. Important component speeds and machine and harvest functions are displayed on electronic monitors.

Detailed specifications are given in APPENDIX I.

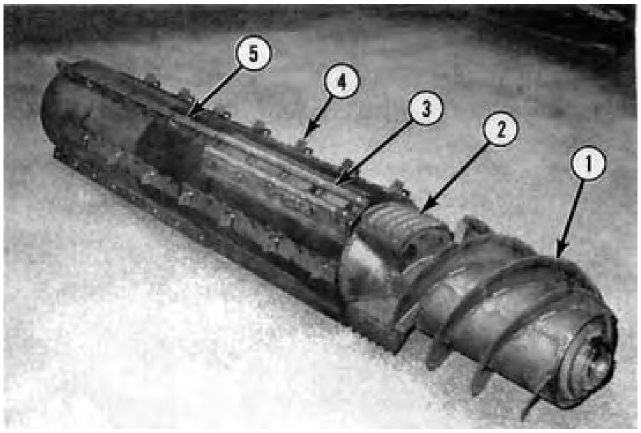

FIGURE 2. Rotor: (1) Intake Flighting, (2) Threshing Elements, (3) Rasp Bars, (4) Rotor Knives, (5) Separating Fins.

FIGURE 3. Rotor Housing: (1) Threshing Concaves, (2) Separating Concaves, (3) Vanes.

SCOPE OF TEST

The main purpose of the test was to determine the functional performance of the Massey 8560. Measurements and observations were made to evaluate the Massey 8560 for rate of work, quality of work, ease of operation and adjustment, engine performance, operator safety, and the suitability of the operator's manual. Although extended durability testing was not conducted, the mechanical failures, which occurred during the test, were recorded.

The Massey 8560 was operated for 123 hours while harvesting about 1270 ac (514 ha) of various crops. In addition, capacity tests were conducted in two barley crops and three wheat crops.

The operating conditions for the season are shown in TABLES 1 and 2.

RESULTS AND DISCUSSION

TERMINOLOGY

MOG, MOG Feedrate, Grain Feedrate, MOG/G Ratio and Total Feedrate: A combine's performance is affected mainly by the amount of straw and chaff it is processing and the amount of grain or seed it is processing. The straw, chaff, and plant material other than the grain or seed is called MOG, which is an abbreviation for "material-other-than-grain". The quantity of MOG being processed per unit of time is called the "MOG Feedrate". Similarly, the amount of grain being processed per unit of time is the "Grain Feedrate".

The MOG/G ratio, which is the MOG Feedrate divided by the Grain Feedrate, indicates how difficult a crop is to separate. For example, MOG/G ratios for prairie wheat crops may vary from 0.5 to 1.5. In a crop with a 0.5 MOG/G ratio, the combine has to handle 50 lbs (22.7 kg) of straw for every 100 lbs (45.4 kg) of grain harvested. However, in a crop with a 1.5 MOG/G ratio for a similar 100 lbs (45.4 kg) of grain harvested the combine now has to handle 150 lbs (68.1 kg) of straw - 3 times as much. Therefore, the higher the MOG/G ratio, the more difficult it is too much. Therefore, the higher the MOG/G ratio, the more difficult it is to separate the grain.

Total feedrate is the sum of MOG and grain feedrates. This gives an indication of the total amount of material being processed. This total feedrate is often useful to confirm the effects of extreme MOG/G ratios on combine performance.

TABLE 1. Operating Conditions

Crop	Variety	Yield Range		Width of Cut		Sep. Hours	Field Area		Crop Harvested	
		bu/ ac	t/ha	ft	m		ac	ha	bu	t
Barley	Argyle Herrington	25-65 55-75	1.4-3.4 3.0-4.0	24 50,20	7.3 15.2,6.1	30 10	305 80	122 33	14200 4800	309.0 105.5
Canola	Tobin Westar	15-20 20-40	0.9-1.1 1.2-2.1	20,21 20,25	6.1,6.4 6.1,7.6	14 13	150 140	62 58	2700 3600	61.5 82.0
Flax	Norlin	15-20	0.8-1.2	18	5.5	7	45	17	900	19.5
Lentils	Laird	12	0.8	25	7.6	2	25	10	300	8.0
Rye	Musketeer	25-35	1.5-2.3	20,22 25,30	6.1,6.4 7.6,9.1	29	215	86	6500	141.0
Wheat	Katepwa	20-30	1.2-2.1	25,40 50,60	7.6,12.2 15.2, 18.3	18	310	126	7800	212.5
Total						123	1270	514	40800	939.0

TABLE 2. Operation in Stony Conditions

Field Conditions	Hours	Field Area	
		ac	ha
Stone Free	110	1175	475
Occasional Stones	13	95	39
Total	123	1270	514

Grain Loss, Grain Damage, Dockage and Foreign Material: Grain loss from a combine can be of two main types: Unthreshed Loss, consisting of grain left in the head and discharged with the straw and chaff, or Separator Loss which is free (threshed) grain discharged with the straw and chaff. Separator Loss can be further defined as Shoe Loss and Walker (or Rotor) Loss depending where it came from. Loss is expressed as a percentage of the total amount of grain being processed.

Damaged or cracked grain is also a form of grain loss. In this report the cracked grain is determined by comparing the weight of the actual damaged kernels to the entire weight of a sample taken from the grain tank.

Dockage is determined by standard Canadian Grain Commission methods. Dockage consists of large foreign particles and of smaller particles that pass through a screen specified for that crop. It is expressed as a percentage of the weight of the total sample taken.

Foreign material consists of the large particles in the sample, which will not pass through the dockage screens.

Capacity: Combine capacity is the maximum rate at which a combine, adjusted for optimum performance, can process crop at a certain total loss level. PAMI expresses capacity in terms of MOG Feedrate at 3% total loss. Although MOG Feedrate is not as easily visualized as Grain Feedrate, it provides a much more consistent basis for comparison. A combine's ability to process MOG is relatively consistent even if MOG/G ratios vary widely. Three percent total loss is widely accepted in North America as an average loss rate that provides an optimum trade-off between work accomplished and grain loss. This may not be true for all combines nor does it mean that they cannot be compared at other loss levels.

Reference Combine: It is well recognized that a combine's capacity may vary greatly due to differences in crop and weather conditions.

These differences make it impossible to directly compare combines not tested in the same conditions. For this reason, PAMI uses a reference combine. The reference combine is simply one combine that is tested along with each combine being evaluated. Since the test conditions are similar, each test combine can be compared directly to the reference combine to determine a relative capacity or "capacity ratio". This capacity ratio can be used to indirectly compare combines tested in different years and under different conditions. As well, the reference combine is useful for showing how crop conditions affect capacity. For example, if the reference combine's capacity is higher than usual, then the capacity of the combine being evaluated will also be higher than normally expected.

For 10 years PAMI had used the same reference combine. However, capacity differences between the reference combine and some of the combines tested became so great that it was difficult to test the reference combine in conditions suitable for the evaluation combines.

PAMI changed its reference combine to better handle these conditions. The new reference combine is a larger conventional combine that was tested in 1984 (see PAMI report #426). To distinguish between the reference combines, the new reference will be referred to as Reference II and the old reference as Reference I.

RATE OF WORK

Capacity Test Results: The capacity results for the Massey 8560 are summarized in TABLE 3.

The performance curves for the capacity tests are presented in FIGURES 4 to 8. The curves in each figure indicate the effect of increased feedrate on rotor loss, shoe loss, unthreshed loss and total loss. From the graphs, combine capacity can be determined for loss levels other than 3%. The rate at which loss changes with respect to feedrate shows where the combine can be operated effectively. Portions of loss curves, which are "flat" or slope gradually indicate stable performance. Where the curves hook upward sharply, small increases in feedrate cause loss to increase greatly. It would be difficult to operate in this range of feedrates without having widely varying loss.

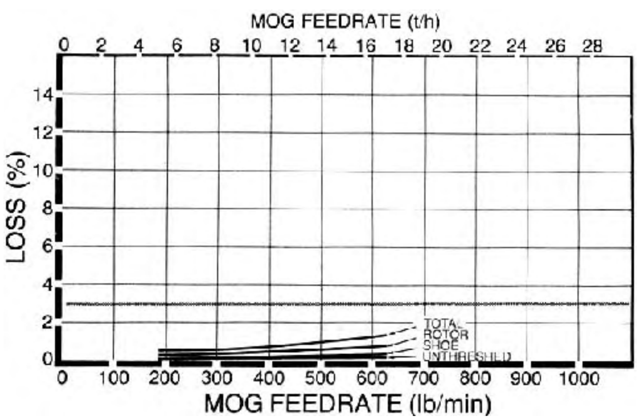

FIGURE 4. Grain Loss in Argyle Barley.

Both of the barley crops used for the test came from uniform stands and were laid in well formed single windrows. The crops were mature and the grain was dry, but the straw in the Argyle barley was tough, which resulted in relatively low straw break-up and corresponding low shoe load. The Harrington barley crop had a relatively high MOG/G ratio. Despite the dry straw, break-up in the Harrington barley crop was about average. Both crops were easily threshed, and the awns broke off readily.

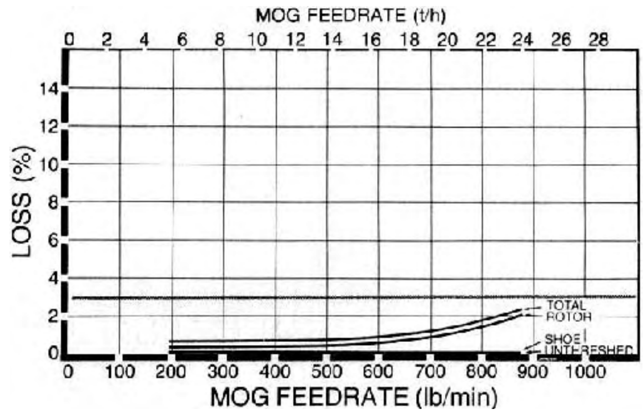

FIGURE 5. Grain Loss in Harrington Barley.

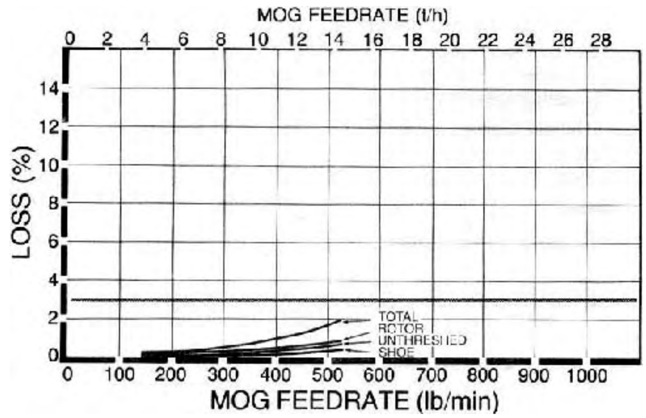

FIGURE 6. Grain Loss in Katepwa Wheat "A".

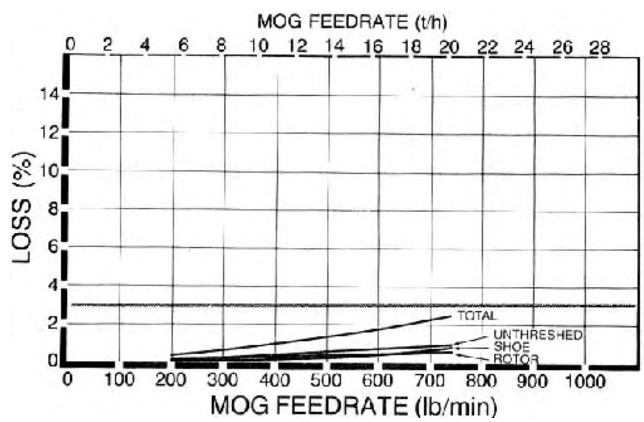

FIGURE 7. Grain Loss in Katepwa Wheat "B".

In barley, the maximum feedrates attained were 630 lb/min (17.2 t/h) MOG in the Argyle crop and 870 lb/min (23.5 t/h) MOG in the Harrington crop. The dryer straw and high MOG/G ratio of the Harrington barley crop contributed to the higher MOG feedrate attained. In both crops, the power limit of the engine was reached before total loss approached 3%.

Rotor loss was the greatest component of total loss in both barley crops and would likely limit capacity if wider concave clearances were used.

All three Katepwa wheat crops came from uniform stands and were laid in well formed, side-by-side double windrows. All three

TABLE 3. Capacity of the Massey 8560.

Crop Conditions									Results										
		Width of Cut		Crop Yield		Moisture Content			MOG Feedrate		Grain Feedrate		Total Feedrate		Grain Cracks	Dockage	Foreign	Fig.
Crop	Variety	ft	m	bu/ac	t/ha	Straw %	Grain %	MOG/G	lb/min	t/h	bu/h	t/h	lb/min	t/h	%	%	Material	No.
Barley	Argyle	24	7.2	73	3.9	14.2	12.7	0.87	630	17.2	9.5	19.9	1360	37.1	0.2	1.4	0.4	4
Barley	Harrington	20	6.1	74	4.0	8.4	11.1	1.23	870	23.5	885	19.5	1575	43.0	0.4	2.9	0.4	5
Wheat	Katepwa"A"	40	12.2	26	1.8	6.7	13.0	0.73	530	14.3	725	19.6	1255	33.9	0.6	1.8	0.4	6
Wheat	Katepwa"B"	60	18.3	37	2.5	8.7	14.1	0.75	740	20.0	985	26.6	1725	46.6	0.5	1.9	0.9	7
Wheat	Katepwa"C"	60	18.3	38	2.6	10.9	16.3	1.30	915	24.7	705	19.0	1620	43.7	0.2	1.5	1.2	8

crops were mature and the straw was dry. The grain for the first two tests was dry, but it was tough for the last test. The straw in the first two tests was short and the yield was average, which resulted in low MOG/G ratios. The last test crop had longer straw, which gave a much higher MOG/G ratio. The last two crops had been rained on and dried in the windrow.

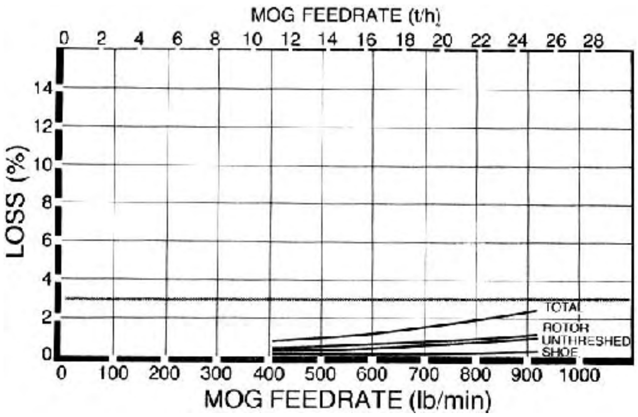

FIGURE 8. Grain Loss in Katepwa Wheat "C".

In wheat, the maximum MOG feedrates attained ranged from 530 to 915 lb/min (14.3 to 24.7 t/h). The "weathered" state of the second and third test crops and the high MOG/G ratio in the third test crop probably contributed to higher MOG feedrates. As in the barley crops, engine power limit was reached before total loss reached 3%. In the wheat tests, unthreshed loss was a large part of the total loss even though the rotor was run at maximum speed.

In both wheat and barley, total loss was generally low. Also, the relatively "flat" curve over most of the operating range meant that loss was relatively constant even when there were large variations in ground speed and windrow density.

In all crops more engine power would have increased combine capacity.

Average Workrates: TABLE 4 shows the range of average workrates achieved during day-to-day operation in the various crops encountered. The table is intended to give a reasonable indication of the average rates most operators could expect to obtain, while acknowledging the effects of crop and field variables. For any given crop, the average workrates may vary considerably. Although a few common variables such as yield and width of cut are included in TABLE 4, they are by no means the only or most important ones. There are many other crop and field conditions which affect work rate; as well, operating at different loss levels, availability of grain handling equipment and differences in operating habits can have an important effect.

TABLE 4. Field Workrates.

Crop	Range	Grain Feedrate		Area Rate		Width of Cut		Yield		Variety
		bu/h	t/h	ac/h	ha/h	ft	m	bu/ac	t/ha	
Barley	High Low Avg.	730 205 480	15.9 4.5 10.5	13.0 8.0 9.5	5.1 3.2 3.9	24 24	7.3 7.3	57 26 50	3.1 1.4 2.7	Argyle Argyle
Canola	High Low Avg.	420 170 235	9.5 3.8 5.3	11.0 10.5 11.0	4.5 4.2 4.4	25 20	7.6 6.1	38 16 22	2.1 0.9 1.2	Westar Tobin
Flax	High Low Avg.	135 90 125	3.5 2.2 3.2	6.5 6.0 6.0	2.5 2.5 2.5	18 18	5.5 5.5	22 14 20	1.4 0.9 1.3	Norlin Norlin
Lentils	Avg.	145	3.9	12.0	4.8	18	5.5	12	0.8	Laird
Rye	High Low* Avg.	320 135 225	8.2 3.4 5.7	9.5 4.5 7.5	3.9 1.7 3.0	21 25	6.4 7.6	33 31 30	2.1 2.0 1.9	Musketeer Musketeer
Wheat	High Low Avg.	665 175 435	18.1 4.8 11.8	21.5 9.5 17.5	8.6 4.0 6.9	40 25	12.2 7.6	31 18 25	2.1 1.2 1.7	Katepwa Katepwa

*Tough conditions were the main reason for this low work rate.

The effect of the variables, as indicated in TABLE 4, explains why even the maximum average workrates may be considerably lower than the capacity results, which are instantaneous workrates. Clearly TABLE 4 should not be used to compare performance of combines. The factors affecting average workrates are simply too numerous and too variable to be duplicated for each combine tested.

Comparing Combine Capacities: The capacity of combines tested in different years or in different crop conditions should be compared only by using the PAMI reference combines. Capacity ratios comparing the test combine to the reference combine are given in the following section. For older reports where the ratio is not given, a ratio can be calculated by dividing the MOG feedrate listed in the capacity table by the corresponding MOG feedrate of the reference combine listed in APPENDIX II for that particular crop.

Once capacity ratios for different evaluation combines have been determined for comparable crops, they can be used to approximate capacity differences. For example, if one combine has a capacity ratio of 1.2 times the reference combine and another combine has a capacity ratio of 2.0 times the reference combine, then the second combine is about 67% larger [(2.0 - 1.2) - 1.2 x 100 = 67%]. An evaluation combine can also be compared to the reference combine at losses other than 3%. The total loss curves for the test combine and reference combine are shown in the graphs in the following section. The shaded bands around the curves represent 95% confidence belts. Where the bands overlap, very little difference in capacity exists; where the bands do not overlap a significant difference can be noticed.

PAMI recognizes that the change to the Reference II combine may make it difficult to compare test machines, which were compared to Reference I. To determine a relative size it is necessary to use a ratio of the two reference combines. Tests indicated that Reference II had about 1.50 to 1.60 times the capacity of Reference I in wheat and about 1.40 to 1.50 times Reference I's capacity in barley.

Capacity Compared to Reference Combine: The capacity of the Massey 8560 was greater than that of the PAMI Reference II combine in both wheat and barley. In all crops, the capacity of the test combine was limited by engine power and did not reach 3% loss. When compared to the Reference II at 3% loss, the capacity of the Massey 8560 was 1.6 and 2.4 times the Reference II's capacity in Argyle and Harrington barley respectively, and 1.0 to 1.4 times its capacity in Katepwa wheat. FIGURES 9 to 13 compare the total losses of both combines.

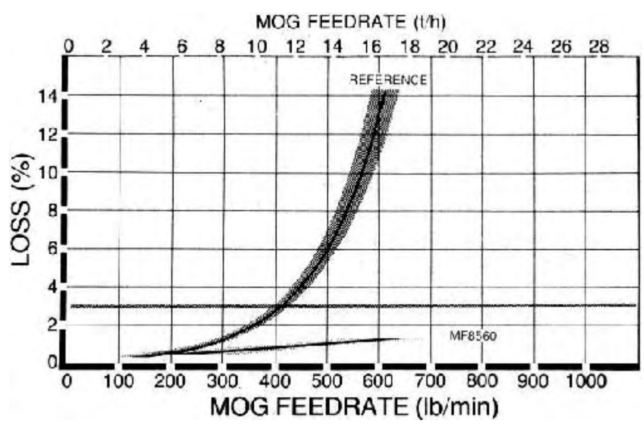

FIGURE 9. Total Grain Loss in Argyle Barley.

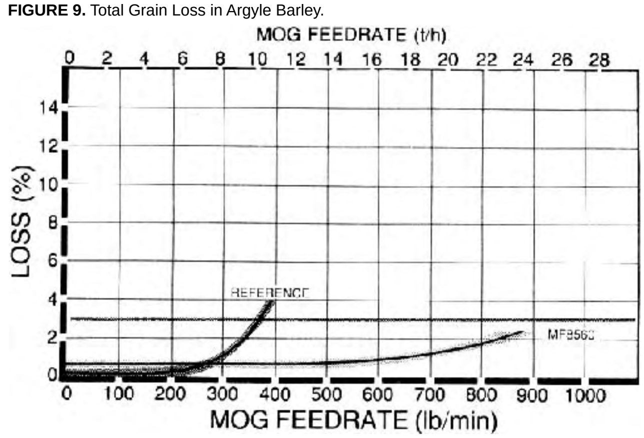

FIGURE 10. Total Grain Loss in Harrington Barley.

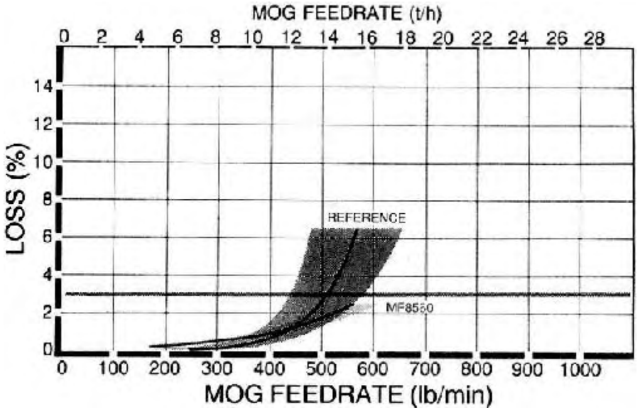

FIGURE 11. Total Grain Loss in Katepwa Wheat "A".

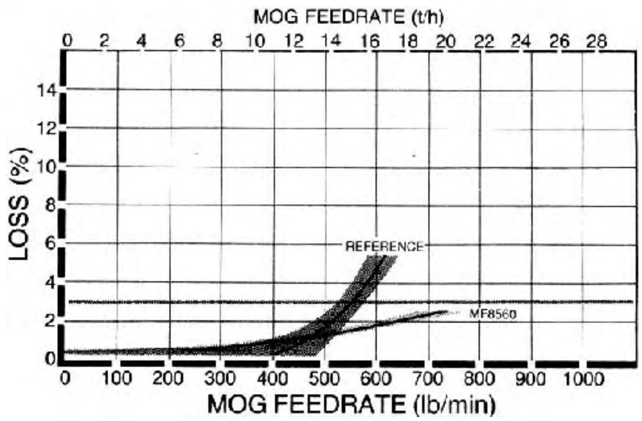

FIGURE 12. Total Grain Loss in Katepwa Wheat "B".

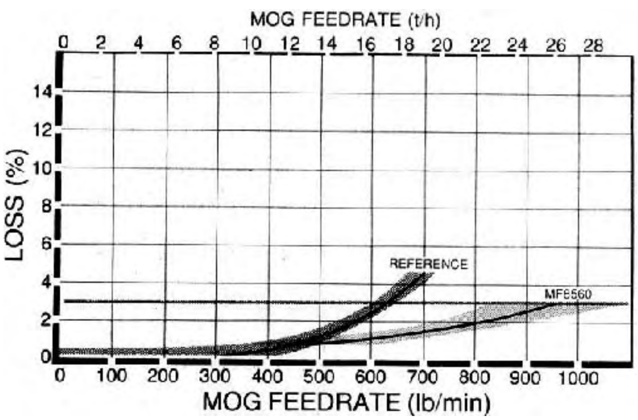

FIGURE 13. Total Grain Loss in Katepwa Wheat "C".

QUALITY OF WORK

Picking: Pickup performance was very good.

The pickup was normally operated at about a 300 angle to the ground, with the gage wheels adjusted so the teeth just touched the ground. The draper speed was set just slightly faster than ground speed. The combine's pickup speed control system automatically maintained the pickup speed to ground speed ratio as the ground speed was varied. This feature was very convenient and helped reduce shattering loss while harvesting very dry canola. A well supported windrow was picked cleanly at speeds up to 6 mph (9.7 km/h). Picking aggressiveness was increased in poorly supported windrows by increasing pickup speed and reducing the pickup angle. The pickup picked a few smaller stones when operating in stony conditions.

In green weedy conditions or if chopped straw was picked, plugging occurred between the transfer drapers and the stripper plate. This damaged a transfer draper on one occasion.

The pickup was wide enough for picking around most windrow corners.

Feeding: Feeding was very good.

As is typical of many rotary combines, feeding windrows off-centre did not have any noticeable effect on combine performance.

Crop was usually fed below the centreline of the large diameter table auger. Initially, the table auger plugged frequently when operating in slightly bunchy or tough windrows. Adjusting the table auger slip clutch for maximum torque still did not stop the plugging. PAMI modified the spacers in the slip clutch adjustment. Once properly adjusted the table auger slipped only under severe conditions. It is recommended that the manufacturer consider modifications to the table auger slip clutch to permit more adjustment.

In all crops, after modification to the slip clutch, the slow turning table auger provided gentle, positive material flow and fed crop smoothly into the feeder conveyor. Even in flax, the table auger did not wrap.

The feeder conveyor was aggressive and did not plug, and there was no evidence of back feeding.

Stone Protection: Stone protection was good.

Although the combine was not operated in stony conditions, some small stones and hard objects were found in the stone trap. The largest object emptied from the stone trap was an 8 in (20 mm) length of 2 x 4 board. The stone trap was most effective if emptied regularly to prevent grain and dirt from hardening in the trap. Some small stones did enter the rotor of the Massey 8560 and caused minor concave damage.

Threshing: Threshing was good.

In most crops and conditions, crop fed smoothly into the rotor. However, on a few occasions when harvesting green or damp crops a low frequency "rumble" occurred. This happened even though not operating at engine power limit. No cause was determined and no problems resulted.

The rotor speeds used produced threshing bar speeds similar to or slightly faster than the threshing bar speeds used by many conventional combines. In most crops as high a rotor speed as practical was used. Close concave clearance was used in hard-to-thresh crops to minimize unthreshed and separating loss. Wider concave settings were often used in easier threshing crops such as fall rye, barley, and canola in order to increase throughput and minimize straw break-up.

In barley and easy-to-thresh crops, unthreshed loss was usually very low. In wheat, even using aggressive settings, unthreshed loss was a significant part of the total loss. Concave blanks helped reduce unthreshed loss but also increased separating losses. Faster rotor speeds would have helped reduce unthreshed loss.

Grain damage was low in all crops. Even when using settings for aggressive threshing, grain damage was much lower than for a conventional combine.

TABLE 5 shows the settings that PAMI found to be suitable for different crops. The suggested settings in the operator's manual were useful as initial settings, but in most crops PAMI found faster rotor speeds provided more suitable threshing.

TABLE 5. Crop Settings

Crop	Rotor Speed	Concave Setting Position	Sieve Openings						Fan Speed
			Chaffer		Tailings		Cleaning		
	rpm		in	mm	in	mm	in	mm	rpm
Barley	950 - 970	3 - 4	7/8	23	1	25	3/8	10	700 - 750
Canola	600 - 650	3	3/4	20	7/8	22	1/4	5	550 - 605
Flax	940 - 960	4*	3/8	10	3/4	18	1/16	2	400 - 450
Rye	670 - 700	5	1/2	12	3/4	20	5/8	15	550 - 600
Wheat	950 - 970	0 - 2	3/4	20	7/8	24	1/4	6	650 - 730

*Three concave blanks installed.

Separating: Separating was very good.

In all crops, the crop flowed smoothly through the separating section. Plugging and bridging did not occur. The narrow spaced threshing concaves were used in all crops. In accordance with the manufacturer's recommendations for harvesting small grains, the rotor knives were removed from the threshing section.

In barley, although rotor loss was the major part of the total loss it generally did not limit capacity. Rotor loss increased gradually with feedrate indicating stable separating characteristics. It is possible that the optional wide spaced threshing concaves would have reduced rotor loss in barley.

In wheat, rotor loss was low over the entire operating range, increasing very gradually with feedrate. Installing the concave blanks increased rotor loss slightly.

In canola and flax, rotor loss was small and did not limit capacity. The settings PAMI used for the various crops are shown in TABLE 5.

Cleaning: Cleaning shoe performance was very good.

Material from the rotor often loaded the shoe unevenly. Chaff loads were usually heavier along the left side (FIGURE 14). Under most conditions this uneven loading had no apparent detrimental effect on shoe performance. Only in very dry conditions with high straw break-up did shoe load become heavy enough to occasionally overload part of the chaffer and cause grain to slough over. The concave deflector adjustment helped distribute the chaff load more evenly. However, in the severe conditions, reducing threshing aggressiveness, increasing fan speed or reducing feedrate was also required to compensate for the heavy, uneven loading.

FIGURE 14. Uneven Shoe Loading.

At the beginning of the season, much of the loss coming from the shoe originated from gaps between the side walls and sieve frame which the sieve access door did not seal. A seal installed by PAMI (FIGURE 15) eliminated this grain loss. It is recommended that the manufacturer consider modifications to prevent grain loss along the side walls at the rear of the shoe.

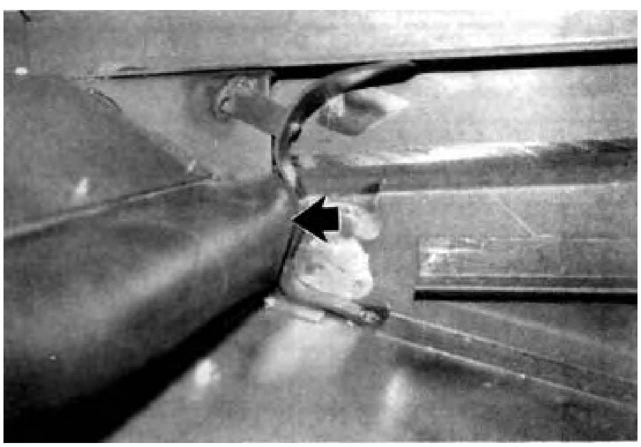

FIGURE 15. PAMI installed Seal.

In nearly all conditions in both wheat and barley shoe loss was very low over the entire operating range even at high grain feedrates.

In canola and flax, total loss over 1 to 1.5% is often considered unacceptable. Reasonable feedrates were attained within this loss range but as with most combines, shoe loss limited capacity in these crops.

In all crops, the Massey 8560 had a clean grain sample when the shoe was set for minimal loss. TABLE 5 shows the settings PAMI found suitable for the crops encountered.

Clean Grain Handling: Grain handling was very good. The open grain tank filled very evenly, except for a small portion of the top corners. A full grain tank held about 195 Imp bu (7.1 m^3) of dry wheat. A full bin sensor warned the operator when the grain tank was about 95% full. If overfilled, grain spilled over the front of the grain tank first.

The unloading auger was electro-hydraulically positioned for unloading to the left. This enabled easy topping of loads and unloading on-the-go. The unloading auger had ample reach and clearance for unloading into all trucks and trailers encountered (FIGURE 16). The auger discharged grain in a compact stream and unloaded a full tank of dry wheat in 116 seconds. Grain spillage out of the auger when swung back was stopped by an optional “spill saver” mounted at the outlet.

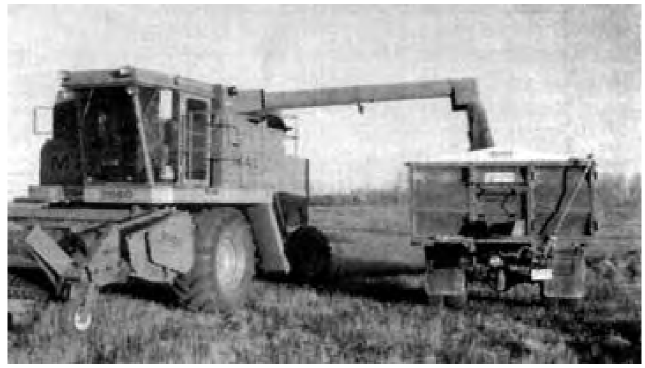

FIGURE 16. Unloading.

Straw Spreading: Straw spreading was fair.

In most conditions, most of the straw from the rotor entered the left side of the straw chopper, resulting in a heavier discharge of straw to the left (FIGURE 17). Adjusting the rotor discharge deflector did not change the distribution appreciably. The straw chopper spread most of the straw over 15 to 20 ft (4.6 to 6.1 m), which was narrow for the width of cut most suitable for this combine. The chaff was not spread with the straw.

FIGURE 17. Uneven Straw Chopper Discharge.

A provision was made for conversion of the straw chopper to drop straw, but it was not very convenient. Several bolts had to be removed and the chopper tailplate had to be pivoted 90° to provide clearance for swing-away of the chopper. The opening for straw discharge was small and impeded free material flow. It is recommended that the manufacturer consider modifications to the straw chopper mounting system to allow simpler conversion for windrowing straw and to provide a larger opening for straw discharge.

Due to the high straw break-up, the windrow formed when dropping the straw was generally not suitable for baling.

EASE OF OPERATION AND ADJUSTMENT

Operator Comfort: Operator comfort was very good.

The Massey 8560 was equipped with an operator’s cab positioned left of centre. The cab was quiet and easily accessible. Incoming air was effectively filtered while fans pressurized the cab to reduce dust leaks. The heater and air conditioner provided comfortable cab temperatures. The seat adjustment provided a comfortable operating position for most operators, but many operators found that the steering column did not tilt far enough back for comfortable operating. It is recommended that the manufacturer consider providing greater steering column tilt adjustment.

The operator had a clear view forward and to the sides. The rear view mirrors provided rear visibility. View of the incoming swath was slightly obstructed by the steering wheel (FIGURE 18). Visibility of the grain coming into the tank was restricted by the grain tank screen and completely blocked as the tank became nearly full. The unloading auger was visible when swung fully forward but the operator had to lean forward to see the auger if it was swung back slightly.

FIGURE 18. View of incoming Windrow.

Instruments: Instrumentation was good.

The instruments were located on a console to the right of the operator (FIGURE 19). The console contained gauges, warning lights, and a digital display. The gauges indicated engine hours, oil pressure, and coolant temperature, while the warning lights and an audible alarm indicated low fuel level, reduced battery voltage, excessive coolant temperature, low engine oil pressure, low coolant level, air filter restriction, parking brake engagement, full grain tank, and speed reduction of major drives. The digital display selectively indicated engine, ground, rotor, and cleaning fan speeds, remaining fuel and battery voltage. A separate warning light indicated overload of the hydrostatic rotor drive.

FIGURE 19. instrument Console.

The Massey 8560 was often operated at or near engine power limit, so most operators selected the digital engine speed display to monitor performance. A provision to monitor engine speed simultaneously with any of the other digital display functions would have been useful.

The “rotor overload” light was effective at night as the light was easy to see and caught the operator’s attention. However, during the day the light was often too dim to effectively alert the operator, and no audible alarm was provided. It is recommended that the manufacturer consider modifications to the rotor overload indicator to make it more noticeable during daylight operation.

All of the other instruments worked well, were conveniently located, and were clearly visible.

Controls: The Massey 8560 controls were very good.

Most of the controls were located to the right of the operator (FIGURE 19). The unloading auger engagement lever was on the left, and the lights and cab climate controls were situated overhead (FIGURE 20). Most of the controls were conveniently placed and easy to use.

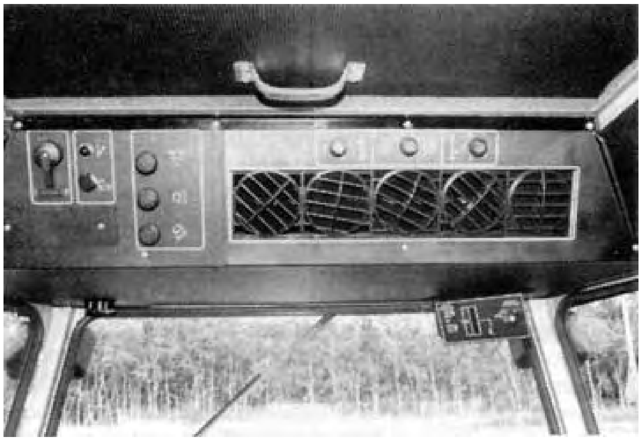

FIGURE 20. Overhead Console.

The pickup speed was controlled electronically, and could be varied manually or set to respond automatically to changes in ground speed. Both modes worked well, response was quick and the control was very convenient to use. The header height control switch was incorporated into the handle of the hydrostatic lever. Header height control was convenient and the raise and drop rates were suitable.

The separator and header engagement switches were resistant to accidental engagement yet were still convenient to disengage in an emergency. However, they were not easy to distinguish from each other at a glance. The hydrostatic rotor speed control was conveniently placed and easy to use.

Loss Monitor: The loss monitor was good.

The loss monitor display was located in the upper right corner of the cab (FIGURE 20). The loss monitor’s LED display was very easy to interpret and clearly visible under all conditions. The monitor displayed shoe loss only. A rotor loss display would have been desirable as rotor loss was often a significant part of total loss. It is recommended that the manufacturer consider providing grain loss sensors for the rotor.

As with all loss monitors, the reading was meaningful only if it was compared to actual loss and monitor response then set for each field condition.

The monitor was effective in warning of changes in shoe loss. On occasions when shoe overloading caused grain to be sloughed over the chaffer, the display warned the operator.

Lighting: Lighting was fair.

The test combine was equipped with four field lights, a grain tank light, a cab ladder light, and an unloading auger light. The field lights provided adequate short to mid-range forward lighting, but marginal long range forward lighting and side lighting. In certain conditions extra lighting may be necessary. It is recommended that the manufacturer consider providing extra forward and peripheral lighting.

The light on the unloading auger illuminated the grain discharge and truck box regardless of auger position, which was very convenient for unloading at night. The unloading auger light also provided rear lighting when the unloading auger was in the transport position. The light which shone on the ladder greatly aided convenience and safety of mounting and dismounting at night. The grain tank light effectiveness was reduced by the perforated grain tank screen. The instruments and console were well lit, and a cab dome light provided extra cab lighting. The service light in the engine bay was convenient.

The road lights were adequate. The two red tail lights and four amber warning lights aided in safe road transportation.

Handling: Handling was very good.

The Massey 8560 was easy to drive and very maneuverable. Steering was smooth and responsive. The wheel brakes were effective and aided in cornering, but were not required for picking around most windrow corners.

The transmission was often difficult or impossible to shift if the operator was unfamiliar with the machine. A somewhat complex stopping procedure using the pressure release pedal permitted easier shifting. The procedure was only briefly referred to in the operator's manual. It is recommended that the manufacturer consider modifications to permit easier shifting of the transmission.

The hydrostatic ground drive was very convenient for matching ground speed to crop conditions. It also made backing up on hard to pick corners quick and easy.

The combine was very stable in the field, even with a full grain tank. Normal caution was needed when operating on hillsides and when travelling at transport speeds. The combine travelled well up to its maximum 17 mph (27 km/h).

Adjustment: Ease of adjusting combine components was good.

Pickup speed and rotor speed were easily adjusted from the cab while operating. Concave clearance and sieve settings were located externally on the machine.

Auger finger timing and auger clearance were easily adjusted to suit crop conditions and once set, did not have to be readjusted. Adjusting concave clearance was easily done from the left side of the combine. In all crops encountered, the narrow spaced threshing concaves provided acceptable performance. However, if the wide spaced threshing concaves were required, changing the concaves would be a difficult and time consuming adjustment. Changing all seven concave sections took two men from 2.5 to 3 hours. Concave blanks were quick and easy to install and remove. To improve access to the concaves PAMI installed a work platform.

Chaffer and tailings sieve adjustment was easy, but access to the cleaning sieve adjusting lever was limited, especially if the sieves were in the closest position of shoe stroke. It was very difficult to see the cleaning sieve opening while adjusting.

Fan speed could be varied over a limited range from the cab. To access the other available speed ranges the fan drive belt had to be moved to a different drive sheave and the idler sheaves and the actuator repositioned. This was time consuming and very inconvenient. In addition, fan speed ranges did not overlap unless the actuator length was manually adjusted. Again, readjusting was time consuming and inconvenient. It is recommended that the manufacturer consider modifications to permit convenient full range fan speed adjustment from the operator's station.

Field Setting: Ease of setting the Massey 8560 to suit field conditions was good. Usually, little "fine tuning" was required after initial adjustments were made.

Setting the shoe for optimum performance required some experience to become familiar with its performance characteristics. "Kill stalls" were effective for checking the material distribution on the grain pan and shoe and aided setting the rotor deflectors. Airborne loss and sloughed loss were easily mistaken for each other because of the high velocity and the horizontal discharge pattern of shoe effluent (FIGURE 21). Until sealed, the grain loss between the side walls and sieve access door also caused confusion when adjusting.

FIGURE 21. Shoe Discharge.

The discharge area of the shoe was relatively unobstructed and was convenient for catching a sample. The grain tank was difficult to access from the operator's station to get a clean grain sample. It is recommended that the manufacturer consider modifications to improve grain tank access from the operator's station. No provision was made for sampling the return tailings. It is recommended that the manufacturer consider modifications to permit safe, convenient sampling of the rerun tailings while harvesting.

The manufacturer's suggested settings were close for fan and cleaning sieve settings. However, PAMI found that larger chaffer openings than suggested were generally more suitable. The optional windboard was found to be unnecessary for the crops encountered so was not installed.

Unplugging: Ease of unplugging was fair.

Unplugging the table auger and feeder conveyor was difficult as the Massey 8560 was not equipped with a header reverser or slug wrench. The operator's manual made no reference to clearing obstructions from the header. When the table auger or feeder plugged, the obstruction often had to be "backed out" by using a suitable wrench to turn the header drive countershaft. This was inconvenient and on occasion ineffective. It is recommended that the manufacturer consider modifications to permit quick, convenient header unplugging.

The rotor seldom plugged, but when a plug did occur, it was easily cleared by lowering the concave and rocking the slug out with the hydrostatic rotor control.

Machine Cleaning: Ease of cleaning the Massey 8560 completely was fair.

Grain tank cleaning was complicated by the numerous support braces in the tank. The grain tank sump retained approximately 1 bu (0.4 hL) of grain and was difficult to access from the ground. The PAMI installed platform greatly improved access for cleaning the sump.

The sieves were fairly easy to remove which provided access for cleaning the clean grain and tailings auger troughs. The grain conveyor pan and concaves were accessible through removable panels on both sides of the machine, but could not be easily accessed from ground level. The tailings were returned to the rotor inlet where a steel deflector formed a pocket that was impossible to access and would retain approximately 1 quart (1 L) of material. This would complicate machine cleaning for harvesting of seed grain.

The exterior of the combine was easy to clean. Most chaff and dust accumulation was easy to remove, except on top of the fan housing. A considerable amount of chaff accumulated in this area and was difficult to remove.

Lubrication: Ease of lubrication was very good.

Daily lubrication was quick and easy. Most lubrication points were easily accessible. The combine had 32 pressure grease fittings. Twelve required greasing at 10 hours, thirteen at 50 hours, and an additional seven at 500 hours. Lubrication decals on the sides of the combine greatly aided greasing at the specified intervals, and grease banks were used wherever practical.

Access to the feeder conveyor drive chain for daily lubrication, was hampered by the feeder housing side shield, which was difficult to remove.

Engine, transmission, and hydraulic oil levels required regular checking. Changing engine oil and filters was easy, but changing the hydraulic filter was very messy. The use of a large catch pan under the filter housing is advised when changing the hydraulic filter.

The fuel inlet was 9.5 ft (2.9 m) above the ground, which was to high for most gravity tanks. The cab platform provided safe and convenient access to the inlet.

Maintenance: Ease of performing routine maintenance was good.

Most of the belt drives on the Massey 8560 were clustered around the engine power output pulley and the main countershaft on the left side of the combine. Spring loaded tensioning idlers were used on the slack side of many belts which simplified adjustment. However, several critical drives utilized an idler stop screw in addition to the spring, which required frequent checking and adjustment. Access to most of these drives was possible from the engine deck, but a few could not be easily reached from either the engine deck or the ground. Again, the installation of the access platform on the left side of the separator body permitted quick access for routine maintenance.

Straw chopper, cleaning shoe, and fanning mill drives were easily accessible, but the feeder side shields were difficult to remove and replace which complicated feeder chain adjustment. Proper tensioning of the tailings elevator chain was very difficult as there was almost no clearance for tools around the inner bearing support plate. It is recommended that the manufacturer consider revising the tailings elevator chain tensioning system to simplify adjustment.

The stone trap latching lever was inconvenient to reach and operate. Care was required to ensure proper latching. On several occasions when improperly latched, the stone trap door opened during operation and went undetected. It is recommended that the manufacturer consider modifications to permit easy access to the stone trap latching lever and to provide positive latching.

There was ample room in and around the engine bay for inspection and service, but climbing up to the rear deck was inconvenient as the access ladder was narrow and almost vertical. Operators often had difficulty carrying tools or service items to the engine bay, as both hands were needed to climb the ladder.

Thistle infested crops presented problems for the radiator and engine air intake. Thistle fuzz easily penetrated the rotary radiator screen and plugged the radiator, oil cooler, and air conditioning condenser. This accumulation had to be cleaned out every 3 to 4 hours in severe conditions, although access to the radiator was relatively easy. It is recommended that the manufacturer consider modifications to the rotary screen to prevent radiator plugging in these conditions. The aspirated pre-cleaner on the engine air-inlet failed to remove thistle fuzz. This resulted in primary filter plugging. This restriction was indicated by the alarm in the cab.

Slip clutches protected the table auger, feeder, and clean grain drives.

The complete header and feeder house assembly was easily removed and installed. The feeder house jack supplied with the test combine was convenient, but proper blocking of the header was essential for safe separation.

Removing the rotor was moderately difficult. The rotor was heavy, thus, caution was required when handling it.

ENGINE AND FUEL CONSUMPTION

The Cummins 6BTA 5.9 diesel engine started easily and ran well. The engine had adequate power to achieve reasonable harvest rates in most conditions even though it often reached its power limit before loss became excessive. Black exhaust smoke was always noticeable, even under light loads.

Average fuel consumption was about 7.4 gal/h (33.6 L/h) when harvesting. Oil consumption was insignificant.

OPERATOR SAFETY

The operator's manual emphasized safety. The Massey 8560 had warning decals to indicate dangerous areas. All moving parts were well shielded. Most shields were easy to remove for access but the shields on the feeder house were difficult to remove and reinstall.

No safety hazards on the Massey 8560 were apparent. However, normal safety precautions were required and warnings had to be heeded.

A header lift cylinder safety stop was provided and should be used when working near the header or when the combine is left unattended. If the operator must make adjustments or work in dangerous areas, all clutches should be disengaged and the engine shut off.

The combine was equipped with a slow moving vehicle sign, warning lights, signal lights, tail lights, road lights, and rear view mirrors to aid safe road transport.

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

OPERATOR'S MANUAL

The operator's manual was very good.

It was clearly written, and well organized. It provided useful information on safety, controls, adjustments, crop settings, servicing, trouble shooting, and machine specifications.

MECHANICAL HISTORY

The intent of the test was evaluation of functional performance. Extended durability testing was not conducted. However, TABLE 6 outlines the mechanical history of the Massey 8560 for the 123 hours of field operation during which about 1270 ac (514 ha) of crop was harvested.

TABLE 6. Mechanical History

Item	Operating Hours	Field Area ac	Field Area (ha)
– Paint overspray on the over loader drive pulley caused inadvertent unloader engagement. The paint was removed at No further problems occurred.		Beginning of Test	
– Oil in the clean grain system slip clutch prevented the fountain auger from completely filling the grain tank. The clutch was dried and reassembled at		Beginning of Test	
– The fuel tank float stuck against the side of the fuel tank, requiring removal of the sender and reshaping of the arm to prevent interference at		Beginning of Test	
– The fan speed control switch was found to be wired backwards at		Beginning of Test	
– The steering return hose blew off of its nipple causing loss of hydraulic oil. The hose was reinstalled with extra clamps at	2	15	(6)
– The fuel gauge began giving erratic readings due to a poor ground at the sender. An extra jumper wire was installed to complete the ground at	29	215	(86)
– The rotor drive pump mounting bracket loosened, requiring retightening of the bolts at	32	250	(100)
– The drive chain at the top of the tailings elevator jumped off due to sprocket misalignment. The sprockets were aligned and the chain reinstalled at	35	260	(105)
– An idler tensioning spring broke, damaging the lower spring tension bracket and eyebolt. The damage was repaired and a new spring installed at	45	430	(174)
– The starter solenoid failed and was replaced at	45	430	(174)
– The serpentine engine belt was found to be defective and was replaced at	56	585	(237)
– The steering return line failed due to abrasion with other lines and was replaced at	61	625	(252)
– The radiator plugged repeatedly with thistle fuzz and had to be blown out at	61, 66, 114	625, 665, 930	(252, 269, 377)
– An air intake hose clamp was found to be improperly installed and was relocated at	78	885	(359)
– The straw chopper idler tensioning spring came off and was lost at	114	930	(377)
– The coolant reservoir took in chaff and debris and was cleaned out at		End of Test	

Steering Return Line: This hose was fabricated from "fabric-braided" tubing. A crimped-on hydraulic fitting at one end threaded into the steering motor, while the other end was simply hose clamped onto a steel nipple which teed into the hydraulic return line to the reservoir. It is unknown if the first failure was caused by an improperly tightened hose clamp or if a pressure spike in the return circuit simply exceeded the capacity of the clamp, When the hose was reinstalled, a second clamp was tightened onto the hose beside the original one as a precaution.

The second failure of the line was caused by abrasion with adjacent components. To prevent further abrasion related failures, the hose was replaced with high-pressure, steel braided hydraulic hose. This provided better abrasion resistance, but this stiffer hose was then difficult to clamp onto the steel nipple.

It is recommended that the manufacturer consider modifications to prevent steering return line failures and repetitive hydraulic oil loss.

Air Intake Hose Clamp: The hose clamp on the outlet of the air filter canister was not properly positioned when it was tightened onto the hose, resulting in a portion of the clamp protruding past the end of the hose, The clamp was repositioned so that its entire width was used to retain the hose to the air filter outlet. There was no evidence of dust infiltration, but the observation is significant because of the potential expense of an engine repair if dirt were allowed to enter the air systems.

Coolant Reservoir: At the end of the season, the coolant reservoir was found to contain a significant amount of chaff and dirt, which had entered through the rather large, open vent at the top of the reservoir. Intake of debris into the cooling system could eventually cause core blockage in the radiator and premature failure. It is recommended that the manufacturer consider modifications to prevent dirt and chaff entry into the coolant reservoir.

APPENDIX I
SPECIFICATIONS

MAKE:	Massey Self-Propelled Combine
MODEL:	8560
SERIAL NUMBER:	Header- H00254 Body - H00246 Engine - 6BTA94474
MANUFACTURER:	Massey Combines Corporation Massey Ferguson Industries Ltd. 225 Henry Street Brantford, Ontario N3T 5M1

WINDROW PICKUP:

-- make and model	Melroe 388
-- type	rubber draper and transfer belts
-- pickup width	12 ft (3.7 m)
-- number of belts	8
-- type of teeth	steel
-- number of rollers	4
-- height control	castoring gage wheels
-- speed control	electric over hydraulic
-- speed range	0 to 423 ft/min (0 to 2.15 m/s)

HEADER:

-- type	centre feed
-- width	
- table	13 ft (4.0 m)
- feeder house	44 in (1110 mm)
-- auger diameter	24 in (610 mm)
-- feeder conveyor	3 roller chains with under shot slatted conveyor
-- conveyor speed	630 ft/min (3.2 m/s)
-- picking height range	-35 to 36.4 in (-900 to 925 mm)
-- number of lift cylinders	2
-- raising time	adjustable
-- lowering time	adjustable
-- options	rigid header, flex header, corn heads, auto header height control, accumulator, additional retractable fingers, flighting extensions

STONE PROTECTION:

-- type	sump
-- cleaning	manually operated access door

FEED BEATER:

-- type	4 wing square
-- speed	670 rpm

ROTOR:

-- number of rotors	1
-- type	longitudinally mounted, closed tube with intake auger flighting, 3 front threshing elements, 3 pairs of rasp bars, 3 separating fins, and 3 rows of rotor knives
-- diameter	
- tube	22.2 in (565 mm)
- feeding	25.2 in (640 mm)
- threshing	27.2 in (690 mm)
- separating	27.8 in (705 mm)
-- length	
- feeding	41.7 in (1060 mm)
- threshing	39.6 in (1005 mm)
- separating	58.8 in (1495 mm)
- total	140.1 in (3560 mm)
-- drive	hydrostatic variable speed with reverse
-- speeds	0 to 970 rpm
-- options	high torque rotor drive, rice rotor

CONCAVE (THRESHING):

-- number	7	
-- type	bar and wire	
-- number of bars	25 each	
-- configuration		
- narrow space	24 intervals with 0.2 in (5 mm) wires and 0.22 in (5.8 mm) spaces	
- wide space	24 intervals with 0.26 in (6.5 mm) wires and 0.37 in (9.4 mm) spaces	
-- area	WIDE	NARROW
- concave total	2217 in^2 (1.43 m^2)	2217 in^2 (1.43 m^2)
- concave open	930 in^2 (0.60 m^2)	868 in^2 (0.56 m^2)
- open area	42%	39%
-- wrap	1510	
-- grain delivery to shoe	reciprocating grain pan	
-- options	concave blanks, perforated concave overlaps	

CONCAVE (SEPARATING):

-- number	4
-- type	bar and wire
-- area total	2232 in^2 (1.44 m^2)
-- area open	1345 in^2 (0.87 m^2)
-- open area	60%
-- wrap	1900
-- grain delivery to shoe	reciprocating grain pan

THRESHING AND SEPARATING CHAMBER:

-- number of spirals	18
-- pitch of spirals	34°

SHOE:

-- type	opposed action
-- speed	300 rpm
-- chaffer sieve and tailings sieve	
- type	adjustable lip
- louvre spacing	1-1/8 in (29 mm) hinge, 7/8 in (22 mm) teeth total 3302 in^2 (2.13 m^2), tailings sieve 372 in^2 (0.24 m^2)
- travel	0.9 in (24 mm) vertical, 1.8 in (46 mm) horizontal
-- cleaning sieve	
- type	adjustable lip
- louvre spacing	1-1/8 in (29 mm) hinge, 7/16 in (11 mm) teeth
-- area	2651 in^2 (1.71 m^2)
-- travel	0.9 in (24 mm) vertical, 1.8 in (46 mm) horizontal
-- options	
-- chaffer sieves	- 1-5/8 in (41 mm) regular tooth - 1-5/8 in (41 mm) deep tooth
-- cleaning sieves	- 1-1/8 in (29 mm) specialty
-- round hole sieves	- 7/64 in (3 mm), 5/16 in (8 mm), 3/8 in (10 mm) - 7/16 in (11 mm), 9/16 mm (14 mm), 5/8 in (16 mm) side-hill divider extensions

CLEANING FAN:

-- type	5 blade undershot
-- diameter	28 in (720 mm)
-- width	46 in (1162 mm)
-- drive	electrically controlled variable pitch belt
-- speed range	290 to 850 rpm
-- options	slow speed kit, windboard kit (accommodates 2)

ELEVATORS:

-- type	roller chain with rubber paddles
-- clean grain (bottom drive)	10.0 x 10.9 in (254 x 278 mm)
-- tailings (top drive)	6.0 x 9.3 in (152 x 237 mm)
-- options	perforated cleanout doors

GRAIN TANK:

-- capacity	195 Imp bu (7.1 m^3)
-- unloading time	116 s
-- unloading auger diameter	12 in (304 mm)
-- unloading auger length 1	67 in (4250 mm)
-- options	"scoop" style discharge boot, "spill-saver"

STRAW CHOPPER:

-- type	hammer and knife
-- width	53 in (1345 mm)
-- speed	2770/1400

ENGINE:

-- make	Cummins
-- model	6TBAS.9
-- type	diesel, turbo-charged and inter-cooled
-- number of cylinders	6
-- displacement	360 in^3 (5.9 L)
-- governed speed (full throttle)	2680 rpm
-- manufacturers rating	190 hp (142 kW)
-- fuel tank capacity	84.7 gal (385 L)

CLUTCHES:

-- header	electro-magnetic friction disk
-- separator	electro-magnetic friction disk
-- unloading auger	over-centre belt tightener
-- traction drive	hydraulic valve

NUMBER OF CHAIN DRIVES:	7
NUMBER OF BELT DRIVES:	16
NUMBER OF GEARBOXES:	4

LUBRICATION POINTS:

-- 10 hour	12
-- 50 hour	13
-- 500 hour	7

TIRES:

-- front	24.5 x 32 R1
-- rear	14.9 x 24 R1

TRACTION DRIVE:

-- type	hydrostatic
-- speed ranges	
- 1st gear	0 to 3.1 mph (0 to 5.0 km/h)
- 2nd gear	0 to 6.7 mph (0 to 10.8 km/h)
- 3rd gear	0 to 16.5 mph (0 to 26.6 km/h)
- options	extended drive axles, powered rear wheel drive

OVERALL DIMENSIONS:

-- wheel tread (front)	9.9 ft (3.0 m)
-- wheel tread (rear)	10.0 ft (3.0 m)
-- wheel base	12.1 ft (3.7 m)
-- transport height	11.1 ft (3.4 m)
-- transport length	31.5 ft (9.6 m)
-- transport width	15.7 ft (4.8 m)
-- field height	11.1 ft (3.4 m)
-- field length	29.8 ft (9.1 m)
-- field width	15.7 ff (4.8 m)
-- unloader discharge height	12.8 ft (3.9 m)
-- unloader reach	9.5 ft (2.9 m)
-- unloader clearance	11.9 ff (3.6 m)
-- turning radius	
- left	23.3 ft (7.1 m)
- right	23.3 ft (7.1 m)

WEIGHT (EMPTY GRAIN TANK):

-- right front wheel	9,460 lb (4,290 kg)
-- left front wheel	9,720 lb (4,410 kg)
-- right rear wheel	3,530 lb (1,600 kg)
-- left rear wheel	3,530 lb (1,600 kg)
TOTAL	26,240 lb (11,900 kg)

APPENDIX II

PAMI REFERENCE COMBINE CAPACITY RESULTS

TABLE 7 and FIGURES 22 and 23 present the capacity results for the PAMI reference combines in barley and wheat crops harvested from 1984 to 1987.

FIGURE 22 shows capacity differences in barley crops for 1984, 1986 and 1987. The 1997 Argyle barley crop shown in TABLE 7 had average grain and straw yield and average straw and grain moisture.

FIGURE 23 shows capacity differences in wheat crops for the three years In 1987, the Katepwa wheat crops had below average straw yield, and average grain yield They also had average grain moisture and slightly below average straw 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 years

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

		Crop Conditions									Capacity Results								
				Width of Cut		Crop Yield		Moisture Content			MOG Feedrate		Grain Feedrate		Total Feedrate		Grain Cracks	Dock-age	Foreign Material
		Crop	Variety	ft	m	bu/ac	t/ha	Straw %	Grain %	MOG/G Ratio	lb/min	t/h	bu/h	t/h	lb/min	t/h	%	%	%
REF II	1987	Barley	Argyle	24	7.2	69	3.5	12.6	13.0	0.82	395	10.8	600	13.1	876	23.8	0.5	1.5	1.2
		Barley	Harrington	20	6.4	79	4.3	7.7	10.8	0.81	370	10.1	570	12.4	825	22.5	1.5	3.0	0.1
		Wheat	Columbus	25	7.6	43	2.9	5.0	13.4	1.16	540	14.7	465	12.7	1005	27.4	1.5	3.5	0.1
		Wheat	Katepwa"A"	40	12.2	31	2.2	6.9	12.9	0.65	520	14.2	800	21.8	1320	35.9	1.5	2.5	0.2
		Wheat	Katepwa"B"	60	18.3	37	2.6	8.3	14.5	0.64	580	15.8	905	24.6	1485	40.4	2.0	2.0	0.1
		Wheat	Katepwa"C"	60	18.3	31	2.1	12.8	16.0	1.07	630	17.2	590	16.1	1220	33.2	1.5	1.5	0.1
	1986	Barley	Harrington	56	17.0	62	3.3	10.5	10.8	0.64	424	11.6	828	18.1	1090	29.7	0.4	0.3	0.2
		Wheat	Columbus	56	17.0	51	3.4	8.8	16.7	1.14	647	17.7	568	15.5	1210	33.0	1.5	4.6	3.5
		Wheat	Katepwa	29	8.9	49	3.3	6.5	14.0	1.32	644	17.6	488	13.3	1135	31.0	1.8	1.7	1.0
	1984	Barley	Bonanza	42	12.8	52	2.8	15.0	11.2	0.70	363	9.9	648	14.1	875	23.8	0.5	1.0	
		Barley	Bonanza	24	7.3	77	4.1	11.3	11.6	0.66	352	9.6	687	14.6	880	24.0	0.5	1.0	
		Wheat	Neepawa	44	13.4	36	2.4	6.3	10.9	1.32	539	14.7	408	11.1	950	25.9	1.1	5.5	
		Wheat	Neepawa	22	12.8	44	3.0	8.7	10.2	1.18	601	16.4	509	13.9	1110	30.3	4.5	7.0	
REF I	1986	Barley	Harrington	28	8.5	59	3.7	10.5	9.2	0.56	294	8.0	656	14.3	820	22.3	0.8	0.5	0.2
		Wheat	Columbus[1]	42	12.8	32	2.2	11.8	14.7	1.09	438	12.0	402	11.0	835	22.8	1.2	4.9	3.0
		Wheat	Katepwa	29	8.9	50	3.4	7.5	14.1	1.33	420	11.5	316	8.6	735	20.1	1.3	1.5	0.7
	1985	Barley	Argyle	60	18.0	75	4.0	25.5	11.4	0.94	293	8.0	390	8.5	600	16.4	2.0	1.0	0.4
		Barley	Bonanza	55	16.8	83	4.5	21.0	15.0	0.76	285	7.7	469	10.2	660	18.0	1.0	1.7	1.2
		Wheat	Neepawa	42	12.8	42	2.8	23.7	18.0	1.43	391	10.7	273	7.5	660	18.0	4.9	2.3	0.2
		Wheat	Katepwa	41	12.5	82	4.2	24.8	18.5	0.95	435	11.9	458	12.5	890	24.3	2.5	1.3	0.2
	1984	Barley	Bonanza	42	12.8	68	3.7	18.5	12.9	0.74	275	7.5	464	10.1	645	17.6			
		Barley	Bonanza	24	7.3	85	4.8	12.0	12.1	0.62	213	5.8	429	9.4	550	15.0			
		Wheat	Neepawa	44	13.4	42	2.8	6.7	11.8	1.47	308	8.4	209	5.7	510	13.9			
		Wheat	Neepawa	42	12.8	41	2.8	8.5	10.3	1.17	356	9.7	304	8.3	655	17.9			
		Wheat	Neepawa	42	12.8	23	1.8	7.2	12.5	0.99	345	9.4	348	9.5	695	19.0			

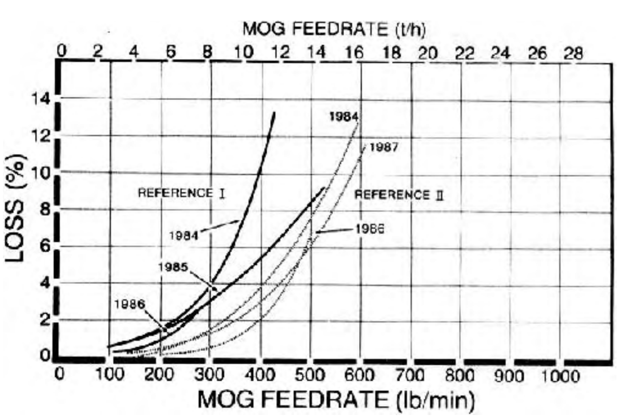

FIGURE 22. Total Grain Loss for the PAMI Reference Combines in Barley.

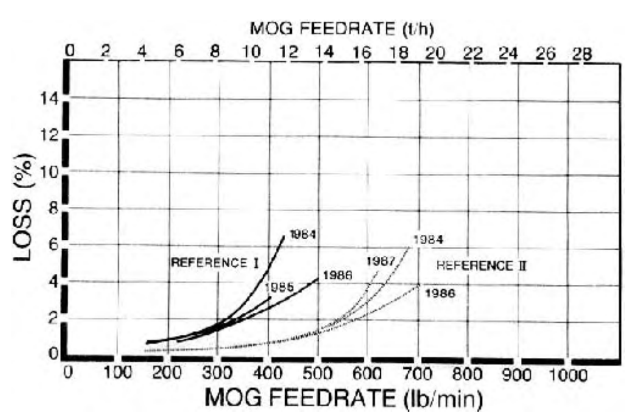

FIGURE 23. Total Grain Loss for the PAMI Reference Combines in Wheat.

APPENDIX III
REGRESSION EQUATIONS FOR MASSEY FERGUSON 8560 CAPACITY RESULTS

Regression equations for the capacity results shown in FIGURES 4 to 8 are presented in TABLE 8. In the regressions, U = unthreshed loss in percent of yield, S = shoe loss in percent of yield, W = walker loss in percent of yield, F = the MOG feedrate in lb/min, while $\ln$ is the natural logarithm, Sample size refers to the number of loss collections. Limits of the regressions may be obtained from FIGURES 4 to 8 while crop conditions are presented in TABLE 3.

TABLE 8. Regression Equations

Crop - Variety	Figure Number	Regression Equations	Simple Correlation Coefficient	Variance Ratio	Sample Size
Barley - Argyle	4	$\ln U = -2.61 + 1.67 \times 10^{-3}F$ $\ln S = -8.32 + 1.12 \times 10 \ln F$ $R = 0.32 + 2.10 \times 10^{-9}F^3$	0.60 0.52 0.92	9.12[1] 6.47[1] 71.04[2]	8
Barley - Harrington	5	$U = 0.22 - 9.14 \times 10^{-5}F$ $S = 0.11 + 5.92 \times 10^{-5}F$ $R = 0.45 + 3.34 \times 10^{-15}F^5$	0.09 0.05 0.98	0.41 0.22 246.18[2]	6
Wheat - Katepwa "A"	6	$\ln U = -3.60 + 6.257 \times 10^{-3}F$ $\ln S = -4.64 + 7.17 \times 10^{-3}F$ $\ln R = -2.76 + 4.84 \times 10^{-3}F$	0.95 0.88 0.88	82.09[2] 29.89[2] 26.69[2]	6
Wheat - Katepwa "B"	5	$U = -0.17 + 1.59 \times 10^{-3}F$ $S = 0.05 + 2.63 \times 10^{-9}F^3$ $R = 0.01 + 8.75 \times 10^{-4}F$	0.95 0.96 0.94	87.23[2] 105.12[2] 73.53[2]	7
Wheat - Katepwa "C"	8	$\ln U = -2.10 + 2.28 \times 10^{-3}F$ $\ln S = -3.57 + 2.56 \times 10^{-3}F$ $\ln R = -1.86 + 2.23 \times 10^{-3}F$	0.86 0.73 0.73	32.16[2] 13.19[1] 13.73[1]	7

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

APPENDIX IV
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

Excellent	Fair
Very Good	Poor
Good	Unsatisfactory

SUMMARY CHART

MASSEY FERGUSON 8560 SELF-PROPELLED COMBINE

RETAIL PRICE	$139,204.00 (March, 1988, f.o.b. Humboldt, Sask.)
CAPACITY	
Compared to Reference Combine	
- barley - Argyle	1.6 x Reference II
- Harrington	2.4 x Reference II
- wheat - Katepwa	1 to 1.4 x Reference II
MOG Feedrates	
- barley - Argyle	630 lb/min (17.2 t/h) at 1.5% total loss, FIGURE 4
- Harrington	870 lb/min (23.5 t/h) at 2.5% total loss, FIGURE 5
- wheat - Katepwa “A”	530 lb/min (14.3 t/h) at 2% total loss, FIGURE 6
- Katepwa “B”	740 lb/min (20 t/h) at 2.5% total loss, FIGURE 7
- Katepwa “C”	915 lb/min (24.7 t/h) at 2.5% total loss, FIGURE 8
QUALITY OF WORK	
Picking	**Very Good;** picked cleanly, automatic pickup speed control was very convenient
Feeding	**Very Good;** after modifying slip clutch, provided gentle, positive crop flow
Stone Protection	**Good;** small stones caused minor concave damage
Threshing	**Good;** faster rotor speed would have reduced unthreshed loss in wheat, grain damage very low
Separating	**Very Good;** rotor loss consistently low
Cleaning	**Very Good;** clean sample, low loss
Grain Handling	**Very Good;** unloading system was fast and convenient
Straw Spreading	**Fair;** spread unevenly over 20 ft (6.1 m)
EASE OF OPERATION AND ADJUSTMENT	
Comfort	**Very Good;** cab was clean, quiet and easily accessible
Instruments	**Good;** rotor overload light difficult to see in daylight
Controls	**Very Good;** convenient and easy to use
Loss Monitor	**Good;** only shoe loss monitored
Lighting	**Fair;** inadequate forward and peripheral lighting
Handling	**Very Good;** easy to maneuver
Adjustment	**Good;** changing fan speed ranges was inconvenient
Field Setting	**Good;** shoe setting could be confusing
Unplugging	**Fair;** no header reverser or slug wrench
Cleaning	**Fair;** grain tank difficult to clean, some excessive chaff build-up
Lubrication	**Very Good;** daily lubrication quick and easy
Maintenance	**Good;** some adjustments difficult to access, stone trap difficult to latch
ENGINE AND FUEL CONSUMPTION	
Engine	**Very Good;** ran well, adequate power
Fuel Consumption	7.4 gal/h (33.6 L/h)
OPERATOR SAFETY	No safety hazards were apparent
OPERATOR’S MANUAL	**Very Good**; contained much useful information
MECHANICAL HISTORY	Some mechanical problems

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