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Evaluation Report 145

Massey-Ferguson MF 560 Baler

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI

PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

MASSEY-FERGUSON MF 560 BALER

MANUFACTURER:
Vermeer Manufacturing Company
Pella, Iowa 50219
U.S.A.

DISTRIBUTORS:
Massey-Ferguson Industries Ltd.
-- 2330 - 34 South Railway Street
Regina, Saskatchewan
S4P 0B6
-- 2615 Barlow Trail S.E.
Calgary, Alberta
T2C 1G3

RETAIL PRICE:
$7,700.00 (January, 1979, f.o.b. Humboldt).

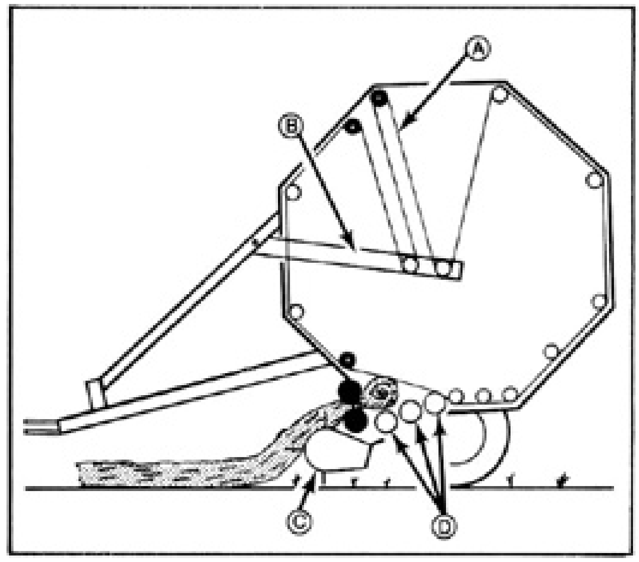

FIGURE 1. Massey-Ferguson MF 560 Baler: (A) Bale Forming Belts, (B) Tension Arm, (C) Pickup, (D) Platform Rollers.

SUMMARY AND CONCLUSIONS

Overall functional performance of the Massey-Ferguson MF 560 round baler was *good.* Ease of operation and adjustment were *good,* while operation of the twine wrapping mechanism was poor.

Average field speeds varied from 11.0 to 16.3 km/h (6.8 to 10.1 mph) while average throughputs varied from 2.1 to 5.9 t/h (2.3 to 6.5 ton/h). Maximum instantaneous feedrates up to 19 t/h (21.0 ton/h) were measured in heavy, uniform hay windrows. Ground speed was usually limited by pickup loss and not by baler capacity. Feeding was aggressive in most crops. Feedrates had to be reduced in long coarse-stemmed sweet clover to permit even feeding through the compression roi lers.

Bales were well formed and neat. The MF 560 produced bales with an average length of 1.5 m (59 in) and an average diameter of 1.8 m (71 in). Hay bales weighed from 464 to 721 kg (1022 to 1589 lb) with an average density of 136 kg/m^3 (8.5 lb/ft^3).

Resistance of bales to moisture penetration was *good.*

Peak power take-off requirements were about 13 kW (17 hp) in hay and 18 kW (24 hp) in straw on flat firm fields. More power was needed on soft or hilly fields.

Leaf loss was comparable to that of other large round balers, In heavy conditioned windrows at optimum moisture content, bale chamber loss was 2% while pickup loss was 1%. In light dry unconditioned hay an average bale chamber loss as high as 15% and pickup loss as high as 15% can be expected. Heavy windrows, proper conditioning and baling at the maximum permissible moisture content all were important in reducing bale chamber loss.

The Massey-Ferguson MF 560 was safe to operate if the manufacturer's safety recommendations were closely followed.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifying the twine wrapping mechanism to improve twine cutter operation.

Chief Engineer - E. O. Nyborg
Senior Engineer - L. G. Smith
Project Technologist - D. H. Kelly

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. The MF 560 is a discontinued model and has been superseded by the MF 1560. On the MF 1560, the rope controlled twine mechanism has been replaced by a hydraulic remote control. This eliminates rope geometry problems and improves operator convenience. The new mechanism has the twine knife as an extension of the twine arm which improves the reliability and reduces maintenance.

MANUFACTURER'S ADDITIONAL COMMENTS
This report very adeptly describes the benefits derived from conditioning and baling at proper moisture content. We find this to be beneficial ',o our customers and the industry.

GENERAL DESCRIPTION

The Massey-Ferguson MF 560 is a pull-type, power take-off driven baler with a cylindrical baling chamber and a floating drum pickup. The twine wrapping mechanism is manually actuated.

Hay is fed to the baling chamber between two compression rollers. The upper roller is rubber covered while the lower roller is steel. The baling chamber consists of three full width platform rollers on the bottom and a set of two 252 mm wide belts and five 101 mm wide belts on the top. The platform rollers rotate in a fixed location while the spring loaded forming belts position themselves around the bale during formation.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Massey-Ferguson MF 560 was operated in a variety of Saskatchewan crops (TABLES 1 and 2) for 82 hours while producing 698 bales. It was evaluated for rate of work, quality of work, power consumption, ease of operation, ease of adjustment, operator safety and suitability of the operator's manual.

TABLE 1. Operating Conditions.

CROP	HOURS	NUMBER OF BALES	FIELD AREA ha
Alfalfa	12	132	28
Alfalfa, Bromegrass & Crested Wheatgrass	19	127	34
Clover	14	106	33
Green Feed	10	108	16
Prairie Hay	13	92	25
Wheat Straw	7	58	23
Barley Straw	7	73	27
TOTAL	82	698	186

TABLE 2. Operation in Stony Fields.

FIELD CONDITION	HOURS	FIELD AREA ha
Stone Free	18	32
Occasional Stones	24	75
Moderately Stony	40	79
TOTAL	82	186

RESULTS AND DISCUSSION

RATE OF WORK

Average throughputs for the MF 560 (TABLE 3) varied from 2.1 t/h in wheat straw to 5.9 t/h in clover. The average throughputs reported in TABLE 3 are average workrates for daily field operation. They are representative of the actual workrates that may be expected in typical field operation. These values are based on the total operating time and the total baler throughput for each day of baling.

In heavy uniform hay crop windrows, instantaneous feedrates up to 19 t/h were measured. These were peak values, representing maximum baler capacity, which cannot be achieved continuously.

In most crops, the feedrate was limited by pickup performance and not by bale chamber capacity. Pickup loss usually limited ground speed from 11 to 16 km/h. Heavy windrows were desirable to fully utilize baler capacity.

Feeding was aggressive in most crops, but overall baler capacity was reduced by poor performance of the twine wrapping system.

QUALITY OF WORK

Bale Quality: The MF 560 produced firm, durable bales (FIGURE 2) with flat ends, uniform density and uniform diameter. Bales averaged 1.5 m in length and 1.8 m in diameter. Average hay bales weighed from 464 to 721 kg with an average density of 136 kg/m3.

Bale Weathering: A common practice in the prairie provinces is to store round bales outside. FIGURE 3 shows the condition of a typical MF 560 hay bale (bromegrass and alfalfa mixture) after 100 days of weathering. The weathering period was the time between baling and freeze-up. Bales were situated in a well drained area with prevailing winds striking one side. Bales were exposed to about 75 mm of rain and average prairie wind conditions.

The condition of the weathered bales was good. Moisture had penetrated to a maximum of 150 mm on the windward bale side. Since bales had retained 82% of their original height, they were easy to pick with round bale handlers.

TABLE 3. Average Throughputs.

CROP	CROP YIELD t/ha	AVERAGE SPEED km/h	AVERAGE THROUGHPUT t/h
Alfalfa	1.5 to 2.0	12.0	4.1
Alfalfa, Bromegrass & Crested Wheatgrass	1.5 to 3.5	11.0	4.5
Clover	2.5	11.0	5.9
Green Feed	2.5	11.4	4.0
Prairie Hay	0.8 to 1.5	11.5	2.2
Wheat Straw	0.3 to 1.0	16.3	2.1
Bartey Straw	0.3 to 0.8	12.3	2.2

FIGURE 2. Typical Hay or Straw Bale.

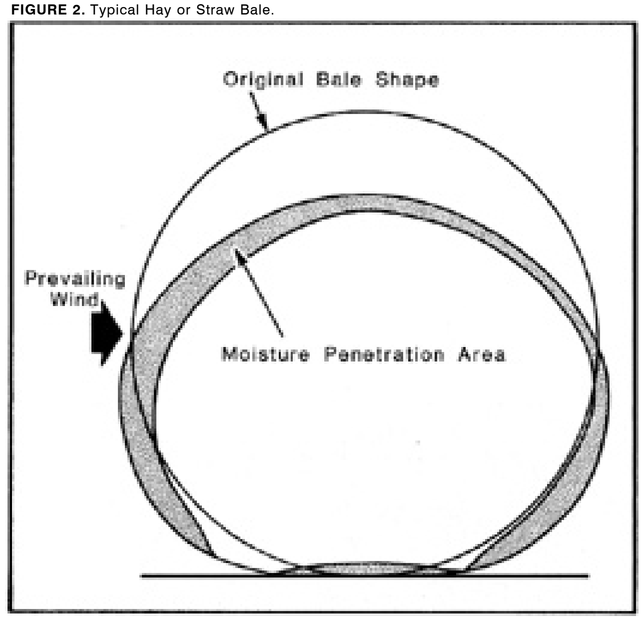

FIGURE 3. A Typical Bale After 100 Days of Weathering.

Leaf Loss: Leaf loss was comparable to that of other large round balers. In heavy, conditioned windrows, baled near optimum moisture content, pickup loss was about 1% while bale chamber loss was about 2%. In very light, dry windrows, which have not been conditioned, pickup and bale chamber losses as high as 15% each can be expected.

FIGURE 4 shows the importance of baling at high moisture contents. This figure shows the total measured leaf loss, over a range of hay moisture contents, in fields of mixed alfalfa, crested wheatgrass and bromegrass. The crop had been cut with a 3.7 m

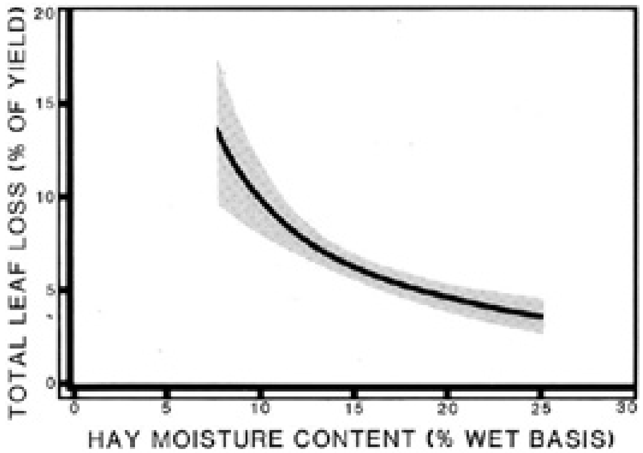

FIGURE 4. Leaf Loss in Mixed Alfalfa, Crested Wheatgrass and Bromegrass.

mower-conditioner. Yields ranged from 2.7 to 4.6 t/ha with an average of 3.5 t/ha. As can be seen, total leaf loss ranged from about 15% when baled at 8% hay moisture content to 3% when baled at 22% hay moisture content. At 8% moisture content, pickup loss was about 9% and bale chamber loss about 6% whereas at 22% moisture content pickup loss was about 1% and bale chamber loss about 2%.

Although FIGURE 4 represents an accumulation of data for several round balers, performance of the MF 560 was within the range presented in this figure. FIGURE 4 represents nearly ideal baling conditions with relatively heavy windrows which had been conditioned to enhance drying of the hay stems. Much higher leaf loss can be expected in light unconditioned windrows. While feedrate did not appreciably affect losses in the ideal conditions shown in FIGURE 4, loss tests in light unconditioned windrows have shown that round baler losses can be reduced by keeping the feedrate as high as possible to minimize time in the baling chamber. Bale chamber losses in light crops can also be reduced by running the tractor at a lower power take-off speed to reduce the number of turns needed to form a bale.

POWER CONSUMPTION

Power Requirements: FIGURE 5 shows the power take-off and drawbar input for the MF 560 in alfalfa. The power input is plotted against bale weight to show the power requirements while a bale is formed. Power take-off input varied from 6 kW at no load to a maximum of 13 kW in alfalfa and 18 kW in wheat straw. Drawbar requirements at 11 km/h were 4 kW.

Although maximum power requirements did not exceed 22 kW, additional power was needed to suit field conditions. In soft, hilly fields a 75 kW tractor would be needed to fully utilize baler capacity.

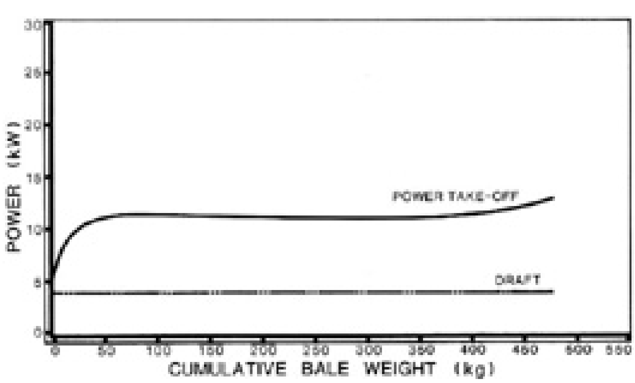

FIGURE 5. Power Consumption During Bale Formation in Alfalfa.

Specific Capacity: Specific capacity is a measure of how efficiently a machine performs a task. A high specific capacity indicates efficient energy use while low specific capacity indicates inefficient operation. The specific capacity of the MF 560 was about 0.90 t/kW·h in hay and 0.55 t/kW·h in wheat straw. This compares to an average specific capacity of 0.98 to 1.45 t/kW·h for small square balers in alfalfa. These values represent average field conditions and not peak outputs.

EASE OF OPERATION

Forming a Bale: An inexperienced operator had some difficulty in starting a bale with the MF 560, but once the operator gained experience, it was relatively easy to form a neat durable bale. When starting a bale, it was necessary to weave the baler back and forth across the windrow, so hay fed evenly across the width of the baling chamber. The bale forming belts on the MF 560 did not turn until the bale core was large enough to press the belts against the drive rollers. If the bale core did not have a uniform diameter when the forming belts began to turn, the belts on the smaller end of the bale core sometimes slipped past the core end preventing bale formation. If this happened, the baler had to be stopped and the bale core ejected without twine. Once the bale core was properly formed, a slight weaving action was needed during bale formation to maintain a uniform diameter.

FIGURE 6 shows the position of the forming belts during bale formation.

Wrapping the Twine: A mechanical indicator at the front of the baler shows when a bale is full size and ready for twine wrapping. The twine tube is manually controlled from the tractor with a rope.

To start wrapping, the twine tube lock is released, causing a spring to pull the twine tube to the left of the bale chamber. Once the twine has been caught by the incoming hay, the operator stops tractor forward travel, but allows the power take-off to run. When the twine has made at least two wraps around the left bale end, the operator slowly pulls the rope moving the twine tube across the front of the bale. The rate at which the rope is pulled determines the number of wraps. When the twine tube reaches the right side of the bale, the operator momentarily holds the rope to complete at least two wraps around the right bale end. The operator then slowly pulls the rope, returning the twine tube to the latched position, where the twine is automatically cut.

The twine tube mechanism (FIGURE 7) has a mechanical lock positioned so that its weight holds the twine tube in latched position. To release the lock, the operator pulls sharply on the twine rope, causing the tube to move upward, striking the tube lock and forcing it to open. The twine tube then has to be lowered before the lock plate swings back into locked position. To relatch, the twine tube is slowly moved upward until the lock latches on the end of the tube.

Many problems occurred with the twine wrapping mechanism. An excessive pull was needed to latch the twine tube. Frequently the twine broke at the end of the twine tube, rather than at the twine cutter. When switching between synthetic and sisal twines, adjustment to the twine system was necessary. As a result of wrapping problems, overall capacity of the baler was lowered significantly. Modifications to the twine wrapping mechanism to improve its operation are recommended.

Twine consumption was about 87 m/t. This compares to a twine consumption of about 225 m/t for small square balers.

Discharging a Bale: Once the twine is cut, the power take-off is shut off and the tractor and baler are backed up about 6 m. The gate is hydraulically opened, and the bale falls out of the bale chamber. The tractor and baler are then moved ahead about 4.5 m, the power take-off engaged and the rear gate closed. A slight pressure is required on the hydraulic cylinders to ensure that the gate lock is activated. When the twine wrapping mechanism performed properly, about one minute was needed to wrap and discharge a bale.

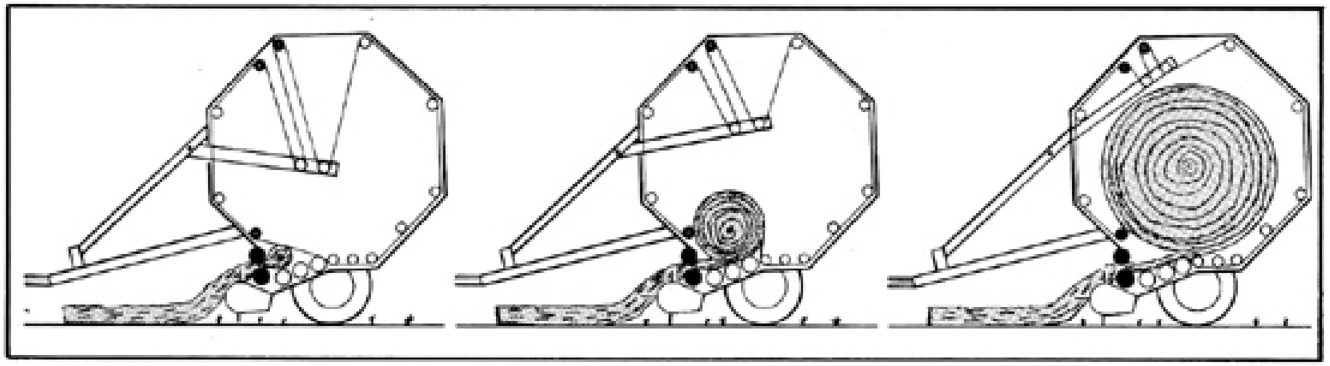

FIGURE 6. Stages of Bale Formation: (Left) Bale Core, (Centre) Half-Completed Bale, (Right) Completed Bale.

During baling, fine hay accumulated between the bale forming belts (FIGURE 8). When discharging a bale, this hay usually fell on the gate lock mechanism sometimes preventing proper locking. If baling was resumed with the gate unlocked, it opened during baling preventing bale formation.

Transporting: The MF 560 was easy to maneuver and transport. Ground clearance was adequate and there was ample hitch clearance for turning sharp corners. The baler could easily be towed behind a tractor or a suitably sized truck.

Hitching: The MF 560 was easy to hitch to a tractor. If the tractor was equipped with a cab, it was sometimes difficult to find a suitable place for the twine rope to enter the cab and have the rope completely operative.

Feeding: Feeding was positive and aggressive in nearly all crops with only infrequent plugging. One exception was in long coarse-stemmed hay, such as sweet clover. In such crops, stalks occasionally fed up the front of the forming belts rather than through the compression rollers. This problem was not too severe and it was still possible to bale at a reduced feedrate.

Twine Threading: Twine threading was quite easy, however, a stiff piece of wire was needed to thread the twine through the twine tube.

The twine cutter performed poorly. Modifications to improve its operation are recommended.

EASE OF ADJUSTMENT

Compression Rollers: The upper rubber compression roller was held against the lower steel roller with adjustable springs. The operator's manual gave the recommended spring length to provide proper contact pressure. All evaluation was conducted with the specified spring length.

Forming Belts: Two adjustable springs maintain tension in the forming belts. No adjustment to the springs was required during the test once the springs had been set to the manufacturer's recommended length.

The forming belts and the compression rollers were chain driven. The drive chain was spring tensioned needing only infrequent adjustment.

Platform Rollers: The platform rollers were not adjustable. Rollers were chain driven from the lower compression roller.

Pickup: Pickup flotation was controlled with an adjustable spring which also set pickup ground clearance. The operator's manual recommends a 25 mm minimum clearance between the pickup tines and ground.

The test baler was equipped with four fixed pickup compression bars. No adjustment of the compression bars was possible.

The pickup tooth pattern was cam controlled and was not adjustable. The pickup drive belt had a spring loaded tightener and needed no adjustment.

Servicing: The MF 560 had six chains, 34 grease fittings and one gearbox. The operator's manual recommended chain oiling and lubrication of 26 grease fittings daily. The operator's manual also recommended lubrication of six grease fittings every 50 hours and checking wheel bearings and gearbox oil level every season. About 20 minutes were needed to service the MF 560.

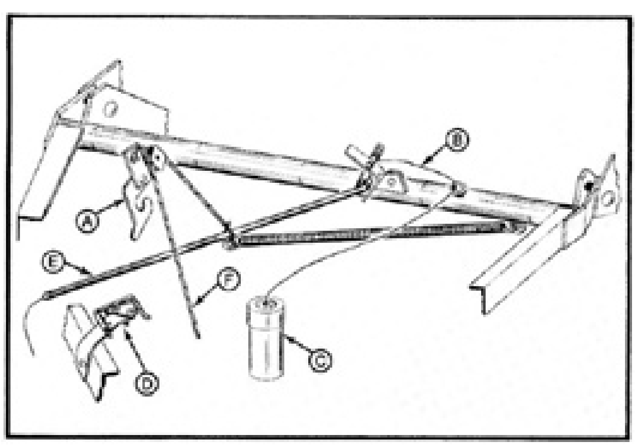

FIGURE 7. Twine Wrapping Mechanism: (A) twine tube lock, (B) twine, (C) twine box, (D) twine cutter assembly, (E) twine tube, (F) rope.

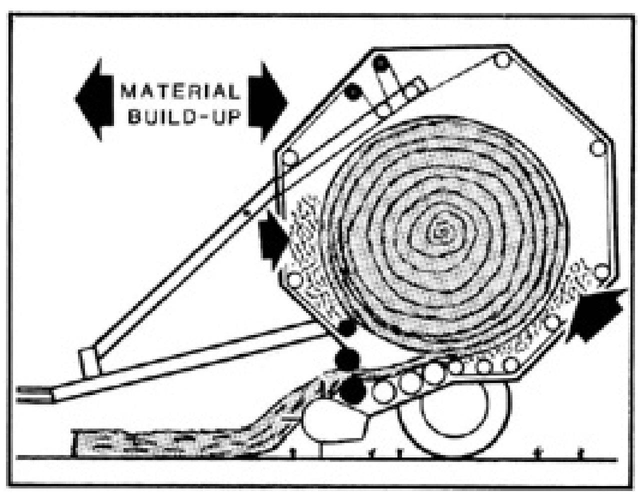

FIGURE 8. Hay Buildup Between Belts.

OPERATOR SAFETY

The MF 560 was safe to operate and service as long as common sense was used and the manufacturer's safety recommendations were followed. Rotating parts were well shielded. The pickup and compression rollers were well shielded to discourage operators from attempting to clear blockages with the baler in operation.

The MF 560 had rear gate cylinder locks to permit safe servicing with the rear gate open.

GENERAL SAFETY COMMENTS

The operator is cautioned that a round baler is potentially very dangerous. The operator must disengage the power take-off and stop the tractor engine to clear blockages or to make adjustments.

Many serious and fatal accidents have occurred with round balers. Most of these are caused by operators dismounting from the tractor while leaving the baler running. The manufacturer can only. go to certain limits in providing shielding and safety devices and must rely on the operator's common sense in following established safety procedures.

OPERATOR'S MANUAL

The operator's manual was clear, well written and contained much useful information on operation, servicing, adjustments, and safety procedures.

DURABILITY RESULTS

TABLE 4 outlines the mechanical history of the Massey-Ferguson MF 560 during 82 hours of operation while baling about 186 ha. The intent of the test was functional evaluation. The following failures represent those which occurred during functional testing. An extended durability evaluation was not conducted.

TABLE 4. Mechanical History.

ITEM	OPERATING HOURS	NUMBER OF BALES
Bale Forming Belts		
--One bale forming belt splicing failed and was repaired at	64	545
Twine Tie Mechanism		
--The twine tube was replaced at	69	587

DISCUSSION OF MECHANICAL PROBLEMS

Bale Forming Belts: The splice on one bale forming belt failed when the belt flipped due to improper bale core formation. The belt easily repaired with a splicing repair kit.

Twine Tie Mechanism: The twine tie tube was replaced in an attempt to reduce twine breakage at the twin tube during bale wrapping. The new twine tube also caused twine breakage problems.

APPENDIX I

SPECIFICATIONS

MAKE: Massey-Ferguson Round Baler
MODEL: MF 560
SERIAL NUMBER: 003044
MANUFACTURER: Vermeer Manufacturing Company
Pella, Iowa 50219
U.S.A.

OVERALL DIMENSIONS:	
-- width	2380 mm
-- height	2765 mm
-- length	4300 mm
TIRES:	
-- size	2, 11 x 15 LT, 6 ply
WEIGHT: (With drawbar in field position and two balls of twine)	
-- left Wheel	882 kg
-- right wheel	758 kg
-- hitch point	278 kg
Total Weight	1918 kg
BALE CHAMBER:	
-- width	1513 mm
-- maximum diameter	2050 mm
-- tension method	spring
PLATFORM ROLLERS:	
-- number of rollers	3
-- diameter of rollers	150 mm
-- length of rollers	1530 mm
-- roller composition	1 rubber, 2 steel
-- roller speed	81 rpm
FORMING BELTS:	
-- number of belts	7
-- belt width	2 -- 252 mm 5 -- 101 mm
-- belt thickness	5 mm
-- spacing (centre to centre)	150 mm
-- belt speed (at 540 rpm)	2.2 m/s
BALE SIZE INDICATOR:	mechanical linkage
COMPRESSION ROLLERS:	
-- number of rollers	2
-- roller surface	
-- upper	rubber
-- lower	steel
-- length	1536 mm
-- diameter	150 mm
-- speed	81 rpm
PICKUP:	
-- type	floating cylindrical drum with spring teeth
-- height adjustment	adjustable spring
-- width	1530 mm
-- diameter	250 mm
-- number of tooth bars	4
-- tooth spacing	70 mm
-- speed (at 540 rpm)	115 rpm
TWINE SYSTEM:	
-- capacity	2 balls
-- recommended twine size	none
-- twine feed	manual
-- twine cutter	manual
SAFETY DEVICES:	adjustable power take-off slip clutch rear gate cylinder locks
SERVICING:	
-- grease fittings	26, daily 8, weekly
-- chains	6, daily
-- wheel bearings	2, yearly
-- gearbox	1, yearly

APPENDIX II

MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

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

APPENDIX III

METRIC UNITS

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

1 hectare (ha)	= 2.47 acres (ac)
1 kilometre/hour (km/h)	= 0.62 miles/hour (mph)
1 tonne (t)	= 2204.6 pounds (lb)
1 tonne/hour (t/h)	= 1.10 ton/hour (ton/h)
1 tonne/hectare (t/ha)	= 0.45 ton/acre (ton/ac)
1000 millimetres (mm) = 1 metre (m)	= 39.37 inches (in)
1 kilowatt (kW)	= 1.34 horsepower (hp)
1 kilogram (kg)	= 2.20 pounds (lb)
1 tonne/kilowatt hour (t/kW.h)	= 0.82 tons/horsepower hour (ton/hp.h)

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