Evaluation Report No. E3079A
Printed: May, 1980
Tested at: Humboldt
ISSN 0383-3445

Evaluation Report 190

John Deere 7721 Pull-Type Combine

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

JOHN DEERE 7721 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 3L8

RETAIL PRICE:
$48,521.68, February 1980, f.o.b. Humboldt, with 3.78 m header, 3.35 m belt pickup, straw chopper, high speed beater, and hitch extension.

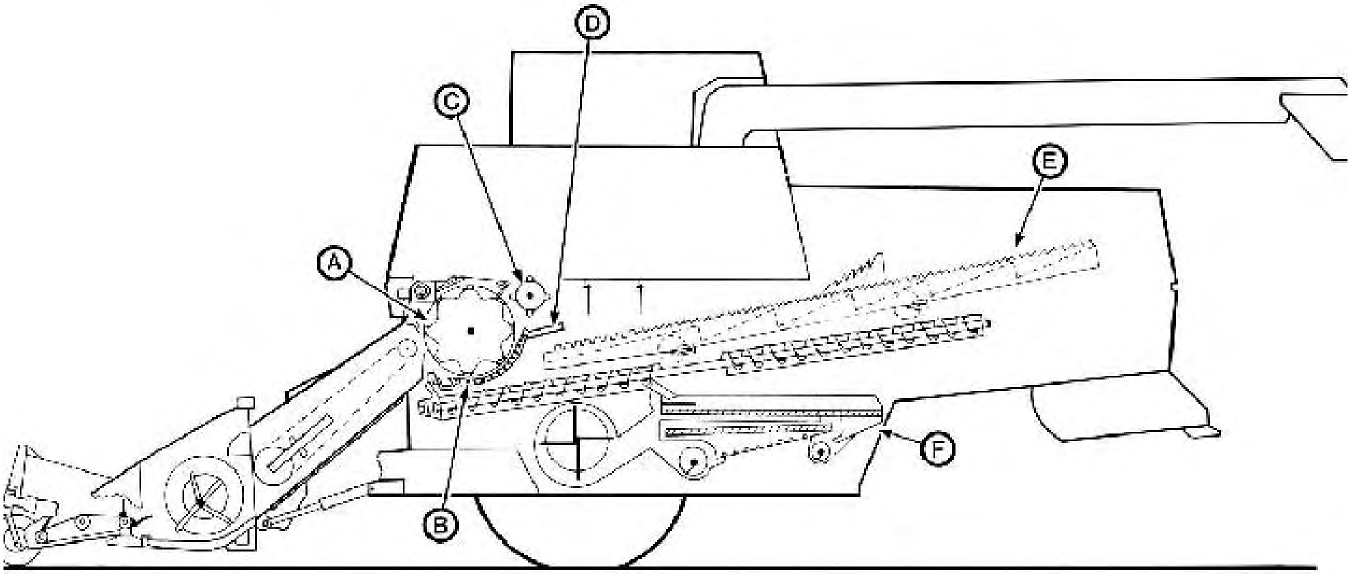

Figure 1. John Deere 7721: (A) Cylinder, (B) Concave, (C) Back Beater, (D) Beater Grate, (E) Straw Walkers, (F) Shoe.

SUMMARY AND CONCLUSIONS

Functional performance of the John Deere 7721 pull-type combine was very good in dry grain and oil seed crops and good in tough grain and oil seed crops.

The MOG feedrate[1] at 3% total grain loss varied from 16.3 t/h (600 lb/min) in 2.7 t/ha (40 bu/ac) Neepawa wheat to 8.1 t/h (300 lb/min) in 3.7 t/ha (68 bu/ac) Klages barley.

The capacity of the John Deere 7721 was much greater in wheat and somewhat greater in barley than the capacity of the PAMI reference combine for a similar total grain loss. Straw walker loss limited capacity in most crops. A reduction in grain loss over the straw walkers would have permitted higher combining rates. In easy-to-thresh crops, on level ground, cylinder and shoe losses usually were insignificant.

At a 3% total grain loss, average power requirements were 53 kW (71 hp) in wheat and 33 kW (44 hp) in barley. Although the manufacturer recommends a minimum 93 kW (125 hp) tractor, a 112 kW (150 hp) tractor was required when combining in hilly fields.

The John Deere 7721 was very maneuverable and was easily changed from transport to field position. Header visibility, ease of handling and control convenience depended on the tractor used. Feedrate control depended on the range of ground speeds provided by the tractor.

Grain level visibility was very good. Combine lighting provided good night visibility when supplemented by tractor lights. The unloading auger had ample reach and clearance for unloading on-the-go.

The combine control box provided the operator with very good warning of component malfunction. It also gave finger tip control of important functions.

The John Deere 7721 was very easy to adjust for specific field conditions. The pickup speed and cylinder speed were adjusted from the tractor while the concave, fan and shoe adjustments were located on the combine. Inspection of return tailings was both hazardous and inconvenient.

Ease of servicing was very good as hard-to-reach fittings were located by lubrication banks.

The table auger and feeder had very good capacity in all crops and plugging was infrequent. Cylinder plugging occurred occasionally. Cylinder access was poor.

The stone trap stopped most stones and roots before they entered the cylinder and was easy to clean. The pickup had good picking and very good feeding characteristics in all crops.

The John Deere 7721 transported well at speeds up to 30 km/h (20 mph). Transport width required extra caution when operating on most roads. Rear visibility was restricted.

Some minor safety hazards were encountered during operation.

The operator's manual was well illustrated and clearly written providing much useful information on service and adjustments.

Several minor durability problems occurred during the test.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Supplying a hitch safety chain.
2. Modifying the grain tank extension screens to eliminate leakage in rapeseed.
3. Modifications to eliminate unloading auger run-on after disengagement and to concentrate the stream of grain at the auger discharge to reduce wind losses.
4. Supplying a rocking hub on the table auger to facilitate unplugging.
5. Improving cylinder accessibility and modifying the lugs on

[1]MOG Feedrate (Material-Other-than-Grain Feedrate) is the weight of straw and chaff passing through a combine per unit time.

the cylinder drive pulley to prevent rocking bar slippage, to improve the ease and safety of cylinder unplugging.
6. Modifications to reduce header twist when the table is locked in transport position.
7. Providing inspection ports for the front of the concave and improving the accessibility of the concave front levelling bolt.
8. Modifications to improve the ease and safety of sampling return tailings.
9. Supplying a straw chopper belt shield.
10. Modifying the combine ladder to improve safety.
11. Supplying a lock for the grain tank extensions.
12. Modifying the torque sensing unit on the variable cylinder drive to provide proper belt tension over the entire speed range and to reduce grease loss from the housing.
13. Revising the operator's manual to include more appropriate recommended cylinder speeds for rapeseed.
14. Modifying the concave front levelling bolt support member to eliminate bending of the support during operation.
15. Modifications to reduce dust at the feeder entrance.

Chief Engineer -- E.O. Nyborg
Senior Engineer -- J.D. MacAulay
Project Technologist -- L.G. Hill

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Hitch chains are available as optional equipment but were not ordered with the test combine.
2. Grain tank extension screens are used to allow good visibility when filling the tank. There are no plans to change these extensions.
3. The five second run-on time has been considered acceptable but this will be evaluated again. Changes to alter the discharge stream are being considered for future production.
4. A method of assisting the operator in unplugging the header is under evaluation.
5. This will be evaluated in future designs.
6. The operator's manual does not recommend lowering the header to the safety stop for transport. However, there is no adverse affect from the situation described.
7. This will be evaluated in future designs.
8. The operator's manual will be revised to recommend sampling tailings by opening the lower elevator door.
9. Current shielding meets ASAE Standard S-318. The need for additional shielding will be evaluated.
10. The operator's manual will be revised to recommend against mounting and dismounting during operation.
11. This will be considered for future production.
12. Improvements have been introduced on 1980 machines and farmer owned machines are being modified to remedy this problem.
13. Operator's Manual instructions will be revised to recommend a cylinder speed of 450 to 650 rpm.
14. This will be considered for future production.
15. This will be evaluated in future designs.

NOTE: This report has been prepared using SI units of measurement. A conversion table is given in APPENDIX V.

GENERAL DESCRIPTION

The John Deere 7721 is a power take-off driven pull-type combine with a transverse-mounted, tangential threshing cylinder, straw walkers and a cleaning shoe. Threshing and initial separation occurs at the cylinder and concave while the straw walkers accomplish final separation of grain from straw. Grain is cleaned at the shoe and the tailings delivered to the cylinder.

The test machine was equipped with a straw chopper and a 3350 mm (132 in) three-roller belt pickup mounted on a 3780 mm (12.4 ft) centre delivery header.

The separator drive is controlled by the tractor power take-off clutch. The header and unloading auger drives are controlled by electromagnetic clutches, while header height and unloading auger swing is controlled by the tractor hydraulics. Cylinder and pickup speeds are hydraulically actuated and electrically controlled from the combine control box mounted in the tractor cab. Cylinder speed and harvesting functions are monitored at the control box.

Concave clearance is adjusted with a ratchet lever located on the right combine side. Fan speed is adjusted with a hand-wheel controlling a variable speed belt drive while the sieves are adjusted with levers at the rear of the shoe. Return tailings may be inspected through a door at the top of the tailings return elevator.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The John Deere 7721 was operated* in a variety of Saskatchewan crops (TABLES 1 and 2) for 120 hours while harvesting about 315 ha (780 ac). It was evaluated for ease of operation, ease of adjustment, rate of work, grain loss characteristics, power requirements, operator safety and suitability of operator's manual. Throughout the tests comparisons were made to the PAMI reference combine.

TABLE 1. Operating Conditions

Crop	Variety	Average Yield t/ha	Swath Width m	Hours	Field Area ha
Barley	Fergus	2.6	5.4 to 7.3	11	18
Barley	Klages	2.4	6.0 to 7.5	8	19
Flax	Dufferin	1.4	6.8 to 6.1	6	17
Rapeseed	Candle	1.5	5.1	10	21
Rapeseed	Regent	1.4	6.0	7	21
Rapeseed	Torch	1.1	5.9 to 6.2	19	69
Rye	Cougar	1.1	4.4 to 11.8	24	59
Wheat	Neepawa	2.6	5.9 to 7.3	35	91
Total				120	315

TABLE 2. Operation in Stony Conditions

Field Condition	Hours	Field Area (ha)
Stone Free	16	44
Occasional Stones	85	217
Moderately Stony	19	54
Very Stony	0	0
Total	120	316

RESULTS AND DISCUSSION

EASE OF OPERATION

Hitching: A tractor with a 45 mm (1.75 in) spline, 1000 rpm power take-off, a 12 volt negative ground electrical system and dual hydraulics, was required to power the John Deere 7721 combine. The following adjustments were needed before attaching the tractor to the combine: The tractor had to be equipped with a seven pin electrical connector. The control box had to be suitably located in the tractor cab and the control cables routed out of the cab. The tractor draw bar had to be pinned in line with the power take-off and a suitable hitch extension used to provide 660 mm (26 in) distance from the end of the power take-off shaft to the hitch pivot. The power take-off driveshaft had to be adjusted to minimize the vertical drive line angle. The short turn warning switch had to be mounted and connected. The tractor drawbar had to be backed into the hitch extension, a pin inserted and locked, and the six bolts on the extension tightened and locked. Three hydraulic hoses, two electrical connectors, and the power take-off shaft, had to be coupled to the tractor.

Hitching and unhitching was inconvenient because of the hitch extension. No hitch safety chain was supplied and it is recommended that the manufacturer consider supplying a safety chain.

Operator Location: Operator comfort and visibility depends mainly on the type of tractor used. Being located farther away from the combine reduces the "feel" for combine performance thus combine monitoring equipment becomes more important.

Controls: The separator drive was controlled with the power take-off clutch. Electromagnetic clutches activated from the control box (FIGURE 2) controlled the header drive and the unloading auger drive. The tractor hydraulics were used to control header height and unloading auger position. Cylinder and pickup speeds were hydraulically operated and also electrically controlled from the control box. The control box also contained a cylinder tachometer and shaft speed monitors for the straw chopper, shoe supply augers, tailings return, clean grain elevator, and straw walkers as well as a warning light for straw walker plugging and unloading auger engagement. The combine lights were controlled with the tractor light switch. The range of ground speeds available depended upon the tractor transmission.

Lights: The John Deere 7721 was equipped with three field lights, one for the header, one for the grain tank, and one for the unloading auger.

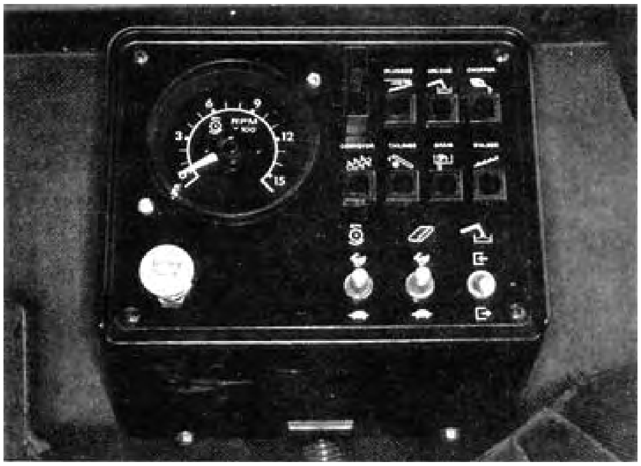

FIGURE 2. Tractor Mounted Control Box.

The tractor and combine lights were adequate for night-time harvesting, however, in some crops the dust coming from the feeder restricted night visibility (FIGURE 3). It is recommended that the manufacturer consider modifications to reduce dust at the feeder entrance. Warning lights and the taillight were adequate for safe road travel.

FIGURE 3. Excessive Dust at Feeder Entrance.

Stability: The John Deere 7721 was quite stable, even with a full grain tank, when operating on level ground. The centre of gravity with the grain tank three-quarters full of wheat was about 1930 mm (76 in) above ground, 250 mm (10 in) ahead of the axle and 110 mm (4 in) to the left of the combine centre-line. Care was necessary when operating in hills as the hitch load became negative when travelling up slopes greater than 11 degrees with a three-quarter full tank. In hilly, sandy fields with the grain tank two-thirds full, the tractor had insufficient traction for climbing slopes greater than 10 degrees even when fully ballasted and equipped with dual wheels.

Maneuverability: The John Deere 7721 was very maneuverable. The centre delivery header made it easy to pick windrows around most corners and to feed windrows directly into the feeder throat opening (FIGURE 4). The drawpole, when set in mid-position, allowed a maximum wheel width of 4600 mm (180 in) even when combining fluffy windrows such as rapeseed (FIGURE 5). This allowed the tractor to be equipped with dual wheels. The minimum width of windrower, which permitted back-and-forth combining was 6100 mm (20 ft) when combining fluffy windrows with a 3600 mm (140 in) tractor width.

Grain Tank: Grain tank volume was 7.1 m³ (195 bu). The grain tank filled evenly and completely in all crops, however in Candle rapeseed, seed leaked through the perforations in the tank extension screens (FIGURE 6). It is recommended that the manufacturer consider modifying the extension screen to eliminate leakage in rapeseed.

The unloading auger had ample reach and clearance for easy on-the-go unloading. It could be hydraulically positioned from the tractor seat. In dry wheat, the 7.1 m³ (195 bu) tank could be unloaded in 105 seconds. The auger discharge characteristics (FIGURE 7) and high discharge height often resulted in grain loss when unloading in windy conditions. The unloading auger also continued to run for about 5 seconds after the clutch was disengaged, which made topping-off a load inconvenient. It is recommended that the manufacturer consider modifications to eliminate auger run-on after disengagement and to concentrate the stream of grain at the auger discharge to reduce wind losses.

FIGURE 4. Direct Feeding of Windrow.

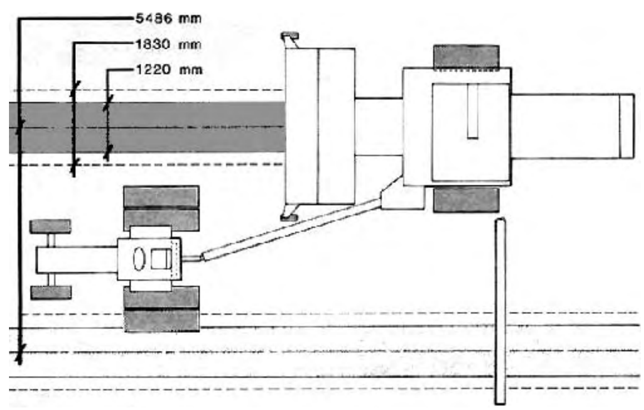

FIGURE 5. Tractor Wheel and Windrow Spacing Needed for In-Line Feeding.

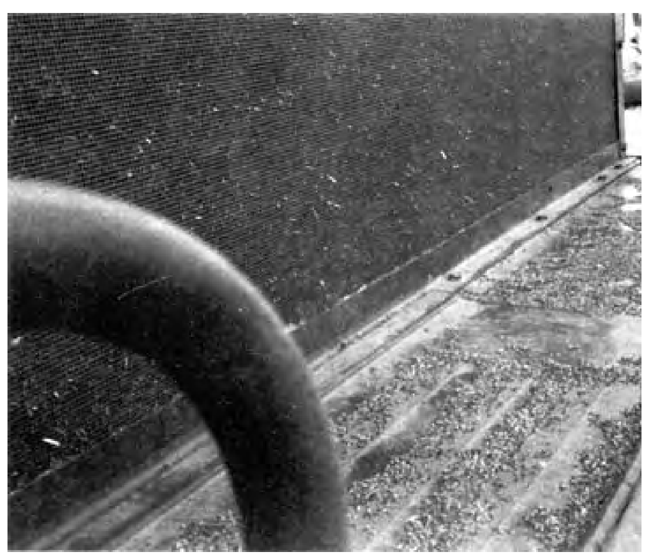

FIGURE 6. Rapeseed Leakage.

Pickup: The John Deere 7721 was equipped with a John Deere 3350 mm (132 in), three-roller belt pickup. Picking height was controlled by the pickup castor wheels while pickup angle was determined by header height. Pickup speed was adjusted by an electrically controlled variable speed hydrostatic drive. The pickup performed well in all crops. Best performance was with the top two rollers run parallel to the ground, causing the windrow to feed under the header auger.

FIGURE 7. Unloading Auger Discharge.

Stone Trap: The stone trap located in front of the cylinder prevented most stones and roots from entering the cylinder. The stone trap opened easily by tripping the overcentreing levers (FIGURE 8). Complete cleaning required hand removal of objects, which was inconvenient.

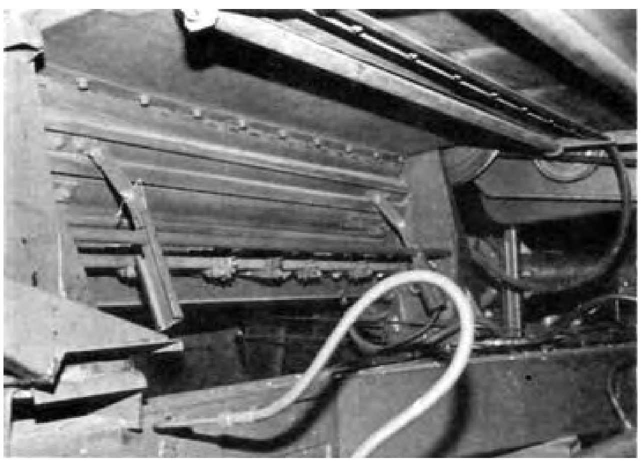

FIGURE 8. Stone Trap.

Straw Chopper: The optional straw chopper attachment performed satisfactorily in all crops. The length of cut could be varied by adjusting knife protrusion into the chopper housing. The width of spread could be changed by adjusting the deflector fins and the tail plate. Maximum spreading width was about 5 m (16 ft), but varied with wind and straw conditions. Spreading was inadequate for swath widths greater than 5 m (16 ft). Removal of the straw chopper, for windrowing unchopped straw, was difficult.

Plugging: The table auger and feeder were very aggressive and did not plug or limit capacity in normal operation. The feeder plugged only once during the test, due to cylinder plugging. Clearing the feeder required reversing the header by turning the table auger backwards. This is an awkward and dangerous procedure and it is recommended that the manufacturer consider supplying a rocking hub on the table auger.

The cylinder plugged occasionally when a wad of straw was picked up or when too high feedrates were attempted. Once the cylinder had plugged, lowering the concave to the clean out position and attempting to "power feed" the slug through was ineffective and usually increased the severity of plugging. This could also cause damage to the tailings return auger housing, cylinder housing and front panel stripper (FIGURES 9 and 10). Unplugging the cylinder by hand was very difficult. Access to the cylinder was poor and it was difficult and hazardous to reverse the cylinder as the rocking bar easily slipped off on the rocking hub. It is recommended that the manufacturer consider improving cylinder accessibility and modifying the cylinder rocking hub to prevent bar slip.

Machine Cleaning: Complete cleaning of the John Deere 7721 was laborious and time consuming. The grain tank had many obstructions, which retained seeds, and the turret auger sump retained a large amount of grain which had to be removed through the clean out door at the bottom of the vertical auger. The shoe supply augers under the concave and straw walkers were cleaned by dropping the rear trough and opening front clean out pods. Removal of the sieves was inconvenient. Sieve removal and replacement required two people. With the sieves removed the tailings return cross auger was accessible. The clean grain cross auger had clean out doors on the bottom of its housing. Dust and chaff accumulation on the combine body was quite easy to clean.

FIGURE 9. Deformed Return Auger Housing & Cylinder Housing.

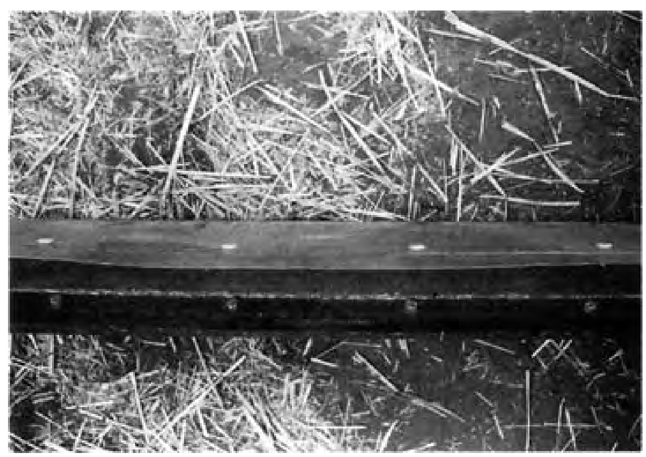

FIGURE 10. Deformed Front Panel Stripper.

Transporting: The John Deere 7721 was easily changed to transport position by one person. The unloading auger was positioned hydraulically while the hitch pole latching pin was spring loaded. Blocking the right combine wheel made it easy to swing the draw pole in and out of transport position.

The header transport lock, which was attached to the left header lift ram, was inconvenient to reach. Since only the left ram was locked, the right end of the table settled noticeably during transport (FIGURE 11). It is recommended that the manufacturer consider modifications to reduce header twist when the table lift is locked in transport position.

The John Deere 7721 transported well at speeds up to 32 km/h (20 mph). It had adequate reflectors, warning lights and a slow-moving vehicle sign. Due to its overall width, care had to be taken in transporting on narrow roads.

Lubrication: There were 27 pressure grease fittings on the John Deere 7721. Five needed greasing every 10 hours, seventeen need greasing every 50 hours, two every 100 hours, and three every 200 hours. Lubrication banks improved ease of servicing. All lubrication points were very accessible.

The hydraulic oil should be checked daily and the powershaft gearcase every 100 hours.

EASE OF ADJUSTMENT

Field Adjustments: The John Deere 7721 was easy to adjust. As with all pull-type combines, having a second person available enabled faster setting.

FIGURE 11. Header Twist During Transport.

Concave adjustment: The John Deere 7721 had a single segment concave. The front of the concave was levelled with a single drawbolt while front clearances were gauged through the stone trap. Checking the front clearances and adjusting the draw bolt were difficult due to poor accessibility. It is recommended that the manufacturer consider providing inspection ports for the front of the concave, and improving the accessibility of the front levelling draw bolt.

After the front of the concave was levelled and set at 5 mm (0.20 in) clearance the rear of the concave was levelled and set to zero clearance. This was accomplished with draw bolts on each side while inspection ports were available to gauge the rear concave clearance. Levelling the rear of the concave was easy although the draw bolts were not easily accessible. At these settings the concave clearance indicator was set to 0. These clearances should be checked periodically throughout the season.

Threshing clearances were easily set with the reversible ratchet assembly on the right side of the combine (FIGURE 12). The linkage allowed the front of the concave to open about twice the rate of the rear. The range of clearances at the second bar from the front were from 5 to 15 mm (0.2 to 0.6 in) and from 0 to 5 mm (0 to 0.2 in) at the fourth bar from the rear.

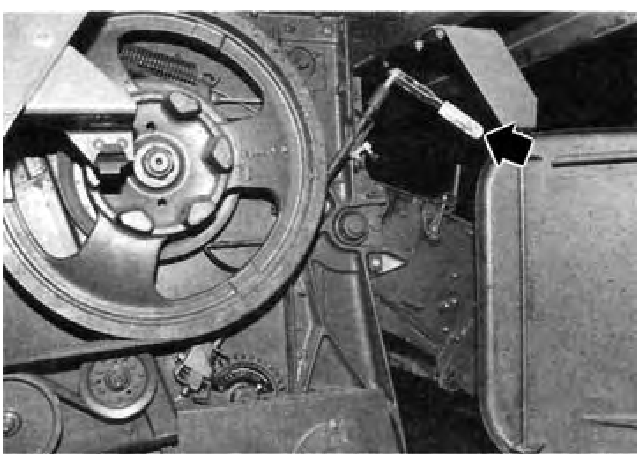

FIGURE 12. Concave Clearance Adjustment.

Suitable concave settings were numbers 0 to 2 in spring wheat, number 1 in barley, 0 to 2 in fall rye, 3 to 6 in rapeseed and 0 in flax.

Optional filler bars were not evaluated.

Cylinder Adjustment: The cylinder was equipped with a variable speed drive, adjustable from the tractor seat, and a tachometer located on the control box. The variable drive provided speeds from 430 to 1220 rpm. This range was adequate for all crops encountered during the test.

Suitable cylinder speeds were 800 to 950 rpm in spring wheat, 750 to 900 rpm in barley, 700 to 900 rpm in fall rye, 450 to 650 rpm in rapeseed and 1000 rpm in flax.

Beater Grate Adjustment: The back beater grate could be set in two positions. The top position was used throughout the test.

Shoe Adjustment: The shoe was convenient to adjust. Fan blast was varied with a hand wheel operated variable speed drive (FIGURE 13). The chaffer, chaffer extension and clean grain sieves were adjusted with levers at the rear of the shoe. The return tailings could be inspected only at the top of the tailings elevator. Access to the return tailings inspection door was inconvenient and dangerous.

The shoe was easy to set and performed very well in all crops. The foreign material in the tank sample varied from 0.3 to 3.3% when properly adjusted.

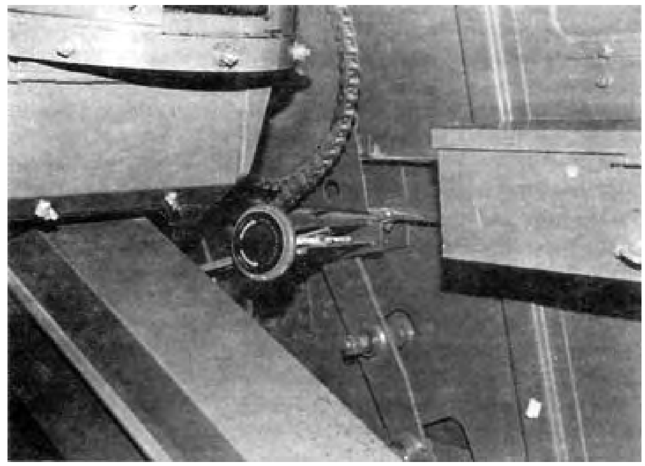

FIGURE 13. Fan Adjustment Hand Wheel.

It was important to feed the windrow centred on the feeder housing and to load the full cylinder width to ensure uniform shoe loading. As with most combines, shoe loss increased noticeably when combining on side slopes greater than 5 degrees due to non-uniform shoe loading.

Header Adjustments: The John Deere 7721 was tested only with the windrow pickup header. The table could be removed by one man in about 15 minutes. Removal of the complete header and feeder assembly took two men about 30 minutes.

Simple adjustments permitted levelling the header, adjusting the feeder chain, adjusting the feeder conveyor float, setting the table auger clearance and timing the feeding fingers.

Slip Clutches: Individual slip clutches protected the table auger, feeder conveyor, straw walkers, shoe grain supply augers and the tailings return elevator.

RATE OF WORK

Average Work Rates: TABLE 3 presents average workrates for the John Deere 7721 in all crops harvested during the test. Average work rates are affected by crop conditions in a specific year and should not be used to compare combines tested in different years. In some crops, workrates were reduced by bunched or sunken windrows, rough ground, irregular shaped fields and insufficient grain handling equipment. During the 1979 harvest, average workrates varied from 6.9 t/h (254 bu/h) in 2.6 t/ha (39 bu/ac) Neepawa wheat to 2.6 t/h (104 bu/h) in 1.1 t/ha (17.5 bu/ac) in Cougar fall rye.

Maximum Feedrate: The workrates given in TABLE 3 represent average workrates at acceptable loss levels. The tractor used had ample power to achieve higher workrates in nearly all crops. In most crops the maximum acceptable feedrate was limited by grain loss and the maximum feedrate was limited by cylinder and header plugging. In light crops the maximum feedrate was limited by pickup performance.

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 yield and moisture content, 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 the straw and chaff being processed and the quantity of grain being processed. The weight of the straw and chaff passing through a combine per unit time is called 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.

TABLE 3. Average Workrates

Crop	Variety	Average Yield t/ha	Average Speed km/h	Average Workrate ha/h	Average Workrate t/h
Barley	Fergus	2.6	4.2	1.6	4.1
Barley	Klages	2.4	4.5	2.4	5.8
Flax	Dufferin	1.4	6.0	2.8	3.9
Rapeseed	Candle	1.5	6.0	2.2	3.4
Rapeseed	Regent	1.4	6.0	3.0	4.2
Rapeseed	Torch	1.1	7.0	3.6	3.8
Rye	Cougar	1.1	5.3	2.5	2.6
Wheat	Neepawa	2.6	6.2	2.6	6.9

The weight of grain or seed passing through the combine per unit time is called Grain Feedrate. The ratio of the MOG Feedrate to the 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 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 as MOG/G ratio when determining combine capacity. MOG/G ratios for prairie wheat crops vary from about 0.5 to 1.5.

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 and chaff. Unthreshed grain is called cylinder loss. Free grain in the straw and chaff is called separator loss and consists of shoe and walker loss. 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 John Deere 7721: TABLE 4 presents capacity results for the John Deere 7721 in six different crops. MOG Feedrates for a 3% total grain loss varied from 16.3 t/h (600 lb/rain) in a field of 2.7 t/ha (40 bu/ac) Neepawa wheat to 8.1 t/h (300 lb/min) in a field of 3.7 t/ha (68 bu/ac) Klages barley.

GRAIN LOSS CHARACTERISTICS

The grain loss characteristics for the John Deere 7721 in the six crops described in TABLE 4 are presented in FIGURES 14 to 19.

Walker Loss: Common to most conventional combines, walker loss was the most significant factor limiting capacity in all grain crops. Cylinder 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.

Shoe Loss: Shoe loss did not limit combine capacity in grain crops; however, in rapeseed and flax shoe losses were significant at high feedrates. High shoe losses could occur on hilly fields or with improper settings.

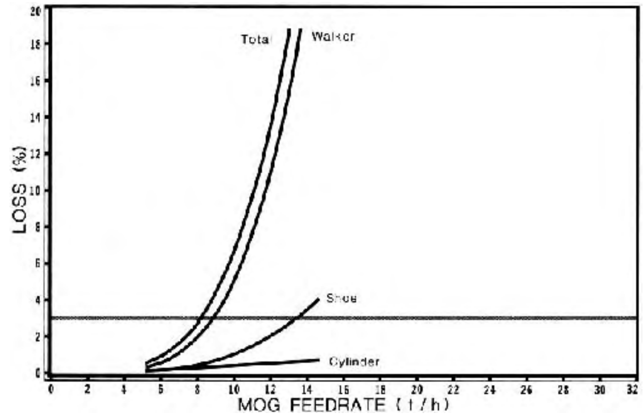

FIGURE 14. Grain Loss in Klages Barley.

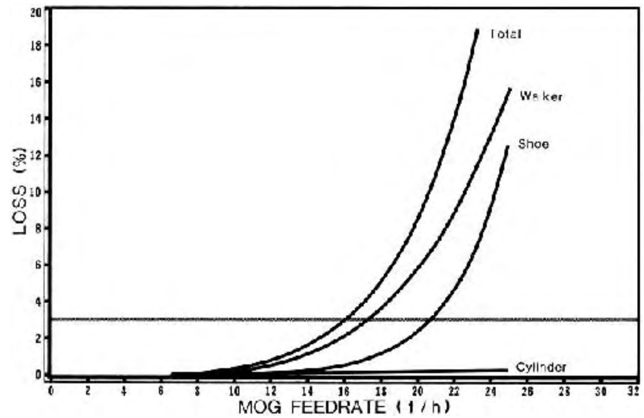

FIGURE 15. Grain Loss in Neepawa Wheat (Field A).

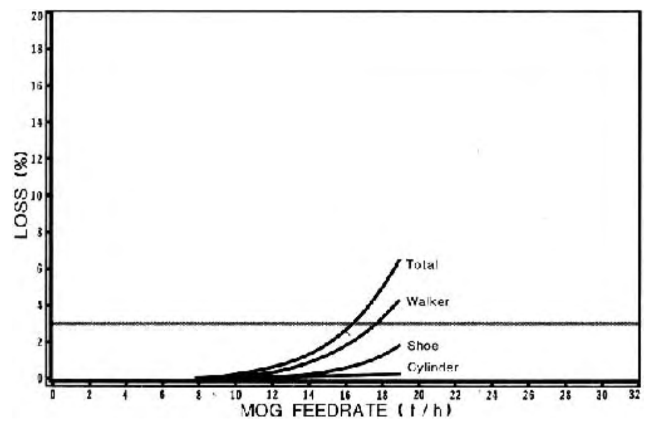

FIGURE 16. Grain Loss in Neepawa Wheat (Field B).

Cylinder Loss and Grain Damage: Cylinder loss was low in most dry and well matured crops (FIGURES 14 to 17 and 19). Grain cracks in Fergus and Klages barley ranged from 2 to 4% and in easier threshing Neepawa wheat (fields A, B and C) from 2 to 3.5%. In field D in difficult-to-thresh Neepawa wheat (FIGURE 18), the final cylinder and concave adjustments were a compromise between cylinder loss and grain damage. In this case grain cracks varied from 6 to 7% (FIGURE 20) while cylinder loss ranged from 1 to 4.5%.

Body Loss: Body loss was negligible in grain and oil seed crops.

TABLE 4. Capacity at a Total Loss of 3% of Yield.

Crop Conditions							Capacity Results			
Crop	Variety	Width of Cut m	Crop Yield t/ha	Straw Breakup	Grain Moisture %	MOG/G	MOG Feedrate t/h	Grain Feedrate t/h	Ground Speed km/h	Loss Curve
Barley	Klages	6.1	3.67	medium	11.5	0.69	8.1	11.7	5.2	Fig. 14 & 21
Wheat (A)	Neepawa	7.3	3.12	very high	14.1	1.04	16.0	15.3	6.7	Fig. 15
Wheat (B)	Neepawa-	7.3	2.71	high	13.3	1.18	16.3	13.8	7.0	Fig. 16 & 22
Wheat (C)	Neepawa	6.1	2.69	high	14.0	1.04	14.7	14.1	8.6	Fig. 17 & 23
Wheat (D)	Neepawa	7.3	3.22	high	12.2	1.10	12.7	11.5	4.9	Fig. 18
Barley	Fergus	7.3	2.87	medium	12.1	0.68	9.0	13.2	6.3	Fig. 19 & 24

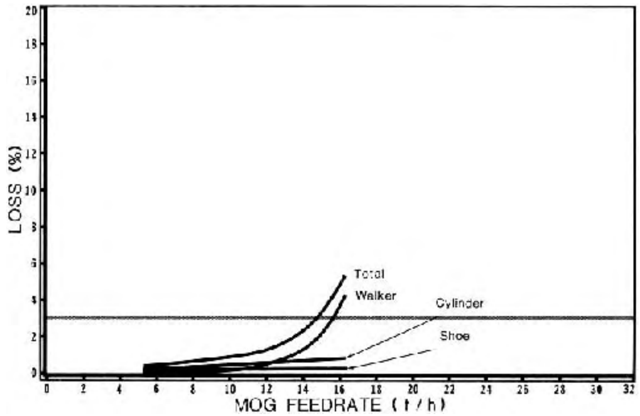

FIGURE 17. Grain Loss in Neepawa Wheat (Field C).

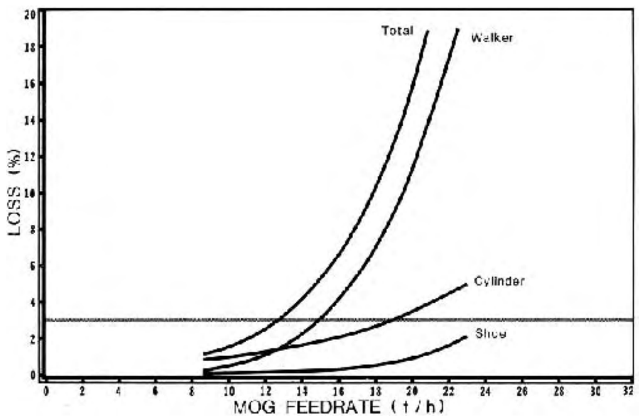

FIGURE 18. Grain Loss in Neepawa Wheat (Field D).

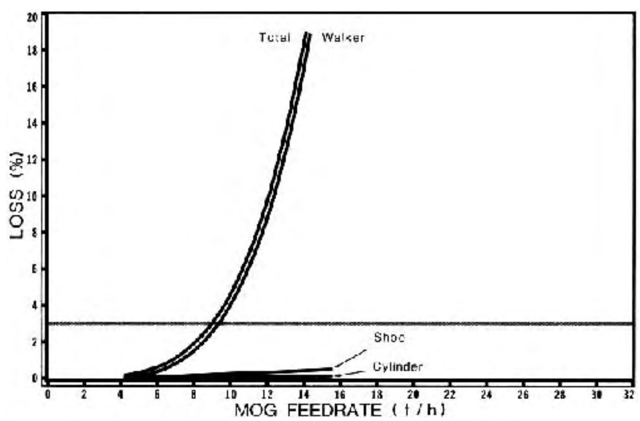

FIGURE 19. Grain Loss in Fergus Bailey.

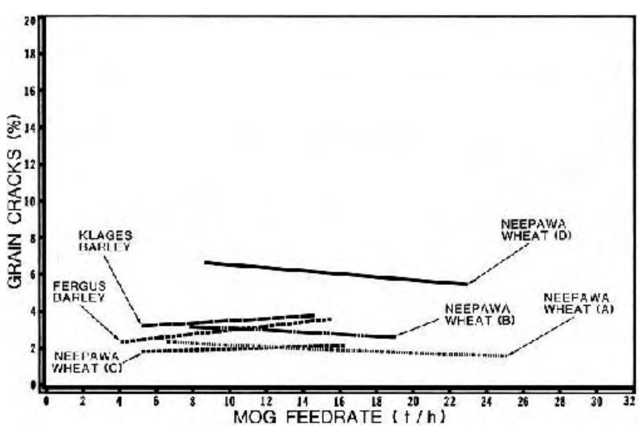

FIGURE 20. Grain Damage.

Comparison to Reference Combine: Comparing combine capacities 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. See APPENDIX III for PAMI reference combine capacity results.

FIGURES 21 to 24 compare the total grain losses of the John Deere 7721 and the PAMI reference combine in four of the crops described in TABLE 4. The shaded areas on the figures are 95% confidence belts. If the shaded areas overlap, the loss characteristics of the two combines are not significantly different whereas if the shaded areas do not overlap, losses are significantly different. The capacity of the John Deere 7721 was much greater in wheat and somewhat greater in barley than the capacity of the reference combine and the John Deere 7721 had lower grain losses than the reference combine when operating at the same feedrate.

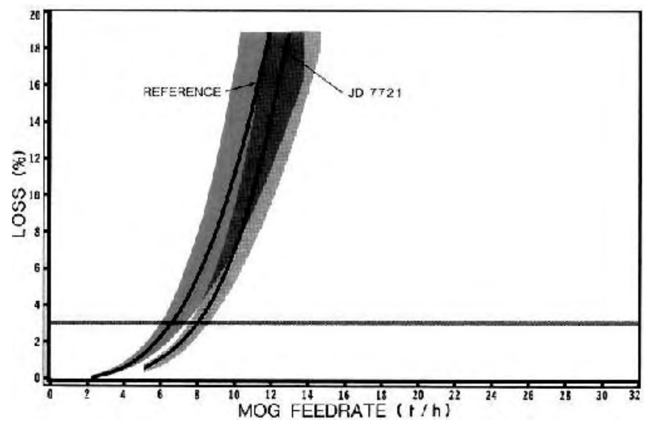

FIGURE 21. Total Grain Losses in Klages Barley.

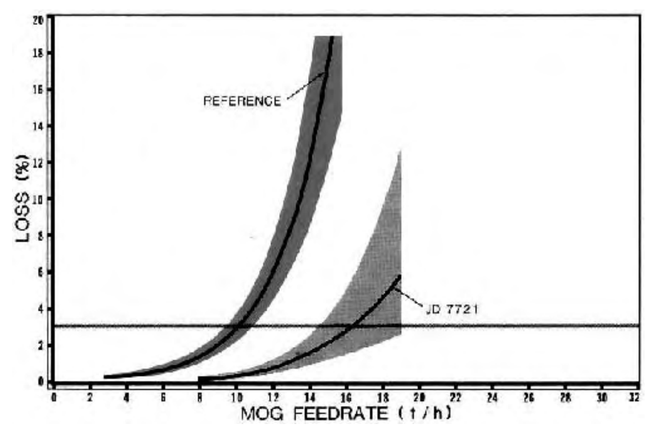

FIGURE 22. Total Grain Losses in Neepawa Wheat (Field B).

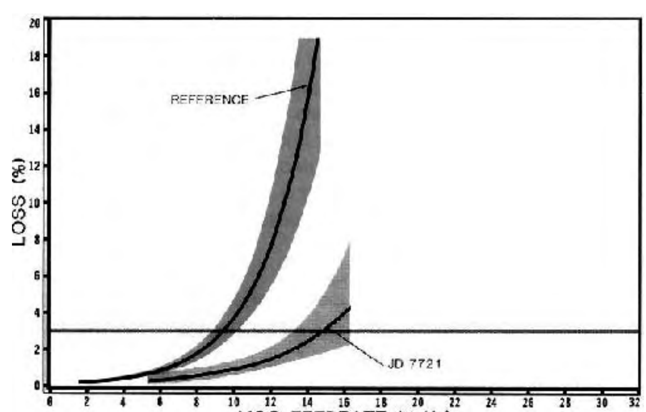

FIGURE 23. Total Grain Losses in Neepawa Wheat (Field C).

POWER REQUIREMENTS

Power Consumption: The manufacturer recommends a minimum tractor size of 93 kW (125 hp). This tractor size was suitable for average conditions, however when operating in hilly fields a minimum tractor size of about 112 kW (150 hp) was needed.

Power take-off input (FIGURE 25) was measured in wheat and barley. When operating at a 3% total grain loss, power input was 50 kW (67 hp) in easy-to-thresh wheat, 55 kW (74 hp) in hard-to-thresh wheat and 31 kW (42 hp) in barley (FIGURE 25).

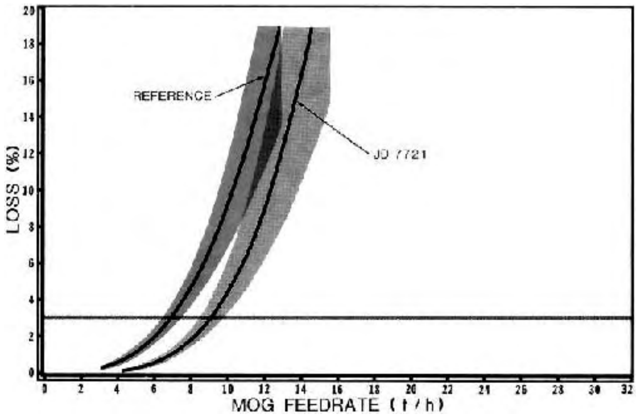

FIGURE 24. Total Grain Losses in Fergus Barley.

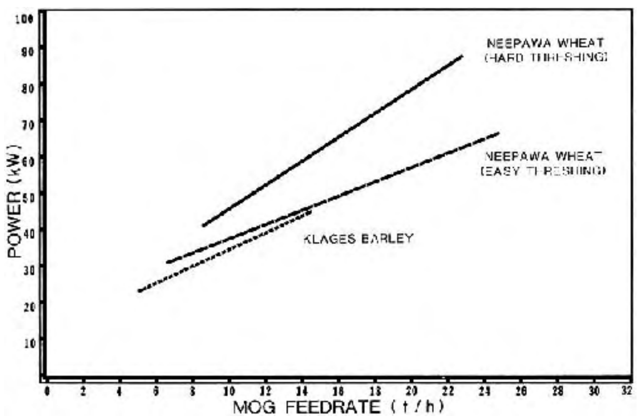

FIGURE 25. Power Take-Off Input.

Specific Capacity: Specific capacity is a measure of how efficiently a combine uses energy. It is the MOG Feedrate divided by the power take-off input, when operating at a 3% loss level. A high specific capacity indicates efficient energy use, while a low specific capacity indicates less efficient operation. Average specific capacity for the John Deere 7721 was about 0.26 t/kW-h as compared to 0.33 t/kW-h for the reference combine.

OPERATOR SAFETY

The operator's manual emphasized operator safety.

The John Deere 7721 had adequate warning decals and was equipped with a slow-moving vehicle sign, warning lights, taillight and reflectors for road transport.

The shielding provided good protection from most moving parts. Most shields either swung out of the way or were easily removed for servicing.

The combine 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 near or beneath the header.

No rocking wrench or hub was provided for unplugging the feeder or auger which necessitated entry into the header thus creating a potential hazard. Before attempting to unplug any part of the combine, all clutches should be disengaged and the tractor shut off.

The hitch jack was safe and easy to use. A second jack stand was provided at the rear of the combine to prevent the combine from tipping rearward when the header was removed.

Inspecting the return tailings was extremely dangerous. Since return tailings must be sampled on-the-go, inspection required standing in a potentially dangerous area. Loose clothing could become entangled in the drive shaft, or loss of balance could result in a fall under the combine wheel or inserting a hand into the tailings elevator. It is recommended that the manufacturer consider modifications to improve the ease and safety of sampling return tailings.

When using the slug wrench to unplug the cylinder, or when unplugging the table auger or feeder housing, all clutches should be disengaged and the tractor shut off.

The operator is cautioned about loaded springs used for tensioning drive tighteners and variable speed sheaves.

The exposed straw chopper belt could cause injury when a person was mounting the combine ladder or inspecting shoe performance. It is recommended that the manufacturer consider supplying a shield for the straw chopper drive belt.

The curved section of the combine ladder made dismounting awkward and could cause falls. It is recommended, that the manufacturer consider modifying the ladder to improve safety.

The grain tank extension panels folded inward when leaned upon. This could result in operator injury when losing his balance. It is recommended that the manufacturer consider supplying a locking mechanism for the extensions.

A fire extinguisher should be carried on the combine at all times.

OPERATOR'S MANUAL

The operator's manual was clearly written and well illustrated. It contained useful information on safe operation, adjustments, settings, service and lubrication.

Initial cylinder speeds suggested in the operator's manual for rapeseed were too high. It is recommended that the manufacturer consider revising suggested settings for rapeseed.

DURABILITY RESULTS

TABLE 5 outlines the mechanical history of the John Deere 7721 during the 120 hours of operation while harvesting about 315 ha (780 acres). 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
Drives		
-The cylinder variable speed drive belt was burned when the cylinder plugged. The belt was replaced at	14 and 33	39 and 93
-The outer seal on the cylinder drive Posi-Torq hub failed and was replaced at	83	235
-The main cylinder drive belt jumped out of groove. The belt tightener was aligned at	83	235
-The magnetic header clutch failed and locked at	103	285
-and was repaired at		end of test
Miscellaneous		
-The top cylinder access panel and stripper bent and were straightened at	14	39
-The concave front levelling bolt support bracket deformed and was straightened at	61	172
-It required straightening again at end of test The oil seal on the input shaft of the main gear box leaked	throughout test	

DISCUSSION OF MECHANICAL PROBLEMS

Posi-Torq Drive: The Posi-torq drive did not keep the cylinder variable speed belt properly tensioned over the full speed range. Drive belt slippage occurred especially at lower cylinder speeds. This resulted in cylinder plugging and burning of the variable speed cylinder belt.

Seal problems occurred on the torque sensing unit. The outside wiper seal failed and was replaced, while at high cylinder speeds the inner seal allowed grease to escape. It is recommended that the manufacturer consider modifying the torque sensing unit to provide proper belt tension throughout the speed range and to reduce grease loss from the housing.

Concave Support: The front levelling bolt support deformed during operation (FIGURE 26). It is recommended that the manufacturer consider modifying the concave front levelling bolt support member to eliminate bending of the support during operation.

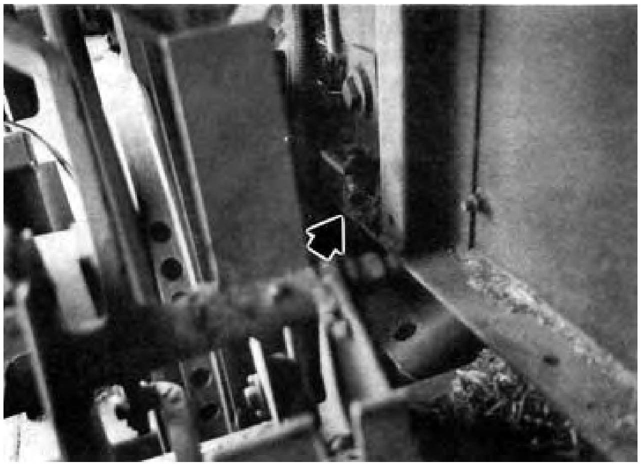

FIGURE 26. Deformed Concave Support.

APPENDIX I
SPECIFICATIONS

MAKE:	John Deere Pull-Type Combine
MODEL:	7721
SERIAL NUMBER:	Header: 373043 H Body: 362962 H
MANUFACTURER:	John Deere Harvester Works East Moline, Illinois 61244 U.S.A.
WINDROW PICKUP:	
--make and model	John Deere
--type	belt
--width	3350 mm
--number of belts	6
--teeth per belt	120
--type of teeth	nylon
--number of rollers	3
--height control	castor wheels
--speed control	hydrostatic
--speed range	0.3 to 2.1 m/s
HEADER:	
--type	centre feed
--width	3780 mm
--auger diameter	605 mm
--feeder conveyor	3 roller chains, undershot slatted conveyor
--conveyor speed	2.21 m/sec
--range of height	-100 to 1330 mm
--number of lift cylinders	2
--options	50 Series Row Crop Head or 40 Series Corn Head
CYLINDER:	
--type	rasp bar
--number of bars	8
--diameter	560 mm
--width	1400 mm
--drive	hydraulically controlled variable pitch belt
--speed range	430 to 1200 rpm
--stripper bar	rubber
--options	300 to 860 rpm drive, 150 to 250 rpm drive, cylinder filler plates
CYLINDER BEATER:	
--type	drum with 4 triangular bats
--diameter	340 mm
--speed	645 to 1645 rpm
CONCAVE:	
--type	bar and wire grate
--number of bars	14
--configuration	13 intervals with 6.4 mm wires and 16.5 mm spaces
--area total	0.749 m^2
--area open	0.405 m^2
--transition grate area total	0.294 m^2
--transition grate area open	0.224 m^2
--wrap	110°
--grain delivery to shoe	augers
--options	stone trap cover, concave cover strips
STRAW WALKERS:	
--type	rotary, formed metal
--number	5
--length	3770 mm
--walker housing width	1394 mm
--separating area	5.165 m^2
--crank throw	150 mm
--speed	157 rpm
--grain delivery to shoe	augers
--options	risers
SHOE:	
--type	Opposed action
--speed	314 rpm
--chaffer sieve	adjustable lip, 2.046 m, 2 with 45 mm throw
--clean grain sieve	adjustable lip, 1.595 m, 2 with 45 mm throw
CLEANING FAN:	
--type	4 blade undershot
--diameter	450 mm
--width	1400 mm
--drive	hand wheel controlled variable pitch belt
--speed range	308 to 1090 rpm
ELEVATORS:	
--type	roller chain with rubber flights, top delivery
--clean grain (top drive)	160 x 240 mm
--tailings (bottom drive)	130 x 205 mm
GRAIN TANK:	
--capacity	7.1 m^3
--unloading time	105 s
STRAW CHOPPER:	
--type	rotor with 30 freely swinging hammers
--speed	2345 rpm
--options	straw spreader

CLUTCHES:
--header electromagnetic
--unloading auger electromagnetic

NUMBER OF CHAIN DRIVES: 7

NUMBER OF BELT DRIVES: 17

NUMBER OF GEARBOXES: 2

NUMBER OF PRELUBRICATED EARINGS: 60

LUBRICATION POINTS:
--10 h lubrication 5
--50 h lubrication 17
--100 h lubrication 2
--200 h lubrication 3
--400 h lubrication 1

TIRES: 2,23.1 x 26, 10-ply

OVERALL DIMENSIONS:
--wheel tread 3580 mm
--transport height 3790 mm
--transport length 12940 mm
--transport width 4460 mm
--field height 4080 mm
--field length 11035 mm
--field width 8520 mm
--unloader discharge height 4000 mm
--unloader clearance 3820 mm
--unloader reach 4070 mm

WEIGHT: (empty grain tank and hitch in field position)
--right wheel 3670 kg
--left wheel 3050 kg
--hitch 690 kg
TOTAL 7410 kg

APPENDIX II
REGRESSION EQUATIONS FOR CAPACITY RESULTS

Regression equations, for the capacity results shown in FIGURES 14 to 19 are presented in TABLE 6. In the regressions, C= cylinder loss in percent of yield, S = shoe loss in percent of yield, W = walker loss 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 14 to 19 while crop conditions are presented in TABLE 4.

TABLE 6. Regression Equations

Crop - Variety	Fig. No.	Regression Equations	Simple Correlation Coefficient	Variance Ratio	Sample Size
Barley - Klagas	14	$C = -0.1926 + 0.06618F$ $\ln S = -7.8331 + 3.4469 \ln F$ $\ln W = -8.1007 + 4.2317 \ln F$	0.46 0.82 0.98	1.85 14.43[2] 149.95[2]	9
Wheat - Neepawa (Field A)	15	$C = -0.1555 + 0.02215F$ $\ln S = -5.8072 + 0.33401F$ $\ln W = -11.4549 + 4.4156 \ln F$	0.90 0.94 0.98	28.57[2] 57.17[2] 14431[2]	9
Wheat - Neepawa (Field B)	16	$C = -0.1508 + 0.02337F$ $\ln S = -6.2721 + 0.36525F$ $\ln W = -13.5299 + 5.0978F$	0.79 0.92 0.92	11.30[1] 37.78[2] 39.87[2]	9
Wheat - Neepawa (Field C)	17	$\ln C = -3.1714 + 1.0777 \ln F$ $S = 0.09949 + 0.01214F$ $\ln W = -6.5519 + 0.49548F$	0.87 0.16 0.90	18.66[2] 0.16 24.84[2]	8
Wheat - Neepawa (Field D)	18	$\ln C = -1.22007 + 0.12318F$ $\ln S = -5.44794 + 0.27186F$ $\ln W = -10.930 + 4.45684 \ln F$	0.93 0.95 0.99	43.32[2] 69.75[2] 335.74[2]	9
Barley - Fergus	19	$C = -0.02496 + 0.01154F$ $S = -0.25979 + 0.04951F$ $\ln W = -8.24281 + 4.2045 \ln F$	0.89 0.87 0.98	28.83[2] 21.62[2] 218.98[2]	9

[1]Significant at $P \leq 0.05$
[2]Significant at $P \leq 0.01$

APPENDIX III
PAMI REFERENCE COMBINE CAPACITY RESULTS

TABLE 7 and FIGURES 27 and 28 present capacity results for the PAMI reference combine in wheat and barley crops harvested from 1976 to 1979.

FIGURE 27 shows capacity differences in Neepawa wheat for the four years. The 1979 Neepawa wheat crops shown in TABLE 4 were of average-to-heavy straw yield, easier-to-thresh than normal and most had high straw break-up.

FIGURE 28 also shows differences in capacities in six-row Bonanza barley for 1976 to 1978, and in two-row Fergus barley for 1979. The 1979 Fergus barley crop shown in TABLE 4 was of average straw yield and easy-to-thresh.

Results show that the reference combine is important in determining the effect of crop variables and in comparing capacity results of combines evaluated in different growing seasons.

TABLE 7. Capacity of the PAMI Reference Combine at a Total Grain Loss of 3% of Yield.

	Crop Conditions							Capacity Results			
			Width of Cut	Crop Yield	Grain Moisture			MOG Feedrate	Grain Feedrate	Ground Speed	
Year	Crop	Variety	m	t/ha	Straw %	Grain %	MOG/G	t/h	t/h	km/h	Loss Curve
1979	Barley	Klages	6.1	3.67	dry	11.7	0.64	6.8	10.6	4.7	
	Wheat	Neepawa	7.3	2.77	dry	14.1	1.21	9.5	7.8	3.9	
	Wheat	Neepawa	6.1	2.67	dry	14.3	1.09	9.7	8.9	5.4	Fig. 27
	Barley	Fergus	7.3	3.46	dry	12.5	0.77	7.3	9.5	3.7	Fig. 28
1978	Wheat	Canuck	7.3	2.54	7.1	12.1	1.15	11.8	10.3	5.6	
	Wheat	Lemhi[1]	11.0	2.13	6.6	12.0	0.75	10.9	14.5	6.2	
	Wheat	Neepawa	6.1	4.37	10.4	15.9	1.04	9.3	8.9	4.5	Fig. 27
	Barley	Bonanza	6.1	4.06	7.7	13.5	0.68	6.1	9.0	3.6	Fig. 28
1977	Wheat	Neepawa	6.1	3.97	13.4	14.6	0.79	11.1	14.1	5.8	Fig. 27
	Barley	Bonanza	7.3	4.74	25.7	14.6	0.84	7.9	9.4	2.7	Fig 28
1976	Wheat	Neepawa	5.5	2.78	dry to tough	14.7	1.29	7.1	5.5	3.6	Fig. 27
	Barley	Bonanza	7.3	3.18	dry to tough	14.6	0.96	4.8	5.0	2.2	Fig 28

[1]Side by Side Double Windrow

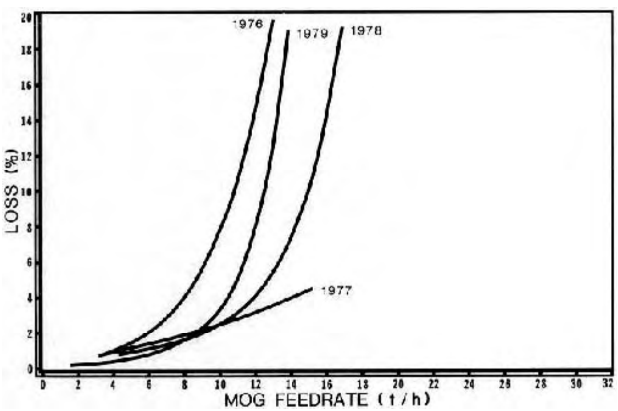

FIGURE 27. Total Grain Loss for the PAMI Reference Combine in Neepaws Wheat.

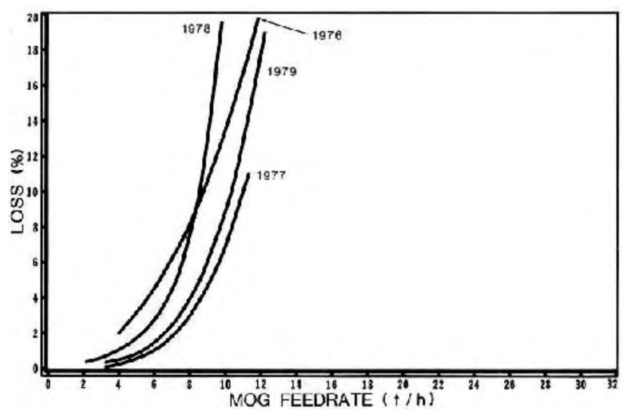

FIGURE 28. Total Grain Losses for the PAMI Reference Combine in Bailey.

APPENDIX IV
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 V
CONVERSION TABLE

1 kilometre/hour (km/h) = 0.6 miles/hour (mph)
1 hectare (ha) = 2.5 acres (ac)
1 kilogram (kg) = 2.2 pounds mass (lb)
1 tonne (t) = 2 200 pounds mass (lb)
1 tonne/hectare (t/ha) = 0.5 ton/acre (ton/ac)
1 tonne/hour (t/h) = 37 pounds mass/minute (lb/min)
1 kilowatt (kW) = 1.3 horsepower (hp)
1 litre/hour (L/h) = 0.2 Imperial gallons/hour (gal/h)
1 metre (m) = 3.3 feet (ft)
1 millimetre (mm) = 0.04 inches (in)

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

This report is published under the authority of the minister of Agriculture for the Provinces of Alberta, Saskatchewan and Manitoba and may not be reproduced in whole or in part without the prior approval of the Alberta Farm Machinery Research Centre or The Prairie Agricultural Machinery Institute.