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Evaluation Report 246

John Deere 2320 Self-Propelled Windrower

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

JOHN DEERE 2320 SELF-PROPELLED WINDROWER

MANUFACTURER:
John Deere Ottumwa Works
Ottumwa, Iowa
52501 U.S.A

DISTRIBUTOR:
John Deere Limited
455 Park Street
Regina, Saskatchewan
S4P 3L8

RETAIL PRICE:
$33,085 (November, 1981, f.o.b. Portage la Prairie, Manitoba with 6.3 m (20.5 ft) twin-swath draper head, operator cab.)

SUMMARY AND CONCLUSIONS

Overall functional performance of the John Deere 2320 windrower was *very good* to *excellent* in all crops.

Cutting ability was *excellent* in all grain and hay crops of average yield. Header floatation was *very good.* Maximum header lift was adequate to clear heavy windrows.

Windrow formation was *very good* in both single and double windrowing. Parallel, angled parallel, and fantail windrows were predominant in grain crops. Fantail windrows occurred in most heavy crops while herringbone patterns occurred in light crops. On-the-go reel speed adjustment and convenient draper speed adjustment permitted the operator to maintain windrow quality and reduce shatter losses at most travel speeds.

Double windrowing was convenient due to the wide divider margin made possible by the narrow right end draper. This permitted some deviation in travel direction when laying a second windrow adjacent to the first windrow.

The header windrow opening was adequate for all crops except heavy rapeseed. Maximum field speeds were about 12 km/h in average grain crops and about 10 km/h in average hay crops.

Operator controls were convenient and well positioned.

Adjustments were simple and convenient. Daily maintenance took about ten minutes.

Operator station sound level was about 87 dBA. Visibility from the operator's platform *wasgood.* Stability on slopes was *excellent.*

The operator manual was *very good.*

Several minor durability problems occurred during the test.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

Modifying the reel drive overload protection to allow reduced reel torque and a reduction in reel damage.

Chief Engineer - E.O. Nyborg
Senior Engineer - J.C. Thauberger
Project Engineer - R.R. Hochstein

THE MANUFACTURER STATES THAT

With regard to the recommendation:

On twin swath platforms having variable speed hydraulic drive for the canvasses and reel: sufficient torque is provided to handle heavy crops. The relief valve is presently non-adjustable. The bat deformation can be minimized by lowering the reel to move the crop being harvested and position the reel far enough forward to gently place the crop on the canvas.

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

GENERAL DESCRIPTION

The John Deere 2320 is a self-propelled, double-swath windrower capable of centre, left or right end delivery. It is supported by two traction d rive wheels and d ual rear caster wheels. It is powered by a Chrysler, 3.7 L, six cylinder gasoline engine. The traction drive is hydrostatic with two pumps driven through a series of sheaves and belts from the engine crankshaft. Two hydraulic motors drive the wheels directly through planetary gear red ucers.

The cutterbar is controlled by a wobble box, driven by a belt and driveshaft arrangement while the reel and draper components are driven by hydraulic motors.

Draper position, direction of rotation and reel speed are adjustable from the operator station. Draper speed is adjustable ouside the operator station. A steering wheel and a lever on the console control the direction and speed of travel. The header lift control is both foot and hand operated while the reel lift control is hand operated.

The test machine was equipped with a 6.3 m (20.5 ft) double-swath draper header and bat reel. Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The John Deere 2320 was operated in the conditions shown in Table 1 for 200 hours while cutting about 866 ha (2140 ac). It was evaluated in forage crops, cereal grains and oil seed crops for windrow formation, cutting ability, ease of operation and adjustment, sound level, fuel consumption, operator safety and suitability of the operator manual.

Table 1. Operating Conditions

Crop	Operating Mode	Hours	Field Area (ha)
Alfalfa	Centre delivery	52	228
Barley		44	186
Wheat		49	253
Oats		21	84
Flax		12	40
Buckwheat		6	14
Rapeseed		2	6
Wheat	Alternating end delivery (double swath)	10	35
Barley		4	20
TOTAL		200	866

RESULTS AND DISCUSSION

WINDROW FORMATION

Windrow Types: Windrows may be broadly classified into four general patterns (Figure 1) although many combinations and variations exist. The John Deere 2320 produced parallel, angled parallel and fantail windrows in most grain crops. Herringbone windrows were formed in light grain crops with short stem height while fantail wind rows occurred primarily in heavy crops. Ground speed had little influence on wind row formation, due to the capability for instantaneous adjustment of reel speed. APPENDIX IV illustrates typical windrows, formed by the John Deere, in different crops.

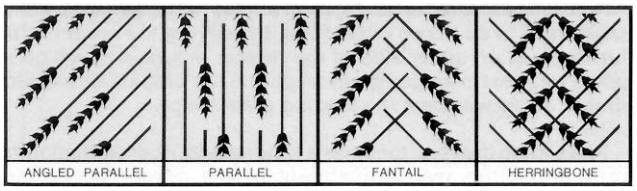

FIGURE 1. Windrow Types.

Leaning Crops: Direction of travel was important when windrowing lodged or leaning grain crops. Cutting in the direction of the crop lean resulted in parallel windrows, while cutting at an angle to the direction of lean generally resulted in angled parallel windrows.

Uniformity: Windrows were uniform in most cereal crops, provided reel height was set so that the bats contacted the stalks below the head. Setting the reel height at this height reduced drag of the stems on the ridge at the cutterbar. Bunching occurred in badly lodged crops and in heavy stands of rapeseed. In lodged cereal crops, bunching was primarily due to crop accumulation on the cutterbar; in rapeseed, bunching occurred at the dividers at speeds above 8 km/h (5 mph). Bunchy windrows occurred in short alfalfa and clover hay crops. The crop tended to rest on the cutterbar before being brought onto the draper with the reel. It was usually best to operate the windrower with the reel just clearing the cutterbar, in forage crops.

Draper and Reel Speed: Draper speed could be adjusted to control windrow formation with a crank at the centre of the header just ahead of the operator platform. Reel speed could be adjusted from the operator station to control reel shatter loss. The d raper speed was variable from 2.4 to 3.5 m/s (7.9 to 11.5 ft/s). The reel speed was variable from 0 to 69 rpm. Reel tip speed varied from 0 to 4.9 m/s (0 to 16 ft/sec).

The draper speed could be adjusted only when the windrower was stopped. This was not inconvenient since it was usually only necessary to adjust the draper speed while starting a field and draper speed had little influence on windrow formation. The reel speed was usually adjusted, to a reel speed index of 1.1 or 1.2 to minimize shatter loss.

Header Angle: The header angle was variable which allowed adjustment from a steep guard angle when cutting forage crops close to the ground to a low draper angle when cutting grain crops. The header angle could be adjusted from about 9° for grain, (measured with header height set for a 200 mm (8 inch) stubble) to 16° for hay, (measured with cutterbar at ground level).

Travel Speed: Windrow formation was sometimes influenced by the relation of the reel and draper speed to the travel speed. A significant increase in ground speed without adjustment of the reel speed usually resulted in a non-uniform windrow. It was necessary to maintain a reel index of 1.1 to 1.2. Maximum forward speed was usually limited by field roughness and cutting performance.

Double Windrowing: Double windrowing was done by alternately setting drapers for right and left end delivery with the selectors on the control console. An angled parallel windrow usually resulted when cutting straight standing crops of wheat and barley. Crop lean opposite to the draper travel direction resulted in parallel windrows. Both types were satisfactory for weathering and picking with a combine.

Windrow Opening: Windrow opening clearance was adequate for both centre and end delivery in most crops. In heavy, matted crops such as rapeseed, non-uniform flow sometimes occurred as the windrow cleared the opening. Clearance under the windrower frame and the drive wheels was adequate.

CUTTING ABILITY

Cutterbar: All test work was conducted with low-rise oversserrated knife sections. Cutting ability was excellent in both grain and hay crops. Cutterbar plugging occurred in heavy sloughgrass and damp flax when the wobble box drive belt was not properly tightened, although cutterbar hammering did not result.

In hay crops the maximum forward speed of 8 km/h (5 mph) was governed by the ability of the cutterbar to cut.

Dividers: Divider performance was excellent in average stands of grain and hay crops and adequate in lodged crops. When cutting rapeseed it was usually best to cut back and forth since the dividers worked on the principle of pushing the crop down at the divider. The resulting narrow path of pushed down crop was best recovered while cutting in the opposite direction. In heavy, green, matted rapeseed it was necessary to operate with the reel almost completely lowered to clear the cutterbar of crop near the divider.

Header Floatation: Header floatation was adequate for cutting hay and pulse crops close to the ground and for cutting cereal crops at normal stubble height. At the recommended floatation setting, the windrower negotiated stones along the ground and followed ground contour very well. However, when cutting cereal crops with the header off the ground at the recommended floatation setting, the floatation was quite sensitive to field roughness. At speeds greater than 8 km/h (5 mph), an undulating stubble usually resulted.

EASE OF OPERATION

Operator and Controls: The John Deere 2320 was equipped with an optional operator cab. Visibility of the header and dividers was fair. Although visibility of the cutterbar was good, the front corner posts of the cab interfered with visibility of the dividers. View of the draper over the windboard was limited to the lowermost portion of the draper, especially when cutting at a steep draper angle. The outward curvature of the windshield caused further visibility problems when operating with the sun to the rear, during early mornings or late evening, due to the reflection of the windshield glass. Seat position and operator weight adjustment provided comfort for a wide range of operators. There was no steering wheel position adjustment.

Most of the controls were conveniently placed and easy to use (Figure 2). Location of the header drive control lever above the ground speed control lever helped to ensure against confusion when operating these controls. Stopping quickly was convenient with the stop at the neutral position of the travel control lever. Backing the windrower was done simply by sliding the lever past the stop.

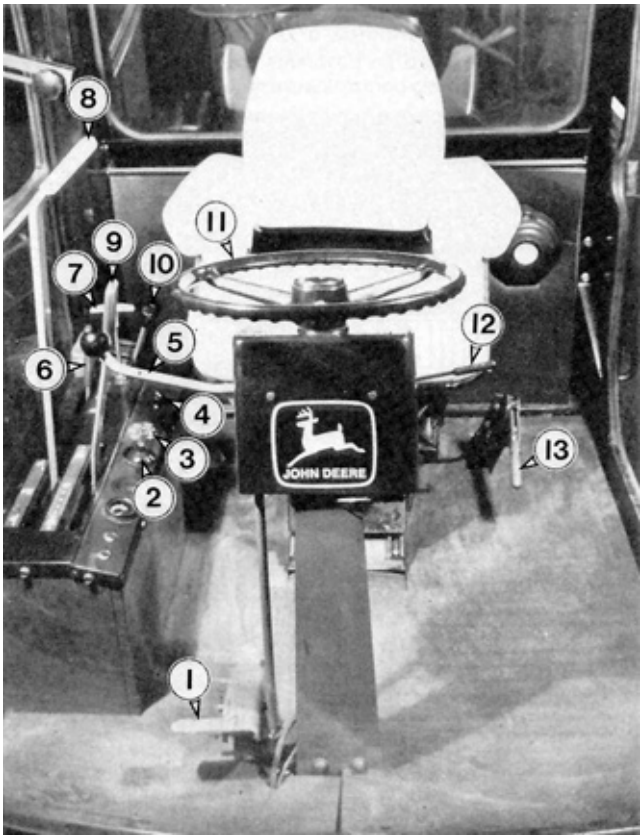

FIGURE 2. Operator Station. (1) Header height control pedal, (2) Light switch, (3) Ignition switch, (4) Choke, (5) Header/reel height control lever, (6) Throttle, (7) Reel speed control, (8) Header drive control, (9) Travel speed control lever, (10) Draper position selector levers, (11) Steering wheel, (12/Turn indicator switch, (13) Parking brake.

The header and reel height controls, located to the right of the steering column, were hand operated with one lever; fore and aft movement for reel height control; up and down movement for header height control. A foot pedeal for header height control was also provided. This dual hand/foot control proved convenient for most operators. The response of the header and reel controls was suitable for all crops.

The speed control for the reel and the end/centre delivery selector controls were both located at the rear of the console.

The cab was relatively dust free. The air conditioning system provided operator comfort in all weather conditons.

Total noise at operator ear level was about 87 dBA with the ventilating fan operating, and about 90 dBA with the door and window open and fan off. Although the sound level was not unduly high, the frequency pitch of the sound was annoying to some operators.

Steering: Directional Control and maneuverability were excellent. Steering was positive and effortless. The John Deere 2320 did not pull sideways in soft fields or on moderate slopes.

Travel Speed Control: Travel speed was variable from 0 to 22 km/h (0 to 13 mph) in the forward direction and from 0 to 13 km/h (0 to 8 mph) in reverse. Speed control was positive and effortless.

Braking: Hydrostatic braking was accomplished with the speed control lever. Braking motion usually was smooth and no rear ballasting was needed to prevent upending. A mechanical parking brake was provided.

Transporting: Towing the John Deere 2320, with the drive wheels on the ground, was possible by unlocking the planetary gear reducers at the drive wheels. Backing the windrower onto a transporter did not present any stability problems. The maximum safe downward slope that the wind rower could negotiate with the rear wheels in contact with the ground was a comfortable 24°.

Double Windrowing: Double windrowing with the John Deere was very convenient due to the wide divider margin made possible by the narrow canvas on the right end of the draper header. This narrow canvas permitted the laying of the first windrow about 300 mm (12 in) away from the uncut crop (Figure 3). This allowed deviation of travel direction, and good operator control, when cutting the second swath, without the hairpinning of material from the previous windrow or uncut crop.

Cornering presented no problems while double windrowing. The draper positioning controls were responsive and easy to use.

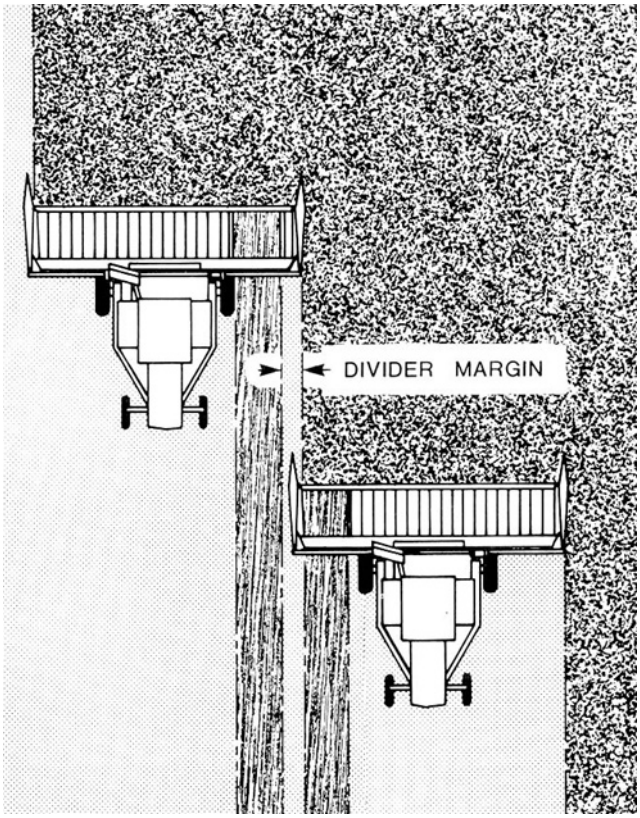

FIGURE 3. Double Windrowing.

Adjustments: Draper and guard angles were adjusted simultaneously, to suit crop conditions, by varying the length of the turnbuckles on either side of the header mount. A steep guard angle was best in lodged grain crops and hay crops whereas a low draper angle was best in standing grain crops.

The sliding drapers, for double windrowing, operated smoothly throughout the test. Adjustment of the draper positioning mechanism was convenient. The reel lift range and clearance were varied by adjusting the lower or upper cylinder mounts.

The draper tension was convenient to adjust. Header floatation adjustment was convenient.

Servicing: Daily lubrication and inspection of the John Deere 2320 took about 10 minutes. Two grease points required lubrication twice daily.

POWER AND FUEL CONSUMPTION

The engine had sufficient power for all conditions. Average fuel consumption while windrowing wheat was 11.6 L/h (2.6 gal/h). The 150 L (33 gal) fuel tank permitted about 13 hours of operation between fillings.

OPERATOR SAFETY

Access to the operator station was safe and convenient. Controls were well positioned with respect to the operator. The two headlights and rear working light provided good illumination for night operation. The slow moving vehicle sign on the rear and flashing safety lights provided good marking for transport on public roads. A turn indicator light switch and windshield wiper were also provided.

Safety blocking devices were provided on reel and header hydraulic cylinders to permit safe servicing and maintenance to the header. All components were well shielded.

A safety lockout permitted the engine to be started only when the parking brake was engaged.

OPERATOR MANUAL

The operator manual was clear, concise and contained much useful information on the operation of the windrower.

DURABILITY RESULTS

Table 2 outlines the mechanical history of the John Deere 2320 windrower during 200 hours of operation while windrowing 866 ha. The intent of the test was evaluation of functional performance. An extended durability evaluation was not conducted.

Table 2. Mechanical History

Item	Operating Hours	Equivalent Field Area (ha)
The return hose for the right draper hydralic drive motor began leaking and was replaced at	80	350
The right draper tension adjusting cable broke and was replaced at	120	520
The right draper hydraulic drive motor began leaking and the seal was replaced at	end of test	866
One reel bat was broken and all the others had bent by	end of test	866
The engine governor failed and was replaced at	end of test	866

DISCUSSION OF MECHANICAL PROBLEMS

Reel: The reel was chain driven from a hydraulic motor. In the event of the reel plugging, the hydraulic relief valve did permit reel stoppage, however, reel damage occurred before the reel stopped. It is recommended that the manufacturer consider modifying the reel drive overload protection to reduce the possibility of reel bat damage.

APPENDIX I

SPECIFICATIONS

Make:	John Deere
Model:	2320
Serial No.:	
-- tractor	542208E
-- header	540612E
Cutterbar:	
-- width of cut (divider points)	6330 mm
-- effective cut (inside divider)	6300 mm
-- range of cutting height	70 mm (min.)
-- guard spacing	77 mm
-- length of knife section (overserrated)	full depth 80 mm cutting length 52 mm
-- knife stroke	77 mm
-- knife speed	675 cycles/min
Header:	
-- range of header angle (from horizontal)	
-- fully raised	5.0° - 9.5°
-- fully lowered	10.5° - 16.0°
-- number of drapers	3
-- width of drapers	1065 mm
-- length of drapers	
-- main drapers	2290 mm
-- narrow end draper	560 mm
-- draper speed range	
-- left	2.4 to 3.6 m/s
-- right	2.4 to 3.4 m/s
-- narrow end draper	2.2 m/s
-- draper roller diameter	48 mm

	Centre delivery	End delivery
-- height of windrow opening		
-- 9° table angle	625 mm	730 mm
-- 16° table angle	760 mm	820 mm
-- width of windrow opening		
-- between windboards	1110 mm	1040, right end 1070, left end
-- between rollers	1040 mm	1050, right end

-- raising time of header	1.5 sec.
-- lowering time of header	3.0 sec.
Reel:	
-- number of bats	5
-- number of reel arms per bat	5
-- diameter	1390 mm
-- speed range	0 to 68 rpm
-- range of adjustment	
-- fore and aft	300 mm
-- height above cutterbar	40 mm to 650 mm
-- raising time	0.6 sec
-- lowering time	1.6 sec.
Traction Drive:	
-- type	hydrostatic motors driving Borg-Warner planetaries on drive
--speed control	hand lever
-- maximum forward speed	22 km/h
-- maximum reverse speed	13 km/h
Steering:	steering wheel operating hydrostatic pumps
Brakes:	hydrostatic control lever disc operated by over-centre hand lever
Hydraulic System:	
-- hydrostatic traction drive	(see Traction Drive)
-- reel and draper drives	auxiliary pump operating motors at reel and main drapers
-- header and reel lift	master & slave cylinders assemblies
-- draper position	double acting cylinders
No. of Chain Drives:	
No. of V-belts:	
-- single V	3
-- multiple V	1
No. of Pressure Lubrication Points:	22
Engine:	
-- make	Chrysler
-- model	HB 225 (slant six)
-- no load speed	2400 rpm
-- power	46 kW
-- fuel tank capacity	151.4 L
Tires:	
-- main drive wheels	two, 13.50 - 16.1, 6 ply rating
-- castor wheel	two, 25 x 7.50-15, 4 ply rating
Machine Dimensions:	
-- wheel tread	
-- drive wheels	2650 mm
-- rear wheels	2620 mm
-- wheel base	3300 mm
-- overall width	6640 mm
-- overall length	6230 mm
Weight as Tested: (header raised, full fuel tank, centre delivery)	
-- right drive wheel	1534 kg
-- left drive wheel	1400 kg
-- castor wheels	456 kg
-- TOTAL	3390 kg
Centre of Gravity: (header raised)	
-- height above ground	1380 mm
-- distance behind drive wheels	444 mm
-- distance left of right drive wheel	1265 mm

Options and Attachments Available:

- -- various draper and auger header options
- -- hay conditioner
- -- rear ballast weights
- -- windrow forming shields
- -- various lighting options
- -- engine air precleaner
- -- high speed option for road travel

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/hectare (t/ha)	= 0.45 ton/acre (ton/ac)
1 metre (m)	= 3.3 feet (ft)
1 litre (L)	= 0.22 Imperial gallons (gal)

APPENDIX IV

TYPICAL WINDROW FORMATION

FIGURE 4. Barley, Yield: 2.7 t/ha (50 bu/ac).

FIGURE 6. Wheat, Single Windrow, Yield: 2.7 t/ha (40 bu/ac).

FIGURE 5. Wheat, Double Windrow, Yield: 2.0 t/ha (30 bu/ac)

FIGURE 7. Flax, Yield: 1.6 t/ha (25 bu/ac)

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