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Evaluation Report 279

International Harvester Model 445 Baler

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

INTERNATIONAL HARVESTER MODEL 445 BALER

MANUFACTURER:

International Harvester Company
401 North Michigan Avenue
Chicago, Illinois 60611
U.S.A.

DISTRIBUTOR:

International Harvester Company of Canada Limited
10914 - 120 Street
Edmonton, Alberta
T5H 3P7

RETAIL PRICE:

$12,594.00 (May, 1981, f.o.b. Lethbridge, Alberta).

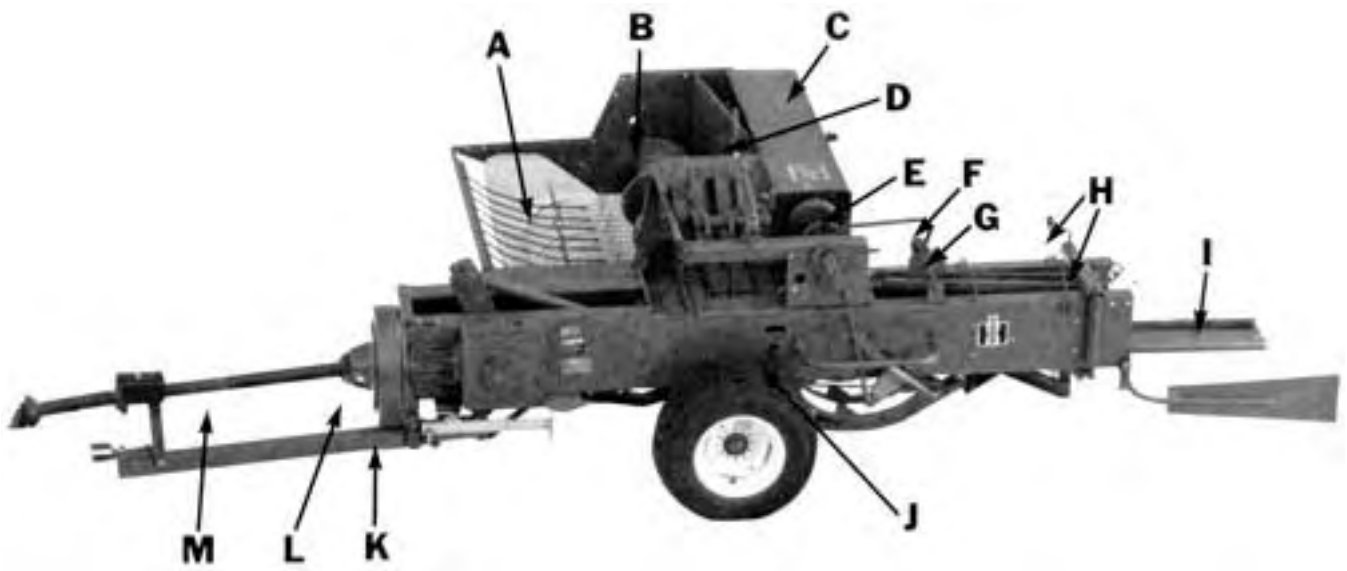

FIGURE 1. International Harvester 445 Baler: (A) Pickup, (B) Feed Auger, (C) Twine Box, (D) Packer Fingers, (E) Knotters, (F) Metering Arm, (G) Metering Wheel, (H) Bale Density Adjustment, (I) Quarter Turn Bale Chute, (J) Bale Chamber, (K) Flywheel, (L) Slip Clutch, (M) Power Shaft.

SUMMARY AND CONCLUSIONS

Overall functional performance of the International Harvester 445 baler was good.

Average feedrates varied from 2 to 11 t/h (2.2 to 12.1 ton/h). Field speeds were usually limited to 10 km/h (6.2 mph) due to bouncing on rough ground and reduced pickup performance at higher speeds. Maximum instantaneous feedrates in excess of 22 t/h (24.2 ton/h) were measured in heavy uniform alfalfa windrows. Feeding was aggressive in most crops.

The International Harvester 445 was capable of producing firm, durable bales. Length of the 356 x 457 mm (14 x 18 in) bales could be adjusted from 305 to 1140 mm (12 to 45 in). Bale length variation, at the 1000 mm (39 in) setting, was about 120 mm (4.7 in). For a certain length setting, longer bales were usually produced at higher feedrates. Average hay bales weighed from 23 to 39 kg (50 to 85 lb), while average straw bales weighed from 20 to 27 kg (45 to 60 lb). Bale density varied from 234 kg/m^3 (14.6 lb/ft^3) in heavy alfalfa-bromegrass to 115 kg/m^3 (7.7 lb/ft^3) in light wheat straw.

The International Harvester 445 was easy to operate and adjust. Knotter performance was satisfactory with both sisal and synthetic twines and required few field adjustments. However, correct knot bow length was often difficult to obtain.

Average power requirements were usually less than 16 kW (21 hp) but a 40 kW (54 hp) tractor was needed to overcome power take-off fluctuations and to provide sufficient power on hilly and soft fields. Total leaf and stem loss was usually less than 4%, similar to that of other conventional square balers.

The International 445 was safe to operate if the manufacturer's safety recommendations were closely followed and normal safety precautions were observed.

Several mechanical problems occurred during the test. The power take-off shaft shielding broke due to binding. The bale chute chain support bracket bent and the billhook cams broke.

RECOMMENDATIONS:

It is recommended that the manufacturer consider:

1. Modifications to prevent binding between the power takeoff shaft and flywheel shielding.

Senior Engineer: E H. Wiens

Project Technologist: P. A. Bergen

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Since the failure occurred immediately after assembly, we suspect that the bell of the power take-off shaft was deformed to an oval shape, due to either improper packing in shipment, or improper storage prior to assembly. Clearances are necessarily close to afford maximum protection, and the plastic shield material, although much superior to steel in impact resistance, can deform slightly if stored with a load applied. The deformation gradually disappears when the load is removed. Our service and warranty records indicate that this has not been a significant problem. However, we have alerted our manufacturing plant to take special precautions in packaging for shipment.

MANUFACTURER'S ADDITIONAL COMMENTS

Although not cited in your recommendations, we would like to respond also with the following:

1. Although a smaller bow can be tolerated with sisal twine without reducing knot strength, for consistent use with heavy plastic or sisal twine, a larger jaw assembly (our part number 201613C91) is available for the bill hook. This is described in our service manual.
2. We are investigating using a heavier bale chute chain support bracket with the bale turner attachment.

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

GENERAL DESCRIPTION

The International Harvester Model 445 is a pull-type, 540 rpm, power take-off driven, automatic twine tie baler. A floating drum pickup delivers hay to the feed chamber, where it is fed into the 356 x 457 mm (14 x 18 in) bale chamber by a floating auger and packer fingers. Hay is compacted and bales formed by a slicing plunger operating at 75 strokes per minute.

FIGURE 1 shows the location of major components while detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The International Harvester 445 was operated in a variety of crops (TABLE 1) for 116 hours while producing 16,387 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
Alfalfa	43	6819
Alfalfa, Bromegrass	35	6090
Bromegrass	8	435
Greenfeed - Barley	1	62
- Oats	1	113
Wheat Straw	15	1553
Barley Straw	6	455
Oat Straw	7	860
Total	116	16,387

RESULTS AND DISCUSSION

RATE OF WORK

Average feed rates varied from 2 t/h (2.2 ton/h) in light barley straw to 11 t/h (12.1 ton/h) in heavy alfalfa. Average feedrate depended on windrow size and uniformity, crop condition, field surface, available tractor speeds and operator skill. Speeds were normally limited to about 10 km/h (6.2 mph) due to bouncing on rough ground and poorer pickup performance at higher speeds.

In heavy, uniform alfalfa windrows, instantaneous feedrates of over 22 t/h (24.2 ton/h) were measured. These were peak values, representing maximum baler capacity, which could not be maintained continuously.

Feeding was aggressive in most crops. Feedrate was usually limited by reduced pickup performance at higher ground speeds and poor bale quality. In heavy crop conditions, feedrate was limited by slipping of the power take-off shaft slip clutch or shearing of the flywheel shear bolt.

QUALITY OF WORK

Bale Quality: The International Harvester 445 was capable of producing firm durable bales with square ends in most crops (FIGURE 2). Average hay bales weighed 23 to 39 kg (50 to 85 lb), while average straw bales weighed 20 to 27 kg (45 to 60 lb). Average bale density varied from 122 to 234 kg/m³ (7.6 to 14.6 lb/ft³) in hay and from 115 to 161 kg/m³ (7.2 to 10.0 lb/ft³) in straw.

At higher feedrates when producing bales with less than 12 charges per 1000 mm (39.4 in) long bales, bale quality was reduced, due to non-creased bale ends. Bale quality was also reduced in very light, dry barley straw due to twine slipping off the bale as shown in FIGURE 3.

Bale Length Variation: As with most conventional square balers it was difficult to obtain consistent bale length, especially in non-uniform windrows. When set for 1000 mm (39.4 in) length, bale lengths typically varied from 930 to 1070 mm (36.6 to 42.2 in).

Bale length is adjusted by adjusting the metering arm stop (FIGURE 4). The metering wheel advances the metering arm with each plunger stroke. Bale length uniformity depends on a consistent number of plunger strokes to form each bale. If the metering arm trips at the beginning of the last plunger stroke, rather than at the end of the stroke, bale length is increased by the length of compressed hay delivered during the last plunger stroke. Uniform feedrates are therefore important in reducing bale length variation.

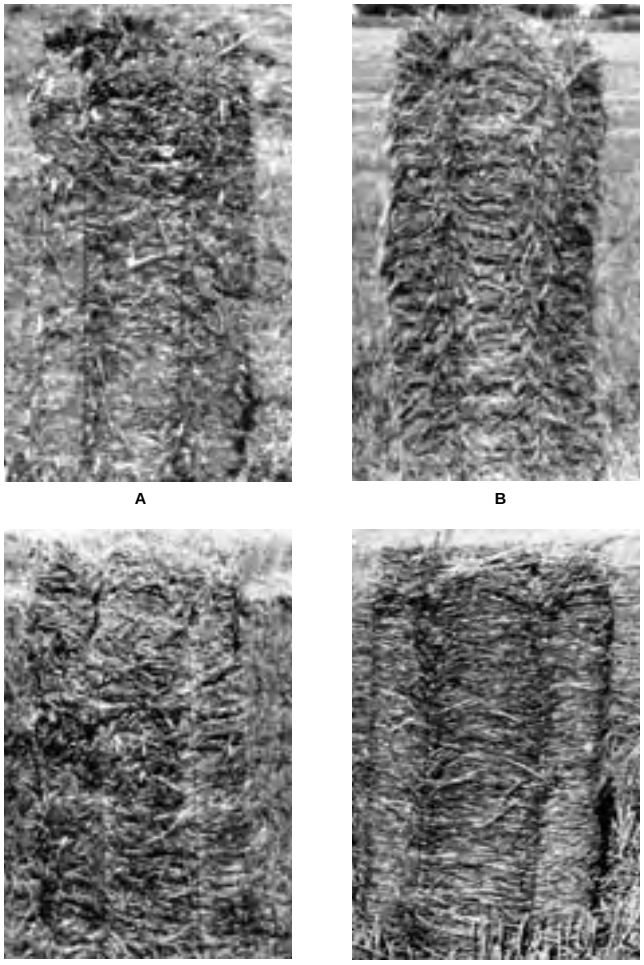

FIGURE 2. Typical Bales: (A) Alfalfa, (B) Bromegrass, (C) Greenfeed, (D) Wheat Straw.

FIGURE 3. Twine Slipping Off Bale in Light, Dry Barley Straw.

For the same length setting, higher feedrates usually produced longer bales. For example, in a uniform alfalfa field, average bale length was 910 mm (35.9 in) when baling at 5 t/h (5.5 ton/h), but increased to 975 mm (38.5 in) at 15 t/h (16.5 ton/h). The same trend was evident in wheat straw with average bale length increasing from 1020 mm (40.2 in) at 3 t/h (3.3 ton/h) feedrate to 1160 mm (45.7 in) at 15 t/h (16.5 ton/h).

Leaf and Stem Loss: As with most conventional square balers, leaf and stem loss in dry hay was lower than with round balers. Total loss from the pickup and bale chamber was about 4% in dry alfalfa. At optimum baling conditions in alfalfa, the total loss was less than 2%. Pickup losses were normally insignificant unless ground speed was very high or windrows were poorly formed. Proper moisture content at the time of baling is the most important factor in keeping

leaf loss to a minimum.

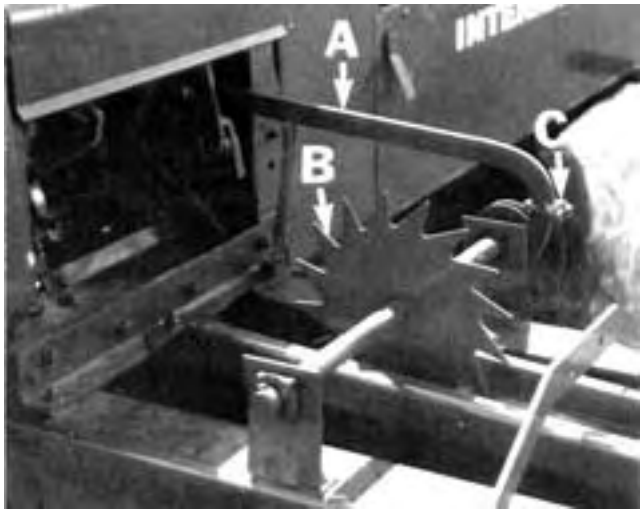

FIGURE 4. Bale Length Adjustment: (A) Metering Arm, (B) Metering Wheel, (C) Adjustable Stop.

Knotter Reliability and Performance: The knotters performed satisfactorily with most twines, requiring very few field adjustments. When using very small diameter synthetic twine or very large diameter sisal twine, the knotter hook closing pressure spring did not have sufficient adjustment range to obtain the correct knot bow length. However, the knots were usually of adequate durability. Knotter adjustments were clearly outlined in the operator's manual.

POWER CONSUMPTION

Power Take-off Requirements: FIGURE 5 shows typical instantaneous power take-off requirements for the International Harvester 445. Power requirements fluctuated from 0 to 31 kW (0 to 42 hp) on each plunger stroke. Due to these wide power fluctuations, average power requirements were less than instantaneous requirements, varying from 4 to 16 kW (5 to 21 hp) over a full range of feedrates. FIGURE 6 shows the average power take-off requirements at various feedrates in alfalfa and wheat straw.

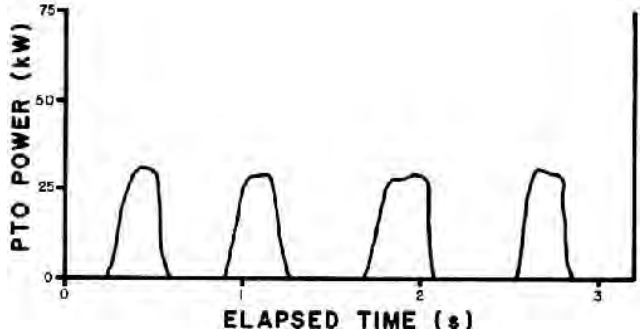

FIGURE 5. Instantaneous Power Take-off Requirements when Baling Alfalfa at an 11 t/h Feedrate.

Tractor Size: The manufacturer recommended that a 2 plow (25 kW) (35 hp) tractor be used. Average power take-off requirements were usually less than 16 kW (21 hp) and power required to pull the baler on level ground was usually less than 4 kW (5 hp). A 40 kW (54 hp) tractor was, however, needed to fully utilized baler capacity in soft or hilly fields and to overcome the power fluctuations illustrated in FIGURE 5.

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 International Harvester 445 varied from 0.9 to 1.2 t/kW•h (0.7 to 1.0 ton/hp•h) in alfalfa and from 0.6 to 0.8 t/kW•h (0.5 to 0.6 ton/hp•h) in wheat straw. This compares to an average specific capacity of 0.5 t/kW•h (0.4 ton/hp•h) for large round balers in alfalfa. These values represent average conditions and not peak output.

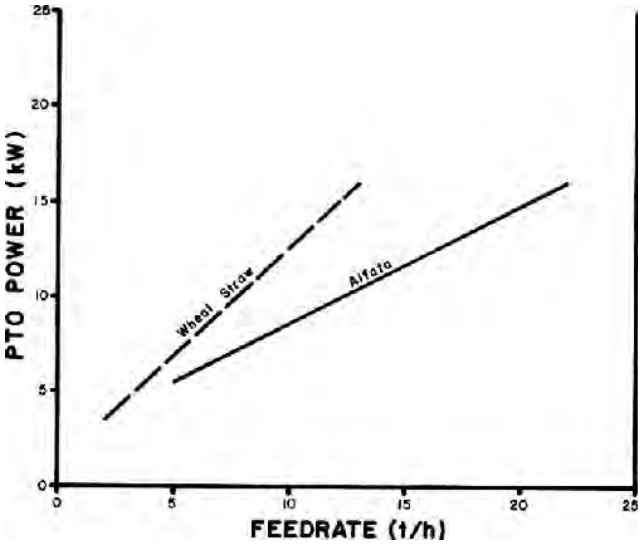

FIGURE 6. Average Power Take-off Requirements when Baling Alfalfa and Wheat Straw.

EASE OF OPERATION

Hitching: The International Harvester 445 was easily hitched to tractors equipped with a 540 rpm power take-off. The hitch jack was convenient for raising or lowering the hitch tongue. The power take-off shaft pedestal and the hitch clevis were adjustable to suit various drawbar heights.

Transporting: The hitch tongue could easily be swung into transport or field position without getting off the tractor. Dismounting the tractor was necessary to fold the bale chute and raise the pickup. The International Harvester 445 could normally be placed into field or transport position in about two minutes.

The baler towed well behind a tractor or suitably sized truck.

Feeding: Feeding was aggressive and positive in most crops. The pickup was wide enough to accommodate most well formed windrows with minimum trampling by the rear tractor tire. Pickup and feed chamber visibility were excellent from most tractors.

Maneuverability: The International Harvester 445 was sufficiently maneuverable for efficient baling.

Twine Threading: Twine threading was convenient. The operator's manual gave a clear description of twine threading procedures and a twine threading diagram was provided on the twine box lid.

EASE OF ADJUSTMENT

Bale Length: Bale length was conveniently adjusted with a wrench. Bale length settings from 305 to 1140 mm (12 to 45 in) were possible. Obtaining a consistent bale length was difficult, since bale lengths varied, depending on windrow uniformity and feedrate.

Bale Density: Bale density was easily adjusted by hand cranks located at the rear of the bale chamber. Setting the cranks for a specific crop was a trial and error procedure and required the operator to dismount the tractor. The hand cranks had sufficient adjustment range to produce bales of adequate density in most crops, provided additional bale wedges were installed in the bale chamber. Normally, twine knot strength was the only factor limiting bale density.

Feeding System: The packer fingers had five settings (FIGURE 7), which were adequate to produce square, well formed bales in most crops. The packer fingers were easily adjusted by hand. Occasionally in very light dry straw, further adjustment was required by changing the packer fingers from the right to the left side of the packer finger bearing. This required the use of wrenches.

Pickup: Pickup height was easily adjusted with an adjustment lever located on the right side of the baler (FIGURE 8). Wrenches were required to position the pickup gauge wheel. The pickup windguard was easily adjustable to suit windrow size. No wrenches were required.

Overload Devices: The power take-off shaft slip clutch functioned well but required adjustment several times during the test. Replacing the shear bolts on the flywheel, packer fingers and knotter was convenient.

Bale Chute: The optional quarter turn bale chute was easily

adjusted to place the bales on edge. Consistently placing the bales on edge was a problem in rough or hilly field conditions. The bale chute was reversible so bales could be dropped on either the left or right side.

FIGURE 7. Packer Finger Adjustment.

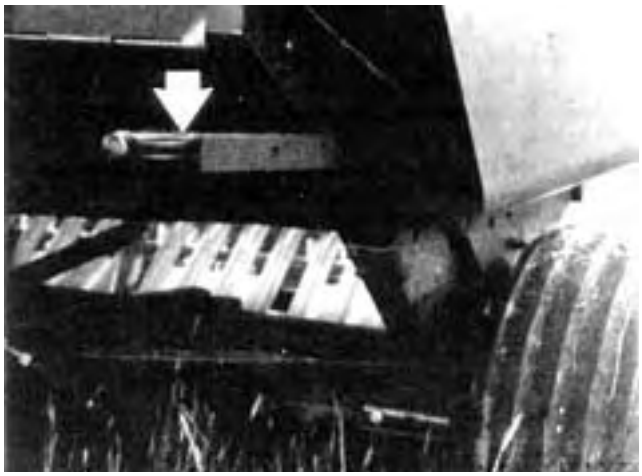

FIGURE 8. Pickup Height Adjustment Lever.

Servicing: The International Harvester 445 had two chain drives, 35 grease fittings and one gearbox. The operator's manual recommended lubrication of two grease fittings every five hours, 28 grease fittings every 10 hours, four grease fittings every 50 hours, periodic lubrication of one grease fitting and two chains, and annual servicing of the gearbox and wheel bearings. About 13 minutes were needed to service the International Harvester 445. A diagram indicating lubrication points and intervals was conveniently located on the shielding above the twine box.

Tool Box: A tool box compartment is located on the left side of the baler in front of the packer fingers. It was convenient for carrying tools, spare shear bolts or parts. The tool box readily became filled with dust and chaff.

OPERATOR SAFETY

The International Harvester 445 was safe to operate and service if normal safety precautions were observed. All moving parts, except for the flywheel, were well shielded. As with most power take-off equipment, the power take-off must be disengaged and the tractor engine stopped before adjusting or servicing.

OPERATOR'S MANUAL

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

DURABILITY RESULTS

TABLE 2 outlines the mechanical history of the International Harvester 445 during 116 hours of field operation while baling 16,387 bales. 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 2. Mechanical History

Item	Operating Hours	Equivalent Bales
Drive Train		
-The power take-off shaft shielding broke when it caught on the flywheel shielding at	beginning of test	
-The power take-off latch pin broke and was replaced at	66	10,280
-The set screw securing the center universal joint of the power take-off shaft was lost and replaced at	99	14,420
-The power take-off shaft pedestal pivot was loose and was tightened at	end of test	
-The slip clutch was readjusted at	63, 80, 87, 90	10,020, 12,400, 13,410, 13,630
Pickup Assembly		
-The pickup drive chains required tightening at	36, 87	7070, 13,410
-The collar securing the right bearing on the pickup shaft was loose. The set screws were tightened at	87	13,410
Feeding Assembly		
-The auger drive belt began to slip and required tightening at	22, 78	5440, 12,230
Plunger		
-The plunger and stationary knives were sharpened and clearances were checked at	63	10,020
-Plunger adjustments were checked, and the plunger adjusted to specifications at	98	15,660
Knotter Assembly		
-The needle brake was loose and required adjustment at	47	8950
-The right twine slack spring broke. It was replaced at	47	8950
-The billhook cams broke due to overtightening when using sisal twine. One cam was repaired and the other replaced at	103	15,080
-The knotter twine knives were dull and chipped. They were replaced at	115	16,330
Bale Chute		
-The bale chute chain support bracket bent and was straightened at	97	14,140

DISCUSSION OF MECHANICAL PROBLEMS

DRIVE TRAIN

Power Take-off Shaft Shielding: The power take-off shaft shielding broke (FIGURE 9) due to binding between the flare in the shielding and the flywheel shield. It is recommended that the manufacturer consider modifications to prevent binding between the power take-off shaft and flywheel shielding.

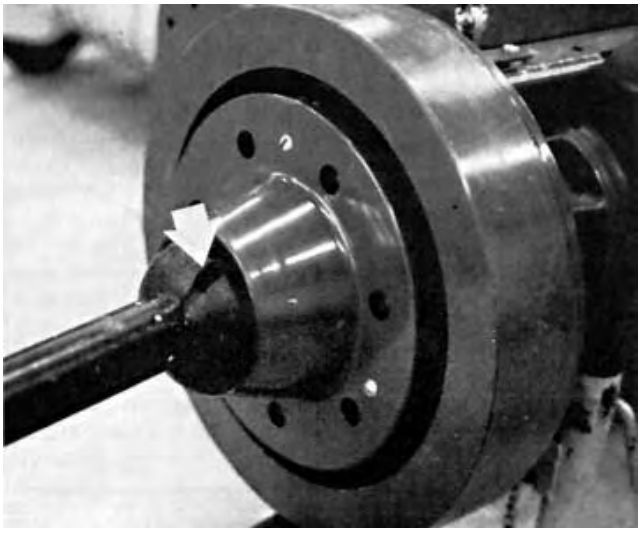

FIGURE 9. Broken Power Take-off Shaft Shielding.

BALE CHUTE

The bale chute chain support bracket was bent (FIGURE 10) due to excessive bouncing of the bale chute, allowing the chains to fall from their brackets. The brackets required straightening to prevent the bale chute from falling to the ground.

FIGURE 10. Bent Bale Chute Bracket.

KNOTTER ASSEMBLY

Billhook Cams: The billhook cams broke due to over-

tightening of the billhook closing pressure spring when attempting to obtain correct knot bow length with sisal twine. Since knots were of adequate durability without having proper bow length, over-tightening was not necessary. No further problems were encountered after the billhook cams were replaced.

APPENDIX I
SPECIFICATIONS

MAKE:	International Harvester Baler
MODEL:	445
SERIAL NUMBER:	0030097U002022
OVERALL DIMENSIONS: (Field Position)	
-- width	2870 mm
-- length	5900 mm
-- height	1850 mm
-- ground clearance	190 mm
WEIGHTS:	
-- left wheel	855 kg
-- right wheel	395 kg
-- hitch	145 kg
Total	1395 kg
TIRES:	
-- left	11L-15, 6-ply tubeless
-- right	26 x 12.00-12, 4-ply tubeless
-- pickup gage	3.00 x 12, solid rubber
PICKUP:	
-- type	cam actuated drum pickup
-- height adjustment	adjustment lever
-- width	1510 mm
-- number of tooth bars	6
-- number of teeth	120
-- tooth spacing	71 mm
-- speed	73 rpm
FEEDING MECHANISM:	
-- type	auger and packer finger
-- auger diameter	408 mm
-- auger speed	188 rpm
-- packer finger speed	75 strokes per minute
PLUNGER:	
-- strokes per minute	75
-- length of stroke	711 mm
BALE CHAMBER:	
-- width	457 mm
-- height	356 mm
-- range of bale lengths	305 mm to 1140 mm
-- bale density	control compression bar (primary) hay wedges (secondary)
TWINE CAPACITY:	4 balls
DRIVES:	
-- number of belt drives	1
-- number of chain drives	2
-- number of gear drives	5
-- number of universal joints	3
SAFETY FEATURES:	
-- power take-off	slip clutch
-- pickup	slip clutch
-- flywheel	shear bolt
-- packer finger s	hear pin
-- knotter and auger drive	shear bolt
-- needle drive	shear bolt
-- plunger	safety stop
SERVICING:	
-- grease fittings	2, every 5 hours 28, every 10 hours or daily 4, every 50 hours or weekly 1, periodically
-- chains	2, oil periodically
-- gearbox	1, check periodically, replace lubricant annually
-- wheel bearings	2, service annually

OPTIONAL EQUIPMENT: (Not supplied on test machine)
- -- trailer hitch and bale chute
- -- safety lighting
- -- hydraulic bale tension device
- -- bale turner
- -- bale thrower
- -- safety chain

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
CONVERSION TABLE

1 hectare (ha)	= 2.5 acres (ac)
1 kilometre/hour (km/h)	= 0.6 miles/hour (mph)
1 tonne (t)	= 2200 pounds mass (lb)
1 tonne/hour (t/h)	= 1.10 ton/hour (ton/h)
1 tonne/hectare (t/ha)	= 0.45 ton/acre (ton/ac)
1 millimetre (mm)	= 0.04 inches (in)
1 metre (m)	= 39.4 inches (in)
1 kilowatt (kW)	= 1.3 horsepower (hp)
1 kilogram (kg)	= 2.2 pounds mass (lb)
1 kilogram/cubic metre (kg/m^3)	= 0.06 pounds mass/cubic foot (lb/ft^3)
1 tonne/kilowatt hour (t/kW•h)	= 0.8 ton/horsepower hour (ton/hp•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