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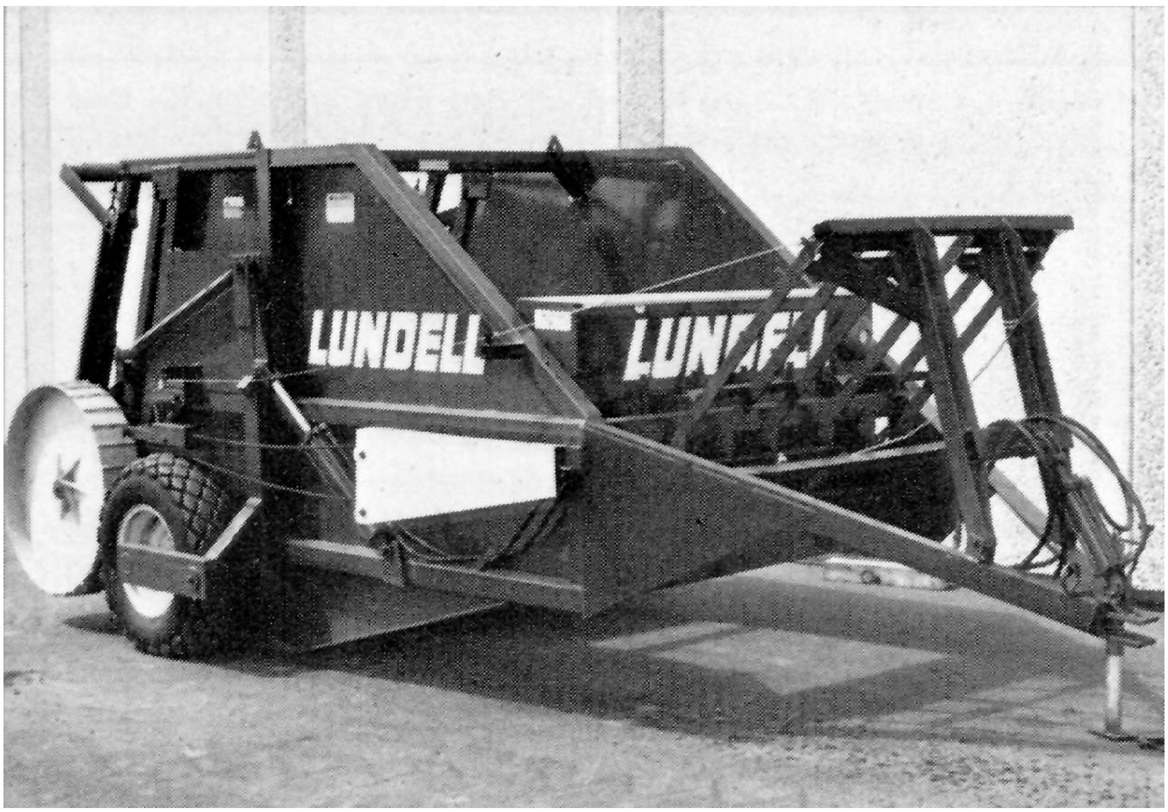
Evaluation Report 100



Lundell 760C Round Baler

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

LUNDELL 7600 BALER

MANUFACTURER:
Lundell Manufacturing
Cherokee, Iowa 51012
U.S.A.

DISTRIBUTOR:
Interline Distributors
Box 1738
Edmonton, Alberta
T5J 2P1

RETAIL PRICE: $5,918.00 (May, 1978, f.o.b. Cherokee, Iowa.)

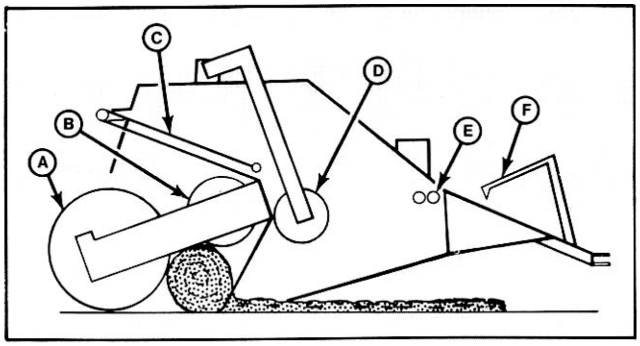


FIGURE 1. Lundell 7600: (A) Pickup, (B) Bale Forming Roller, (C) Bale Forming Cables, (D) Bale Forming Roller, (E) Twine Rollers, (F) Second Bale Starter.

SUMMARY AND CONCLUSIONS

Without major improvements, the Lundell 7600 round baler is not suitable for typical prairie haying conditions. Overall functional performance of the Lundell 7600 was *fair* in long coarse hay, *poor* in average hay crops, and *unsatisfactory* in short hay and straw. Ease of operation and adjustment both were *fair*. Operation of the twine tie mechanism was *fair*.

Average field speeds varied from 7 to 8 km/h (4.3 to 5.0 mph) while average throughputs varied from 1.5 to 3.0 t/h (1.7 to 3.3 ton/h). Maximum instantaneous feedrates of up to 16 t/h (17.6 ton/h) were measured in heavy uniform crops in long hay. Ground speed was usually limited by the uniformity of the bale and by baler losses. Pickup flotation was poor resultIng in unsatisfactory performance on rough or irregular field surfaces due to digging of the pickup drum in the ground and skidding of the drive wheels.

Bales were poorly formed and had an irregular shape. The Lundell 7600 produced bales with an average length of 1.6 m (63 in) and an average diameter of 1.8 m (71 in). Hay bales weighed from 350 to 630 kg (772 to 1389 lb) with an average density of 119 kg/m^3 (7.4 lb/ft^3). Acceptable bales usually could not be produced in grain straw and short hay.

Resistance of the hay bales to moisture penetration was poor.

Peak drawbar power requirements were about 14 kW (19 hp) in alfalfa and 12 kW (16 hp) in straw on flat terrain under normal conditions. More power was needed in hills or soft ground.

Losses usually were higher than with conventional round balers, tn heavy, non-brittle crops, at near optimum moisture content losses were 12%, while in light dw alfalfa, average losses were as high as 39%. Losses were more dependent upon hay fragility and brittleness than upon hay moisture content or feedrate.

The Lundell 7600 was safe to operate if the manufacturer's safety recommendations were closely followed.

A considerable number of mechanical problems occurred during the short test period. Six weld failures occurred on main structural members, the bale forming cable frayed requiring replacement twice, while both the original and replacement twine metering rollers were eccentric causing faulty twine metering.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifying the twine tie mechanism to improve its operation.
2. Modifying the pickup drum to increase its effectiveness in short hay or straw and to eliminate ground interference on rough, irregular or hilly fields.
3. Modifying the bale forming cables to reduce cable fraying and bending.
4. Increasing hitch jack lift height and eliminating interference between the jack handle and the baler frame.
5. Modifying the second bale starter to improve its operation in short hay and in heavy windrows.
6. Modifications to reduce main frame weld failures.
7. Improving quality control on replacement parts to ensure matching with original parts.
8. Modifying the bale drive method to permit operation in short hay, grain straw, and non-uniform windrows.
9. Supplying pickup cylinder lock pins and a cylinder lock storage mount to improve operator safety.
10. Installing a bale size indicator.
11. Supplying a stow-moving vehicle sign as standard equipment.

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Senior Engineer: L. G. Smith
Project Technologist: D. H. Kelly

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. The twine feed is now belt driven and has been modified to improve ease of adjustment.
2. Optional lifters will soon be available to permit operation of the baler with increased pickup height to improve performance on uneven ground and hilly fields. These will be available for field installation.
3. The bale forming cables have been modified to improve ease of adjustment. Cable ends have been soldered for a length of 150 mm (6 in) to reduce fraying.
4. The hitch jack has been modified to eliminate frame interference.
5. We are taking this under consideration.
6. Present field results do not indicate a severe problem.
7. Quality control has been improved.
8. An additional power packer roller, which is supplied as standard equipment on 1978 models, increases driving power to the bale, improves bale uniformity and increases overall bale density. This roller will also fit all 1977 models.
9. Pickup cylinder locks were supplied by the factory to all distributors for installation on 1977 models. We don't know why they were not included on your baler.
10. A bale size indicator will be included on all new balers.
11. A slow-moving vehicle sign will be included on all new balers.

MANUFACTURER'S ADDITIONAL COMMENTS

A number of improvements have been made to the 1978 model baler which improve the ease of operation and increase turning power and bale density. Our company is making these improvements available to any owner of the 1977 model baler.

GENERAL DESCRIPTION

The Lundell 760C is a pull-type, ground roll baler with a series of cables and rollers forming the bale chamber and with a solid ground driven 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 drum. which is friction driven from the baler tires, lifts the windrow upward and forward, around the rolling bale forcing it beneath two rollers and a set of nine steel cables. The pickup position is fixed while the rollers and cables position themselves about the bale during formation. The Lundell 760C is equipped with a second bale starter to permit continuous operation while wrapping a bale with twine.

Detailed specifications are gwen in APPENDIX I.

SCOPE OF TEST

The Lundell 760C was operated in a variety of Saskatchewan crops (TABLES 1 and 2) for 22 hours while producing 74 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.

Note: Although the test machine was in the field for a full baling season, only 74 bales were produced. The low output was due to the fact that the Lundell 760C would perform only in certain field conditions. Poor performance and unacceptable bale quality prevented operation in many fields.

TABLE 1. Operating Conditions.

CROP	HOURS	NUMBER OF BALES	FIELD AREA ha	(ac)
Alfalfa	4	19	5	(12.4)
Alfalfa, Bromegrass & Crested Wheatgrass	15	43	14	(34.6)
Green Feed	1	7	2	(5.0)
Wheat Straw	1	3	1	(2.5)
Barley Straw	1	2	1	(2.5)
TOTAL	22	74	23	(57)

TABLE 2. Operation in Stony Fields.

FIELD CONDITION	HOURS	FIELD AREA ha	(ac)
Stone free	19	19	(47)
Moderately stony	3	4	(10)
TOTAL	22	23	(57)

RESULTS AND DISCUSSION

RATE OF WORK

Average throughputs for the Lundell 760C (TABLE 1) varied from 1.5 t/h (1.7 ton/h) in wheat and barley straw to 3.0 t/h (3.3 ton/h) in green oats. 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 16 t/h (17.6 ton/h) were measured. These were peak values representing maximum baler capacity which cannot be achieved continuously.

Bale uniformity usually limited ground speed from 7 to 8 km/h (4 to 5 mph). Higher speeds were possible only in ideal conditions. Feeding was positive in long hay, but capacity was severely reduced in short, slippery hay or straw by the inability of the baler to form a bale.

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)	7.0	(4.3)	2.9	(3.2)
Alfalfa, Bromegrass & Crested Wheatgrass	0.7 to 4.7	(0.3 to 2.1)	7.2	(4.5)	2.5	(2.8)
Green Feed	1.0 to 2.0	(0.4 to 0.9)	8.0	(5.0)	3.0	(3.3)
Wheat Straw	1.0 to 2.0	(0.4 to 0.9)	8.0	(5.0)	1.5	(1.7)
Barley Straw	15	(0.7)	7.5	(4.6)	1.5	(1.7)

QUALITY OF WORK

Bale Quality: The Lundell 760C produced soft, low density hay bales (FIGURE 2) with irregular surfaces. Poor bale quality was more pronounced in non-uniform windrows. Bales usually had varying diameters throughout their length but had fairly flat ends. Hay bales averaged 1.6 m (63 in) in length and 1.8 m (71 in) in diameter. Average hay bales weighed from 350 to 630 kg (772 to 1389 lb) with an average density of 119 kg/m^3 (7.4 lb/ft^3). Density was not uniform throughout the bale.

It was very difficult to form a bale in grain straw. Usually the bale began to slide on the slippery grain stubble during formation and had to be discharged before twine wrapping (FIGURE 3). Since it was possible to form only five bales during many trials in straw, no reliable estimate could be made of bale weight, size or quality.

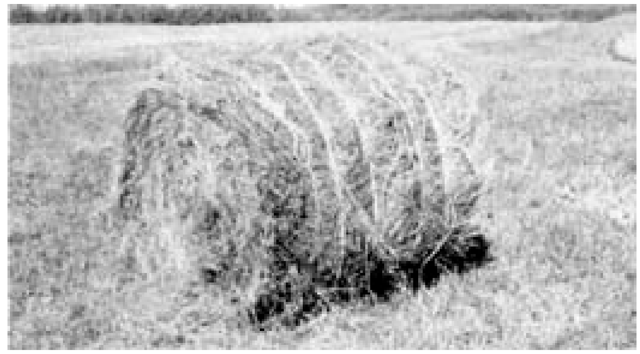

FIGURE 2. Typical Hay Bale.

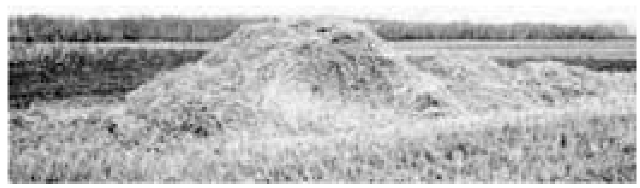

FIGURE 3. Typical Straw Bale.

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 Lundell 760C 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.

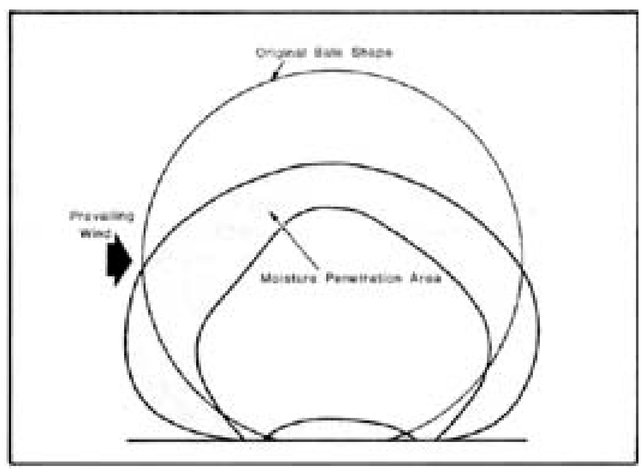

FIGURE 4. A Typical Hay Bale After 100 Days of Weathering.

The condition of weathered bales was poor. The irregular bale surface and low bale density had permitted moisture penetration to a maximum of 415 mm (16.3 in) on the windward bale side. As a result, nearly 50% of the hay in each bale had discoloured due to moisture penetration. Bales had settled to 74% of their original height due to low bale density. As a result of settling, bales were very difficult to pick with round bale handlers.

Pickup and Bale Chamber Losses: Measured hay loss from the Lundell 760C (TABLE 4) varied from 12% in ideal windrows to 39% in light windrows. 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.

Losses from the Lundell 760C were highest in fragile crops such as alfalfa with dry leaves. Losses were more dependent upon hay fragility than upon hay moisture content or feedrate. The compressing action of the bale rolling on the windrow and the aggressiveness of the rigid pickup both contributed to shattering of fragile hay.

The effect of shattering is illustrated by comparing the second and third crops in TABLE 4. In the second crop, the alfalfa had not been conditioned and the stalks were at a moisture content which would just permit storage while the leaves were very dry and brittle. Total losses in this field were 39%. The third crop, being composed of over one-half bromegrass, was much less susceptible to shattering and total losses were only 12%.

TABLE 4. Pickup and Bale 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)	30.5	36
Alfalfa	3.2	(1.4)	3.7	(12)	23.1	39
Alfalfa & Bromegrass	4.4	(2.0)	4.6	(15)	12.3	12
Alfalfa & Bromegrass	0.9	(0.4)	4.6	(15)	12.6	12

Losses from the Lundell 760C were usually somewhat higher than for conventional round balers. The pickup-to-ground speed ratio could not be altered. This resulted in increased material loss since the operator could not alter the rate at which the windrow was added to the bale, to compensate for field conditions.

POWER CONSUMPTION

Drawbar Power Requirements: The Lundell 760C is completely ground driven. All baler components are friction driven from the baler tires. FIGURE 5 shows the drawbar power input for the Lundell 760C in alfalfa. Power input is plotted against bale weight to show the power requirements as a bale is being formed. Power requirements at 7 km/h (4.4 mph) varied from 7 kW (9 hp) at no load to a maximum of 14 kW (19 hp) in alfalfa and 12 kW (16 hp) in barley straw.

Although total measured power requirements on flat, firm fields did not exceed 14 kW (19 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 Lundell 760C was about 0.39 t/kW.h (0.32 ton/hp.h) in alfalfa and 0.23 t/kW.h (0.19 ton/hp.h) in barley straw. This compares with 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.

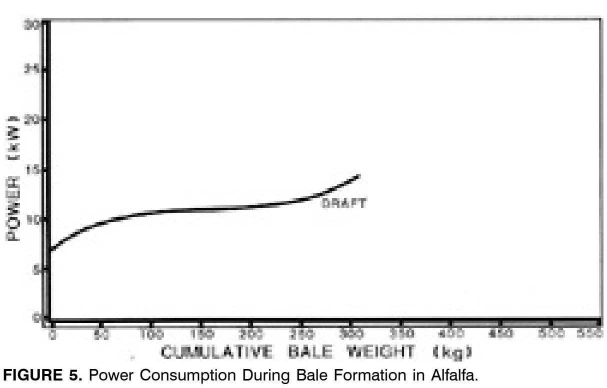

FIGURE 5. Power Consumption During Bale Formation in Alfalfa.

EASE OF OPERATION

Forming a Bale: It was difficult to form a neat, durable bale in most crops. When starting a new bale, visibility of the bale core was restricted by the front bale forming roller until the bale was greater than 700 mm (2.5 ft) in diameter. Since the bale core could not be seen it was difficult to determine how to feed the baler to obtain a uniform bale. Once the bale was larger than 700 mm (2.5 ft) in diameter, the bale could be seen, but due to the rigidity of the bale rollers, the operator still had no indication of the actual bale shape. It was, therefore, easy to form a bale with high density on one end and very low density on the other end without realizing the non-uniformity until the bale was discharged.

Poor quality bales occurred in uneven windrows. Since hay is added to a bale in the same way it is positioned in a windrow, with little redistribution by the baler, non-uniform windrows resulted in very irregular bale surfaces with lumps and cavities. These irregularities increased moisture penetration when the bales were stored in the field.

The Lundell 760C sometimes could not produce acceptable bales if crop conditions changed abruptly in a windrow. For example, in a field of alfalfa, bromegrass and crested wheatgrass mixture with patches of wild barley, bale formation problems occurred as soon as wild barley patches were encountered. The short, slippery wild barley would not wrap into the bale and a second bale would begin forming between the original bale and the pickup. The operator could not see the second bale and was not aware of problems until the second bale became large enough to prevent the first bale from turning (FIGURE 6). As a result, both bales had to be discharged, unrolled and rebaled.

Bale formation was poor or unacceptable in short, slippery hay or straw. Bales require a certain internal rigidity to maintain their shape during bale formation. In short, slippery crops, bales were not firmly tied together and collapsed from the weight of the top bale roller. Once the bale had collapsed, it was severely out-of-round and ground speed had to be reduced to keep it turning.

FIGURE 6. Formation of Double Bales when Encountering Wild Barley Patches. Ejected Bale (right) with Second Bale Core (left).

Out-of-round bales could be wrapped with twine (FIGURE 7) but bales that completely collapsed and stopped turning had to be ejected without twine (FIGURE 8).

The Lundell 760C was very ineffective on rough or hilly fields. On rough or irregular ground, the pickup roller often contacted the soil and would either scrape soil into the bale or would turn backwards, tearing a portion out of the bale and discharging it behind the baler. Sometimes the pickup soil interference forced the baler drive wheels to turn backwards. The wheels dug deeply into the soil (FIGURE 9) lowering the baler and preventing the bale from turning. In soft or sandy soils, once the bale stopped turning, soil 'accumulated in front of the bale necessitating discharge without twine wrapping.

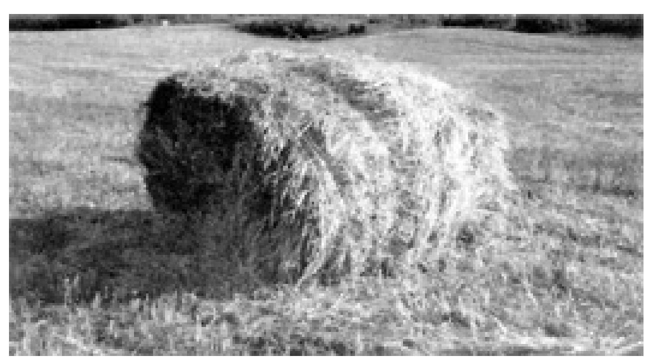

FIGURE 7. A Bale Wrapped with Twine After Going Out-of-Round.

Forming a neat, full sized bale in grain straw was difficult. The amount of drag applied to the bale by the non-moving baler parts was greater than the rotational force applied by the ground or the pickup. As a result, the bale slid on the incoming windrow and had to be ejected without twine (FIGURE 3). Wide, irregularly shaped straw windrows left by large combines also prevented bale formation. Wide straw windrows would not completely fit into the bale chamber, resulting in straw being fed under the baler skids and tires. Straw decreased the traction of the baler drive wheels causing the wheels to skid and the bale to stop turning.

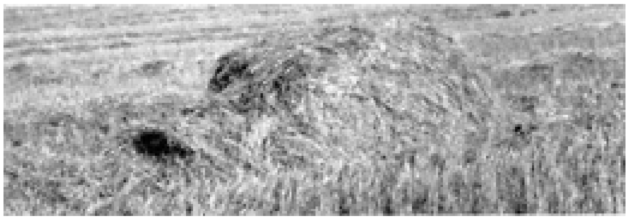

FIGURE 8. A Collapsed Bale that had to be Ejected Without Twine Wrapping.

FIGURE 9. Skidding of the Drive Wheels on Rough, Irregular Ground Surfaces.

Bale formation depended on properly functioning bale forming cables. The cables position themselves around the rotating bale during formation, providing drag to result in bale compression. The ends of the bale forming cables frequently became frayed or bent (FIGURE 10) requiring replacement. Damaged cables dragged heavily preventing free bale rotation. Modifications, to reduce the frequency of cable damage, are recommended.

The Lundell 760C could not be backed up with a bale in the chamber without damaging the baler or the bale. This reduced ease of operation since the operator had to carefully preplan the baling route. On several occasions, a bale had to be ejected to permit maneuvering in sharp corners.

FIGURE 11 shows the position of the baler components during bale formation.

Twine Wrapping Mechanism: The Lundell 760C has a unique twine wrapping mechanism (FIGURE 12) consisting of two knurled twine metering rollers friction driven from one baler wheel. The twine roller drive chain position is controlled by the second bale starter. When the second bale starter is lowered, the twine roller drive chain contacts the right baler tire, driving the twine rollers at about 80% of ground speed. As the rollers turn, they meter five individual twines from five twine balls.

Wrapping the Twine: As the Lundell 760C did not have a bale size indicator, the operator had to watch the bale to ensure it did not contact the baler cross member before twine wrapping, or the bale would stop turning and have to be ejected without twine. A bale size indicator is recommended to reduce this problem, especially in dusty conditions.

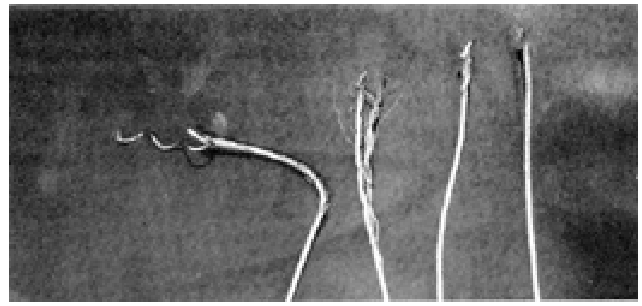

FIGURE 10. Damaged Bale Forming Cables.

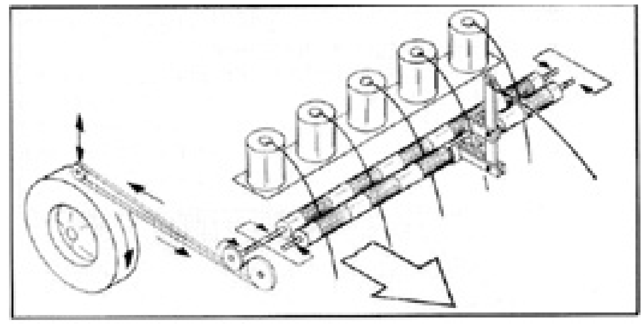

FIGURE 12. Twine Wrapping Mechanism.

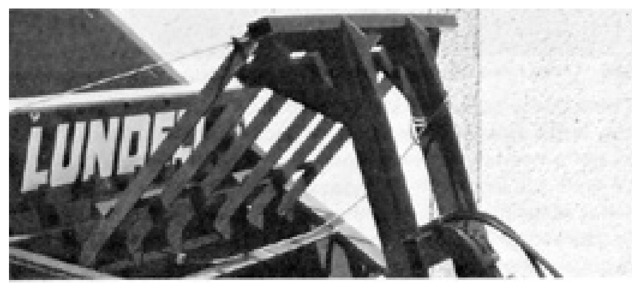

FIGURE 13. Second Bale Starter.

To start wrapping, the second bale starter (FIGURE 13) is partially lowered to allow the twine roller drive to contact the right baler tire and begin twine metering. Once the twine has wrapped into the bale with the incoming hay, the second bale starter is lowered completely to accumulate the incoming hay while the twines make two to three wraps around the bale.

When the twine wrapping is completed, a roller brake is activated by a rope, initially with light pressure to increase twine tension, and then heavily applied to stop the rollers, breaking the twines. Satisfactory operation of the twine system depended on proper roller adjustment. It was not possible to properly adjust the twine rollers on the test baler due to roller eccentricity. A replacement set of twine rollers was obtained, but this set also was out-of-round. Eccentric rollers could not be adjusted to prevent twine slippage unless they were tightened until they jammed. Twine roller knurling was too aggressive for some types of sisal twine, causing the twines to adhere to the knurling (FIGURE 14) and wrap around the rollers.

The twine roller drive chain was very slack with no provision for tightening. The front chain idler also was misaligned. As a result, the chain would bind on the roller drive sprocket. A

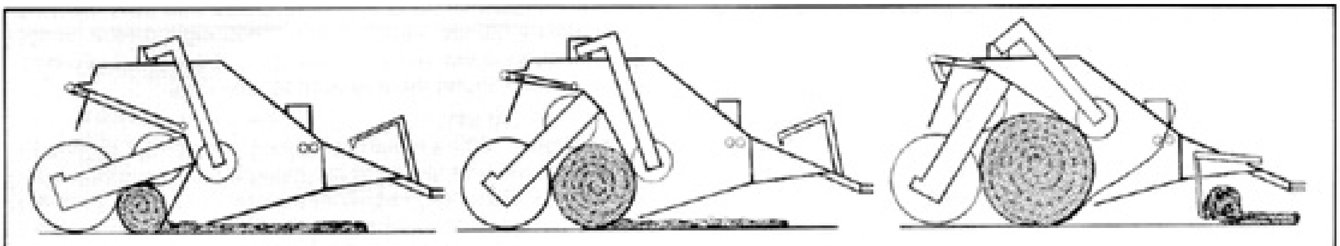

FIGURE 11. Stages of Bale Formation: (Left) Bale Core, (Centre) Half-Completed Bale, (Right) Completed Bale with Second Bale Starter Lowered for Twine Wrapping.

replacement idler and mounting bracket were obtained, but could not be properly installed due to bolt hole misalignment.

In ideal windrows, the second bale starter performed well, effectively increasing baler capacity by collecting the second bale core while the first bale was wrapped. As a result, the only loss of baling time occurred while actually discharging the bale. The second bale starter was, however, ineffective in light windrows, short hay or very heavy windrows. In short hay or in light windrows, hay passed through the bale starter teeth and impaired twine wrapping. In heavy windrows, the second bale starter could not accumulate all the incoming hay during twine wrapping. In both conditions, the most effective method of wrapping was to move the baler out of the windrow, wrapping the twine on the previously baled field area and turning around to resume baling. This considerably lowered baler output.

Operation of the hydraulic cylinder on the second bale starter was very aggressive. It was difficult to raise or lower the second bale starter without abruptly reaching the limit of its movement. As a result the second bale starter mount weldment broke and the baler frame cross member bent during the test.

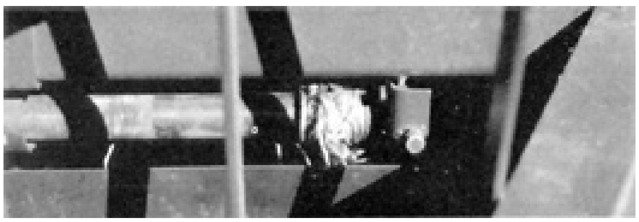

FIGURE 14. Sisal Twine Wrapping on the Twine Rollers.

Twine consumption for the Lundell 760C was greater than for other large round balers or for small square balers. The operator's manual recommended wrapping one revolution of the bale while still feeding the windrow, and making two to three additional wraps after stopping the incoming windrow. Bales made with the recommended number of wraps were very loose and settled considerably. By increasing to two wraps while feeding the windrow and five to six additional wraps after stopping the incoming windrow, bales were much tighter and settled less. With the increased number of wraps, twine consumption for the Lundell 760C baler was about 339 m/t (1010 ft/ton) as compared to about 225 m/t (670 ft/ton) for small square balers, and about 60 m/t (180 ft/ton) for other large round balers.

The twine system on the Lundell 760C presented many problems with proper operation and adjustment during the test. Modifications to the twine system to improve its effectiveness are recommended.

Discharging a Bale: Once the twine is cut, tractor forward travel is stopped and the second bale starter is raised. The pickup is then hydraulically raised while the baler is slowly moved forward. When the pickup is clear of the bale it is lowered to catch the accumulation of hay left by the second bale starter. Pressure is required on the pickup hydraulic cylinders to create the necessary friction to drive the pickup from the baler tires.

Transporting: The Lundell 760C was easy to maneuver and transport. With the pickup raised and the cylinder stops in place, ground clearance was adequate and there was ample hitch clearance for turning sharp corners. The nine bale forming cables had to be tied up to reduce damage to them when transporting long distances. The baler could easily be towed behind a tractor although rear visibility was restricted when towed by a small truck.

Hitching: The hitch jack on the Lundell 760C was poorly positioned and did not lift high enough to hitch to tractors with drawbars higher than 45.7 cm (18 in). With the second bale starter in its uppermost position the hitch jack handle could only turn half of its rotation (FIGURE 15). Modifications to the hitch jack to correct these problems are recommended.

The Lundell 760C required a tractor with dual hydraulics. If the tractor was equipped with a cab, it was sometimes difficult to find a suitable place for the twine roller brake rope to enter the cab and have the rope completely operative.

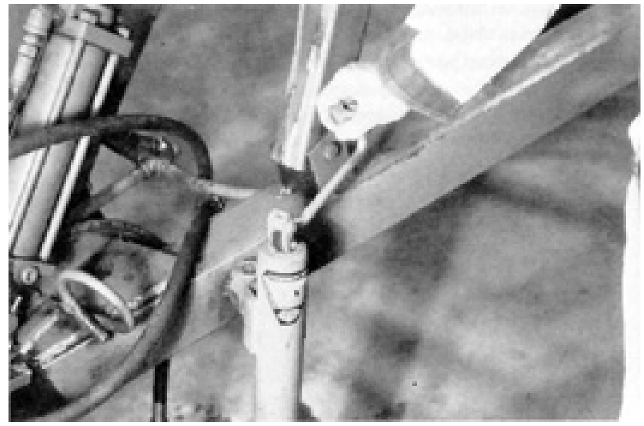

FIGURE 15. Hitch Jack Handle Interference.

Feeding: Feeding was positive in long hay and dense windrows but was unsatisfactory in short slippery hay or straw. In short crops, the pickup losses were high and suitable bales could not be formed. Performance was best in long coarse-stemmed hay. Only in such crops were there no problems with feeding or bale formation.

Twine Threading: Twine could be threaded easily. The twine box held five balls. Since all five balls were used simultaneously there was no room to carry additional twine. This was somewhat inconvenient since the operator could only replace the twine when each individual ball was empty.

EASE OF ADJUSTMENT

Bale Forming Cables: The Lundell 760C baler was supplied with nine 4.7 mm (3/16 in) diameter steel bale forming cables, although it was possible to mount up to 18 cables. Bale density could be adjusted by varying the number of forming cables. The test baler was used with nine cables since bale density became too low with fewer cables and cable drag prevented bale rotation if more cables were used.

Bale forming cable length was adjustable. The cables were installed at the length specified in the operator's manual and did not need readjustment for the duration of their serviceable life.

Bale Forming Rollers: The front bale forming roller was not adjustable. The contact pressure of the rear powered bale forming roller could be adjusted with a spring. Proper spring adjustment was critical since increased pressure improved bale density, but also increased the frequency of bale collapse. The spring usually needed adjustment in each field since bale formation was very dependent on crop condition and type.

Pickup: The pickup drum was fixed to the same assembly which carried the powered bale forming roller. The pickup drum was powered through a friction drive from the baler tires, while the bale forming roller was chain driven from the pickup. The pickup and bale forming roller assembly could be pivoted about the upper baler frame by two hydraulic cylinders which also held the assembly against the baler tires.

The pickup height could be adjusted with turnbuckles on each side of the baler. The turnbuckles were set to give 38 to 50 mm (1.5 to 2 in) clearance between the ground and the pickup teeth. The pickup teeth were rigidly mounted around the pickup drum. No adjustment of tooth pattern or position was possible.

Servicing: The Lundell 760C had two chain drives and 16 grease fittings. The manufacturer recommended daily greasing of six grease fittings, weekly lubrication of eight grease fittings and two chain drives and yearly greasing of the wheel bearings. About fifteen minutes were needed for servicing.

OPERATOR SAFETY

The Lundell 760C was safe to operate and service as long as common sense was used and the manufacturer's safety recommendations were followed. The Lundell 760C was generally much safer to operate than conventional large round balers since it was ground driven. There was no possibility of being pulled into the baler when clearing blockages since all components stopped turning as soon as forward travel ceased.

The Lundell 760C was not equipped with a slow-moving vehicle sign or mounting bracket. It is recommended that a slow-moving vehicle sign be supplied to comply with provincial safety regulations.

The pickup lift cylinder locks were not supplied with retaining pins or a convenient storage location. Working on the inside of the bale chamber with the pickup raised and with lock pins not inserted is a definite hazard and should not be attempted. It is recommended that the manufacturer supply a cylinder stop storage mount and provide lock pins to improve operator safety.

OPERATOR'S MANUAL

The operator's manual contained useful information on operation, servicing, adjustment, and safety procedures. Insufficient information was provided on proper twine system adjustment.

DURABILITY RESULTS

TABLE 5 outlines the mechanical history of the Lundell 760C during 22 hours of field operation while baling about 23 ha (57 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
Bale Forming Cables		
--The cable ends frayed requiring replacement at	15	50
--This recurred at	18	62
Twine System		
--The twine metering rollers and roller drive chain idler were replaced at	15	50
Weldment Failure		
--The second bale starter mount weld broke and was rewelded at	19	66
--Five main frame weld failures had occurred by end of test		

DISCUSSION OF MECHANICAL PROBLEMS

Bale Forming Cables: The bale forming cable ends became badly frayed and bent, necessitating replacement, twice during the test. Proper baler operation depended on smooth, straight cables. Modifications to reduce cable bending and fraying are recommended.

Twine Metering Rollers: The original twine metering rollers were eccentric, and would not allow proper twine wrapping. A replacement set of rollers were obtained, but these were also eccentric. Modifications to improve twine metering roller quality are recommended.

Twine Roller Drive Chain: The twine roller drive chain idler was not properly aligned with the chain. A replacement sprocket and mount bracket were obtained, but could not be properly instalied due to bolt hole misalignment. Standardization of replacement parts allowing them to be mounted directly onto existing balers is recommended.

Weld Failures: Six weld failures had occurred after only 22 hours of baling. All failures were considered major since they cccurred on main structural members. Manufacturing or design modifications are recommended to improve main frame integrity.

APPENDIX

SPECIFICATIONS

MAKE: Lundell Round Baler
MODEL: 760C
SERIAL NUMBER: 459
MANUFACTURER: Lundell Manufacturing
Cherokee, Iowa 51012
U.S.A.

OVERALL DIMENSIONS:	
-- width	2500 mm (98 in)
-- height	2260 mm (89 in)
-- length	5180 mm (204 in)
TIRES:	
-- size	2, 9.5 x 16, 4 ply
WEIGHT: (With drawbar in field position and five balls of twine)	
-- left wheel	918 kg (2023 lb)
-- right wheel	938 kg (2068 lb)
-- hitch point	250 kg (551 lb)
TOTAL WEIGHT	2106 kg (4642 lb)
BALE CHAMBER:	
-- width	1550 mm (61 in)
maximum diameter	1905 mm (75 in)
-- tension method	spring, additional cables
PRESSURE ROLLERS:	
-- number of rollers	2
-- diameter of rollers	
-- rear roller	711 mm (28 in)
-- front roller	508 mm (20 in)
-- length of rollers	1365 mm (54 in)
-- roller composition	steel
-- roller speed	same as ground speed
FORMING CABLES:	
-- number of cables	9
diameter of cables	4.7 mm (3/16 in)
-- length of cables	5 512 mm (217 in)
-- cable spacing (centre to centre)	152 mm (6 in)
PICKUP:	
-- type	fixed drum with rigid teeth
-- height adjustment	turnbuckles
-- width	1365 mm (54 in)
-- diameter	910 mm (36 in)
-- number of tooth bars	14
-- tooth spacing	75 mm (3 in)
-- speed	same as ground speed
TWINE SYSTEM:	
-- capacity	5 balls
-- recommended twine size	none
-- twine feed	chain driven
-- twine cutter	manual
SAFETY DEVICES:	pickup cylinder stops
SERVICING:	
-- grease fittings	6, daily
	8, weekly
-- chains	2, weekly
-- wheel bearings	2, 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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