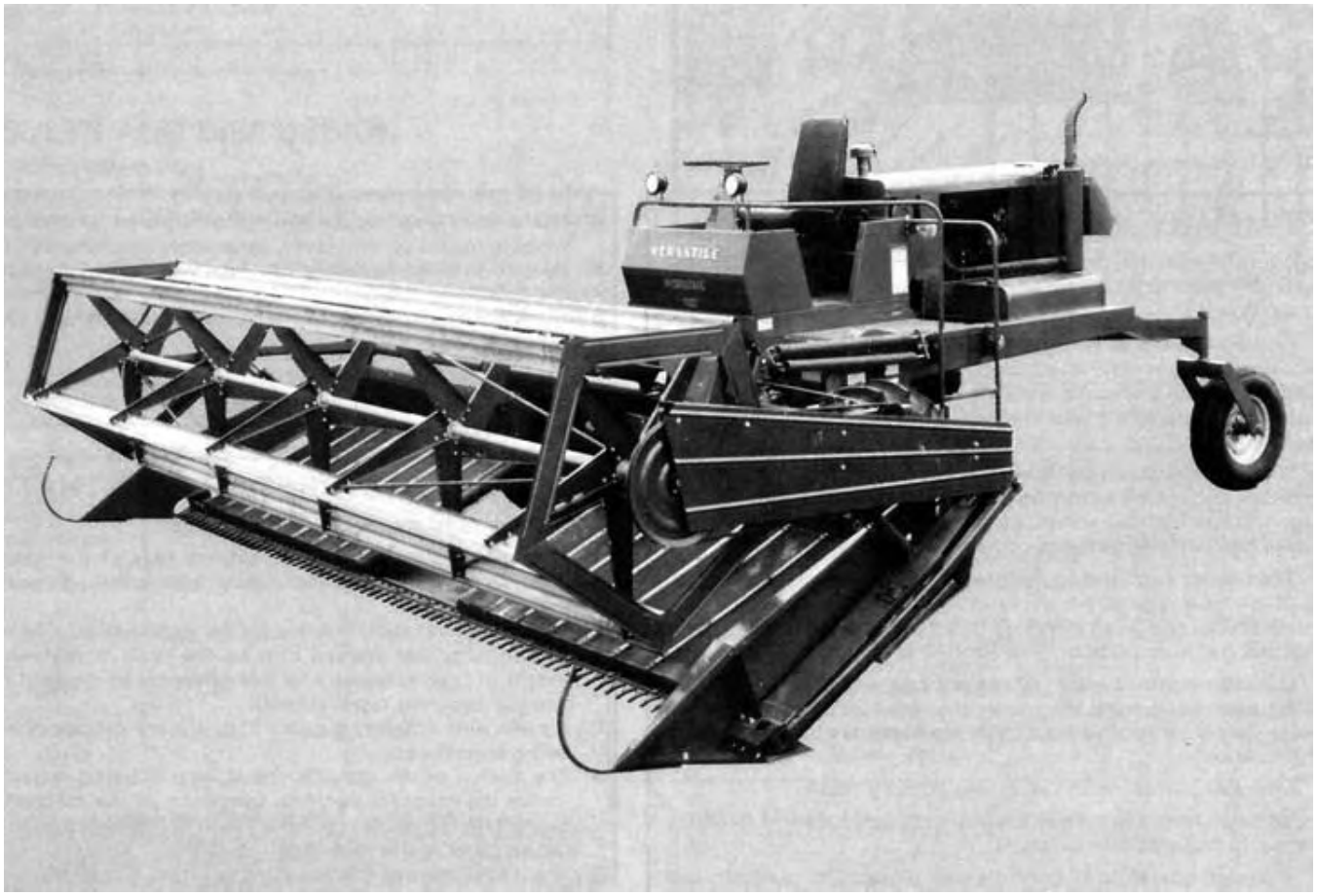
Evaluation Report No. E0178B
Printed: July, 1979
Tested at: Portage la Prairie
ISSN 0383-3445

Evaluation Report 117



Versatile Hydrostatic 400 Self-Propelled Windrower

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

VERSATILE HYDROSTATIC 400 WINDROWER

MANUFACTURER AND DISTRIBUTOR:

Versatile Manufacturing Limited
1260 Clarence Avenue
Winnipeg, Manitoba
R3T 1T3

RETAIL PRICE:

$10,925.00 (July, 1979, f.o.b. Winnipeg, Manitoba)

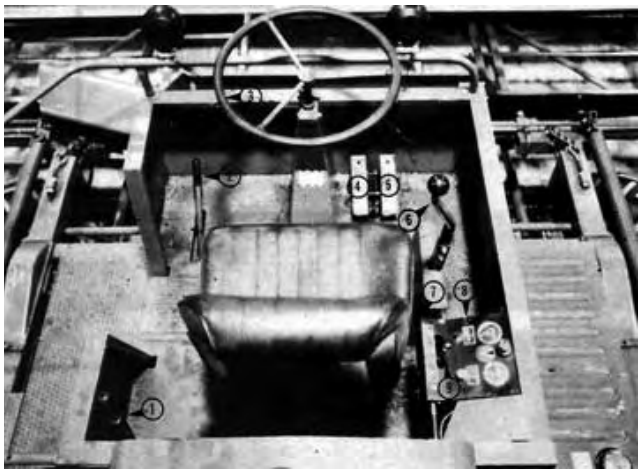


FIGURE 1. Operators Platform. (1) Header control lever, (2) Parking brake, (3) Steering wheel, (4) Table control pedal, (5) Reel control pedal, (6) Speed control lever, (7) Choke, (8) Ignition switch, (9) Throttle,

SUMMARY AND CONCLUSIONS

Overall functional performance of the Versatile 400 windrower was *very good* in all crops, when equipped with the 5.5 m (18 ft) grain header.

Cutting ability was *very good* in all grain crops and most average hay crops. In very heavy, tough hay crops, flax and rapeseed, cutting ability was *good.* Header flotation was *very good,* but maximum header lift was inadequate to clear heavy headland windrows.

Windrow formation and quality were *very good.* Parallel, angled parallel, and fantail windrows were predominant in both hay and grain crops. Fantail windrows occurred in most heavy crops while herringbone patterns occurred in light crops.

The header windrow opening was adequate to clear all crops.

Suitable field speeds were 8 to 11 km/h (5 to 6 mph) in average grain crops, and 5 to 11 km/h (3 to 6 mph) in average hay crops.

Normal fuel consumption was about 9 L/h (2 gal/h).

Operator controls were convenient and well positioned. Handling and maneuverability were *very good.* Most adjustments were simple and convenient. Daily maintenance took from 15 to 20 minutes.

Operator station sound level was about 90 dBA.

Visibility from the operator's platform was *excellent.* Stability on steep hillsides was *excellent.*

Frequent operation of controls was required to maintain reel and header heights.

Two safety problems were evident. Strict speed control was difficult to maintain as the variable speed control lever required a large initial force to move it which caused the machine to lurch forward unexpectedly. Also, the windrower was easily tipped forward on the header, due to the weight distribution.

The operator's manual was *very good.* It was clearly and concisely written, and contained useful information on maintenance, adjustment and safety precautions.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to reduce the frequency of upending especially during braking or loading onto transporters.
2. Modifications to reduce the tendency of the drive to hesitate, when hydraulic controls are activated.
3. Modifications to provide precise, fast response to header and reel lift controls, and to increase maximum header lift height.
4. Modifications to reduce the force required to operate the variable speed control lever, to improve machine control.
5. Reduction of the excessive machine vibration when header is engaged.
6. Modifications to reduce the noise level at the operator station.

Chief Engineer -- E.O. Nyborg
Senior Engineer -- J.C. Thauberger
Project Technologist -- P.H. Perk

THE MANUFACTURER STATES THAT:

With regard to recommendation number:

1. A weight bracket is located on the rear of the machine. Weights of 50 lb increments are available through parts department.
2. The drive hesitation will always be experienced due to the additional power needed to raise the table or reel, and the length of time necessary for the governor to respond to the additional power requirement.
3. A valve with a metering spool to give more precise control is being considered.
4. The design of the variable speed lever is being reviewed to insure the most friction free operation of the mechanisms. Some braking action on the linkage is necessary to prevent the variable speed lever from creeping.
5. The vibration problem is currently under consideration.
6. Depending on header size and the condition of the machine, our tests indicate the 400 swather without cab to be somewhat quieter than 90 dBA during field operation.

GENERAL DESCRIPTION

The Versatile 400 is a self-propelled centre delivery windrower with two traction drive wheels and a single rear castor wheel. It is powered by a Ford six cylinder gasoline engine. The traction drive is hydrostatic with two pumps driven through a series of sheaves and belts from the engine crankshaft. Roller chains transmit the power from the hydrostatic motors to the wheels. The header is driven through a belt and driveshaft arrangement.

A steering wheel is provided, while a hand lever controls the speed and direction of travel. The hydraulic header and reel controls are foot operated. FIGURE 1 shows the position of the operator station and controls.

The test machine was equipped with a 5.5 m grain header with a draper platform and bat reel. Other options and accessory attachments are available.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Versatile 400 was operated in the conditions shown in TABLE 1 for 182 hours while cutting about 564 ha. It was evaluated in forage crops, cereal grains and oil seed crops for windrow formation, cutting ability, ease of operation and adjustment, noise level, fuel consumption, operator safety and suitability of the operator's manual.

RESULTS AND DISCUSSION

WINDROW FORMATION

Windrow Types: Windrows may be broadly classified into four general patterns (FIGURE 2) although many combinations and variations exist.

The Versatile 400 produced parallel, angled parallel and fantail windrows in most grain crops. Herringbone windrows occurred in very light crops while fantail windrows occurred in heavy crops. TABLE 2 describes the types of windrows produced by the Versatile 400 in various crops while FIGURES 3 to 12 illustrate typical windrows.

TABLE 1. Operating Conditions

Crop	Soil Texture	Hours	Field Area ha
Alfalfa	Sandy Loam, Loam and Clay	22	56
Mixed Hay	Loam	12.5	40
Slough Grass	Clay	3.5	4
Rye	Clay Loam	11	39
Barley	Clay Loam, Clay, Sandy Loam	22	91
Wheat	Clay Loam, Clay	35	138
Oats	Clay Loam, Sandy Loam	3.5	6
Rapeseed	Clay Loam, Clay, Sandy Loam	27	62
Flax	Clay Loam	28.5	100
Buckwheat	Clay Loam, Clay	2.5	8
Peas	Clay Loam	14	20
Total		181.5	564

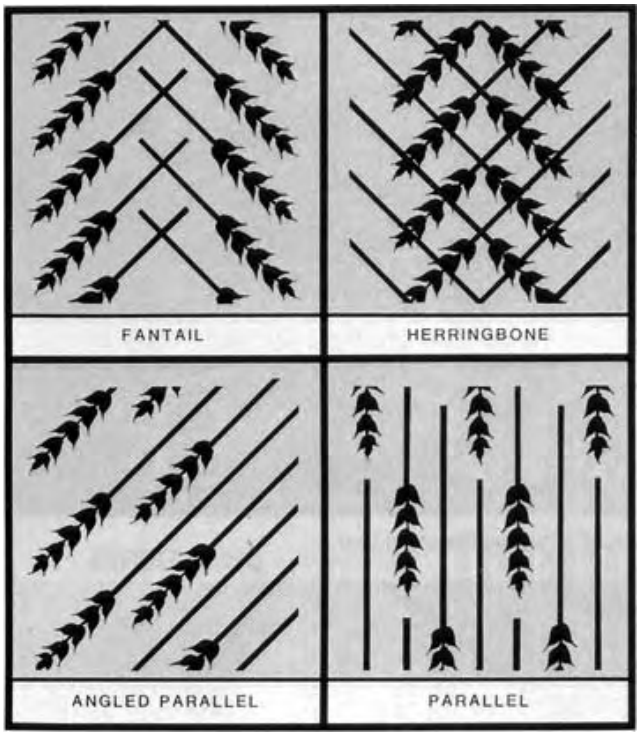


FIGURE 2. Windrow Types.

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

Uniformity: Windrows were very uniform in most crops with bunching occurring only rarely in certain crop conditions. In light short hay crops, hay occasionally collected on the cutter-bar resulting in some slight bunching. Some bunching also occurred in badly lodged crops due to crop flow variation on the drapers. In rapeseed, bunching sometimes occurred at speeds above 8 km/h.

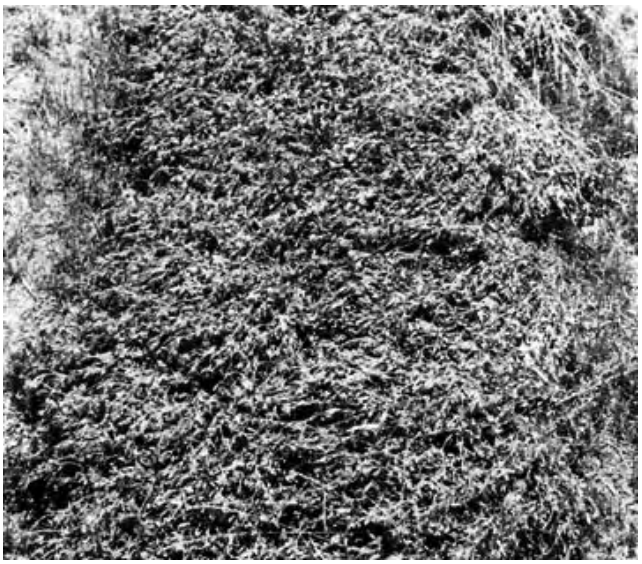


FIGURE 3. Alfalfa (3.0 t/ha).

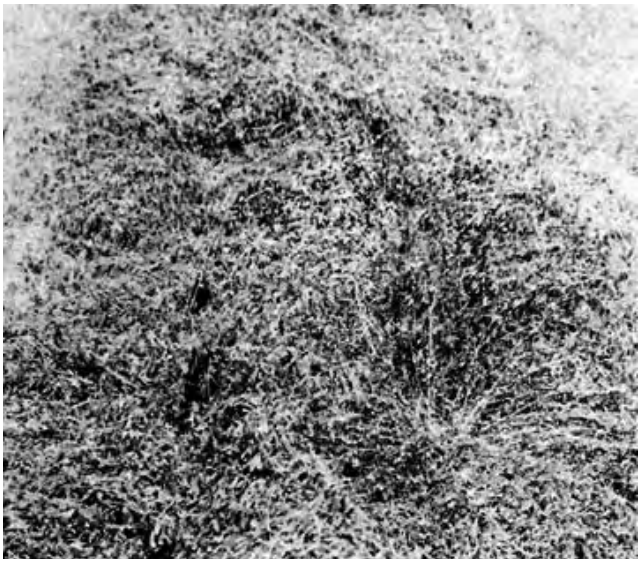


FIGURE 4. Alfalfa (2.5 t/ha).

Draper Speed: Draper speed was variable from 1.8 to 3.2 m/s by changing spacers in the drive pulleys. Higher draper speeds produced denser, narrower, easier-to-pick windrows in light crops. Lower draper speeds were suitable for heavier crops, resulting in wider, more uniform windrows. In short forage crops, hay tended to wrap around the exposed draper drive roller stubs, when backing up was necessary to clear the cutter-bar.

FIGURE 5. Slough Grass (1.0 t/ha).

TABLE 2

Crop	Yield Range t/ha	Cut Crop Length mm	Speed km/h	Windrow Type	Figure Number
Alfalfa	2.7 - 3.6	90 - 600	6.5 - 11.2	Fantail where light: parallel and fantail where heavy	3, 4
Mixed Hay	1.0 - 4.5	100 - 600	5.0 - 10.0	Parallel	
Slough Grass	1.0	50 - 400	2.0 - 10.0	Angled parallel	5
Rye	1.0 - 1.2	300 - 1000	3.0 - 10.0	Parallel and angled parallel	
Barley	1.4 - 1.6	725 - 950	6.5 - 10.0	Parallel and angled parallel; fantail where heavy	
Wheat	0.8 - 2.1	760 - 1015	2.0 - 10.0	Parallel and angled parallel; herringbone in light crop	6, 7, 8
Oats	0.7 - 0.9	750 - 825	2.0 - 6.5	Angled parallel and herringbone	
Rapeseed	0.4 - 0.6	925 - 1000	2.0 - 8.0	Herringbone, fantail and parallel	9
Flax	0.5 - 0.7	400 - 450	8.0 - 10.0	Parallel and fantail predominant, herringbone in light crop	10, 11
Buckwheat	0.5	650 - 725	8.0	Parallel, fantail	

FIGURE 6. Wheat (0.9 t/ha).

FIGURE 7. Wheat (1.1 t/ha).

FIGURE 8. Wheat (1.0 t/ha).

FIGURE 9. Rapeseed (0.45 t/ha).

FIGURE 10. Flax (0.5 t/ha).

FIGURE 11. Flax (0.5 t/ha).

Header Angle: The header angle on the Versatile 400 was not adjustable and was dependent on cutting height. In the completely lowered position, the header angle was 23.5 degrees.

Forward Speed: Forward speed had little effect on windrow

formation. Speed limitations were usually due to field roughness or cutting performance. In very heavy crops, the ability of the wind rower to clear the crop through the windrow opening closely matched its ability to cut.

Windrow Opening: Windrow opening clearance was adequate, even in very heavy, matted crops. In tall, dense, slough grass, the windrow sides occasionally caught and turned outward as they passed through the opening, causing some windrow distortion. Clearance under the windrower frame and past the drive wheels was adequate. In very heavy crops, the rear castor wheel sometimes ran over the outer edges of the windrow.

CUTTING ABILITY

Cutterbar: All test work was conducted with over-serrated knife sections. Cutting ability of the Versatile 400 was very good in all grain crops and in most hay crops. In very heavy, tough hay, cutting ability was good. Cutterbar hammering was not a problem. Cutterbar plugging occurred occasionally in heavy slough grass, heavily lodged grain crops and in damp flax. In lodged crops it was best to cut parallel to crop lodging. Performance in lodged rapeseed was best when travelling in the direction of crop lean. In grain crops, performance was best working back and forth in a direction parallel to the crop lean.

Stubble: The stubble, formed by a windrower, may be divided into three types: ideal, undulating and irregular as shown in FIGURE 12. The Versatile 400 generally produced ideal stubble in all grain crops at speeds up to 10 km/h, provided that the knife and guards were in good condition. In flax or partially lodged rapeseed, ideal stubble was formed at speeds up to 8 km/h. Higher speeds resulted in irregular stubble. Undulating stubble resulted only when the header was allowed to float freely while cutting well above the ground.

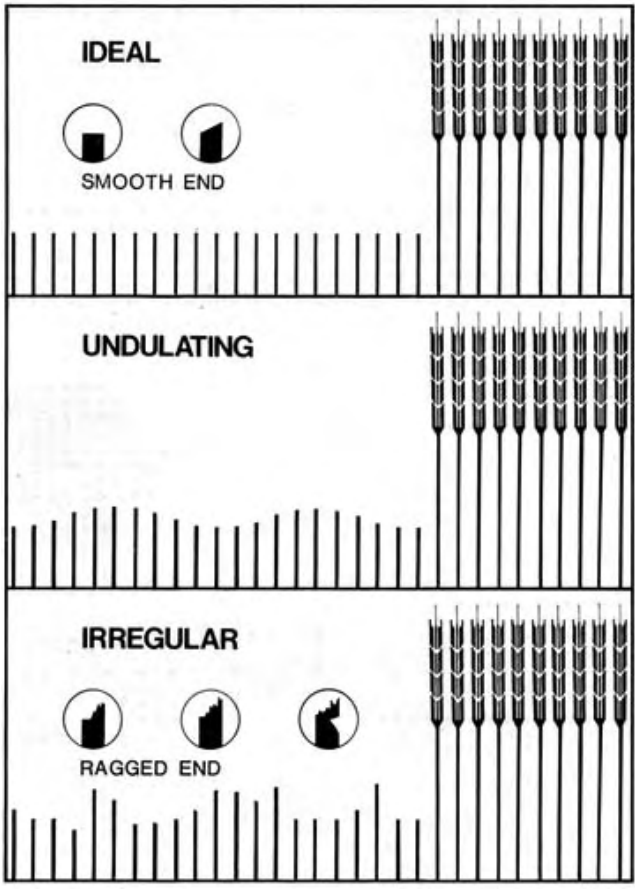


FIGURE 12. Types of stubble formed by windrowers.

In hay crops, the stubble was generally ideal provided that forward speed was matched to crop conditions. Excessive speed in tough hay crops resulted in irregular stubble.

Dividers: In average straight standing grain and hay crops, divider performance was very good. Hairpinning on the dividers occurred in tall leaning grain crops, such as rye.

It was usually best to cut rapeseed back-and-forth, since the dividers worked on the principle of pushing the crop down during separation. The path of pushed down crop was about 90 mm wide and was best recovered by cutting in the opposite direction on the next pass. In heavy, green, matted rapeseed, build-up of crop on the divider rod was a problem. A 13 mm diameter rod was welded to the existing divider rod to extend the divider rod above the crop, which eliminated this problem. (FIGURE 13)

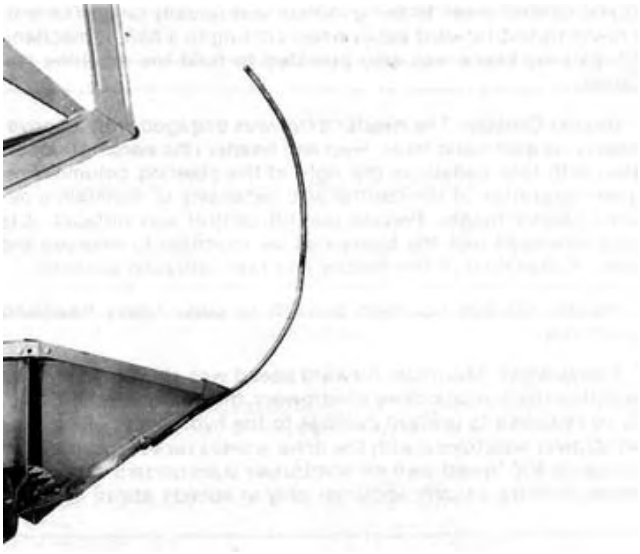


FIGURE 13. Divider Rod Extension.

Reel: Reel speed was variable from 28 to 44 rpm by adjusting the drive pulley. For optimum performance, in most grain crops it was best to have a reel index[1] from 1.1 to 1.2. On the Versatile 400, the optimum reel index was obtained at forward speeds ranging from 6 to 10 km/h. These speeds were adequate for most crops. Operation outside this speed range was also possible in many crops.

Header Rotation: The Versatile 400 was equipped with a header flotation system as standard equipment. Performance was excellent, making it possible to cut hay crops very close to the ground. Flotation was achieved through an arrangement of three springs (FIGURE 14). By adjusting individual spring tensions, the header could be levelled while suspended off the ground. When properly adjusted, the header followed ground contours very well.

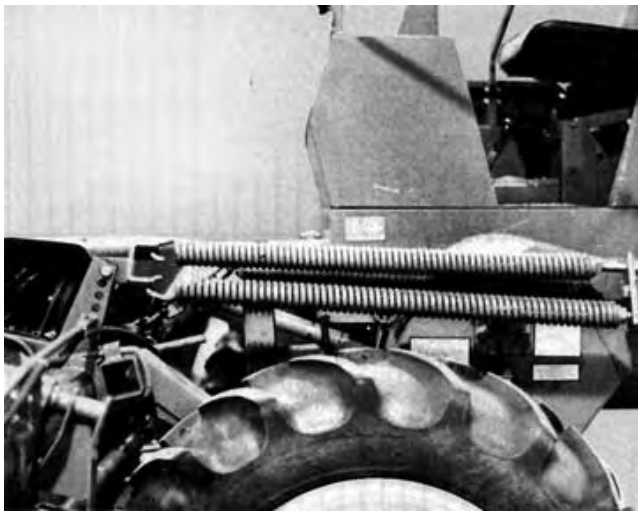


FIGURE 14. Header Flotation System.

EASE OF OPERATION AND ADJUSTMENT

Steering: Directional control and maneuverability of the Versatile 400 were very good. Steering[2] was positive and effortless.

[1]Reel index is defined as the ratio of reel tip speed to travel speed.

[2]Hydrostatic steering, in reverse, is opposite to that of conventional machine operation. In addition, when the variable speed lever is returned to neutral, the steering wheel must also be returned to neutral to stop machine motion.

The Versatile 400 did not pull sideways in soft fields, and the steering was not influenced by different tire pressures in each drive wheel.

Speed Control: Forward speed variation from 0 to 17.3 km/h was possible with the hydrostatic speed control lever. Speeds in reverse could be varied between 0 and 7.6 km/h. The speed control lever was stiff and difficult to operate. Forces up to 220 N were needed to move the speed control lever. It is recommended that the manufacturer modify the lever mechanism to reduce this force.

Braking: Braking was accomplished hydrostatically with the speed control lever. Braking motion was usually jerky. The windrower tipped forward easily when coming to a halt. A mechanical parking brake was also provided to hold the machine stationary.

Header Controls: The header drive was engaged with a conveniently located hand lever. Reel and header lifts were both operated with foot pedals on the right of the steering column. Frequent operation of the control was necessary to maintain a desired header height. Precise reel lift control was difficult. It is recommended that the hydraulics be modified to improve the ease of operation of the header and reel hydraulic controls.

Header lift was not high enough to clear heavy headland windrows.

Transporting: Maximum forward speed was about 17 km/h. As with most hydrostatic drive wind rowers, the final drive chains had to be removed to prevent damage to the hydrostatic units if the windrower was towed with the drive wheels on the ground. The Versatile 400 towed well on windrower transporters and castor wheel shimmy usually occurred only at speeds above 40 km/h.

The low maximum header lift prevented the windrower from clearing many transporters while loading.

Adjustments: Reel and draper speeds were adjusted by varying the number of spacers between the two halves of the drive sheaves. The reel lift cylinders could be repositioned by pinning the top cylinder pivot in any one of the three holes and sliding the bottom pivot in its slots. Horizontal reel repositioning required the removal of two bolts at each end of the reel and sliding the reel to a new position on the reel arm.

Servicing: Daily lubrication of the Versatile 400 took from 10 to 15 minutes.

NOISE LEVEL

Total noise at operator ear level was about 90 dBA. It is recommended that the operator wear suitable ear protection, especially on long working days.

POWER AND FUEL CONSUMPTION

Engine power on the Versatile 400 was adequate. The windrower would often hesitate when the hydraulic controls were operated. Average fuel consumption was about 9.0 L/h, which permitted about 10 hours of operation between fillings.

OPERATOR SAFETY

Access to the operator's platform was safe and convenient. Controls were well positioned and identified with standardized symbols. Visibility was good. The two headlights and rear working light provided adequate illumination for night operation. The Versatile 400 was equipped with a slow moving vehicle sign and flashing safety lights for transport on public roads.

Although the centre of gravity was located above and behind the main drive wheels, the machine upended easily with sudden deceleration.

The stiffness of the variable speed lever made it difficult to control. Once initial force was overcome, the lever moved more freely. This often caused sudden unexpected acceleration, or when braking, caused sudden deceleration and upending.

Backing the Versatile 400 onto a full carrying transporter was hazardous as the windrower tended to upend until the drive wheels were seated in the cradle. The castor wheel would then bounce heavily on the rear wheel support ramp.

Both the steering wheel and speed control lever had to be in neutral to halt machine motion. A safety lock device ensured that both these conditions were met before the engine could be started.

No other safety hazards were apparent, if normal procedures were followed during servicing and operation. Drives were adequately shielded. The windrower was stable on slopes and rough terrain.

OPERATOR'S MANUAL

The operator's manual was very good and provided much useful information on operation, safety, adjustment and servicing. It was clear and well written.

DURABILITY RESULTS

TABLE 3 outlines the mechanical history of the Versatile 400 windrower during 182 hours of operation while windrowing about 564 ha. The intent of the test was evaluation of functional performance. The following failures represent those, which occurred during functional testing. An extended durability evaluation was not conducted.

TABLE 3. Mechanical History

Item	Operating Hours	Equivalent Area ha
-The swaybar was cracked and replaced at	20	62
-Leaks in the right reel lift cylinder were repaired at	24	75
-The outer pitman bearing failed and was replaced at	101	341
-The left header lift cylinder began leaking and was replaced at	139	430
-Leaks at the left reel lift cylinder were repaired at	139	430
-The castor wheel failed at the mounting bolt holes and was replaced at	139	430

DISCUSSION OF MECHANICAL PROBLEMS

Vibration: The Versatile had a recurring vibration problem. Close inspection led to the discovery of cracks on the swaybar near the pitman arm. This was judged to be a result of the vibration. The swaybar had to be replaced at the time shown. At the end of the evaluation, the wind rower drive continued to vibrate. It was found that the vibration problem was caused by improper alignment of the engine.

At 110 hours the outer pitman bearing failed. The vibration problem caused the failure of the cage holding the ball bearings in the race, allowing the balls to drop out. The bearing was replaced and no further problems were experienced with it during the test.

Hydraulic System: The right reel lift cylinder began leaking after 20 hours operation. The leakage of hydraulic fluid became progressively worse. At 21 hours a repair kit was installed eliminating the leak, which had been caused by a faulty O-ring.

The left header lift cylinder began leaking excessively at 139 hours. A scratched piston was the cause of the leakage. A new cylinder was installed.

The right reel lift cylinder began leaking again after about 130 hours. The leakage became progressively worse and the cylinder was dismantled at 139 hours. A faulty O-ring was again replaced.

Castor Wheel: The castor wheel failed and was replaced at 139 hours. The bolts securing the castor wheel loosened and enlarged the bolt holes causing the wheel to fail while the windrower was being transported.

APPENDIX I
SPECIFICATIONS

Model:	Versatile Hydrostatic 400
Serial No.:	78-038222
Cutterbar:	
-- width of cut (divider points)	5425 mm
-- effective cut (inside divider)	5330 mm
-- range of cutting height	56 to 540 mm
-- guard spacing	76 mm
-- length of knife section (over-serrated)	76 mm
-- knife stroke	81 mm
-- knife speed	540 cycles/min
Header:	
-- header angle (from horizontal)	
- fully raised	4.0°
- fully lowered	23.5°
-- number of drapers	2
-- width of drapers	1055 mm
- length of drapers	
- right	4318 mm
- left	4318 mm
-- draper speed range	1.8 to 3.2 m/s
-- draper roller diameter	60 mm
-- height of windrow opening	928 mm
-- width of windrow opening	955 mm
-- between windboards	1115 mm
-- between rollers	890 mm
-- between roller shields	850 mm
-- raising time of header	0.8 s
-- lowering time of header	2.8 s
Reel:	
-- number of bats	5
-- number of reel arms/bats	5
-- diameter	1320 mm
-- speed range	28 to 44 rpm
-- range of adjustment	
- fore and aft	160 mm
- height above cutterbar	50 to 670 mm
-- raising time	1.0 s
-- lowering time	1.6 s
Ground Drive:	
-- type	hydrostatic with final chain drive
-- speed control	hand lever
-- range of forward speed	0 to 17.3 km/h
-- range of reverse speed	0 to 7,6 km/h
Steering:	Steering wheel operating hydrostatic pumps
Brakes:	Hydrostatic speed control lever and lever operated parking brake
Hydraulic System:	
-- traction drive	Sperry-Vickers hydrostatic transmission with 2 Sperry-Vickers hydrostatic drive motors
-- reel lift	Auxiliary pump in hydrostatic transmission
No. of Chain Drives:	6
No. of V-belts:	
-- single V	5
-- multiple V	2
No. of Pressure Lubrication Points:	20
No. of Pre-lubricated Bearings:	24
Engine:	
-- make	Ford
-- model	200CF-6005-A
-- no load speed	2150 rpm
-- power	40 kW
-- fuel tank capacity	91 L
Tire Size:	
-- main drive wheels	2, 11.2 x 24, 4-ply
-- castor wheel	1, 7.60 x 15, 4-ply
Machine Dimensions:	
-- wheel tread - drive wheels	2625 mm
-- wheel base	3230 mm
-- overall width	5660 mm
-- overall length	6390 mm
Weight as Tested: (header raised)	
-- right drive wheel	928 kg
-- left drive wheel	1080 kg
-- castor wheel	120 kg
TOTAL	2128 kg
Centre of Gravity: (header raised)	
-- height above ground	1020 mm
-- distance behind drive wheels	182 mm
-- distance left of right drive wheel	1465 mm
Options and Attachments Available:	pick-up reel hay conditioner, cab, hand controls, skid shoes.

APPENDIX II
MACHINE RATINGS

The following rating scale is used m PAMI Evaluation Reports:

(a) excellent	(d) fair
(b) very good	(e) poor
(c) good	(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)	= 2205 pounds (lb)
1 tonne/hectare (t/ha)	= 0.45 ton to acre (ton/ac)
1 metre (m) = 1000 millimetres (mm)	= 39.37 inches (in)

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