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Evaluation Report 99

Heston 5400 Rounder

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

HESSTON 5400 ROUNDER

MANUFACTURER:
Hesston Corporation
Hesston, Kansas 67062
U.S.A.

DISTRIBUTOR:
Hesston Industries Ltd.
920 - 26th Street N.E.
Calgary, Alberta
T2A 2M4

RETAIL PRICE:
$5,325.00 (May, 1978, f.o.b. Humboldt.)

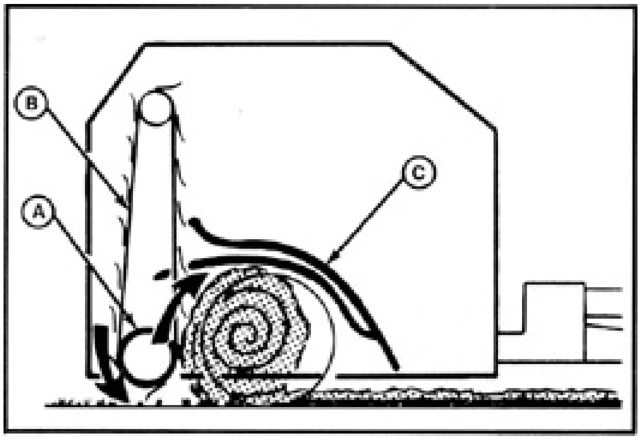

FIGURE 1. Hesston 5400 Rounder: (A) Pickup Drive Roller, (B) Pickup Belts, (C) Bale Forming Grids.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Installation of an adjustable slip clutch to prevent possible damage to the drive mechanism.
2. Modifications to the pickup to reduce failure of teeth mounts.
3. Modifications to the twine wrapping mechanism to improve ease of operation.
4. Modifications to the power take-off shielding to improve ease of servicing.
5. Modifying the bale drive method to improve baler effectiveness in grain straw.
6. Expanding the operator's manual to include information on the twine wrapping mechanism.

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SUMMARY AND CONCLUSIONS

Overall functional performance of the Hesston 5400 Rounder was *fair* in hay and *poor* in grain straw. Ease of operation was *good* while ease of adjustment was *fair.* Operation of the twine wrapping mechanism was *fair.*

Average field speeds varied from 5.0 to 8.5 km/h (3.1 to 5.3 mph) while average throughputs varied from 0.8 to 3.1 t/h (0.9 to 3.4 ton/h). Maximum instantaneous feedrates of up to 16 t/h (17.6 ton/h) were measured in heavy uniform alfalfa windrows. In most crops, ground speed and feedrate were limited by pickup loss.

Hay bales were well formed and neat in appearance, but straw bales were poorly formed with an irregular surface. The Hesston 5400 produced hay bales with an average length of 1.6 m (63 in), an average diameter of 1.7 m (67 in) and weighing from 322 to 447 kg (710 to 985 lb). Average straw bales were 1.6 m (63 in) in length and 0.9 m (36 in) in diameter, weighing only 75 kg (164 lb). Average bale density was 104 kg/m^3 (6.5 lb/ft^3) for hay and 74 kg/m^3 (4.6 lb/ft^3) for straw.

Resistance of hay bales to moisture penetration was *fair.*

Peak power take-off requirements were about 12 kW (16 hp) in hay and 6 kW (8 hp) in straw while draft varied from 2.5 to 10.5 kW (3.3 to 14 hp) during bale formation.

Pickup and bale chamber losses were comparable to that of other large round balers. In heavy windrows at optimum moisture content, total loss was 7%, or less, while in light dry alfalfa, total loss of up to 30% was measured. Heavy windrows, proper conditioning and baling at the maximum permissible moisture content, all were important in reducing bale chamber loss.

The Hesston 5400 was safe to operate if the manufacturer's safety recommendations were closely followed.

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Hesston has investigated the recommendation of installing an adjustable slip clutch and has concluded that it is not required because the driven rollers are normally protected by belt slippage.
2. We are currently investigating usage of heavier attaching bolts.
3. Hesston does presently offer an optional electrically powered twine threader that operates at a slower travel rate and is easier to control.
4. We are investigating this recommendation.
5. Modifications have been incorporated in later Model 5400 Round Balers in order to improve the effectiveness of such units in grain straw. These modifications include the addition of lugs to the pickup belts and the supplying of an optional slow down sprocket which improves baler performance in dry straw. These items may also be installed on earlier Model 5400 Balers. We recognize that baling dry slick straw with the 5400 Round Baler causes performance problems and, therefore, recommend baling straw only during early morning or evening hours when moisture content is higher.
6. A supplement to the operator's manual of the 5400 Rounder is available and has been distributed to Hesston dealers.

GENERAL DESCRIPTION

The Hesston 5400 is a pull-type, ground roll baler with spring loaded steel bale forming grids and a power take-off driven belt pickup. Twine wrapping is controlled with the tractor hydraulic system, while the twine is manually cut with a rope control.

The bale rolls on the ground, on top of the incoming windrow. The pickup, which is fixed at the rear of the bale chamber, lifts the windrow upward and forward, around the rolling bale, forcing it beneath three sets of spring loaded, curved bale forming grids. The pickup has nine 98 mm (3.9 in) wide belts with spring steel teeth.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Hesston 5400 was operated in a variety of Saskatchewan crops (TABLES 1 and 2) for 52 hours while producing 308 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	(ac)
Alfalfa	10	49	12	(30.0)
Alfalfa, Bromegrass & Crested Wheatgrass	29	137	33	(81.5)
Green Feed	9	94	11	(27.0)
Wheat Straw	2	10	1	(2.5)
Barley Straw	2	18	2	(5.0)
TOTAL	52	308	59	(146)

TABLE 2. Operation in Stony Fields.

FIELD CONDITION	HOURS	FIELD AREA ha	(ac)
Stone Free	41	48	(119)
Occasional Stones	9	9	(22)
Moderately Stony	2	2	(5)
TOTAL	52	59	(146)

RESULTS AND DISCUSSION

RATE OF WORK

Average throughputs for the Hesston 5400 (TABLE 3) varied from 0.8 t/h (0.9 ton/h) in wheat straw to 3.1 t/h (3.4 ton/h) in an alfalfa, bromegrass and crested wheatgrass mixture. The average throughputs reported in TABLE 3 are average workrates for daily field operation. They are representative of 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, alfalfa windrows, instantaneous feedrates up to 13 t/h (14.3 ton/h) were measured. These were peak values representing maximum baler capacity which cannot be achieved continuously.

In most crops, the feedrate was reduced by pickup performance. Pickup loss usually limited ground speed from 5.0 to 8.5 km/h (3.1 to 5.3 mph). Heavy windrows were desirable to fully utilize baler capacity.

TABLE 3. Average Throughputs.

CROP	YIELD t/ha	(ton/ac)	AVERAGE SPEED km/h	(mph)	AVERAGE THROUGHPUT t/h	(ton/h)
Alfalfa	0.6 to 4.0	(0.3 to 1.8)	5.0	(3.1)	2.8	(3.1)
Alfalfa, Bromegrass & Crested Wheatgrass	0.7 to 4.7	(0.3 to 2.1)	6.5	(4.0)	3.1	(3.4)
Green Feed	1.0 to 3.5	(0.4 to 1.6)	7.0	(4.3)	2.8	(3.1)
Wheat Straw	1.0 to 2.0	(0.4 to 0.9)	8.5	(5.3)	0.8	(0.9)
Barley Straw	1.5	(0.7)	8.4	(5.2)	1.5	(1.7)

QUALITY OF WORK

Bale Quality: The Hesston 5400 produced relatively light hay bales (FIGURE 2) with flat ends, uniform density, and fairly uniform diameter. Average hay bales were 1.6 m (63 in) long, 1.7 m (67 in) in diameter and weighed from 322 to 447 kg (710 to 985 lb). Hay bales had an average density of 104 kg/m³ (6.5 lb/ft³).

FIGURE 2. Typical Hay Bale.

Straw bales (FIGURE 3) were very soft with a very irregular surface. Average straw bales were 1.6 m (63 in) long, 0.9 m (36 in) in diameter and weighed about 75 kg (164 lb). Straw bales had an average density of only 74 kg/m^3 (4.6 lb/ft^3).

Bale Weathering: A common practice in the prairie provinces is to store round bales outside. FIGURE 4 shows the effect of weathering on a typical Hesston 5400 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 of the bales. During weathering, bales were exposed to about 75 mm (3 in) of rain and average prairie wind conditions.

FIGURE 3. Typical Straw Bale.

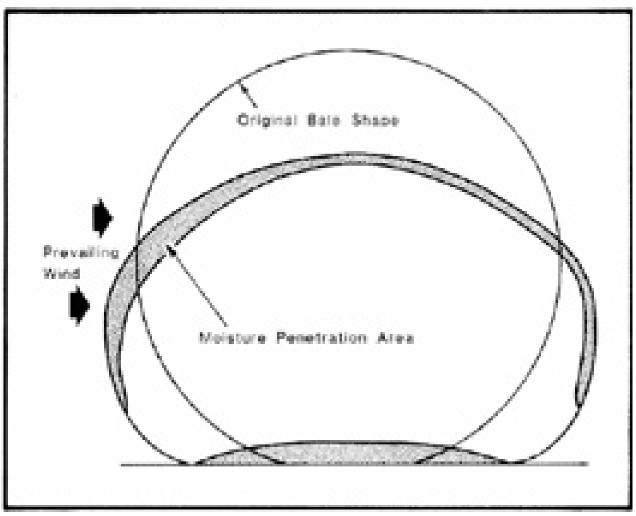

FIGURE 4. A Typical Hay Bale After 100 Days of Weathering.

The condition of the weathered bales was fair. The well formed surface had kept moisture penetration to a maximum of 120 mm (4.7 in) on the windward bale side. Bales had settled to 74% of their original height due to low bale density. As a result of settling, bales were difficult to pick with round bale handlers.

Pickup and Bale Chamber Losses: Measured hay loss from the Hesston 5400 (TABLE 4) varied from 7 to 30% of yield. Since the bale rolls on top of the incoming windrow, all losses appear on the ground behind the pickup and it is not possible to distinguish between pickup loss and bale chamber loss.

Lowest losses occurred in windrows which were heavy enough to fully utilize baler capacity and which were baled at high moisture contents. Proper conditioning of hay was important in reducing leaf loss, especially in alfalfa. While the moisture content of an alfalfa windrow may be at a level which will just permit safe storage, the leaves may be quite dry and brittle. In the second crop reported in TABLE 4, moisture content of the alfalfa stems was over 25% while moisture content of the leaves was less than 15%. and the windrow was too light to fully utilize baler capacity. Proper conditioning of the windrow and cutting a wider swath, would probably have reduced losses to an acceptable level in this crop.

Operating the pickup at the correct speed in relation to ground speed was also important in reducing losses with the Hesston 5400. The bale rolls on the ground requiring forward movement to keep it turning. Since the pickup is independently driven by the power take-off, a tractor gear must be selected to match pickup speed with the speed of the rolling bale. A ground speed faster than the pickup speed increases baler loss due to ineffective picking while a ground speed slower than pickup speed increases baler loss due to the tearing action of the pickup teeth on the rear bale surface.

TABLE 4. Pickup and Bate Chamber Loss.

CROP	YIELD t/ha	(ton/ac)	SWATH WIDTH m	(ft)	MOISTURE CONTENT (% dry basis)	LOSS (% of yield)
Alfalfa	3.2	(1.4)	3.7	(12)	23.9	14
Alfalfa	2.7	(1.2)	3.7	(12)	20.4	28
Alfalfa & Bromegrass	4.3	(1.9)	4.6	(15)	13.3	7
Alfalfa & Bromegrass	1.8	(0.8)	4.6	(15)	12.4	30

POWER CONSUMPTION

Power Requirements: FIGURE 5 shows the power take-off and drawbar input for the Hesston 5400 in alfalfa. The power input is plotted against bale weight to show the power requirements as a bale is being formed. Power take-off input varied from 2.7 kW (3.5 hp) at no load to a maximum of 12 kW (16.0 hp) in alfalfa and 6 kW (8 hp) in barley straw. Drawbar requirements at 7 km/h (4.4 mph) varied from 2.5 kW (3.3 hp) at no load to a maximum of 10.5 kW (14.0 hp) in alfalfa and 5.0 kW (6.7 hp) in barley straw.

Although total measured power requirements on flat, firm fields did not exceed 23 kW (31 hp), additional power was needed to suit field conditions. In soft, hilly fields a 75 kW (100 hp) tractor was needed to fully utilize baler capacity.

Specific Capacity: Specific capacity is a measure of how efficiently a machine performs a task. A high specific capacity indicates efficient energy use while a low specific capacity indicates inefficient operation. The specific capacity of the Hesston 5400 was about 0.46 t/kW.h (0.38 ton/hp.h) in alfalfa and 0.20 t/kW.h (0.16 ton/hp.h) in barley straw. This compares to an average specific capacity of 0.98 to 1.45 t/kW.h (0.8 to 1.2 ton/hp.h) for small square balers in alfalfa. These values represent average operating speeds in average field conditions and not peak outputs.

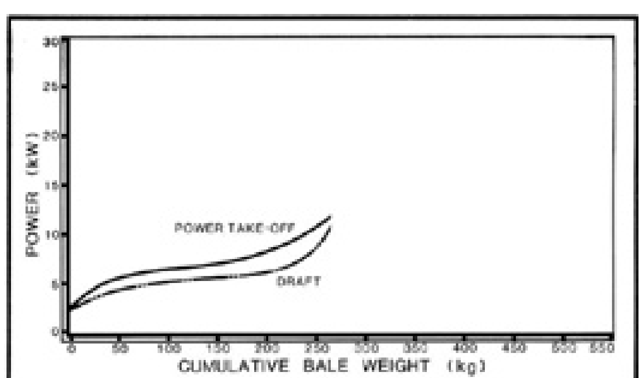

FIGURE 5. Power Consumption During Bale Formation in Alfalfa.

EASE OF OPERATION

Forming a Bale: It was easy to form a neat, durable hay bale with the Hesston 5400. Due to the action of the pickup and the bale forming grids, feeding hay across the entire width of the bale chamber during bale core formation was not as critical as with conventional round balers. During core formation, hay distributed itself fairly uniformly across the bale chamber and only slight weaving was needed to ensure uniform core density. Slight weaving was also needed during bale formation to maintain a uniform diameter. FIGURE 6 shows the position of baler components during bale formation.

The Hesston 5400 was unable to form a neat durable straw bale. In grain straw, the amount of drag applied to the bale by the bale forming grids was greater than the amount of rotational force applied by the ground. As a result, the bale slid on the straw windrow once it reached about a 0.6 m (24 in) diameter. The tension on the forming grids was reduced to lower drag force. This allowed bales to be made up to 0.9 m (36 in) in diameter, but lowered the bale density to an unacceptable level. Modifications are recommended to improve baler performance in grain straw.

The Hesston 5400 could not be backed up with a bale in the chamber. This reduced ease of operation since the operator had to carefully preplan baling routes. On several occasions a bale had to be ejected to permit maneuvering in sharp corners.

Wrapping the Twine: When the bale forming grids reach the limit of their movement, the bale is full size and ready for twine wrapping. To start wrapping, the twine tube is hydraulically moved to the left of the bale chamber. When the twine tube is in the extreme left position, the twine tensioning device is released, allowing the twine to be fed in with the incoming windrow. Once the twine has been caught by the incoming hay and has made at least half a wrap around the bale, the hydraulic control is actuated to move the twine tube about 50 mm (2 in) to the right, activating the twine tensioning mechanism, and the baler is moved off the windrow. Wrapping of the bale then continues while the baler moves alongside of the windrow. The number of wraps is determined by the return speed of the twine tube and the distance travelled while wrapping. When the twine tube reaches the right side, the twine is allowed to make at least one full wrap around the right bale end and then the twine is manually cut. The twine cutter is actuated by a rope from the tractor.

The hydraulic cylinder on the twine tube was very aggressive. Even though a flow restrictor is placed in the hydraulic line, the hydraulic control lever must be repeatedly activated and released to obtain proper twine spacing. Incorporating an adjustable speed control on the hydraulic cylinder is desirable to effectively control the twine spacing.

Moving the baler off the windrow while wrapping considerably lowered overall capacity. In most situations, the baler was driven alongside the windrow while wrapping and once the bale was ejected, the baler had to return to the point it left the windrow. In some cases, where room permitted, the bale could be wrapped while making a large circle into the baled field. This method improved overall baler capacity.

Twine consumption for the Hesston 5400 was about 144 m/t (428 ft/ton). This compares to a twine consumption of about 225 m/t (670 ft/ton) for small square balers.

Discharging a Bale: Once the twine is cut, the power take-off and forward movement are simultaneously stopped. The rear gate is then hydraulically opened, the baler is driven ahead, and the rear gate is closed. The rear gate hydraulic cylinders are single acting and are also used to adjust the pickup height and to release the gate lock mechanism.

Transporting: The Hesston 5400 was easy to maneuver and transport. Ground clearance was adequate with the pickup in the transport position. Hitch clearance was ample when towing the baler behind a tractor if the power take-off input shaft was properly positioned. Hitch clearance was reduced considerably when towing the baler behind the truck, due to interference between the power take-off shaft and the truck bumper when making turns.

Hitching: The Hesston 5400 was easy to hitch to a tractor. The power take-off splines could be aligned by manually turning the baler while hitching. If the tractor was equipped with a cab, it was sometimes difficult to find a suitable place for the twine cutter rope to enter the cab and have the rope completely accessible.

The Hesston 5400 required a tractor with dual hydraulics, although one set of the hydraulics need only be single acting.

Feeding: Feeding was positive and aggressive in all hay crops, but was unsatisfactory in grain straw. Since the windrow is rolled forward by the pickup, windrow size or composition generally did not affect feeding. One exception was when baling very heavy windrows. In this case hay would sometimes catch on the front bale forming grid mount (FIGURE 7). This problem was usually as a result of the tractor hitch dragging in the windrow.

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

The twine cutter performed well. No adjustment was needed during the test.

EASE OF ADJUSTMENT

Bale Forming Grids: The three bale forming grids are held against the bale by adjustable springs. The springs must be adjusted so that all the grids apply even pressure to the bale, or an out-of-round bale will result. No spring adjustment was needed when baling hay but all the springs had to be adjusted before a straw bale could be formed.

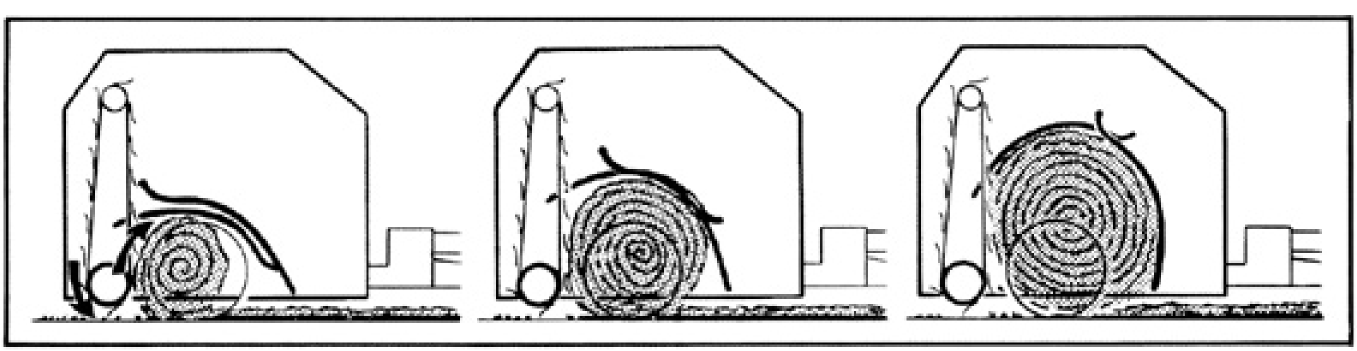

FIGURE 6. Stages of Bale Formation: (Left) Bale Core, (Centre) Half-Completed Bale, (Right) Completed Bale.

FIGURE 7. Accumulation of Hay on Front Bale Forming Grid in Heavy Windrows.

Adjusting the springs for the two rear grids was easy but adjustment of the front grid spring required an additional aid to compress the spring.

Pickup: The pickup on the Hesston 5400 has nine 98 mm (3.9 in) wide belts with spring steel teeth. The pickup belts are chain driven from the lower roller which is part of the tailgate assembly. The pickup is raised or lowered through hydraulic cylinders which vary the baler height. Adjustable mechanical stops determine minimum baler height.

Servicing: The Hesston 5400 had two chain drives, six grease fittings, and one gear box. The operator's manual recommended chain oiling daily, lubrication of all grease fittings every ten hours and checking gear box oil level every season. About 20 minutes were needed to service the Hesston 5400.

The power take-off shielding had to be removed to grease the rear universal joint. Addition of a hole in the shielding to increase ease of servicing is recommended.

OPERATOR SAFETY

The Hesston 5400 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. In general, the Hesston 5400 was safer to operate than many large round balers since the bale stopped rotation as soon as forward travel was stopped. There was, therefore, no possibility of being pulled into the bale chamber when clearing blockages at the front of the baler.

The Hesston 5400 was not equipped with an adjustable slip clutch on the power take-off. The pickup belts were adjusted to slip on the drive roller to prevent over-filling the baler, however, the pickup drive mechanism was not protected. Installation of a slip clutch on the power take-off input shaft is recommended.

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 and well written, containing much useful information on operation, servicing, adjustment, and safety procedu res.

Due to production line changes, the baler supplied for test purposes did not have the twine tie mechanism outlined in the operator's manual. Changes to the operator's manual, so that information contained on the twine system matches the equipment supplied, are recommended.

DURABILITY RESULTS

TABLE 5 outlines the mechanical history of the Hesston 5400 during 52 hours of field operation while baling about 59 ha (146 ac). The intent of the test was functional evaluation. The following failures represent only those which occurred during functional testing. An extended durability evaluation was not conducted.

TABLE 5. Mechanical History

ITEM	OPERATING HOURS	EQUIVALENT NUMBER OF BALES
Pickup Teeth		
--Several pickup teeth had been lost and were replaced at	18,27, 36 44	107,160,213 260
Pickup Belt Lacing		
--The lacing on one pickup belt broke and was repaired at	21	124

DISCUSSION OF MECHANICAL PROBLEMS

Pickup Teeth: By the end of the test, 34 pickup teeth had been lost due to broken mounting bolts. Bolt failure usually occurred when baling on rough ground and was caused by the pickup contacting the ground. Modifications to reduce tooth loss are recommended.

Pickup Belt Lacing: The belt lacing on one pickup belt broke when the pickup was allowed to run after baler forward movement had stopped with a bale in the bale chamber.

APPENDIX I

SPECIFICATIONS

MAKE: Hesston Round Baler
MODEL: 5400 Rounder
SERIAL NUMBER: RB43-02375
MANUFACTURER: Hesston Corporation
Hesston, Kansas 67062
U.S.A.

OVERALL DIMENSIONS:	
-- width	2 300 mm (91 in)
-- height	2 090 mm (82 in)
-- length	4 000 mm (157 in)
TIRES:	
-- size	2, 5.90 x 15, 4 ply
WEIGHT: (With drawbar in field position and two balls of twine)	
-- left wheel	610 kg (1344 lb)
-- right wheel	532 kg (1173 lb)
-- hitch point	52 kg (115 lb)
Total Weight	1194 kg (2632 lb)
BALE CHAMBER:	
-- width	1520 mm (60 in)
-- maximum diameter	1700 mm (67 in)
-- tension method	spring
BALE FORMING GRIDS:	
-- number	3 sets
-- construction	33 mm (1.25 in) formed pipe
PICKUP:	
-- type	fixed, belts with spring teeth
-- height adjustment	hydraulic with mechanical stops
-- width	1520 mm (60 in)
-- bottom roller diameter	292 mm (12 in)
-- number of belts	9
-- number of teeth per belt	12
-- belt width	98 mm (3.9 in)
-- belt thickness	5 mm (0.2 in)
-- belt spacing (centre to centre)	165 mm (6.5 in)
-- belt speed (at 540 rpm)	1.3 m/s (51.7 in/sec)
TWINE SYSTEM:	
-- capacity	2 balls
-- recommended twine size	none
-- twine feed	hydraulic
-- twine cutter	manual
SAFETY DEVICES:	pickup cylinder stops
SERVICING:	
-- grease fittings	6, daily
-- chain	2, daily
-- gearbox	1, yearly

APPENDIX II

MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

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

APPENDIX 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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