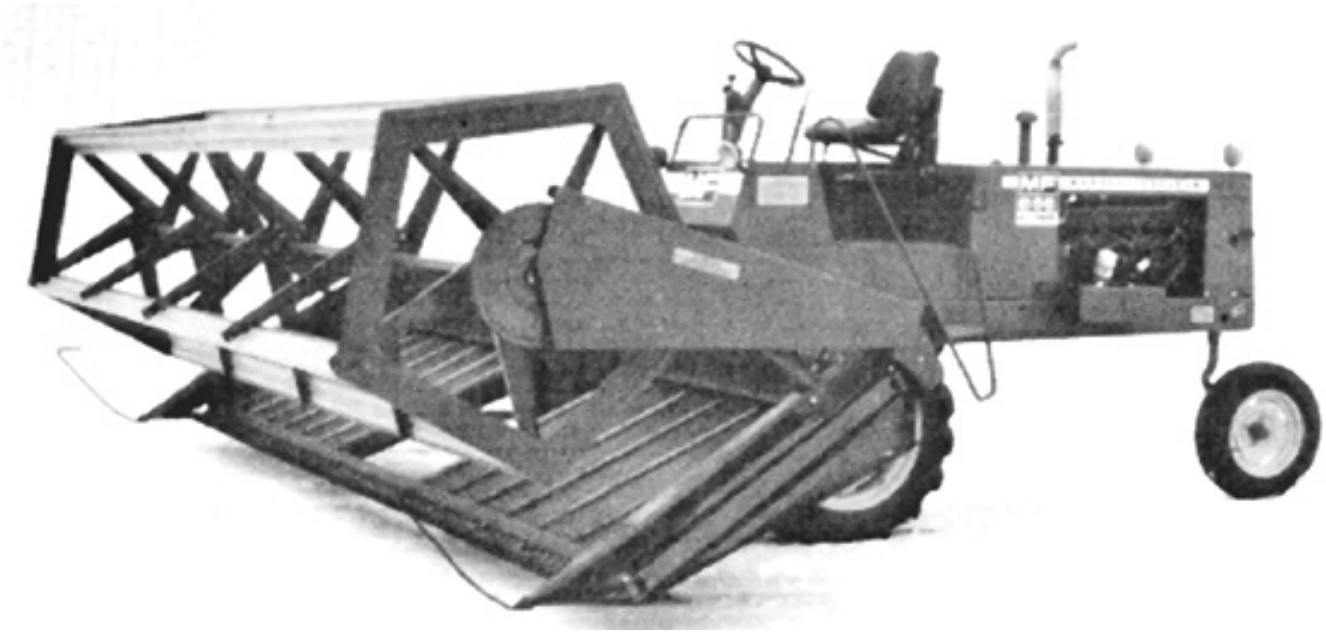
Evaluation Report No. E1876B
Printed: May, 1977
Tested at: Humboldt
ISSN 0383-3445

Evaluation Report 41



Massey - Ferguson MF 655 Swather

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

Massey-Ferguson MF 655 Swather

Manufacturer:

MacDon Industries Limited
680 Moray Street
Winnipeg, Manitoba, Canada
R3J 3S3

Distributor:

Massey-Ferguson Industries Limited
915 King Street West
Toronto, Ontario, Canada
M6K 1E3

Retail Price:

$8,239.95 (April 1, 1977, f.o.b. Winnipeg, with 5500 mm (18 ft) table, lights, swath rod, cone divider, draper shield, tool box and optional table and reel lift controls).

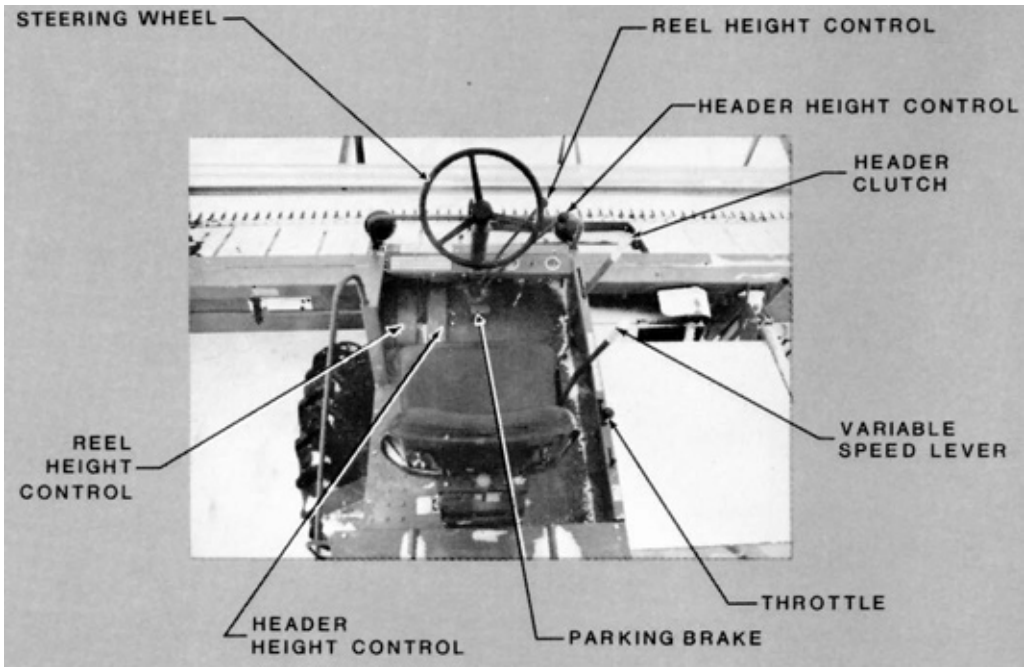


Figure 1. Detailed View of Massey-Ferguson MF 655 Swather.

Summary and Conclusions

Functional performance of the MF 655 was *good* in average grain crops. In heavy grain and rapeseed, performance was,fair to *poor* due to bunching and ineffectiveness of the dividers.

Performance of the MF 655, when equipped with the 5500 mm (18 ft) grain header*, was *good* in alfalfa and alfalfa-brome mixtures but was *poor* to *unsatisfactory* in crested wheatgrass, redtop and slough grass.

During 104 hours of operation, the durability of the MF 655 was *very good* except in tough hay crops where repeated pitman failures occurred.

The MF 655 formed parallel windrows in heavy crops and herringbone windrows in lighter crops. Windrow quality was *good* but was often reduced by bunching. Cutting ability, when equipped with the 5500 mm (18 ft) grain header, was *very good* in grain crops and succulent hay crops but was *poor* to *unsatisfactory* in tough hay crops. Suitable field speeds were 6 to 10 km/h (4 to 6 mph) in average grain crops. Speeds up to 3 km/h (2 mph) were suitable for hay crops.

Controls were conveniently positioned and responsive. Handling characteristics and maneuverability were *excellent.* Adjustment of draper speed and reel speed were slightly inconvenient. Sound level at the operator's ear was about 90 decibels (A scale).

The engine had adequate power for all conditions. Normal fuel consumption was 7.3 L/h (1.6 gal/h).

No serious safety hazards were encountered when operated according to normal safe operating procedures.

**The manufacturer recommends use of a 3650 mm (12 ft) or 4500 mm (15 ft) header with optional pickup reel for hay crops. These headers have additional kn!/e hold down clips which improve cutting in tough wiry crops while the pickup reel aids in feeding and removal of hay build-up on the knife. An optional ha)' header was supplied by the manufacturer during the test but was not evaluated. All results presented in this report are for the MF655 equipped with the 5500 mm (18 ft) grain header and standard five-bat reel.*

Recommendations

It is recommended that the manufacturer consider:

1. Reducing the engine noise level.
2. Modifying the windrow opening to prevent bunching in tall crops.
3. Increasing the maximum header lift height to prevent scattering headland windrows in heavy crops during back and forth cutting.
4. Increasing the fuel tank capacity.
5. Developing optional dividers for tall grains and rapeseed.
6. Modifying the divider boards to prevent hairpinning of leaning grain stalks.

Chief Engineer-E. O. Nyborg *Senior Engineer--L. G. Smith*

The Manufacturer States That:

With regard to recommendation number:

1. A larger muffler can be provided along with a longer tailpipe (at increased cost, of course). Customers who have purchased the MF 655 Swather have not indicated that the noise level is objectionable, and tests conducted by Massey-Ferguson indicate the noise level at 86.5 decibels (A scale).
2. This recommendation is under consideration and, of course, would represent a significant change to the header. In the meantime, we have added a swath pan which is expected to make a significant difference.
3. A high header lift kit has been provided (MF code 2137 921) and will be available for the 1977 season. It will allow the cutterbar to be raised to about 990 mm (39 in), or about 430 mm (17 in) higher than the present 560 mm (22 in).
4. This is under current consideration, however, it has been found that 10 to 12 hours of running time per day is satisfactory for most farmers.
5. Optional high dividers for tall crops are available (MF code 2137 912). Cone dividers for down, tangled grain crop conditions and all hay crops for 3650 mm (12 ft) and 4500 mm (15 ft) tables (MF code 2137 920) are also available. Optional dividers are highly recommended when the standard dividers (intended for normal standing crops) do not appear to be satisfactory for the crop conditions encountered.
6. An extension has been added to the cone divider which will assist deflecting cut material onto the draper.

General Description

The Massey-Ferguson MF 655 is a self-propelled, centre delivery windrower with two traction drive wheels and a rear castor wheel. It is powered by a Chrysler Industrial 225, six cylinder, gasoline engine through a variable speed hydrostatic drive to the drive wheels and a triple B-belt drive to the header. It is controlled with a steering wheel. Several table options are available. The MF 655 described in this report was equipped with a 5500 mm (18 ft) grain header with draper platform and standard reel.

Detailed specifications are given in Appendix I. Figure 1 shows the location of major components and controls.

Scope of Test

The MF 655 was operated in the conditions shown in Table 1 for 104 hours while cutting approximately 380 ha (950 ac). It was evaluated in forage crops, cereal grains and oil seed crops for windrow formation, cutting ability, ease of operation and adjustment, noise level, fuel consumption, operator safety and suitability of the operator's manual.

Table 1. Operating Conditions

Crop	Hours	Field Area ha (ac)	Soil Texture	Stony Conditions
Brome/Alfalfa	23	50 (125)	gravelly loam	very stony
Timothy	3	6 (15)	sandy loam	occasional stones
Fall Rye	10	40 (100)	fine sandy loam	stone free
Barley	22	104 (260)	loam	stone free
Rapeseed	1	2 (5)	loam	stone free
Durum	4	16 (40)	loam	stone free
Flax	5	16 (40)	loam	stone free
Wheat	36	146 (365)	loam to clay loam	occasional stones to moderately stony

Results and Discussion

WINDROW FORMATION

Windrow Types: Windrows may be classified into four general types or patterns as shown in Figure 2. These are called fantail, angled parallel, herringbone and parallel. There are many variations and combinations of these distinct types. Table 2 outlines the types of windrows formed by the MF 655 in various crops. The MF 655 usually formed parallel windrows in heavy crops and herringbone windrows in lighter crops. In leaning or lodged crops, angled parallel and fantail windrows were often formed. Photographs of some typical windrows are shown in Figures 3 to 10.

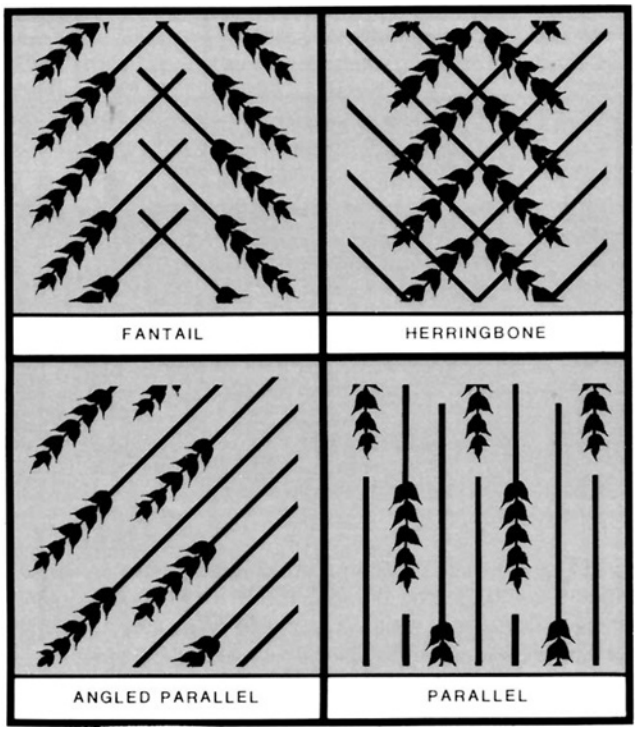


Figure 2. General types of Windrows.

Bunching: Bunchy, uneven windrows were formed in a variety of crop conditions. In tall, heavy grain, bunchy and irregular windrows were often formed due to heads catching on the edges of the windrow opening. Figure 5 shows a bunchy fantail windrow in tall, heavy fall rye.

In leaning grain, bunching was caused by hairpinning of cut stalks on the grain dividers (Figure 11). Once enough material collected on the divider to allow the reel to contact it, it was swept on to the draper in a bunch. Similar hairpinning occurred with the standard rod divider and with the optional high shield and cone dividers.

In short hay crops, bunching was caused by hay being retained on the cutter bar, particularly in those crops where the knife failed to cut cleanly. The reel on the grain header could only be brought to within 25 mm (1 in) of the cutter bar in its lowest position. This resulted in the hay being swept off the cutter bar in bunches as it built up and was contacted by the reel. Use of the optional pickup reel in hay, as recommended by the manufacturer would probably have corrected this problem.

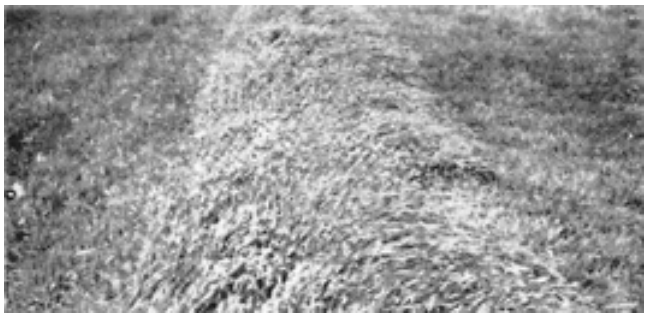


Figure 4. Timothy.

the heads together at the centre. Higher draper speeds were preferable in light crops to form a narrow, dense windrow which was easier to pick. In heavy crops, a lower draper speed was desirable to form a wider more evenly distributed windrow to reduce settling and to aid curing.

Forward Speed: The speed of forward travel had little effect on the type of windrow formed, except in heavy crops where the speed of travel had to be matched to the amount of crop which could pass through the windrow opening. Ground speed was usually limited by field roughness or cutting ability and not by the type of windrow formed.

Table 2. Windrows Formed By The MF 655 in Various Crops

Crop	Yield t/ha	Crop Height mm (in)	Stubble Height mm (in)	Speed km/h (mph)	Windrow Type	Windrow Uniformity	Windrow Density	Remark	Figure Number
Brome/ Alfalfa	2.3 (1 ton/ac)	450 (18)	50 (2)	3 (1.9)	Mixed parallel & herringbone	Non-uniform	Low	Slight bunching due to material hanging on cutter bar.	3
Timothy	2.3 (1 ton/ac)	750 (30)	50 (2)	3 (1.9)	Parallel and fantail	Uniform	Medium		4
Fall Rye	1.9 (30 bu/ac)	1000 (40)	200 (8)	6.5 (4)	Parallel	Uniform	High	Bunching in tall rye due to narrow opening.	5
Barley	2.5 (45 bu/ac)	1000 (40)	150 (6)	8 (5)	Herringbone	Uniform	Medium	Slight bunching due to hairpinning on divider.	–
Barley	3.8 (70 bu/ac)	1500 (60)	250 (10)	8 (5)	Angle Parallel	Non-uniform	Medium	Bunching due to hairpinning on divider.	6
Barley	1.6 (30 bu/ac)	750 (30)	100 (4)	8 (5)	Herringbone	Non-uniform	Low	Bunching due to hairpinning on divider.	7
Rapeseed	1.7 (30 bu/ac)	750 (30)	250 (10)	5 (3)	Mixed	Non-uniform	Medium	Operation discontinued (see discussion).	–
Durum	2.0 (30 bu/ac)	1000 (40)	100 (4)	6.5 (4)	Parallel to herringbone	Uniform	Medium		8
Wheat	2.7 (40 bu/ac)	800 (32)	200 (8)	8 (5)	Parallel to herringbone	Non-Uniform	High		9
Flax	1.9 (30 bu/ac)	700 (28)	150 (6)	8 (5)	Parallel	Uniform	Medium	Plants uprooted at speeds above 8 km/h (5 mph).	10

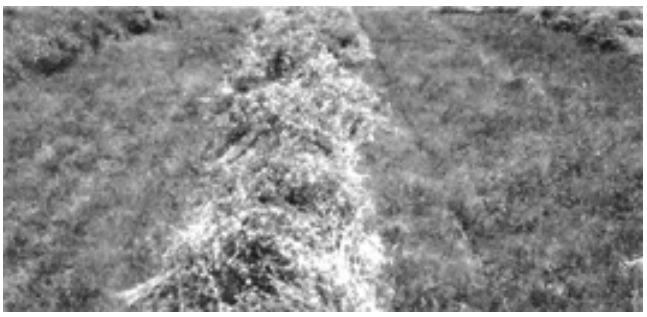


Figure 3. Brome and Alfalfa.

Draper Speed: The draper roller speed could be varied from 610 to 710 rpm by adjusting the drive pulleys. The angle of the stalks in the windrow could be varied by' changing the draper speed. At the lowest draper speed, windrows tended to be parallel, wide-spread and quite loose, as the drapers did not throw the stalks as far. Higher draper speeds increased windrow density and resulted in herringbone windrows with

Figure 5. Fall Rye.

Figure 6. Barley (4 t/ha).

Figure 7. Barley (1.5 t/ha).

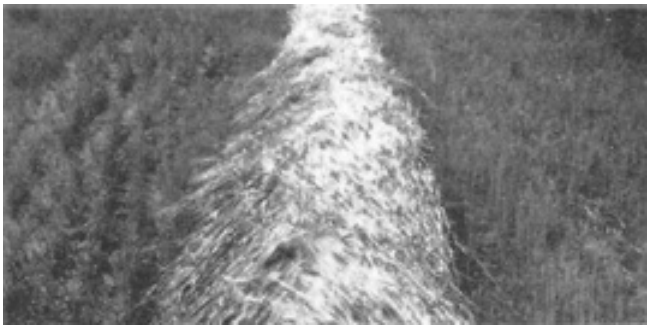


Figure 8. Durum.

Figure 9. Wheat.

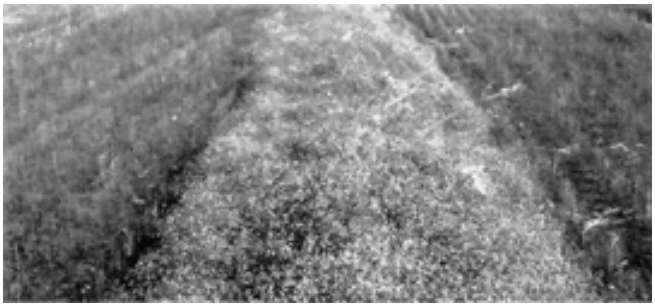


Figure 10. Flax.

Figure 11. Hairpinning of Cut Stalks on Grain Divider in Leaning Crops.

CUTTING ABILITY

Stubble: The types of stubble formed by a windrower may be divided into three types; ideal, undulating, and irregular as shown in Figure 12.

Grain Crops: The MF 655 generally produced ideal stubble in all grain crops at speeds up to 11 km/h (7 mph), provided that the knife and guards were in good condition. In flax, ideal stubble was formed at speeds up to 8 km/h (5 mph). Higher speeds in flax resulted in irregular stubble and some plants being uprooted rather than cut.

Hay Crops: The MF 655, when equipped with the 5500 mm (18 ft) grain header, produced ideal stubble in succulent hay crops, at speeds up to 3 km/h (2 mph). In tough wiry hay crops such as slough grass, crested wheatgrass, and redtop, irregular stubble and cutter bar jamming occurred at all speeds. In these crops, jamming was severe enough to cause pitman failure and operation had to be discontinued. It must be noted that the manufacturer recommends the 3650 mm (12 ft) or 4500 mm (15 ft) header and optional pickup reel for hay crops. (See footnote in "Summary and Conclusions").

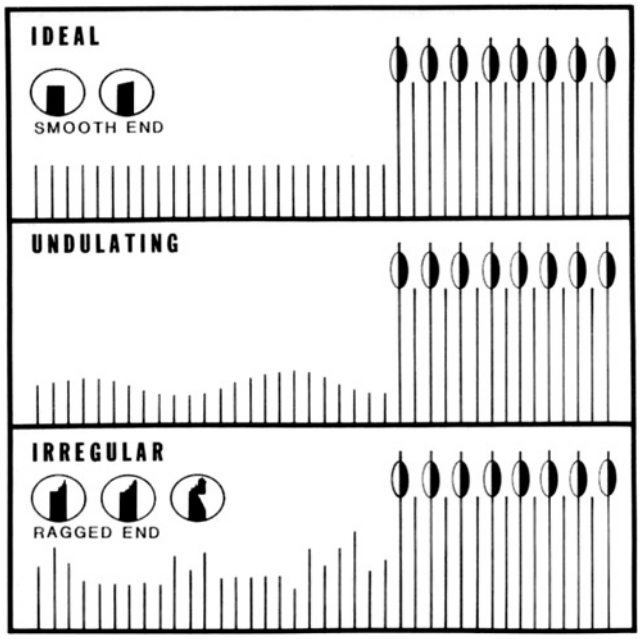


Figure 12. Types of Stubble Formed by Windrowers.

Lodged Crops: In lodged grain, when cutting in the direction of lodging, irregular stubble sometimes occurred. With a sharp knife at speeds below 6 km/h (4 mph) ideal stubble was usually formed. The optional pickup reel would be advantageous in leaning crops since it sometimes was not possible to position the standard reel low enough and far enough forward to feed the cut stalks on to the drapers without causing some to be thrown back over the header.

Dividers: In average straight standing grain and hay crops the standard rod divider, the optional cone divider and optional high shield divider all were satisfactory. In sideways leaning grain crops or when cutting in a strong side wind, the standard rod divider and optional cone divider allowed grain stalks to hairpin over the divider causing bunchy windrows, while the optional high shield divider pushed grain stalks down resulting in some losses. In severely leaning crops, plugging on the divider was severe enough to cause occasional cutter bar plugging. In tangled heavy rapeseed, none of the dividers performed acceptably and field operation had to be discontinued. Severe hairpinning on the divider resulted in uprooting whole plants and subsequent cutter bar plugging. This is a common problem with windrowers. Many rapeseed growers fabricate dividers to suit their specific conditions.

Table Flotation: Table flotation was excellent, making it easy to follow irregular field contours. The header used in the evaluation was equipped with table bottom skid shoes.

Reel: The reel index is the tip speed of the reel divided by the speed of forward travel. The reel index gives an indication of how fast a windrower may travel for a given reel speed. Optimum values of reel index are from 1.1 to 1.2, meaning that the reel tip is travelling slightly faster than the ground speed and is pulling the crop toward the cutter bar. The reel speed on the MF 655 could be varied from 34 to 48 rpm by changing drive sprockets and pulley spacers. This permitted operation from 7 to 11 km/h (4.5 to 7 mph) with an optimum reel index, which was adequate for all crops encountered.

EASE OF OPERATION AND ADJUSTMENT

Steering: Directional control and maneuverability of the MF 655 were excellent. Steering was positive and effortless. Speed control was responsive and positive. Operators who are not familiar with the hydrostatic drive and steering system on the MF 655 are cautioned that steering, while in reverse, is opposite to conventional machine operation. Initial attempts at backing up, with an inexperienced operator, should be done in an open area to become familiar with handling characteristics. In addition, when the variable speed lever is returned to "neutral" the steering wheel must also be returned to "neutral" to stop motion. A safety lockout is provided which prevents engine start-up unless these two conditions are met. Although this steering system differs from that on many machines, operators found no difficulty in getting accustomed to it.

Due to the positive nature of the hydrostatic drive, the MF 655 did not pull sideways in soft fields, as is common with many windrowers with a conventional drive system. In addition steering was not influenced by different tire pressures in each drive wheel.

Brakes: Braking action on the MF 655 was provided by the positive action of the hydrostatic drive as well as by a conventional foot brake. The brakes were adequate under all conditions,

Controls: The reel and platform controls could be operated by foot pedals or by optional hand levers. These controls were responsive and conveniently located. It was convenient to operate the platform with the foot control and reel with the hand control, allowing the foot to remain in one position.

Adjustments: Reel and draper speed could be adjusted by removing or adding shim washers on the drive sheaves. Adjustment required loosening the belt, removing four bolts, adjusting the sheave width, replacing bolts and tightening the belt.

NOISE LEVEL

Total noise at operator ear level was about 90 decibels (A scale) when operating on flat fields at normal speed in average wheat crops. This noise level equals current operator exposure recommendations* for 8 hours per day. It is recommended that the operator wear suitable ear protection if operating for more than 8 hours per day.

POWER AND FUEL CONSUMPTION

The engine on the MF 655 had adequate power for all conditions encountered. Average fuel consumption was 7.3 L/h (1.6 gal/h). Fuel consumption would be greater under extreme conditions.

The 80 L (17.5 gal) fuel tank permitted 10 to 12 hours operation between fillings. This was inconvenient during extended operating hours as normally experienced during harvest.

OPERATOR SAFETY

Since the centre of gravity on the MF 655 was above and slightly behind the drive wheels, the windrower had a tendency to tip forward on steep down slopes or during sudden stops. This was not considered particularly hazardous to the operator, unless the machine was travelling at high speed and the variable speed control lever was suddenly pulled back, resulting in the operator being thrown forward and losing control.

As was previously noted, both the steering wheel and speed control lever must be in "neutral" to stop the windrower. Several inexperienced operators initially encountered problems while attempting to back the MF 655, since the steering, when in reverse, is opposite to conventional vehicles. If, when backing, the variable speed lever is placed in neutral and the steering wheel is not in neutral, the windrower will continue to turn. Inexperienced operators are cautioned that initial operation should be in an open area, to become familiar with the steering system.

OPERATOR'S MANUAL

The operator's manual contained much useful information on operation, adjustment and servicing. It was clear and well written.

**"Occupational Safety and Health Standards", Fed. Regist. 36(105), Pt. H (May 29, 1971).*

Table 3. Mechanical History

Item	Operating Hours	Equivalent area Hectares	(Acres)
The pitman bent and was straight-enedorreplaced, when encountering patches of redtop, crested wheatgrass or slough grass, at	18.5, 23, 26 and 26.5	40, 50 56 and 57	(100), (125), (140) and (143)
The knife sway bar cracked and was welded at	26	56	(140)
The centre support bearing on the hydrostatic motor drive shaft failed, causing shaft wear. The shaft and bearing were replaced at	38	100	(250)
The engine dipstick tube broke above retaining flange and was replaced at	62	186	(470)

Durability Results

The MF 655 was operated for 104 hours while cutting 350 ha (950 ac). Since the intent of the test was functional evaluation, an extended durability evaluation was not conducted. Table 3 represents the mechanical history of the MF 655 during the test. Consider each item separately since some are not as serious as others.

Discussion of Mechanical Problems

KNIFE DRIVE

Knife drive problems occurred only when attempting to use the 5500 mm (18 ft) grain header in tough, wiry hay crops. Pitman failure occurred when encountering patches of redtop, crested wheatgrass or slough grass in a field of tame hay and was caused by hay wrapping on the sickle sections and jamming the knife. The manufacturer recommends use of the 3650 mm (12 ft) or 4500 mm (15 ft) header with optional pickup reel in hay (See footnote in "Summary and Conclusions"). Pitman failure should not be a problem, if these recommendations are followed.

No knife drive problems occurred in grain.

APPENDIX 1
SPECIFICATIONS

Model: Massey-Ferguson MF 655 Swather

Serial Number: 2137 003942

Cutter Bar:	
-width of cut (divider points)	5500 mm (216.5 in)
-effective cut (inside divider)	5385 mm (212 in)
-range of cutting height	-51 mm to 560 mm (-2 to 22 in)
guard spacing	76 mm (3 in)
-length of knife section (overserrated)	76 mm (3 in)
-knife stroke	76 mm (3 in)
-knife speed	580 cycles/min
-platform angle	
- fully raised	15° below horizontal
- fully lowered	25° below horizontal
-num ber of drapers	2
-width of draper	1054 mm (41.5 in)
-draper speed range	1.8 to 2.1 m/s (360 to 420 ft/min)
-draper roller diameter	57 mm (2.25 in)
-height of windrow opening	743 mm (29.25 in)
-width of windrow opening	914 mm (36 in)
-raising time of table	2.25 s
-lowering time of table	3.75 s
Reel:	
-number of bats	5
-number of reel arms per bat	5
diameter	1397 mm (55 in)
speed range	40 to 48 rpm (standard equipment) 34 to 41 rpm (with optional sprocket)
-range of adjustment	
-fore and aft	203 mm (8 in)
height above cutter bar	25 mm to 584 mm (1 in to 23 in)
-raising time	1.4 s
-lowering time	2.0 s
-index at maximum ground speed and maximum reel speed	1.1

Ground Drive:	
-type	hydrostatic
-speed control	hand lever
-range of forward speed	0 - 11.6 km/h (0 - 7.2 mph)
-range of reverse speed	0 - 2.4 km/h (0 - 1.5 mph)

Steering: Steering wheel operating hydrostatic wheel motors

Brakes: Foot operated band brakes

Hydraulic System:
-traction drive-two Sunstrand 15 series hydrostatic motors, belt driven from engine
-table and reel lift-Cessna Model 24117-LAC pump belt driven from engine

No. of chain drives:	5
No. of V belt drives (single V)	4
(multiple V)	2
No. of lubrication points (pressure):	14
No. of pre-lubricated bearings:	29
Engine:	
- make	Chrysler Industrial 225 (slant 6)
-model	HB 225
-power	40 kW (55 hp) @ 2000 rpm (manufacturer's rating)
-no load speed	2400 rpm
Tire size:	
-main drive wheels	2 - 9.50 x 24, 4 ply rating
-castor wheel	1 - 5.90 x 15, 4 ply rating
-wheel tread	2311 mm (91 in)
-wheel base	2426 mm (95.5 in)
-overall width	5664 mm (223 in)
-overall length (reel & platform raised)	5182 mm (204 in)
-overall length (reel & platform lowered)	5359 mm (211 in)
Weight as tested:	
-right drive wheel	714 kg (1570 lb)
-left drive wheel	984 kg (2165 lb)
-castor wheel	214 kg (470 lb)
-Total Weight	1912 kg (4205 lb)
Centre of Gravity:	
-height above ground	1005 mm (39.5 in)
-distance behind drive wheels	272 mm (10.7 in)
-distance left of right drive wheel	1448 mm (57 in)

Options available: pickup reel, flotation tires, lights, deluxe seat, hand operated table and reel lift controls, draper shields for hay, counter balance weights, high divider, cone divider, tool box.

Attachments available: hay conditioner

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

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

APPENDIX III
METRIC UNITS

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

1 hectare (ha)	=	2.47 acres (ac)
1 kilometre/hour (km/h)	=	0.62 miles/hour (mph)
1 tonne (t)	=	2 204.6 pounds (lb)
1 tonne/hectare (t/ha)	=	0.45 ton/acre (ton/ac)
1 metre (m) = 1000 millimetres (mm)	=	39.37 inches (in)
1 kilowatt (kW)	=	1.34 horsepower (hp)
1 kilogram (kg)	=	2.2 pounds (lb)
1 litre/hour (L/h)	=	0.22 Imperial gallons/hour (gal/h)

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