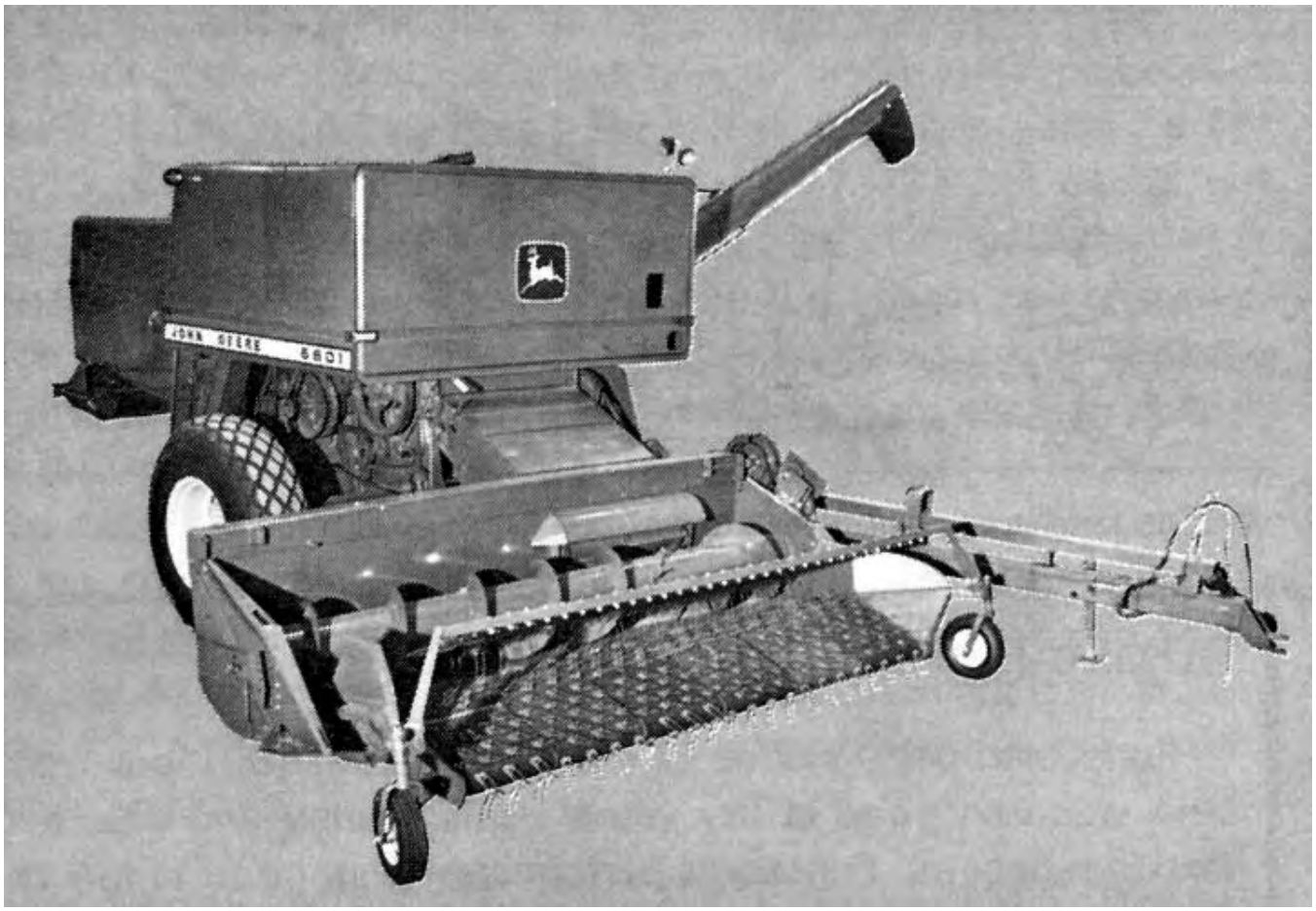
Evaluation Report No. E0576B
Printed: October, 1977
Tested at: Humboldt
ISSN 0383-3445

Evaluation Report 26



John Deere 6601 Pull-Type Combine

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

JOHN DEERE 6601 PULL-TYPE COMBINE

MANUFACTURER:
John Deere Harvester Works
East Moline, Illinois 61244
U.S.A.

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

RETAIL PRICE:
$20,288.72 (July, 1977, f.o.b. Humboldt, with 3960 mm (13 ft) table, 3350 mm (132 in) belt pickup, straw chopper, straw walker plugging sensor, and support stand).

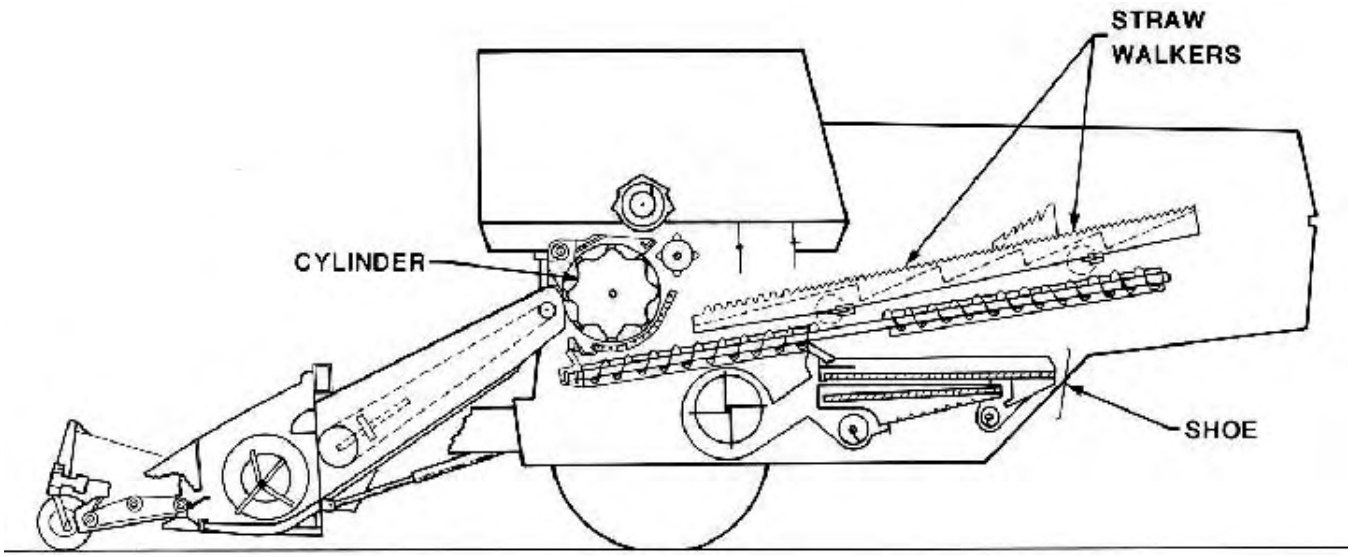


FIGURE 1. Schematic View of John Deere 6601.

SUMMARY AND CONCLUSIONS

Functional performance of the John Deere 6601 pull-type combine was very good in dry wheat, oats, barley and ax, and was fair in rapeseed. Functional performance was good to fair in tough and damp crops.

The MOG feedrate at 3% total grain loss varied from 8.15 t/ha (300 lb/min) in 3.44 t/ha (51 bu/ac) Neepawa wheat to 5.15 t/h (189 lb/min) in 3.90 t/ha (73 bu/ac) Bonanza Barley. The capacity of the JD 6601 was similar to the capacity of the PAMI reference combine for a similar total grain loss. Straw walker loss limited the capacity of the JD 6601 in dry grain crops while in bunchy rapeseed and in tough to damp grain crops, capacity was limited by choking of the table auger and feeder and by cylinder back feeding. A reduction in grain loss over the straw walkers would have permitted higher combining rates. Cylinder and shoe losses usually were small, in comparison to straw walker loss.

In dry wheat, at rated capacity, average PTO power requirements were 37 kW (50 hp). Although the manufacturer recommends a minimum 63 kW (85 hp) tractor, a minimum 75 kW (100 hp) tractor was needed when combining damp crops in soft or hilly elds. Fuel consumption, when powered with a John Deere 4430 tractor, varied from 18 to 25 L/h (4 to 5.5 Imp. gal/h). The JD 6601 was very maneuverable. It was easier to pick corners, formed by self-propelled windrowers, with the JD 6601 than with most self-propelled combines. Header visibility and handling depended upon the type of tractor used while feedrate control depended upon the type of tractor transmission and its available range of ground speeds. For example, when using the John Deere 4430 tractor, handling and header visibility were excellent but feedrate control was poor because, although the tractor could be shifted on-the-go, only two of the eight available forward speeds were suitable for most crops.

All controls were very convenient to operate from the tractor seat. Grain tank visibility was only fair as the front of the tank contained no windows to indicate grain level. The unloading auger had suf cient reach for ef cient unloading on-the-go. As is common with pull-type combines, modern tractor cabs create a better environment for the operator than most cabs on self-propelled combines but, as a result, operator feel for combine performance is eliminated and suitable monitoring instruments become more important.

The John Deere 6601 was easy to adjust for speci c eld conditions if a second person was available. As is normal with pull-type combines, adjusting by one person was more dif cult. Although return tailings could be examined by a second person, through the upper tailings inspection door, this was somewhat hazardous as the person had to stand on the hitch in front of the wheel, while supporting himself on the grain tank. Ease of servicing was good. Six grease ttings were dif cult to reach.

The table auger, feeder and cylinder had very good capacity in dry grain crops and plugging was infrequent. Capacity was reduced in heavy, bunchy rapeseed and in damp grain crops due to choking and plugging of the table auger and feeder and back feeding at the cylinder. Cylinder plugging seldom occurred. Cylinder access was relatively convenient.

The stone trap stopped most stones before they entered the cylinder and was fairly easy to clean.

The pickup had excellent feeding characteristics in all grain crops. In rapeseed the windguard had to be removed to eliminate plugging between the pickup and the table auger. Plugging occurred between the rear pickup roller and the stripper bar in tough, short straw barley.

The hitch was convenient to swing into transport or eld position. Caution had to be observed when pinning the hitch in eld position to avoid pinching the hand between the main drive gear box and the locking pin. It was dif cult for one person to place the unloading auger in eld position as there was no suitable place to stand when securing the over-centre latch. The JD 6601 transported well at speeds up to 32 km/h (20 mph). Transport width was narrow enough for safe and easy movement on most roads.

Except for the location of the tailings inspection door and the hitch locking pin, no serious safety hazards were encountered when operated according to the manufacturer's recommended procedures. The operator's manuals were well illustrated and contained much useful information on servicing and adjustments for most crops. Suggested settings for rapeseed were not included in the combine operator's manual.

No major durability problems occurred during the test, although recurring problems were experienced with the power take-off drive line, and the tailings elevator drive. Fifty-three pickup teeth broke during the test.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Providing an optional variable speed control for the pickup drive, adjustable from the tractor seat.
2. Modi cations to reduce the frequency of pickup tooth breakage.
3. Providing a rocking hub on the table auger drive to facilitate unplugging.
4. Modifying the shielding around the pickup and auger drives to eliminate straw and chaff accumulation under the shields.
5. Providing access holes to facilitate cleaning of the otation guides on the front feeder drum.
6. Modi cations to eliminate the possibility of hand pinching when locking the hitch in eld position.
7. Providing a less hazardous location for sampling return tailings, such as at the bottom of the tailings elevator.
8. Providing inspection holes on both sides of the cylinder for checking concave clearance.
9. Modifying the concave ller plates so they remain in place during operation.
10. Improving the lubrication accessibility for the beater bearings, the beater drive tightener, the cylinder drive tightener and the straw chopper drive tightener pivots.
11. Modi cations to eliminate recurring failure of the drive pin on the lower tailings elevator sprocket.
12. Simplifying the method of shield attachment on the tailings return elevator drive to discourage the practice of permanent shield removal.
13. Providing a shaft rotation indicator for the clean grain elevator.
14. Supplying screen grain tank extensions as standard equipment or providing a window in the front of the grain tank, to improve operator visibility of grain level.
15. Modi cations to improve the. ease of placing the grain unloading auger in eld position.
16. Providing an additional light for the grain unloading auger.
17. Including suggested settings for rapeseed in the operator's manual.
18. Providing decals indicating location and frequency of lubrication.
19. Providing a hitch safety chain as standard equipment.

Chief Engineer - E.O. Nyborg
Senior Engineer - L.G. Smith
Project Engineer - P.D. Wrubleski

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. An optional variable speed control for the pickup drive, adjustable from the tractor seat, is under consideration but not yet adopted. This will be further re-evaluated.
2. Plastic pickup teeth are recommended where tooth breakage is a problem. This is a factory option, which the customer may order.
3. A rocking hub for the table auger drive is being considered.
4. Shielding modi cations are not completely successful in eliminating straw and chaff accumulation. This is not considered a serious problem, however, the area does require periodic cleaning.
5. Modi cations to the otation guides, to prevent trash build up, are being tested.
6. Modi cations are under consideration.
7. Means for more convenient samplings of tailings are being evaluated. Inspection holes are under consideration.
8. A more positive method of retaining the concave ller plates is being considered·
9. Lubrication accessibility for the beater bearings and drive tightener has now been improved. Access to the cylinder drive and chopper drive tightener pivots will be improved.
10. Modifications to the drive pin on the lower tailings elevator sprocket are being evaluated.
11. A simpler method of shield attachment and a hinged shield are being evaluated.
12. Perforated grain tank extensions with a longer discharge auger in the grain tank are now under development. This will make the auger rotation visible.
13. Grain tank extensions have been adopted for the 1978 models.
14. No major changes in the grain unloading auger are planned at this time,
15. An additional light is under Consideration.
16. Settings for rapeseed will be included in future Operator's Manuals,
17. Extended and more uniform greasing intervals are planned rather than the addition of decals.
18. A safety chain will be adopted as standard equipment.

GENERAL DESCRIPTION

The John Deere 6601 is a power take-off driven pull-type combine with a 3350 mm (132 in) three roller belt pickup mounted on a 3960 mm (13 ft) off-set header. A minimum 53 kW (85 hp) tractor with 1000 rpm power take-off and one hydraulic outlet is needed. The separator drive is controlled with the tractor power take-off clutch and header height with the tractor hydraulic system. Header and unloading auger drives are controlled through electric clutches from the tractor seat.

Concave clearance is adjusted by a ratchet lever while cylinder and fan speeds are controlled with hand cranks through variable speed belt drives. Return tailings may be inspected through a door at the top of the return elevator. The chaffer and sieve are adjusted with levers at the rear of the shoe. Complete specifications are given in APPENDIX I.

SCOPE OF TEST

The John Deere 6601 was powered with a John Deere Model 4430 tractor and was operated in a variety of Saskatchewan and Alberta crops (TABLES 1 and 2) for 182 hours while harvesting about 323 ha (798 ac). It was evaluated for ease of operation, ease of adjustment, power requirements, rate of work, grain loss characteristics, operator safety, and suitability of the operator's manual. Throughout the test, comparisons were made to the PAMI reference combine.

TABLE 1. Operating Conditions

Crop	Variety	Average Yield		Swath Width		Hours	Field Area	
		t/ha	bu/ac	m	ft		ha	ac
Wheat	Neepawa	2.9	43	4.9-6.1	16-20	56.5	95	235
Wheat	Park	3.4	50	4.9	16	9.5	10	25
Duram	Wascana	2.0	30	4.6	15	11.0	26	65
Barley	Betzes	2.7	50	5.5-6.1	18-20	32.5	51	126
Barley	Bonanza	2.4	45	5.5-7.3	18-24	10.5	22	54
Oats	Harmon	3.0	80	6.1	20	7.0	9	22
Flax	Noralta	1.6	25	4.9	16	8.0	13	32
Flax	Linott	1.3	20	4.9	16	9.0	22	54
Rapeseed	Tower	2.0	35	5.5	18	24.5	48	118
Rapeseed	Midas	0.8	15	4.9	16	13.5	27	67
Total						182.0	323	798

TABLE 2. Operation in Stony Fields

Field Conditions	Hours	Field Area	
		ha	ac
Stone Free	32	52	126
Occasional Stones	95	161	398
Moderately Stony	39	80	198
Very Stony	15	30	74
Total	182	323	796

RESULTS AND DISCUSSION

EASE OF OPERATION

Hitching: A tractor with 1000 rpm power take-off with a

standard 35 mm (1.38 in) spline was needed to power the JD 6601. When attaching the JD 6601 to a tractor for the first time, several tractor modifications and combine adjustments had to be made. The combine control box, which contained the controls for the header, unloading auger, combine lights and the straw walker warning horn, had to be installed at a convenient location on the tractor. The control box could be converted for 12V or 24V electrical systems with either negative or positive ground. The control box could be permanently attached to the tractor as it contained an extension with receptacle for quickly connecting the combine umbilical cord.

The two-position drawpole clevis had to be placed in the position, which permitted the drawpole to be nearest to level position when attached to the tractor. In addition, the tire bumpers on the drawpole had to be adjusted to contact the tractor tires on tight turns. The tractor drawbar also had to be pinned in line with the power take-off shaft, the tractor drawbar extended to obtain the standard 406 mm (16 in) distance between the power take-off shaft and the hitch pin and the drive line height on the combine had to be adjusted to obtain minimum drive shaft angles. In addition, one bank of the tractor hydraulic system had to be converted to single acting to suit the header lift cylinder.

Once the above adjustments had been made, attaching the JD 6601 to the tractor was safe and convenient. A suitable hitch jack was attached to the drawpole. The drive line contained a quick coupler for attaching to the tractor power take-off while the umbilical cord contained a pronged plug for attaching to the control box receptacle. Although the hitch pin must be secured, to prevent falling out during operation, pin diameter should be about 6 mm (0.25 in) less than the diameter of the hole in either the hitch or the tractor drawbar, to provide flexibility on uneven terrain. Although no hitch safety chain was supplied with the JD 6601, it is recommended that one be installed, especially when transporting or when working on hilly fields.

Maneuverability: The JD 6601 was very maneuverable. As is common with most pull-type combines, picking windrows around tight corners was easier with the JD 6601 than with most self-propelled combines as the tractor could be turned to pivot the combine about the centre of the pickup. The maximum permissible tractor wheel spacing depended on the size of the windrower and the width of the windrow. Since it is desirable to feed the windrow directly into the feed throat opening (FIGURE 2), outside width at the tractor wheels should be no greater than 2440 mm (96 in) in fluffy windrows such as rapeseed. In most grain crops, an outside tractor wheel width of 3050 mm (120 in) was possible. The minimum width of swather to permit passing between windrows on back-and-forth combining was 4570 mm (15 ft) when combining fluffy windrows with a 2440 mm (96 in) tractor width.

In one field of heavy Tower rapeseed, in-line feeding was not possible with the JD 4430 tractor set at minimum wheel spacing of 2185 mm (86 in). When feeding in-line, by driving on the left edge of the windrow, table auger plugging was infrequent, while offset feeding resulted in frequent table auger and feeder plugging.

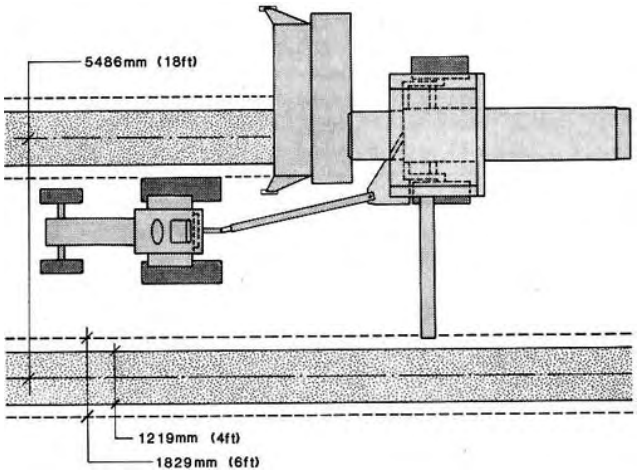


FIGURE 2. Schematic View Showing Tractor Wheel Spacing and Windrow Spacing needed for In-Line Feeding with the JD 6601.

Operator Location: With a pull-type combine, operator comfort, and visibility depends mainly on the type of tractor used. With most modern tractors, operator comfort is better than on self-propelled combines because of lower noise levels and less dust, both due to the location of the tractor away from the combine, and better cabs. At the same time, operator feel for combine performance is nearly eliminated and combine monitoring equipment becomes more important. No grain loss or shaft speed monitoring equipment was available with the JD 6601, however, a straw walker plugging horn was supplied as optional equipment.

Header Visibility: When powered with a JD 4430 tractor, header visibility was excellent from the tractor seat and the rotating flap on the upper return elevator shaft could easily be seen. There was no rotation indicator for the clean grain elevator and grain tank visibility was only fair as it was not possible to determine grain tank level until it was ready to overflow. Screened grain tank extensions should be supplied as standard equipment, or a window should be placed in the front of the grain tank, to improve operator visibility of grain level.

Controls: The main separator drive was controlled with the tractor power take-off clutch while header height was controlled with one bank of the tractor hydraulics. The combine control box had switches and warning lights for the grain unloading auger and the header drive. It also contained the combine light switch as well as the optional straw walker warning horn. Feedrate control was entirely dependent upon the tractor used, its type of transmission and its selection of suitable ground speeds. For example, although the John Deere 4430 had eight forward speeds, and a power shift transmission which could be shifted on-the-go, only two speeds were suitable for most fields combined with the JD 6601 during the test.

Lights: The JD 6601 was equipped with two lights, one for the header and one for the grain tank, to supplement the tractor lights. An additional light for the unloading auger would be beneficial.

The JD 6601 was equipped with warning lights and suitable reflectors for safe transport on public roads.

Stability: The JD 6601 was quite stable, even with a full grain tank. The centre of gravity with a full grain tank was 1836 mm (72 in) above ground, 305 mm (12 in) ahead of the combine axle and 152 mm (6 in) to the left of the combine centre line. Normal care had to be used when turning corners on hillsides and the tractor also had to be properly ballasted on hilly fields. The hitch load became negative when travelling up hills with a slope greater than 13.5 degrees.

Grain Tank: The grain tank held 2.6 t (96 bu) of wheat. Unloading a full hopper of dry wheat took 86 seconds. The tank was equipped with a loading auger, which delivered grain near the top centre of the tank, resulting in uniform filling in all crops. The unloading auger had ample reach and clearance for easy on-the-go unloading. It was difficult for one person to place the unloading auger in field position as there was no suitable place to stand when securing the over-centre latch.

When combining in strong side winds, low density grains such as oats or barley began to be blown out of the grain tank when the grain level approached the level of the filling auger outlet. Screened grain tank extensions, supplied as standard equipment, are recommended to overcome this problem.

Straw Chopper: The optional straw chopper attachment performed well in all crops. Length of cut could be adjusted by varying the clearance between the rotor hammers and the concave. Although the straw deflectors were adjustable to control spreading width, maximum width varied from 4.6 to 6.1 m (15 to 20 ft), depending on straw and wind conditions.

The straw chopper had to be removed if the straw was to be windrowed. Removal or replacement took two men about 10 minutes.

Plugging: The table auger and feeder were quite aggressive in dry grain crops and plugging was infrequent when operating at normal feedrates. At higher than normal feedrates, such as when attempting to combine in a higher tractor gear than suitable, occasional feeder and table auger plugging occurred, even in dry grain crops. In heavy bunchy rapeseed and damp grain crops, choking and plugging of the table auger and feeder occurred frequently. Plugging could be reduced by careful control of the feedrate. In damp or bunchy crops, capacity could be increased appreciably by using a tractor with an infinitely variable traction drive. Otherwise, it was usually

necessary to travel one gear slower than normal to avoid frequent feeder plugging. Proper adjustment of tractor wheel tread, to permit feeding directly into the feeder, was very important in reducing auger and feeder plugging in damp grain crops and in bunchy rapeseed.

Unplugging the table auger or feeder was difficult as no rocking hub was provided on either the table auger or the feeder drive. The pickup wind guard restricted access for unplugging.

In some rapeseed crops, stalks jammed in the right feeder drum flotation guide, holding the right side of the drum in its highest position (FIGURE 3). Unplugging the guide was very difficult, due to limited access, taking one man two hours. Inspection holes in the side of the feeder housing would have greatly aided in cleaning the guide. Plugging could be reduced by adjusting the tractor wheel tread to increase the amount of straw being fed directly into the feeder thus reducing the straw fed to the feeder by the right portion of the table auger.

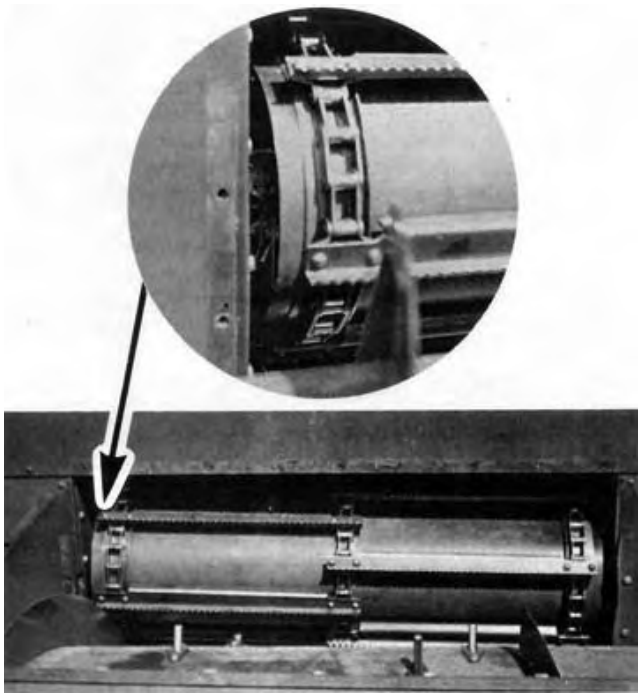


FIGURE 3. Plugging of Right Feeder Drum Flotation Guides in Rapeseed.

Cylinder plugging was very infrequent, as it was usually prevented by feeder plugging. If the cylinder plugged, it could usually be unplugged by lowering the concaves and starting the separator with the feeder drive disengaged. A rocking hub was provided on the cylinder shaft, if severe plugging should occur. Cylinder access was inconvenient, through both the front door and the lower door at the stone trap.

Considerable cylinder back feeding occurred in damp grain crops and especially in rapeseed. The cylinder stripper bar was made of fabric belting and the stripper clearance could not be adjusted. The stripper had worn at the centre creating a 6 mm (0.25 in) clearance by the end of the test. An additional adjustable stripper was provided on the back of the upper cylinder inspection door. Although the operator's manual specified that this stripper be adjusted to maintain a 6 mm (0.25 in) clearance from the cylinder rasp bars, it could only be adjusted to give a minimum 11 mm (0.44 in) clearance. During operation, it bent away from the cylinder, resulting in a 18 mm (0.69 in) clearance at the centre.

As with most combines, dust and chaff collected inside the cylinder rasp bars, causing cylinder imbalance. The inside of the rasp bars occasionally had to be cleaned to prevent cylinder vibration.

Stone Trap: The JD 6601 was equipped with a stone trap in front of the cylinder. The stone trap was quite effective, capturing most roots or stones before they entered the cylinder. As with most combines, if a large stone was inadvertently picked, it could damage the table auger or feeder before being stopped by the stone trap.

Cleaning the stone trap was quite easy. The header had to be raised and secured and an over-centre lever was then pulled to drop the stone trap door (FIGURE 4).

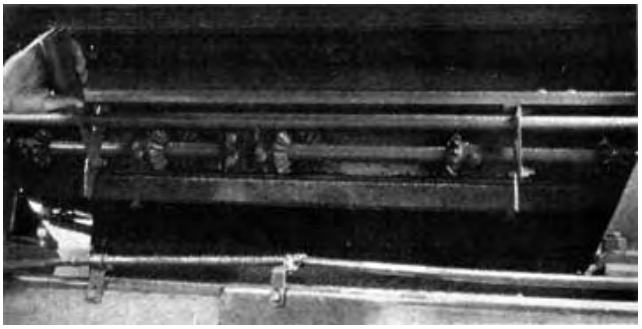


FIGURE 4. Stone Trap Access on the JD 6601.

Pickup: The JD 6601 was equipped with a 3350 mm (132 in) three roller belt pickup with spring steel teeth. The pickup had excellent feeding characteristics, delivering the windrow beneath the table auger in all grain crops. In rapeseed, the pickup wind guard had to be removed as it retarded the crop flow, resulting in bunchy feeding, leading to table auger plugging. With the wind guard removed, pickup performance in rapeseed was excellent.

In tough and damp short-strawed Betzes and Bonanza barley, plugging occurred between the rear pickup roller and the pickup stripper bar causing pickup belt slippage and requiring systematic hand cleaning. Access for cleaning was restricted by the pickup wind guard. Pickup plugging never occurred in dry crops.

In all crops, straw and chaff collected behind the pick-up and auger drive shields, necessitating daily cleaning to eliminate a possible fire hazard.

Pickup speed could be varied by manually adjusting the pitch of the drive pulley. Although this was satisfactory in uniform windrows, an optional variable speed pickup drive, adjustable from the tractor seat, would be very beneficial in non-uniform fields.

Machine Cleaning: As with most combines, completely cleaning the JD 6601 for combining seed grain was laborious and time-consuming. The delivery augers beneath the concave could be cleaned by pivoting the clean-out door upward and blowing compressed air through the exposed slots. Cleaning the rear delivery augers under the straw walkers necessitated removal of four cap screws to drop the auger troughs. The chaffer and sieve were easily removed for cleaning the tailings and clean grain augers. The grain tank was fairly easy to clean if the front discharge auger cover was raised to its maximum height.

Transporting: Swinging the hitch, to place the JD 6601 in and out of transport position, was an easy one man job. The hitch locking pin had to be removed by hand and the tractor either backed or driven ahead to allow the drawpole to pivot. Extreme care had to be taken to avoid pinching the hand between the locking pin and gear box (FIGURE 5) when pinning the hitch in field position. If the combine could inadvertently roll, causing the hitch to swing inward, just as the pin was being inserted, severe hand injury could occur.

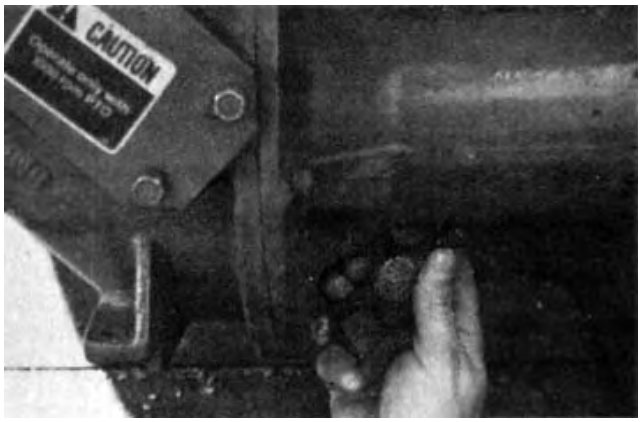


FIGURE 5. Possible Pinching of Hand when Pinning Hitch in Field Position.

The JD 6601 transported well at speeds up to 32 km/h (20 mph). Rear visibility in transport position was partially restricted, however, the combine was adequately equipped with reflectors, warning lights and a slow-moving vehicle sign for safe transport on

public roads.

Lubrication: The JD 6601 had 44 pressure grease fittings. Thirty-two needed greasing every 10 hours, three needed greasing every 50 hours, five needed greasing every 100 hours, while four had to be greased every 250 hours. The left and right rear beater bearings (100 hour), the beater drive tightener pivot (10 hour), the cylinder drive tightener pivot (10 hour) and the straw chopper drive tightener pivot (10 hour) all were difficult to lubricate. Providing extensions from these fittings to more accessible locations would greatly improve ease of lubrication. The grease fitting on the front power shaft universal joint (10 hour) also was difficult to lubricate due to the protective shielding.

The main drive gear box oil level needed checking every 100 hours while the wheel bearings needed repacking every 250 hours.

EASE OF ADJUSTMENT

Field Adjustments: The JD 6601 was easy to adjust. As with all pull-type combines, having a second person available when setting was very beneficial. As with other pull-type combines, it was difficult to determine when to change settings during the day as return tailings and clean grain could not easily be inspected by the operator.

Concave Adjustment: The JD 6601 had a single segment concave. The concave could be levelled with two draw bolts at the rear and a single levelling bolt at the front. Front concave clearance could be gauged through the stone trap door while the rear was gauged by entering the straw walker compartment since no inspection holes were provided on the side of the combine. Concave clearance was easily adjusted with a reversible hand ratchet assembly on the side of the combine (FIGURE 6). The control linkage was designed so that the front concave opening always was twice as large as the rear opening. Front opening could be adjusted from 5 mm (0.20 in) to 38 mm (1.5 in). A clearance indicator was attached to the concave pivot shaft. The indicator was calibrated in numbers from 1 to 6, giving a relative setting but not an actual concave clearance.

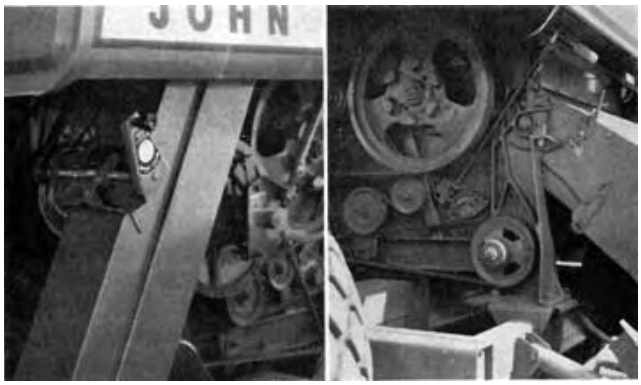


FIGURE 6. Cylinder and Concave Adjustments on the JD 6601.

It was critical to keep a proper balance between concave clearance and cylinder speed. Hard to thresh bottom kernels, especially in Neepawa wheat, were difficult to remove and critical adjustments were necessary to avoid excessive cylinder loss without undue crackage. Suitable front concave clearances were from 10 to 13 mm (0.4 to 0.5 in) for dry wheat. In rapeseed a suitable front clearance was 32 mm (1.25 in). In flax, a front clearance of 5 mm (0.20 in), together with filler plates in the front two concave intervals, was required. The filler plates enabled the cylinder speed to be reduced to eliminate cracking with an acceptable cylinder loss level. After nine hours of operation, the filler plates had been threshed as the spring clips did not hold the filler plates securely.

Cylinder Adjustment: The cylinder was equipped with a variable speed drive, adjustable with a hand crank on the side of the combine (FIGURE 6). An indicator on the crank, calibrated from 1 to 10, indicated relative crank position and not actual cylinder speed. Cylinder speed could be varied from 450 to 1220 rpm, a suitable range for all crops encountered. An optional cylinder drive sheave is available to provide a speed range from 280 to 845 rpm. Suitable cylinder speeds were about 900 rpm in flax, from 800 to 950 rpm in dry wheat, 600 rpm in rapeseed and from 650 to 800 rpm in dry barley. Typical grain crackage varied from 0.5 to 2.0% when properly adjusted.

The cylinder rasp bars were in good condition at the end of the test, showing negligible wear.

Shoe Adjustments: The shoe was convenient to adjust. Fan speed was varied with a calibrated hand wheel (FIGURE 7) while the chaffer and chaffer extension were adjusted with levers at the rear of the shoe. Access to the clean grain sieve adjusting lever was through a door at the rear of the shoe. Return tailings could be inspected at the top of the return elevator. Inspecting tailings was hazardous as it could only be done by standing on the hitch, in front of the wheel while holding onto the grain tank. The shoe was easy to set and performed well in most crops encountered. Total dockage in the grain tank, including cracks, whitecaps and chaff usually varied from 1 to 3% when properly adjusted.

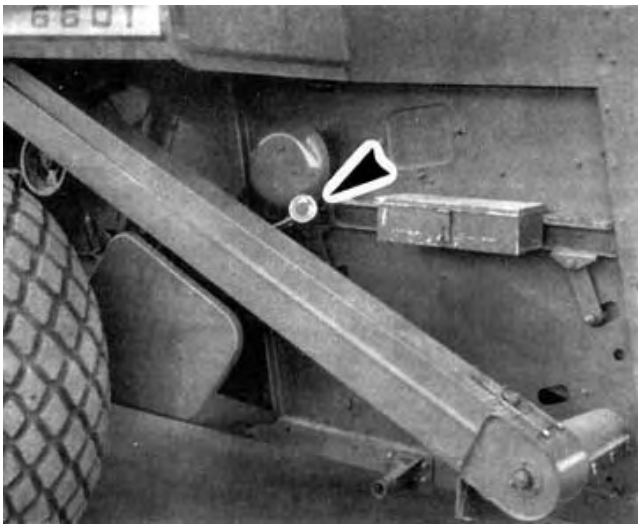


FIGURE 7. Fan Adjustments on the JD 6601.

As is common with most combines, the shoe was difficult to set in non-uniform crops of some varieties of rapeseed due to the large variation in seed size and amount of shoe load between heavy and light windrows. It was found best to set the shoe for optimum performance in the heavy windrow sections and to increase feed rate in light windrow sections to maintain a fairly uniform shoe load. In normal conditions, shoe plugging never occurred. In late fall combining in extremely wet conditions, the chaffer and sieve plugged with wet material and combining could not take place unless the temperature was well below freezing.

As is common with most combines, the windrow should be fed centred on the feeder housing. In rapeseed and flax, shoe loss became significant if the windrow was fed on one side of the feeder housing. One side of the shoe became underloaded while the other side was overloaded, causing seed to be blown over on one side and mechanically transported over on the other. Similarily, as with most combines, shoe loss increased noticeably when combining on side slopes greater than 3°, due to non-uniform shoe loading.

Header Adjustments: The JD 6601 was evaluated only with a pickup attachment for windrowed crops. Straight combining attachments were not evaluated. Header removal necessitated repositioning the hitch jack at the rear of the combine, as the combine would tip backwards when the header was removed. The table and housing detached from the combine as a unit. Removal or replacement took two men about 20 minutes. The left pivot retainer cap screw was very difficult to remove or install due to limited access.

The table auger was easy to adjust both vertically and horizontally while the feeder conveyor was also easy to adjust. As was outlined in the operator's manual, the feeder drive chain tension had to be adjusted with the header in raised position as chain tension varied with header position.

It was necessary to adjust both the table auger slip clutch and the feeder slip clutch to the maximum tension which would still permit slippage, to reduce excessive auger and feeder plugging in rapeseed and in tough grain crops.

Slip Clutches: Individual slip clutches protected the table

auger, feeder conveyor, straw walkers, shoe grain supply augers and the tailings elevator.

RATE OF WORK

Average Workrates: TABLE 3 presents the average workrates for the JD 6601, at acceptable loss levels, in all crops harvested during the test. Average workrates are affected by crop conditions in a specific year and should not be used for comparing combines tested in different years. In some crops, workrates were reduced by bunchy and sunken windrows, muddy or rough ground, irregular shaped fields with many corners and driving the combine empty to unload grain at a central location. During the 1976 harvest, average workrates varied from 4.9 t/h (181 bu/h) in 2.9 t/ha (43 bu/ac) Neepawa wheat to 1.6 t/h (70 bu/h) in 0.8 t/ha (15 bu/ac) Midas rapeseed.

TABLE 3. Average Workrates for the JD 6601

Crop	Variety	Average Yield		Average Speed		Average Workrate			
		t/ha	bu/ac	km/h	mph	ha/h	ac/h	t/h	bu/h
Wheat	Neepawa	2.9	43	4.0	2.5	1.7	4.2	4.9	181
Wheat	Park	3.4	50	3.0	1.9	1.1	2.6	3.7	130
Duram	Wascana	2.0	30	5.4	3.4	2.4	5.9	4.8	177
Barley	Betzes	2.7	50	3.0	1.9	1.5	3.6	4.1	180
Barley	Bonanza	2.4	45	3.6	2.3	1.8	4.4	4.2	191
Oats	Harmon	3.0	52	3.0	1.9	1.3	3.1	3.9	248
Flax	Noralta	1.6	25	4.2	2.6	1.8	4.4	2.8	109
Flax	Linott	1.3	20	6.3	4.0	2.3	5.6	3.0	112
Rapeseed	Tower	2.0	35	4.2	2.6	1.9	4.8	3.6	168
Rapeseed	Midas	0.8	15	5.1	3.2	2.0	5.0	1.6	70

Maximum Feedrate: The workrates given in TABLE 3 represent average workrates at acceptable loss levels. The tractor had ample power to achieve much higher workrates in nearly all crops. In most crops the maximum acceptable feedrate was limited by grain loss, while in light crops the maximum feedrate was limited by pickup performance and in heavy bunchy rapeseed and damp grain crops, maximum feedrate was limited by plugging of the table auger and feeder conveyor.

Capacity: Combine capacity is the maximum rate at which a combine can harvest a certain crop, at a specified total loss level, when adjusted for optimum performance. Many crop variables affect combine capacity. Crop type and variety, grain and straw moisture content, grain and straw yield and local climatic conditions during the growing season all affect the threshing and separating ability of a combine.

MOG Feedrate, MOG/G Ratio and Percent Loss: When determining combine capacity, combine performance and crop conditions must be expressed in a meaningful way. The loss characteristics of a combine in a certain crop depend mainly on two factors, the quantity of straw and chaff being processed and the quantity of grain being processed.

The weight of straw and chaff passing through a combine per unit time is called the MOG Feedrate. MOG is an abbreviation for “material-other-than-grain” and represents the weight of all plant material passing through the combine except for the grain or seed. The weight of grain or seed passing through a combine per unit time is called the Grain Feedrate. The ratio of MOG Feedrate to Grain Feedrate, which is abbreviated as MOG/G gives an indication of how difficult a certain crop is to separate. For example, if a certain combine is used in two wheat fields of identical grain yield but one with long straw and one with short straw, the combine will have better separation ability in the short crop and will be able to operate faster. This crop variable is expressed with the MOG/G ratio when determining combine capacity. MOG/G ratios for prairie wheat crops vary from about 0.5 to 2.25.

Grain losses from a combine are of two main types, unthreshed grain still in the head and threshed grain or seed, which is discharged with the straw or chaff. Unthreshed grain is called cylinder loss. Free grain in the straw and chaff called separator loss and consists of shoe loss and straw walker loss. Shoe and straw walker losses are very dependent upon MOG Feedrate and MOG/G ratio. Losses are expressed as a percent of total grain passing through the combine. Combine capacity is expressed as the maximum MOG Feedrate at which total grain loss (cylinder loss plus separator loss) is 3% of the total grain yield.

Capacity of the JD 6601: TABLE 4 presents capacity results for the JD 6601 in four different crops. MOG Feedrates for a 3% total grain loss varied from 8.15 t/h (300 lb/min) in a field of Neepawa wheat to 5.15 t/h (189 lb/min) in a field of Bonanza barley. In flax, the total loss level was only 1% at a maximum feedrate of 6.8 t/h (250 lb/min). In this crop, capacity was limited by pickup performance at higher speeds.

GRAIN LOSS CHARACTERISTICS

The grain loss characteristics for the JD 6601, in the four crops described in TABLE 4, are presented in FIGURES 8 to 11.

Walker Loss: As is common with most combines, walker loss was the most significant factor limiting capacity in all grain crops. Cylinder loss and shoe loss usually were insignificant in comparison to walker loss. A reduction in free grain loss over the straw walkers would have enabled much higher combining rates especially in difficult-to-separate crops such as barley.

The JD 6601 was equipped with straw walker risers, mounted ahead of the fourth step on each walker. It was also equipped with adjustable extension pans at the rear of each walker. All capacity measurements were conducted with the risers in place and with the walker pans extended halfway to their mid-position. The effect of riser or extension pan position was not evaluated.

Shoe Loss: Shoe loss rarely limited combine capacity although adjustment was critical in rapeseed and flax and high losses could occur with improper settings.

Cylinder Loss: Cylinder loss was low in most dry and well matured crops. In more difficult-to-thresh crops, such as Neepawa wheat, cylinder and concave adjustments were critical and cylinder loss could make a significant contribution to total loss. In tough to damp Neepawa wheat it was very difficult to remove the bottom kernels in the head, even with the cylinder closed tight. In Neepawa wheat with a grain moisture content of 14.7% (FIGURE 8) cylinder loss varied from 2 to 4%, while in Neepawa wheat with a grain moisture content of 12% (FIGURE 9) cylinder loss varied from 0.75 to 1%.

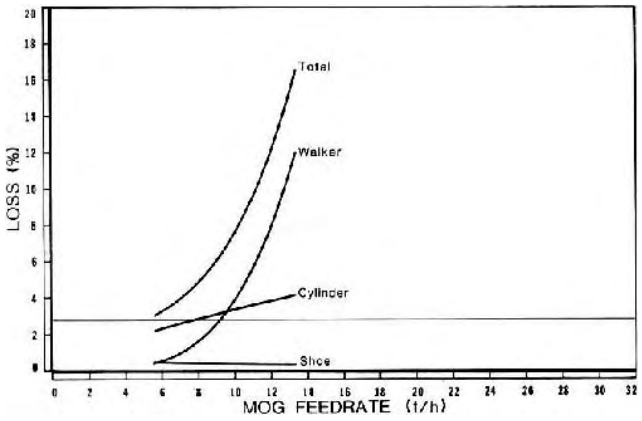


FIGURE 8. Grain Loss for the JD 6601 in Neepawa Wheat at 14.7% Grain Moisture Content.

TABLE 4. Capacity of the JD 6601 at a Total Grain Loss of 3% of Yield*

Crop Conditions									Capacity Results						
Crop	Variety	Width of Cut		Crop Yield		Straw Condition	Grain Moist.ure	MOG	MOG Feedrate		Grain Feedrate		Ground Speed		Loss Curve
		m	ft	t/ha	bu/ac		%	G	t/h	lb/min	t/h	bu/h	km/h	mph	
Wheat	Neepawa	5.5	18	3.36	50	dry to tough	14.7	1.13	8.30	305	7.35	270	4.0	2.25	Fig. 10 & 14
Wheat	Neepawa	5.5	18	3.69	55	dry	12.0	1.23	8.30	305	6.75	248	3.4	2.1	Fig. 11 & 15
Barley	Bonanza	2.3	24	3.56	66	dry to tough	14.6	0.81	5.65	208	6.98	321	2.7	1.7	Fig. 12 & 16
Flax	Linott	4.6	15	1.82	29	very dry	8.7	0.92	5.90	216	6.40	252	8.4	5.2	Fig. 13 & 17

*In flax, maximum total loss was only 1% of yield.

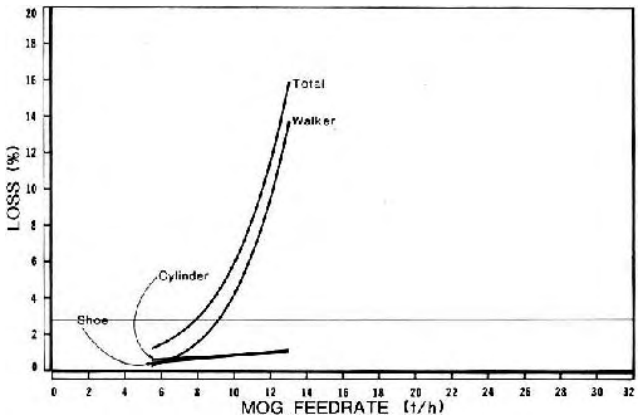


FIGURE 9. Grain Loss for the JD 6601 in Neepawa Wheat at 12% Grain Moisture Content.

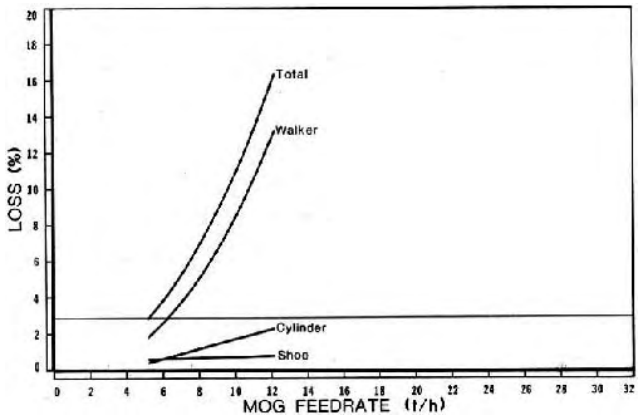


FIGURE 10. Grain Loss for the JD 6601 in Bonanza Barley. Bonanza Barley.

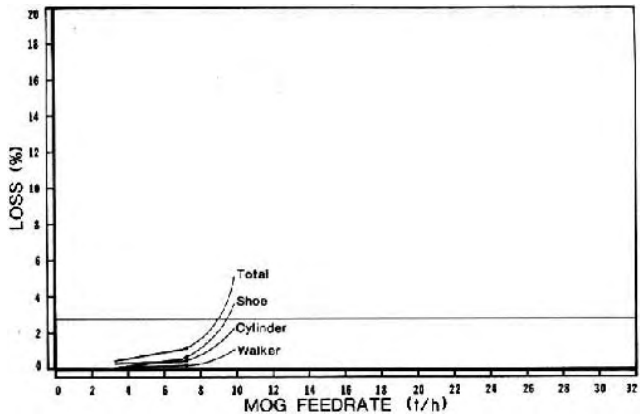


FIGURE 11. Grain Loss for the JD 6601 in Linott Flax.

Body Loss: Slight seed leakage occurred from the top and bottom doors of the tailings return elevator, from the top inspection door of the clean grain elevator and from the junction between the feeder housing and the combine body, but was insignificant. Total grain leakage from the combine body measured in a 1.3 t/ha (20 bu/ac) crop of Linott flax, was only 0.07% of yield.

Comparison to Reference Combine: Comparing the capacities of two combines is complex because crop and growing conditions influence combine performance with the result that slightly different capacity characteristics can be expected every year. As an aid in determining relative combine capacities, PAMI uses a reference combine. This combine is operated alongside test combines whenever capacity measurements are made. This permits the comparison of loss characteristics of every test combine to those of the reference combine, independent of crop conditions. The reference combine used by PAMI is commonly accepted in the prairie provinces and is described in PAMI evaluation report E0576C.

FIGURES 12 to 15 compare the total grain losses of the JD 6601 and the PAMI reference combine in the four crops described in TABLE 4. The shaded areas on the figures are the 95% confidence belts, If the shaded areas (confidence belts) overlap, the loss characteristics of the two combines are not significantly different whereas if the shaded areas do not overlap, the losses are significantly different. The capacity of the JD 6601 was similar to the capacity of the reference combine and both usually had similar grain losses when operating at the same feedrate.

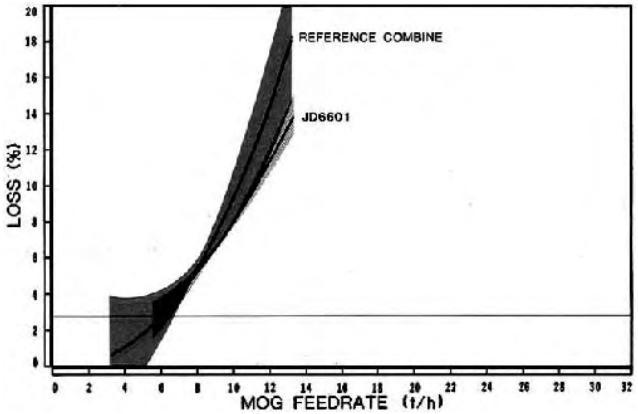


FIGURE 12. Total Grain Losses for the JD 6601 and the PAMI Reference Combine in Neepawa Wheat at 14.7% Grain Moisture Content.

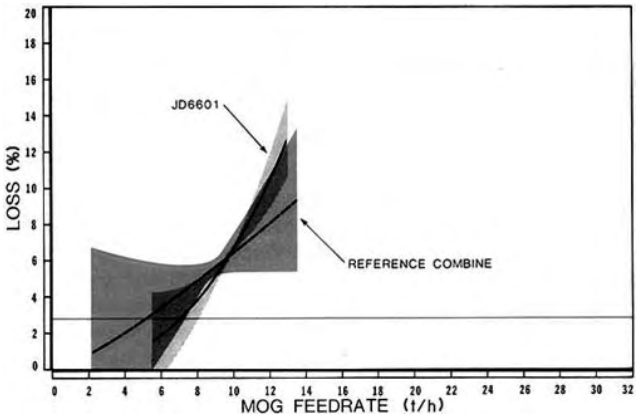


FIGURE 13. Total Grain Losses for the JD 6601 and the PAMI Reference Combine in Neepawa Wheat at 12% Grain Moisture Content.

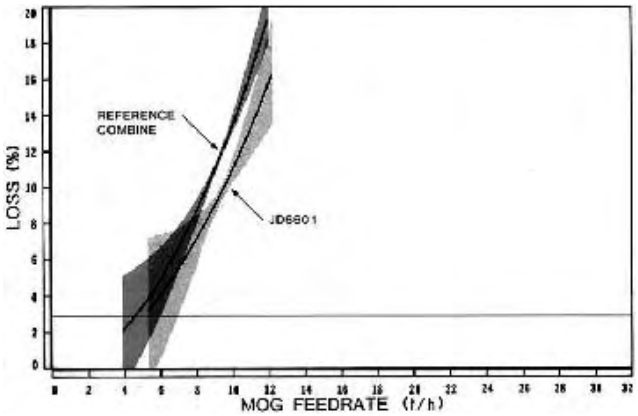


FIGURE 14. Total Grain Losses for the JD 6601 and the PAMI Reference Combine in

POWER REQUIREMENTS

The manufacturer recommended a minimum tractor size of 63 kW (85 hp). This tractor size was suitable for all normal combining however, when using a straw chopper in damp crops in soft or hilly fields, a minimum tractor size of about 75 kW (100 hp) was needed. Power consumption was measured only in one field. In a 3 t/ha (45 bu/ac) crop of dry Neepawa wheat the average power take-off input was 37 kW (50 hp).

The John Deere 4430 tractor, which was used to power the JD 6601 during the test, had ample power for all conditions. Average fuel consumption varied from 18 to 25£/h (4 to 5.5 Imp. gal/h).

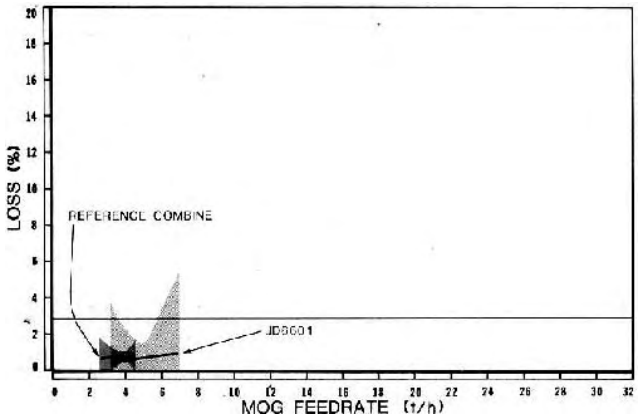


FIGURE 15. Total Grain Losses for the JD 6601 and the PAMI Reference Combine in Linott Flax.

OPERATOR SAFETY

The operator's manuals for both the combine and the pickup attachment emphasized operator safety precautions.

The JD 6601 had adequate warning decals. It was also equipped with a slow-moving-vehicle sign, warning lights and reflectors for safe road transport.

The JD 6601 was well shielded, giving good protection from moving parts. Some shields were easy to remove and install without tools; others were not. The tailings auger drive shield and the table auger and pickup drive shields were difficult to remove and replace. The shield covering the main power drive and feeder drive often swung open during operation as the locking bolt did not secure it sufficiently in closed position. Although the main body shrouding was aesthetically pleasing, it made servicing difficult and increased repair time and difficulty. The JD 6601 was equipped with a header lock and its proper use was emphasized in the operator's manual. The header lock must be used when working beneath the header, such as when cleaning the stone trap or unplugging a choked cylinder.

No rocking wrench or rocking hub was provided for unplugging the table auger or the feeder. This necessitated entry into the header, if plugging occurred. Entry into the header was difficult and hazardous due to sharp pickup teeth and the pickup windguard. A rocking wrench with suitable hubs would improve operator safety and convenience.

The operator must be cautioned about the many loaded springs used for tensioning drive tighteners.

Return tailings inspection was hazardous as a person had to stand on the hitch, in front of the left wheel, while supporting himself on the grain tank. Since return tailings must be inspected on-the-go, it is recommended that a suitable inspection port be installed at the bottom of the tailings elevator.

Care had to be taken to avoid pinching the hand between the main drive gear box and the hitch locking pin when pinning the drawpole in field position (FIGURE 5). A modification, such as a longer locking pin, is recommended to eliminate this possible hazard.

The JD 6601 was quite stable on hilly fields. The tractor hitch load became negative only when going up slopes greater than 13.5 degrees.

The hitch jack was safe and easy to use. The operator is cautioned to place the hitch jack at the rear of the combine before removing the header to prevent the combine from tipping rearward. It is recommended that a hitch safety chain be installed, especially when transporting or operating in hilly fields.

If recommended safety procedures were followed, all servicing and adjustments could be safely performed. A fire extinguisher should be carried on the combine or tractor at all times.

OPERATOR'S MANUAL

Operator's manuals were provided for both the combine and the windrow pickup. Both were clearly written, well illustrated and contained much useful information on servicing, adjustments and suggested settings in various crops. The combine manual did not include suggested settings for rapeseed and the information for the straw chopper referred to an older model, which is no longer produced.

DURABILITY RESULTS

TABLE 5 outlines the mechanical history of the John Deere 6601 combine during 182 hours of operation while combining about 323 ha (798 ac). 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 5. Mechanical History

Item	Operating Hours	Field Area ha	Field Area (ac)
Power Shaft			
-The bolts securing the intermediate wood alignment blocks on the power take-off drive shaft vibrated loose and were tightened and locked at	58	122	(301)
-The bearings in the centre power shaft universal joint failed and the joint assembly was replaced at	91	181	(446)
-The bearings in the rear power shaft universal joint failed and the joint assembly was replaced at	173	313	(773)
Drives			
-A washer was placed between the pickup jackshaft pulley and the jackshaft bearing to prevent the pickup drive chain from rubbing on the pulley at	26	61	(151)
-One drive sprocket attaching capscrew on the electromagnetic header drive clutch was lost and replaced at	73	151	(373)
-The inner race on the clean grain elevator jackshaft bearing cracked, causing the bearing to fail and damaging the shaft. The jackshaft was built up and the bearing replaced at	113	228	(563)
-The inner race on the left straw chopper bearing cracked causing bearing failure and damaging the rotor shaft. The rotor shaft was built up and the bearing replaced at	142	276	(682)
-The cotter pins on the tailings elevator lower sprocket sheared and were replaced at	120	242	(598)
-The cotter pins on the tailings elevator lower sprocket sheared again. The resultant choking loosened the flighting on the lower tailings cross auger. The flighting was rewelded and the cotter pins replaced at	168	306	(756)
-The table auger drive chain broke and was repaired at	175	314	(776)
-Half links were removed from the feeder conveyor chain to permit tightening at	178	318	(786)
-The pickup drive chain broke and was replaced at	180	320	(791)
Miscellaneous			
-The leading edge was ground off the grain tank loading auger flighting to eliminate rubbing on the auger tube at	Start of Test		
-The bolts attaching the right pickup wheel support arm loosened and were tightened at	124	249	(615)
-The bolts attaching the header to the feeder housing loosened and were resecured at	135	266	(658)
-Fifty-three pickup teeth had broken, requiring replacement, by	End of Test		

DISCUSSION OF MECHANICAL PROBLEMS

Pickup Teeth: Most pickup tooth breakage occurred on the outer pickup belts, with 12 breaking on the right belt and 35 breaking on the left belt. Crop cushioning probably reduced the impact of the teeth on the stripper bar resulting in fewer failures on the centre belts.

Modifying the stripper bar location appears necessary as the pickup teeth had worn through the rubber cushion before the end of the test.

Tailings Elevator: Shearing of the cotter pins attaching the lower tailings elevator sprocket to the lower cross auger shaft occurred when combining rapeseed. Optimum combine settings resulted in high return flow of pods and chaff.

Bearing Failures: Failure of bearings on the clean grain elevator jackshaft and on the straw chopper rotor shaft were initiated by cracking of the inner bearing race. This could possibly have been caused by the procedure used in securing the bearing lock collars during combine assembly.

APPENDIX I
SPECIFICATIONS

MAKE:	John Deere Pull Type Combine
MODEL:	6601
SERIAL NUMBER:	Header 21221 eH Combine Body 211933
MANUFACTURER:	John Deere Harvester Works East Moline, Illinois 61244 USA
WINDROW PICKUP:	
-type	belt
-pickup width	3350 mm (132 in)
-number of belts	6
-teeth per belt	70
-type of teeth	spring steel
-number of rollers	3
-height control	castor wheels
-speed control	manually adjusted variable pitch sheaw
-speed range	400 to 490 rpm
HEADER:	
-type	off set
-width	3960 mm (13 ft)
-auger diameter	508 mm (20 in)
-feeder conveyor	3 roller chains, undershot slatted conveyor
-conveyor speed	2.16 m/s (426 ft/min)
-range of picking height	-40 to 1060 mm (-1.5 to 42 in)
-number of lift cylinders	1
-raising time, (with JD 4430 tractor)	3 s
-lowering time, (with JD 4430 tractor)	3 s
-options	header cutting equipment
CYLINDER:	
-type	rasp bar
-number of bars	8
-diameter	559 mm (22 in)
-width	1096 mm (43.15 in)
-drive	crank controlled variable pitch belt
-speeds (standard)	440 to 1210 rpm
-speeds (optional)	280 to 845 rpm
-stripper bar	10 mm (0.38 in) fabric belting
CYLINDER BEATER:	
-type	drum with 4 triangular bats
-diameter	330 mm (13 in)
-speed	varies with cylinder speed
CONCAVE:	
-type	bar and wire grate
-number of bars	13
-configuration	12 intervals with 6.2 mm (0.25 m) wires and 17 mm (0.69 in) spaces
-area	0.57 m^2 (885 in^2)
-transition grate area	0.29 m^2 (455 in^2)
-wrap	105 degrees
-grain delivery to shoe	5 auger conveyors
-options	concave filler bars stone trap cover
STRAW WALKERS:	
-type	rotary, formed metal
-number	4
-length	3302 mm (130 in)
-width of body	1118 mm (44 in)
-separating area	3.69 m^2 (5720 in^2)
-crank throw	152 mm (6 in)
-speed	157 rpm
-grain delivery to shoe	5 auger conveyors
-options	risers, plugging sensor
SHOE:	
-type	opposed action
-speed	275 rpm
-chaffer sieve	adjustable lip, 1.65 m^2 (2550 in^2) with 47 mm (1.88 in) throw
-clean grain sieve	adjustable lip 1.24 m^2 (1928 in^2) with 39 mm (1.50 in) throw
CLEANING FAN:	
-type	4 blade undershot
-diameter	510 mm (20 in)
-width	1080 mm (42.5 in)
-drive	crank controlled variable pitch belt
-speed range	280 to 970 rpm
ELEVATOR:	
-type	roller chain with rubber flights and top delivery
-clean grain (top drive)	162 × 241 mm (638 × 95 in)
-tailings (bottom drive)	130 × 203 mm (5 × 8 in)
GRAIN TANK:	
-capacity	3 5 m^3 (96 bu)
-unloading time	86 s

STRAW CHOPPER:	
-type	rotor with 24 freely swinging hammers
-speed	2350 rpm
-options	straw spreader
NUMBER OF CHAIN DRIVES:	9
NUMBER OF BELT DRIVES:	13
NUMBER OF PRELUBRICATED BEARINGS:	67
LUBRICATION POINTS:	
10 h lubrication	32
50 h lubrication	3
100 h lubrication	5
500 h lubrication	4
CLUTCHES:	
-header	electromagnetic
-unloading auger	electromagnetic
TIRES:	2, 184 x 26 6-ply
OVERALL DIMENSION:	
-wheel tread	2870 mm (113 in)
-transport height	3090 mm (122 in)
-transport length	9180 mm (362 in)
-transport width	4750 mm (187 in)
-field height	3670 mm (145 in)
-field length	9180 mm (362 in)
-field width	7790 mm (307 in)
-unloader discharge height	2770 mm (109 in)
-unloader clearance height	2770 mm (109 in)
-unloader reach	2610 mm (103 in)
WEIGHT: (with empty grain tank and hitch in field position)	
-right wheel	2200 kg (4850 lb)
-left wheel	2280 kg (5030 lb)
-hitch	385 kg (870 lb)
Total	4875 kg (10750 lb)

APPENDIX II
STATISTICAL SIGNIFICANCE OF CAPACITY RESULTS

The following data are presented to illustrate the statistical significance of the capacity results shown in FIGURES 8 to 11. This information is intended for use by those who may wish to check results in greater detail. Sufficient information is presented to permit calculation of confidence belts.

In the following table for the John Deere 6601 pull-type combine, C = cylinder loss in percent of yield, S = shoe loss in percent of yield, W = straw walker toss in percent of yield, F = the MOG feedrate in t/h, while ℓn is the natural logarithm. Sample size refers to the number of loss collections. Limits of the regressions may be obtained from FIGURES 8 to 11 while crop conditions are presented in TABLE 4.

CROP — VARIETY	FIG NO.	REGRESSION EQUATION	SIMPLE CORRELATION COEFFICIENT	STANDARD ERROR OF SLOPE	RESIDUAL MEAN SQUARE	MEAN FEED-RATE	SAMPLE SIZE
WHEAT — Neepawa	8	$\ell nC = -0.49 + 0.74\ell nF$	0.80	0.28	0.03	9.23	6
		$\ell nS = -0.21 - 0.35\ell nF$	0.27	0.63	0.17		
		$\ell nW = -7.72 + 3.94\ell nF$	0.99	0.19	0.01		
WHEAT — Neepawa	9	$C = 0.26 + 0.06F$	0.54	0.05	0.09	9.72	6
		$S = -0.19 + 0.10F$	0.80	0.04	0.06		
		$\ell nW = -6.89 + 4.48\ell nF$	0.97	0.56	0.16		
BARLEY — Bonanza	10	$C = -0.99 + 0.27F$	0.72	0.11	0.43	9.31	8
		$S = 0.42 + 0.03F$	0.18	0.08	0.22		
		$\ell nW = -3.14 + 2.29\ell nF$	0.88	0.50	0.13		
FLAX — Linott	11	$C = 0.13 + 0.04F$	0.80	0.02	0.004	4.80	4
		$S = -0.28 + 0.11F$	0.80	0.06	0.03		
		$\ell nW = -3.17 + 0.73\ell nF$	0.82	0.36	0.05		

APPENDIX III
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 IV
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 kilometre/hour (km/h)	= 0.62 miles/hour (mph)
1 hectare (ha)	= 2.47 acres (ac)
1 kilogram (kg)	= 2.2 pounds (lb)
1 tonne (t)	= 2204.6 pounds (lb)
1 tonne/hectare (t/ha)	= 0.45 ton/acre (ton/ac)
1 tonne/hour (t/h)	= 36.75 pounds/minute (lb/min)
1000 millimetres (mm) = 1 metre (m)	= 39.37 inches (in)
1 kilowatt (kW)	= 1.34 horsepower (hp)
1 litre/hour (L/h)	= 0.22 Imperial gallons/hour (gal/h)

ALBERTA FARM MACHINERY RESEARCH CENTRE

3000 College Drive South
Lethbridge, Alberta, Canada T1K 1L6
Telephone: (403) 329-1212
FAX: (403) 329-5562
http://www.agric.gov.ab.ca/navigation/engineering/afmrc/index.html

Prairie Agricultural Machinery Institute
Head Office: P.O. Box 1900, Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-2555

Test Stations:
P.O. Box 1060
Portage la Prairie, Manitoba, Canada R1N 3C5
Telephone: (204) 239-5445
Fax: (204) 239-7124

P.O. Box 1150
Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-5033
Fax: (306) 682-5080