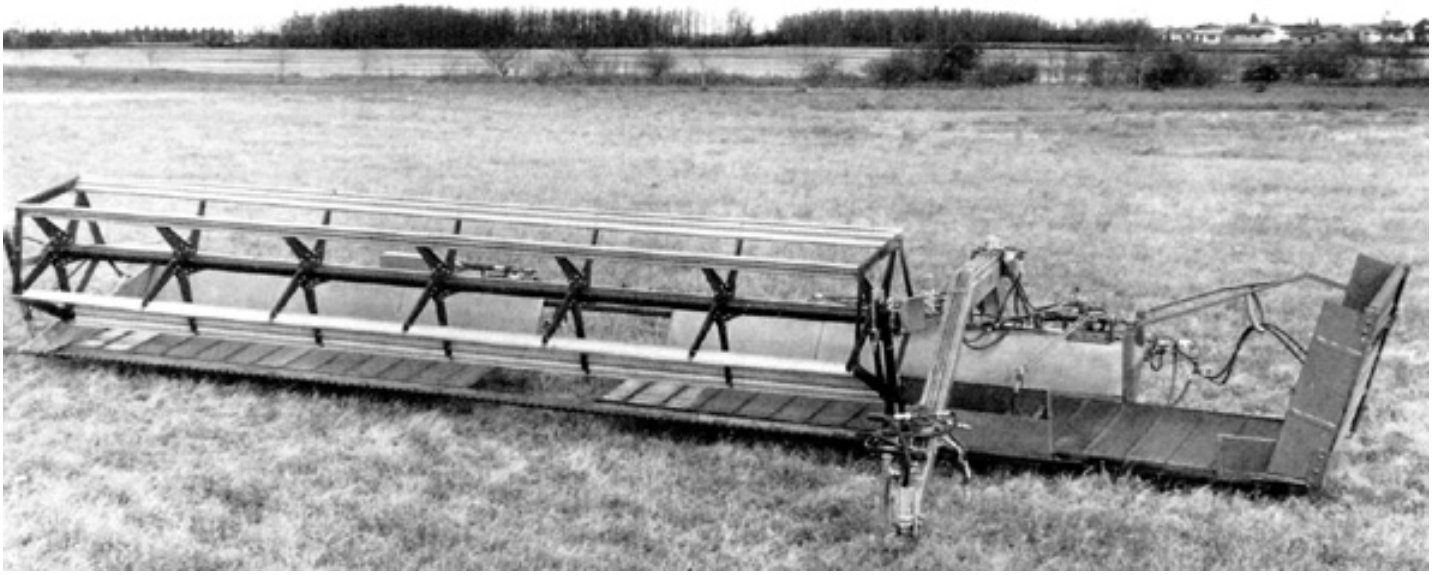
Printed: February, 1983
Tested at: Humboldt
ISSN 0383-3445

Evaluation Report 306



Willcar Autotran 2500 Pull-Type Windrower

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

Willcar Autotran 2500 Pull-type Windrower

Manufacturer and Distributor:
Willcar Industries Ltd.
Box 30
Craik, Saskatchewan
S0G 0V0

Retail Price:
$17,500.00 (March, 1983, f.o.b. Craik, Sask.; 25 ft (7.6 m) cutterbar with sliding table, 53 in (1350 mm) extension table, and 540 rpm power take-off pump).

SUMMARY AND CONCLUSIONS

Functional Performance: Overall functional performance of the Willcar Autotran 2500 Windrower was *good* in cereal grain crops and *fair* in hay, flax and rapeseed.

Cutting Ability: In cereal grain and rapeseed crops, cutting ability was *good.* In hay and flax, cutting ability was *fair* due to insufficient knife cutting power. The divider was adequate for most crops, but in rapeseed, material caught on the divider causing a bunchy windrow. Table flotation was *poor.*

Windrow Formation: Quality of windrows varied from very *good* in clean cereal crops to *fair* in rapeseed. Parallel and angle parallel windrow patterns were predominant, Double windrows were one third to three quarters overlapped on the first windrow. Side-by-side windrows were obtained with the optional 18 in (460 mm) extension table.

Ease of Operation and Adjustment: Double windrowing required some operator experience to reduce cutterbar plugging and windrow bunching. The extension table hindered maneuverability around obstacles.

Ease of transporting the Autotran 2500 was *very good.* It could be easily placed into transport in less than one minute.

Operator controls were convenient to use, but were not labelled. Adjustments were easily made. Daily servicing took less than 10 minutes,

Power Requirements: Peak power take-off requirement was about 20 hp (15 kW). A 65 hp (49 kW)tractor would have ample power reserve to operate the Autotran 2500 in most field conditions. Maximum operating speed was 5 to 7 mph (8 to 11 km/h) in most crops.

Safety: Labelling of the electric switches was required to prevent accidental engagement of the transport system. A twisted frame led to a tire failure and a rim failure when transporting.

Operator Manual: The operator manual was brief and poorly written.

Mechanical History: A number of guards and knife sections were damaged during the test. A tire and a wheel failed due to overload. Other minor problems occurred.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifying the hydraulic system to provide adequate knife drive power.
2. Modifications to improve cutterbar flotation.
3. Labelling the electric console switches, and providing safeguards against accidental battery drain or solenoid damage resulting from switches left on,
4. Installing a restrictor in the table lift hydraulic line to stow the table to a practical rate.
5. Modifications to prevent the front dual wheels from unlocking from their transport position when travelling over uneven roads.
6. Modifications to the right divider skid plate so that the end guard can be changed.
7. Supplying a pressurized oil cap on the hydraulic reservoir as standard equipment.
8. Taking steps to ensure proper frame alignment at the factory to avoid possible tire overload.
9. Providing a more comprehensive operator manual.
10. Modifications to prevent buildup of material at the right end of the cutterbar.

Senior Engineer: G.E. Frehlich

Project Engineer: M.E. Jorgenson

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. We have not received complaints of the knife drive lacking power. However, this problem will be investigated.
2. Modifications to improve cutterbar flotation are currently in progress.
3. The electric switches will be supplied with appropriate labels. The transport switch on future machines will be spring-loaded and wilt return to the off position as soon as it is released. An indicator light on the draper control switch will warn operators when the switch is left on.
4. An in-tine restrictor will be installed on existing machines and will be standard on future machines.
5. A means of locking the turning bracket to the vertical axle shaft has been designed for 1983 machines.
6. With improved cutterbar flotation and modifications to eliminate cutterbar plugging, guard removal will rarely be necessary. The end guard may be removed by cutting the skid plate with a torch or grinding wheel.
7. The pressurized oil cap will be installed on existing machines and will be standard on future machines.
8. Problems with frame alignment have been corrected. Proper wheel alignment and hitch adjustment wilt improve weight distribution and greatly reduce the possibility of tire failure.
9. The operator manual is being revised for 1983.
10. Modifications to eliminate cutterbar plugging are currently in progress.

Manufacturer's Additional Comments

1 A 65 hp (49 kW) tractor will have sufficient power to operate the Autotran. However, a larger tractor should be used to provide better stability.
2. For proper transporting, the front and rear dual wheels should be aligned parallel **to** the tractor and the hitch should be adjusted so that both rear tires are loaded equally.
3. Extension tables 18 in (460 mm) to 6 ft (1.8 m) are available on request.
4. The Autotran model 2100 with 21 ft (6.4 m) cutterbar will be offered in t983 in addition to the model 2500.

GENERAL DESCRIPTION

The Willcar Autotran 2500 is a pull-type, double windrower capable of forming single windrows, overlapped double windrows, or side-by-side double windrows. The cutting platform consists of three drapers with the left draper and the extension draper hydraulically positioned to provide offset or left overshoot delivery. Hydraulic motors on the knife, reel, and drapers are driven by a pump mounted on the tractor power take-off shaft.

The selection of offset or overshoot delivery is controlled from the tractor cab by an electric switch. Knife, reel, and draper speeds are adjusted on the machine by hydraulic valves. Cutterbar height and reel height are controlled by the tractor hydraulics. The Autotran 2500 is placed into transport from the tractor cab by turning on an electric switch and activating the tractor remote hydraulics.

The test machine was equipped with the 25 ft (7.6 mm) cutterbar, 540 rpm power take-off pump, and 53 in (1350 mm) extension table. The optional 18 in (460 mm) extension table was used for a portion of the test.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Autotran 2500 was operated in the conditions shown in TABLES 1 and 2 for 107 hours while cutting about 1400 ac (567 ha). It was evaluated in forage, cereal grain and oilseed crops for windrow formation, cutting ability, ease of operation and adjustment, power requirements, operator safety, and suitability of the operator manual.

TABLE 1. Operating Conditions

CROP	OPERATION	YIELD		HOURS	FIELD AREA	
		bu/ac	(t/ha)		ac	(ha)
Fall Rye		—	—	2	2	(1)
Oats	Single Windrows	70	(2.8)	2	35	(14)
Rapeseed		22	(1.2)	5	57	(23)
Bromegrass		—	—	3	30	(12)
Spring Wheat		30 to 50	(2.0 to 3.4)	43	602	(244)
Durum Wheat	Single and Double	30 to 35	(2.0 to 2.4)	19	252	(102)
Barley	Windrows	25 to 75	(1.4 to 4.2)	26	348	(141)
Flax		16	(1.0)	7	74	(30)
			TOTAL	107	1400	(567)

TABLE 2. Operation in Stony Fields

FIELD CONDITION	HOURS	FIELD AREA	
		ac	(ha)
Stone free	50	674	(273)
Occasional stones	46	561	(227)
Moderately stony	11	165	(67)
TOTAL	107	1400	(567)

RESULTS AND DISCUSSION

CUTTING ABILITY

Cutterbar: Cutting ability was good in most cereal grain and rapeseed crops. In tough, green crops such as hay and flax, performance was reduced by a lack of hydraulic knife drive power. The windrower was initially supplied with an undersized pressure relief valve. Since the proper relief valve was not available, the manufacturer suggested the relief valve be plugged. This provided sufficient power to the knife for most crops, but in one field of flax, operating pressure exceeded the maximum pump rating by 55%. It is recommended that the manufacturer consider modifying the hydraulic system to provide adequate knife drive power.

All field work was conducted with underserrated knife sections. Knife hammering occurred in tough crops and in short grassy patches.

Stubble: Stubble was usually slightly irregular (FIGURE 1). Ideal stubble was produced only in clean, ripe crops. Poor table flotation caused undulating stubble in rough fields.

Alternate stubble heights for snow trapping could be formed with the Autotran 2500 by cutting taller stubble when using the overshoot delivery. This was possible since the windrow was not laid on the tall stubble.

Dividers: In average, straight standing crops, divider performance was satisfactory. Slight hairpinning occurred in tall, leaning grain crops. The divider worked poorly in rapeseed, as material caught on the divider and the reel lift cylinder, resulting in a bunchy windrow.

Table Flotation: Table flotation was poor. Flotation was provided by a compression spring positioned around each of the two lift cylinders (FIGURE 2). The degree of flotation was easily adjusted by moving a single clamp to vary the spring compression. Moderate cutterbar damage resulted from poor flotation in stony fields. It is recommended that the manufacturer consider modifications to improve cutterbar flotation.

WINDROW FORMATION

Windrow Types: Windrows may be classified into four general patterns (FIGURE 3), athough many combinations and variations exist. The Autotran 2500 produced parallel and angled parallel windrows in most grain crops. Herringbone windrows occurred in light crops while fantail windrows occurred primarily in heavy crops and wild oats patches. The adjustable reel speed allowed for good windrow formation over a wide range of ground speeds. FIGURES 4 to 9 show typical single and double windrows formed by the Autotran 2500.

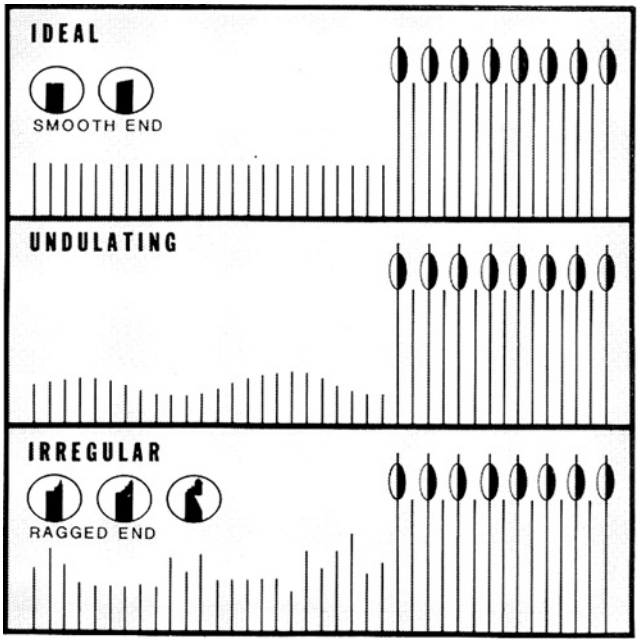


FIGURE 1. Types of Stubble.

FIGURE 2. Table Flotation System.

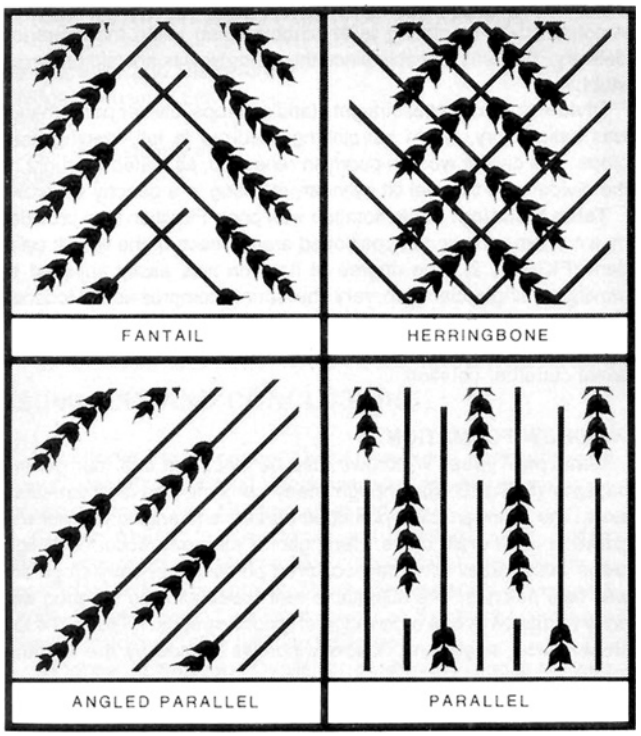


FIGURE 3. Windrow Types.

FIGURE 4. Wheat, Overlapped Double Windrow; 50 bu/ac (3.4 t/ha).

FIGURE 5. Barley, Overlapped Double Windrow; 55 bu/ac (3.2 t/ha).

FIGURE 6. Oats, Single Windrow; 70 bu/ac (2.8 t/ha).

FIGURE 7. Flax, Overlapped Double Windrow; 16 bu/ac (1.0 t/ha).

FIGURE 8. Rapeseed, Single Windrow, Bunchy; 22 bu/ac (1.2 t/ha).

FIGURE 9. Barley, Side-by-Side Double Windrow; 39 bu/ac (2.1 t/ha).

Leaning Crops: The direction of cut affected windrow formation when windrowing lodged or leaning crops. Cutting parallel to the direction of lean usually resulted in parallel windrows while cutting at an angle to the direction of lean generally resulted in angled parallel windrows.

Material hairpinned on the divider when cutting crops leaning to the right. When using overshoot delivery, a leaning crop often caused bunching at the left end of the cutterbar.

Uniformity: Windrows were uniform in most crops. In rapeseed (FIGURE 8), bunchy windrows were formed when material caught on the right divider.

Draper and Reel Speeds: Left, right, and extension draper speeds could be varied from 0 to 512 fpm (0 to 2.6 m/s) by adjusting the hydraulic valve on each draper drive motor.

Reel speed was adjustable from 0 to 53 rpm by adjusting the hydraulic valve at the rear of the machine. Reel tip speed varied from 0 to 9 mph (0 to 14 km/h). The hydraulic drive lacked power at slow reel speeds.

For optimum performance, the drapers were run at maximum speed in all crops, and the reel was operated at a reel index* of about 1.0 to 1.2 for single windrows and 1.5 for double windrows. A higher reel speed was necessary to prevent the cutterbar from plugging when using the overshoot delivery.

The range of vertical and fore-and-afl reel adjustments was suitable for all crops.

Travel Speed: Travel speed had little effect on windrow formation. Speed was usually limited by field roughness or cutting performance. In rapeseed, travel speed was limited as material caught on the right divider and dragged on the right draper.

Double Windrowing: Double windrows laid by the Autotran 2500 were parallel or angled parallel depending on the direction of crop lean. The second windrow usually overlapped the previous windrow by about one-third to three-quarters. Side-by-side windrows (FIGURE 9) could be obtained by installing the optional 18 in (460 mm) extension table.

When using overshoot delivery, plugging at the left end of the cutterbar was reduced by cutting the full width, by moving the reel further behind the cutterbar, and by increasing the reel index.

Cornering: Single windrow corners were typical of those formed by offset delivery windrowers. However, the extension table interfered with the previous windrow on corners sharper than 90°.

In overshoot delivery, the drapers could be shut off on corners to form a double windrow which was easily picked up. FIGURE 10 shows a typical corner formation. The dotted line shows the path the second windrow would follow if the drapers were not shut off.

EASE OF OPERATION

Controls: The selection of offset or overshoot delivery was made on-the-go from the tractor cab using the electric switch provided. The transport system was activated in the tractor cab using the tractor remote hydraulics and the switch provided. The two switches on the Autotran console were not labelled. This was confusing and it is recommended that the manufacturer provide appropriate labels for the electric switches.

Tractor battery drain and possible solenoid damage resulted if the switches were accidentaly left on. It is recommended that the manufacturer provide safeguards to ensure switches are turned off.

The hydraulic table lift was very fast which made cutterbar height adjustments difficult. Installing a restrictor in the table lift hydraulic line slowed table operation to a practical rate. It is recommended that the manufacturer consider installing a restrictor as standard equipment.

Maneuverability: Operation of the Autotran 2500 required some operator skill. Tractor positioning relative to the uncut crop edge could not be adjusted. The extension table hindered maneuverability around obstructions such as trees, poles and ditches.

Some skewing occurred in moderate hills and in soft soil conditions.

**Reel index is the ratio of reel tip speed to travel speed.*

Double Windrowing: Several hours of operation improved the operator's ability to avoid cutterbar plugging and windrow bunching.

When changing from an overlapped to a side-by-side windrow formation, it was necessary to exchange extension tables. Changing tables took one man about 30 minutes. A hand drill and wrenches were required.

Transporting: The Autotran 2500 transported very well at speeds up to 20 mph (32 km/h). Transport width was safe for most roads (FIGURE 11), though it was necessary to drive the tractor on the right shoulder of the road. Left turns were restricted by interference between the tractor tire and the hitch jack. Removing the hitch jack improved left turning.

Weight distribution was poor, resulting in little load on the front dual tires and slight overloading of the rear dual tires. When going through depressions, the front tires lifted off the ground allowing the axle assembly to drop and unlock from the turning, bracket. It is recommended that the manufacturer consider modifications to prevent the front wheels from unlocking from transport position.

It took the operator less than one minute to change between field and transport positions.

Adjustments: Reel, knife and draper speeds were easily adjusted on the machine by turning hydraulic valves. The reel was adjusted fore-and-afl by repositioning 5 bolts, and reel to cutterbar clearance was adjusted with a threaded rod. The right draper was tightened with

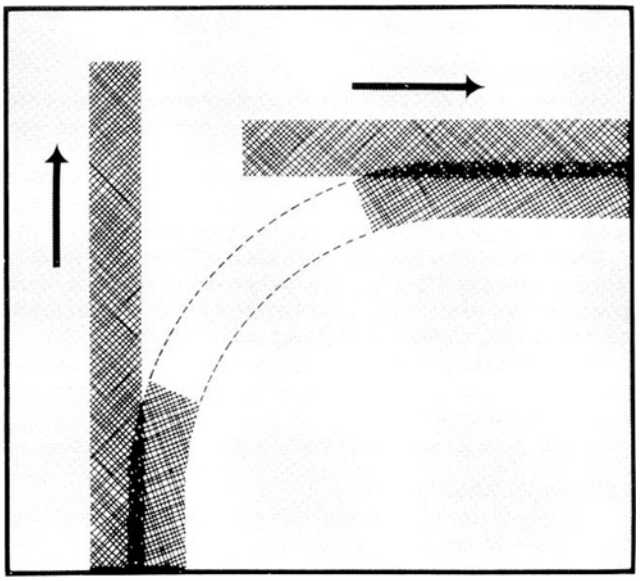


FIGURE 10. Typical Corner Formation.

FIGURE 11. Transport Position.

a hand clamp, while the left and extension drapers were tightened by loosening 4 nuts and sliding the roller. The vinyl drapers did not have to be loosened overnight.

Dual wheel positions were adjustable to provide proper alignment in field and transport positions. The hitch pole tongue was adjusted for fore-and-afl levelling.

Servicing: Daily servicing took from 5 to 10 minutes. Three pressure grease fittings and the hydraulic reservoir oil level required daily servicing. Occasional oiling along the knife improved its performance.

Overall ease of servicing was good. Serviceable parts were accessible. The right divider plate interfered with the removal of the end guard. Part of the skid plate was cut away so that the guard could be removed. It is recommended that the manufacturer consider modifications to the skid plate so that the end guard can be changed.

Oil had to be frequently added to the hydraulic reservoir. Oil losses were greatly reduced when the manufacturer installed a pressurized oil cap in place of the breather cap. It is recommended that the manufacturer consider supplying the pressurized oil cap as standard equipment.

POWER REQUIREMENTS

A 65 hp (49 kW) tractor should have ample power to operate the Autotran 2500 in most field conditions. A maximum of 20 hp (15 kW) was needed to drive the power take-off pump in cereal grains. However, in tough crops such as hay and flax, the hydraulic system did not provide sufficient power to operate the knife. Modifications to provide adequate knife power have been recommended.

OPERATOR SAFETY

Operation was safe if proper safety procedures were followed. The operator manual emphasized safety. Reel and knife drives were shielded.

The control switches were unsafe because they were not labelled. The transport system was engaged if the wrong switch was accidentally turned on. Labelling has been recommended.

The inside tire of the rear duals exceeded the Tire and Rim Association load rating by 125% due to misalignment of the frame during production. It is recommended that the manufacturer consider quality controls to reduce frame misalignment during production.

To accommodate the hydraulic pump, the tractor had to be operated without its power take-off shield. No hazards were apparent if normal was exercised.

A slow moving vehicle sign was provided with the machine.

OPERATOR MANUAL

The operator manual was brief and incomplete. Information was general and did not outline specific operation or adjustments of the Autotran 2500. There were few illustrations. It is recommended that a more comprehensive operator manual be provided.

A complete parts booklet was supplied with the machine.

DURABILITY RESULTS

The Autotran 2500 was operated for 107 hours while cutting about 1400 ac (567 ha). The intent of the test was evaluation of functional performance and an extended durability evaluation was not conducted. TABLE 3 outlines the mechanical failures that occurred during functional testing.

DISCUSSION OF MECHANICAL PROBLEMS

Hydraulic Motor Coupling: A flared end was welded to the left draper motor lock arm to prevent the motor from falling off. The set screws continued to loosen and the jerky operation of the hydraulic motor wore out the coupling. No problems were encountered with the right draper motor coupling.

Guards and Knife Sections: Material buildup at the right end of the cutterbar (FIGURE 12) caused considerable guard and knife section damage. The manufacturer installed an additional knife hold-down clip near the right end which reduced the damage. It is recommended that the manufacturer consider modifications to prevent buildup of material at the end of the cutterbar.

Poor table flotation caused considerable damage to the cutterbar in stony fields. Guards were bent up into the knife, breaking guard tips and knife secitons. Modifications to improve table flotation have been recommended.

Knife Head: Knife head failures were attributed to fatigue cycling. A factory changeover lowered the pitman connection on the knife head by 1-1/2 in (40 mm). No further failures occurred.

TABLE 3. Mechanical History

ITEM	OPERATING HOURS	EQUIVALENT FIELD AREA ac	(ha)
- The wheel turning bracket on the left axle assembly dropped free and was reinstalled at	3	30	(12)
- The left draper hydraulic motor coupling loosened and was tightened at	3, 4, 65	30, 32, 810	(12, 13, 328)
- The coupling and key were replaced at	88	1146	(464)
12 guards and 21 knife sections were replaced		during the test	
- The right inside dual tire failed while transporting and was replaced at	8	32	(13)
- The right draper tightener pins failed and were replaced at	11, 42	42, 490	(17, 198)
- The knife head broke and was repaired at	11, 13	42, 62	(17, 25)
It was replaced at	20	195	(79)
Reel bats were bent when clearing the cutterbar and were straightened at	28, 42	290, 490	(117, 198)
Nut caps on two hydraulic control knobs were lost and replaced at	42	490	(198)
- The right and left drapers tore, but continued to operate		during the test	
- The extension table drive belt wore and was replaced at	47, 104	545, 1350	(221,548)
- A bolt on the left table hinge broke and was replaced at	53, 104	660, 1350	(267, 548)
- The right inside wheel cracked when transporting and was replaced at	65	810	(328)
- A hydraulic hose end pulled apart and was repaired at	69	862	(349)
- Factory representatives installed a new swaybar on the knive drive, replaced and added a knife holddown clip, and reinforced the table lift cylinder mounts at	83	1075	(436)
- The worn pitman bearings were replaced, and the knife drive pulley bearing was tightened at	93	1200	(485)
- The hydraulic power take-oft pump was damaged and replaced at	104	1355	(548)

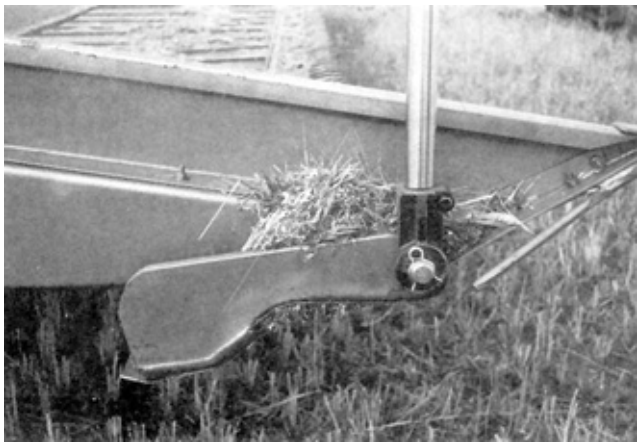


FIGURE 12. Material Buildup at the Right End of the Cutterbar.

APPENDIX I

SPECIFICATIONS

MAKE:	Willcar Autotran
MODEL:	2500
SERIAL NUMBER:	82-25-37
CUTTERBAR:	
- width of cut (divider points)	25.4 ft 5 in (7.75 m)
- effective cut (inside divider)	25.3 ft (7.71 m)
- range of cutting height	2 to 23 in (50 to 580 mm)
- guard spacing	3 in (76 mm)
- length of knife section (underserrated)	full depth 3.1 in (80 mm) cutting length 2 in (52 mm)
- knife stroke	3 in (76 mm)
- knife speed	0 to 540 cycles/min.
HEADER:	
- table angle	
- fully raised	3° above horizontal
- fully lowered	20° below horizontal
- number of drapers	3
- draper material	vinyl with plastic slats
- draper speed range	0 to 510 fpm (0 to 2.6 m/s)
- draper roller diameter	2-1/4 in (57 mm)
- height of windrow opening	32 in (800 mm)
- width of windrow opening	
- between wind boards	47 in (1200 mm)
- between rollers	49 in (1250 mm)
- between roller shields	46 in (1170 mm)
- raising time	3.0 s
- lowering time	
- as supplied	0.8 s
- with restrictor	2.5 s
REEL:	
- number of bats	5
- number of reel arms per bat	7
- diameter	54 in (1380 mm)
- speed range	0 to 53 rpm
- range of adjustment	
- fore-and-aft	11 in (282 mm)
- height above cutterbar	9-1/2 in (240 mm)
- raising time	7 s
- lowering time	5 s
HYDRAULIC SYSTEM:	
- power take-oft pump	
- flow rate @ 540 rpm	23 gpm (1.74 L/s)
- maximum operating pressure	2250 psi (15.5 MPa)
- oil reservoir capacity	23 gal (105 L)
- knife, draper, and reel drives	hydraulic motors
- draper position	double acting cylinder
- tractor hydraulics	
- transport position and reel lift	double acting cylinders
- table lift	single acting cylinders
NUMBER OF DRIVE CHAINS:	1
NUMBER OF V-BELTS:	2
NUMBER OF LUBRICATION POINTS:	
- pressure grease	3
- oil reservoir level	1
NUMBER OF PRE-LUBRICATED BEARINGS:	17

OVERALL DIMENSIONS:

	FIELD POSITION	TRANSPORT POSITION
- length	17.8 ft (5.4 m)	40.6 ft (12.4 m)
- width	37.1 ft (11.3 m)	10.3 ft (3.2 m)
- wheel tread	17.4 ft (5.3 m)	1.6 ft (.5 m)
- wheel base	--	17.4 ft (5.3 m)

TIRES:

- left	2, 8.5L x 14, 6 ply rating
- right	2, 8.5L x 14, 6 ply rating

WEIGHT:

	FIELD POSITION		TRANSPORT POSITION	
- hitch pin	880 lb	(400 kg)	1540 lb	(700 kg)
- left wheels	1850 lb	(840 kg)	460 lb	(210 kg)
- right wheels	2730 lb	(1240 kg)	3460 lb	(1570 kg)
- TOTAL	5460 lb	(2480 kg)	5460 lb	(2480 kg)

OPTIONAL EQUIPMENT:

- 18 in (460 mm) extension table
- 1000 rpm power take-oft pump

APPENDIX II

MACHINE RATINGS

The following rating scale is used in Machinery Institute Evaluation Reports:

excellent	fair
very good	poor
good	unsatisfactory

APPENDIX III

CONVERSION TABLE

1 mile/hour (mph)	= 1.6 kilometres/hour (km/h)
1 acre (ac)	= 0.40 hectares (ha)
1 pound mass (lb)	= 0.45 kilogram (kg)
1 ton/acre (ton/ac)	= 2.2 tonnes/hectare (t/ha)
1 horsepower (hp)	= 0.75 kilowatts (kW)
1 gallon (gal)	= 4.5 litres (L)
1 gallon per minute (gpm)	= 0.08 litre per second (L/s)
1000 pounds per square inch (psi)	= 6.9 megapascal (MPa)
1 foot (ft)	= 0.3 meter (m)
1 inch (in)	= 25.4 millimetres (mm)
100 feet per minute (fpm)	= 0.5 metre/second (m/s)

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