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Evaluation Report 631

John Deere 9500 Self-Propelled Combine

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

JOHN DEERE 9500 SELF-PROPELLED COMBINE

MANUFACTURER:
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RETAIL PRICE:
$143,800.00 [February, 1990, f.o.b. Humboldt, Sask., with a 13 ft (4.0 m) pickup on a 14 ft (4.3 m) pickup header, chaff spreader, header height control, pickup speed control, concave blanking plates, passenger seat, grain loss monitor and row finder lights.]

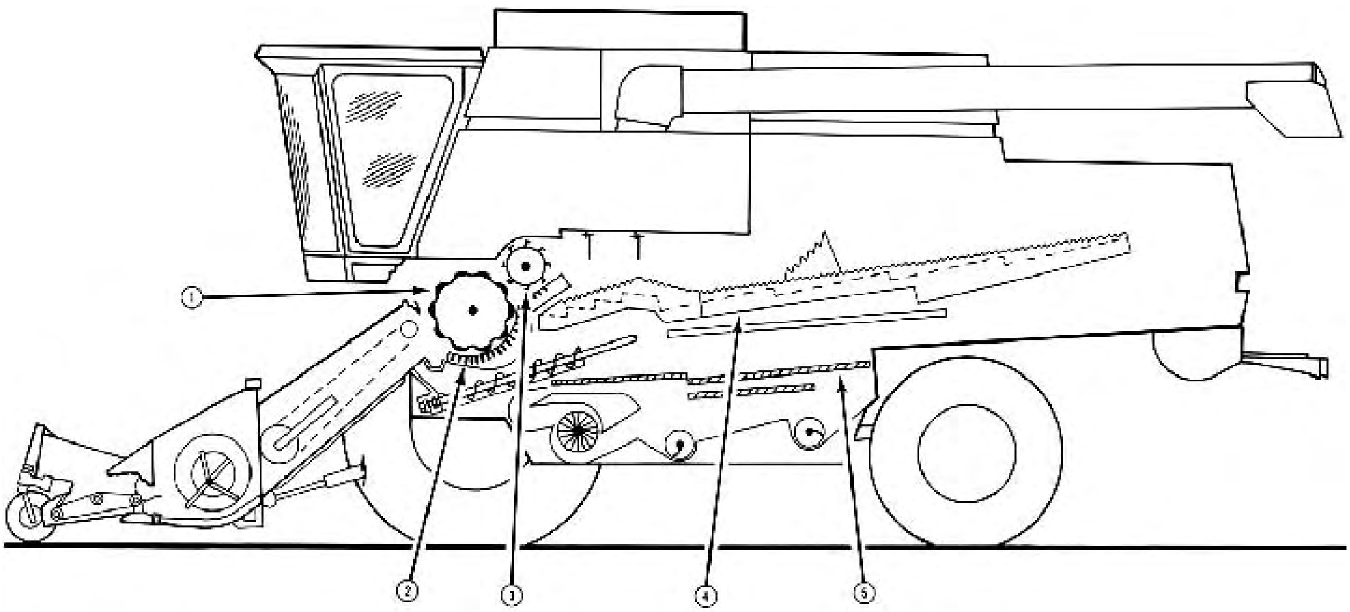

FIGURE 1. John Deere 9500: (1) Cylinder, (2) Concave, (3) Rear Beater, (4) Straw Walkers, (5) Cleaning Shoe.

SUMMARY AND CONCLUSIONS

Capacity: In the capacity tests, the MOG feedrate* at 3% total grain loss in Harrington barley was 425 lb/min (11.6 t/h). Combine capacity was 530 lb/min (14.5 t/h) and 535 lb/min (14.6 t/h) for the two Katepwa wheat crops.

In the barley tests, the John Deere 9500 had about 1.3 times the capacity of the PAMI Reference II combine when compared at 3% total grain loss. in the wheat tests, the capacity of the John Deere 9500 was about 1.1 times that of the Reference II in the Katepwa “A” crop and 1.3 times in the Katepwa “B” crop.

Quality of Work: Pickup performance was very good. The pickup picked cleanly in all reasonably well supported windrows and no plugging occurred.

Feeding was very good. The table auger and feeder were aggressive, feeding crop smoothly and seldom plugging. The stone trap provided very good stone protection. Objects up to 3 in (75 mm) in diameter were emptied from the trap. No cylinder raspbar or concave damage was noticed.

Threshing was good. In hard-to-thresh crops the concave had to be adjusted as close as possible. Faster cylinder speeds than recommended were necessary and concave blanks were needed. Grain damage was lower than for the Reference II combine.

Separating was good. Straw walker loss limited combine capacity in nearly all crops. Cleaning shoe performance was excellent. Shoe loss was very low in all crops and it was tolerant to uneven loading.

Grain handling was very good. The 197 Imperial bu (7.2 m³) grain tank filled evenly in all crops. The unloading auger was hydraulically positioned and had adequate clearance for all trucks and trailers encountered. The auger discharged the grain in a compact stream and unloaded a full tank of dry wheat in about 95 seconds. Being able to unload at only high or low idle made topping loads inconvenient.

Straw spreading was good and chaff spreading was very good. The straw was spread evenly over about 25 ft (7.6 m) while the chaff was spread up to 20 ft (6.1 m).

Ease of Operation and Adjustment: Operator comfort was very good. The cab was clean, quiet, and roomy. The air conditioner and heater provided comfortable cab temperature. The seat and steering column were adjustable to suit most operators. The operator had a clear view forward and to the sides and large convex mirrors were provided for rear visibility. The incoming swath was partially blocked by the steering wheel.

Instrumentation was very good. All important machine and engine functions were monitored with a combination of gauges, a digital display, warning light, and audio alarm. The console in the corner post of the cab contained most routinely checked operating information and was convenient to view. The overhead console was not as convenient to view but the warnings were clearly marked and didn’t have to be checked unless an alarm sounded. The controls were good. The combination arm rest/control console kept most controls conveniently placed regardless of seat position. Most functions were electrically controlled and responded well. The unloading auger swing was inconvenient to make fine adjustment and the automatic pickup speed control did not respond suitably for slower operating speeds.

The loss monitor was very good. It was well suited to the combine’s loss characteristics and was easy to adjust to show sudden changes in loss. It proved a reliable indicator in all crops encountered.

Lighting was good. Forward lighting was adequate although

**MOG Feedrate (material-other-than-grain feedrate) is the mass of straw and chaff passing through the combine per unit of time.*

more light was often required to shine through the dust at the feeder. Optional side lights were useful for windrow conditions.

Handling was very good. The steering was smooth and responsive, and the wheel brakes were seldom required for cornering. The hydrostatic was smooth and responsive and the gear ratios were appropriate for suitable harvest speeds. The combine was stable in the field and while transporting.

Ease of adjustment was good. Most components were very easy to adjust from the cab. However, the concave indicator was too coarse to be reliable and the sieves had to be adjusted with a special tool, which was awkward and inconvenient. The concave proportioning was not convenient since the gauging ports did not line up with the tightest cylinder to concave clearance position. Ease of setting the components to suit crop conditions was good. Once the concave was adjusted to its tightest position and the operator became familiar with the aggressiveness required for proper threshing, setting became quick and easy with little fine tuning required.

Ease of unplugging was very good. The header reverser worked well and neither the cylinder nor tailings plugged during the test season. Ease of cleaning the combine completely was good. Some areas, such as the grain pan under the straw walkers were not easily accessed.

Ease of lubrication was very good. There were only a few daily grease points and all were easily accessed. Ease of performing routine maintenance was very good. Most drives utilized spring loaded idlers and the large hinged side doors provided easy access.

Engine and Fuel Consumption: The engine started quickly and ran well. It had adequate power for all conditions encountered. Average fuel consumption was about 5.7 gal/h (25.9 L/h) and oil consumption was insignificant.

Operator Safety: The John Deere 9500 had several unique safety features, it was well shielded and no safety hazards were apparent. Normal safety precautions were required and warnings had to be heeded. The operator's manual emphasized safe operating procedure.

Operator's Manual: The operator's manual was very good. It was clearly written and well organized. It contained useful information on safety, operation, adjustment, trouble shooting and machine specifications.

Mechanical History: A few mechanical problems occurred during the test.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to eliminate the noise and wear caused by the wind-guard end support flexing.
2. Adding an engine speed setting, which would provide a more suitable unloading rate for topping loads.
3. Modifications to improve the ease of identifying the gear shifter position especially for neutral and second gear.
4. Modifications to make the automatic pickup speed control more convenient to use and to provide more appropriate response for varying windrow conditions.
5. Modifications to make the unloading auger adjustment more suitable for small adjustments.
6. Modifications that allow the concave initial adjustment to be set for more aggressive threshing and to the inspection ports for more convenient inspection of the tightest cylinder-to-concave clearance.
7. Modifications to the concave position indicator to provide a more precise indication of concave clearance.
8. Modifications to eliminate the alarm noise while the engine is cranking during start-up.
9. Modifications to the safety switch in the seat to make it function appropriately for all operators.

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Project Manager: L. G. Hill
Project Engineer: C.A. Hanson

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Changes to the windguard end support will be considered for future upgrading.
2. An additional engine speed setting will be considered for future upgrading.
3. The Maximizer combines incorporate the neutral start system into the hydro ground speed control minimizing the need for selecting neutral. For future upgrading, improvement in neutral and second gear selection will be considered.
4. Changes to the automatic pickup speed control will be considered in future product upgrading.
5. The ability to make small adjustments to the unloading auger swing will be considered for future upgrading.
6. Factory concave settings have been improved resulting in an acceptable balance between aggressive threshing and grain damage. We are continuing development to improve threshing while maintaining low grain damage. No changes to the inspection ports are planned at this time.
7. The concave indicator is intended to give a general concave position. The inspection ports provide for more precise measurement. Consideration will be given to changes in future upgrading.
8. Elimination of the alarm during cranking will be considered for future upgrading.
9. Changes to the safety switch will be considered for future upgrading.

GENERAL DESCRIPTION

The John Deere 9500 is a self-propelled combine. It has a transverse mounted, tangential threshing cylinder, concave, rear beater, straw walkers, and a cleaning shoe. The open cylinder has ten rasp bars with the ribs on alternate bars having the opposite angle. The concave is of bar and wire construction. The eight-wing beater has a contoured cell-type grate. Their are four, multi-step, open bottom straw walkers. The cleaning fan consists of four multiple blade centrifugal fans mounted on a common shaft. An adjustable lip pre-cleaning sieve moves in opposed motion to the adjustable lip chaffer, tailings, and cleaning sieves.

Crop is fed from the feeder to the cylinder. Threshing begins upon first contact with the rasp bars, and continues as the crop is pulled between the cylinder and concave. Grain separation occurs at the concave, beater grate, and straw walkers. Augers convey material from underneath the concave to the pre-cleaning sieve. A reciprocating grain pan conveys material separated by the straw walkers to the front of the chaffer sieve. The grain is cleaned by a combination of pneumatic and sieving action. Tailings are returned to the front of the cylinder.

The test combine was equipped with a 190 hp (142 kW) turbo charged diesel engine, a 14 ft (4.3 m) pickup header, a 14 ft (4.3 m) three-roller belt pickup, straw chopper, and optional equipment as listed on page 2. The John Deere 9500 has a pressurized operator's cab, power steering, hydraulic wheel brakes, and a three-speed transmission with hydrostatic ground drive.

The separator and unloader are electro-hydraulically engaged, while the header is electrically engaged. Header height, unloader swing, and the cylinder speed are controlled electro-hydraulically. Fan speed and concave clearance are electrically controlled from the cab. The pickup is driven hydraulically, and its speed varied electro-hydraulically from the cab. Sieve settings are made externally on the machine. Tailings may be sampled from the operator's platform just outside the cab. Important component speeds and harvest functions are electronically displayed.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The machine evaluated by PAMI was configured as described in the General Description, FIGURE 1, and Specifications section of this report. The manufacturer may have built different configurations of this machine before or after PAMI tests. Therefore, when using this report, check that the machine under consideration is the same as the one reported here. If differences exist, assistance can be obtained from PAMI or the manufacturer to determine changes in performance.

The main purpose of the test was to determine the functional performance of the John Deere 9500. Measurements and observations were made to evaluate the John Deere 9500 for rate of work, quality of work, ease of operation and adjustment, operator safety, and the suitability of the operator's manual. Although extended durability testing was not conducted, the mechanical failures, which occurred during the test were recorded.

The John Deere 9500 was operated for 117 hours while harvesting 970 ac (392 ha) of various crops. The operating conditions for the season are shown in TABLES 1 and 2. In addition, capacity tests were conducted in one barley crop and two wheat crops.

TABLE 1. Operating Conditions

Crop	Variety	Yield Range		Width of Cut		Sep. Hours	Field Area		Crop Harvested	
		bu/ac	t/ha	ft	m		ac	ha	bu	t
Barley	Bonanza	50-60	2.7-3.2	21,25, 30	6.4,7.6, 9.1	15.0	135	55	7460	163
	Duke	47-67	2.5-3.6	20	6.1	8.5	65	26	3690	81
	Johnson	52-57	2.8-3.1	25	7.6	2.0	20	8	1210	26
	Herrington	33-55	1.8-3.0	21, 30	6.4,9.1	5.5	44	18	1975	43
Canola	Tobin	18-23	1.0-1.3	24	7.3	7.0	50	20	1010	23
	Westar	12-35	0.7-2.0	20, 21	6.1,6.4	15.2	120	49	1900	43
Flax	Norlin	20-25	1.3-1.6	30	9.1	6.0	70	28	1525	39
Rye	Musketeer	23-46	1.4-2.9	18, 21	5.5,6.4	17.0	140	57	4205	107
Wheat	Katepwa	23-53	1.5-3.6	18,21, 24,30, 42,60	5.5,6.4, 7.3,9.1, 12.8,18.2	40.5	325	132	12700	346
Total						117	970	393	36675	871

TABLE 2. Operation in Stony Conditions

Field Conditions	Hours	Field Area	
		ac	ha
Stone Free	24	220	89
Occasional Stones	83	660	267
Moderatly Stony	10	90	37
Total	117	970	393

RESULTS AND DISCUSSION

TERMINOLOGY

MOG, MOG Feedrate, Grain Feedrate, MOG/G Ratio and Total Feedrate: A combine's performance is affected mainly by the amount of straw and chaff it is processing and the amount of grain or seed it is processing. The straw, chaff, and plant material other than the grain or seed is called MOG, which is an abbreviation for "material-other-than-grain". The quantity of MOG being processed per unit of time is called the "MOG Feedrate". Similarly, the amount of grain being processed per unit of time is the "Grain Feedrate".

The MOG/G ratio, which is the MOG Feedrate divided by the Grain Feedrate, indicates how difficult a crop is to separate. For example, MOG/G ratios for prairie wheat crops may vary from 0.5 to 1.5. In a crop with a 0.5 MOG/G ratio, the combine has to handle 50 lbs (22.7 kg) of straw for every 100 lbs (45.4 kg) of grain harvested. However, in a crop with a 1.5 MOG/G ratio for a similar 100 lbs (45.4 kg) of grain harvested the combine now has to handle 150 lbs (68.1 kg) of straw - 3 times as much. Therefore, the higher the MOG/G ratio, the more difficult it is to separate the grain.

Total feedrate is the sum of MOG and grain feedrates. This gives an indication of the total amount of material being processed. This total feedrate is often useful to confirm the effects of extreme MOG/G ratios on combine performance.

Grain Loss, Grain Damage, Dockage and Foreign Material: Grain loss from a combine can be of two main types: Unthreshed Loss, consisting of grain left in the head and discharged with the straw and chaff, or Separator Loss which is free (threshed) grain discharged with the straw and chaff. Separator Loss can be further defined as Shoe Loss and Walker (or Rotor) Loss depending where it came from. Loss is expressed as a percentage of the total amount of grain being processed.

Damaged or cracked grain is also a form of grain loss. In this report the cracked grain is determined by comparing the weight of the actual damaged kernels to the entire weight of a sample taken from the grain tank.

Dockage is determined by standard Canadian Grain Commission methods. Dockage consists of large foreign particles and of smaller particles that pass through a screen specified for that crop. It is expressed as a percentage of the weight of the total sample taken.

Foreign material consists of the large particles in the sample, which will not pass through the dockage screens.

Capacity: Combine capacity is the maximum rate at which a combine, adjusted for optimum performance, can process crop at a certain total loss level. PAMI expresses capacity in terms of MOG Feedrate at 3% total loss. Although MOG Feedrate is not as easily visualized as Grain Feedrate, it provides a much more consistent basis for comparison. A combine's ability to process MOG is relatively consistent even if MOG/G ratios vary widely. Three percent total loss is widely accepted in North America as an average loss rate that provides an optimum trade-off between work accomplished and grain loss. This may not be true for all combines nor does it mean that they cannot be compared at other loss levels.

Reference Combine: It is well recognized that a combine's capacity may vary greatly due to differences in crop and weather conditions. These differences make it impossible to directly compare combines not tested in the same conditions. For this reason, PAMI uses a reference combine. The reference combine is simply one combine that is tested along with each combine being evaluated. Since the test conditions are similar, each test combine can be compared directly to the reference combine to determine a relative capacity or "capacity ratio". This capacity ratio can be used to indirectly compare combines tested in different years and under different conditions. As well, the reference combine is useful for showing how crop conditions affect capacity. For example, if the reference combine's capacity is higher than usual, then the capacity of the combine being evaluated will also be higher than normally expected.

For 10 years PAMI had used the same reference combine. However, capacity differences between the reference combine and some of the combines tested became so great that it was difficult to test the reference combine in conditions suitable for the evaluation combines. PAMI changed its reference combine to better handle these conditions. The new reference combine is a larger conventional combine that was tested in 1984 (see PAMI report #426). To distinguish between the reference combines, the new reference will be referred to as Reference II and the old reference as Reference I.

RATE OF WORK

Capacity Test Results: The capacity test results for the John Deere 9500 are summarized in Table 3.

The performance curves for the capacity tests are presented in FIGURES 2 to 4. The curves in each figure indicate the effect of increased feedrate on walker loss, shoe loss, unthreshed loss and total loss. From the graphs, combine capacity can be determined for loss levels other than 3%. The rate at which loss changes with respect to feedrate shows where the combine can be operated effectively. Portions of loss curves which are "flat" or slope gradually indicates stable performance. Where the curves hook upward sharply, small increases in feedrate cause loss to increase greatly. It would be difficult to operate in this range of feedrates without having widely varying loss.

The Harrington barley crop used for the test came from a uniform stand and was laid in a well formed single windrow which was wider than the combine feeder. The crop was mature, and was windrowed just before testing. This resulted in mature, dry grain, while the straw remained slightly tough. The grain yield was average to above average, while the MOG/G ratio was slightly below average. This meant that the grain feedrate was relatively high for the MOG feedrate achieved. The grain was easy to thresh and the awns broke off readily, while straw break-up was about average.

In this barley crop, capacity at 3% total loss was 425 lb/min (11.6 t/h) MOG. Straw walker loss was the major loss and limited capacity. Unthreshed loss and shoe loss remained very low over the entire range of test feedrates. At feedrates below 350 lb/min (9.5 t/h) MOG, losses were very low and stable. At higher feedrates loss increased rapidly and it would be difficult to maintain a stable loss rate.

TABLE 3. Capacity of the John Deere 9500 at a Total Loss of 3% of Yield

Crop Conditions									Results									
		Width of Cut		Crop Yield		Moisture Content			MOG Feedrate		Grain Feedrate		Total Feedrate		Grain Cracks	Dockage	Foreign	Figure
Crop	Variety	ft	m	bu/ac	t/ha	Straw %	Grain %	MOG/G	lb/min	t/h	bu/h	t/h	lb/min	t/h	%	%	Material	Number
Barley	Harrington	30	9.1	76	4.1	12.1	13.8	0.87	425	11.6	795	17.3	1060	28.9	1.4	0.3	0.1	2
Wheat	Katepwa"A"	20	6.1	52	3.5	6.5	16.8	1.06	530	14.5	500	13.6	1030	28.1	1.8	0.8	0.5	3
Wheat	Katepwa"B"	30	9.1	55	3.7	14.9	15.5	1.15	535	14.6	465	12.7	1000	27.3	2.1	0.6	0.3	4

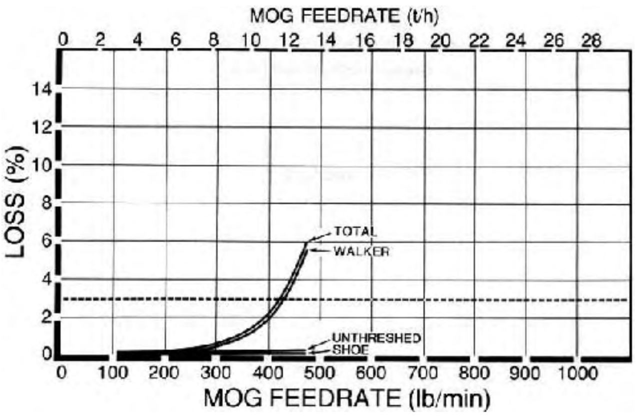

FIGURE 2. Grain Loss in Harrington Barley.

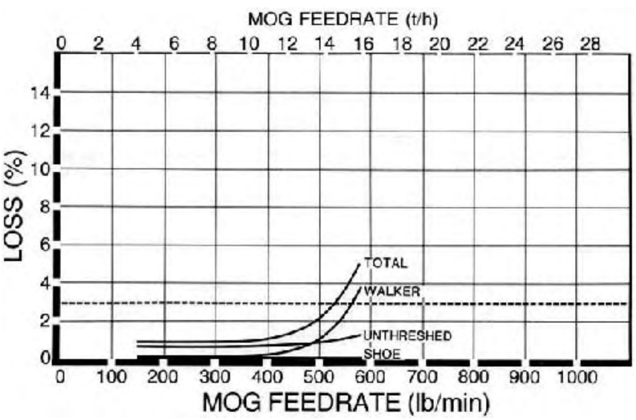

FIGURE 3. Grain Loss in Katepwa Wheat "A".

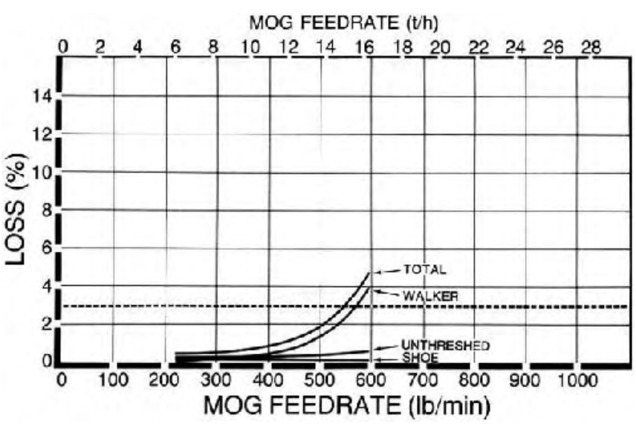

FIGURE 4. Grain Loss in Katepwa Wheat "B".

The Katepwa "A" wheat crop came from a crop stand that was uniform but somewhat lodged. This resulted in variations in windrow formation, although windrow uniformity was not greatly affected. The windrow was wider than the combine feeder, and the heads were generally well distributed across the windrow. Although the grain moisture was in the tough range, the straw was dry, and straw break-up was about average. The grain yield was above average, but so was the straw yield. This provided an average MOG/G ratio, which meant that grain feedrates were typical. The grain was hard to thresh, and was easily damaged due to the weather conditions during the harvest season.

In the Katepwa "A" wheat crop, capacity at 3% total loss was 530 lb/min (14.5 t/h) MOG. Straw walker loss limited capacity. However, unthreshed loss was relatively high at all feedrates. Grain damage was low, which indicated that a higher cylinder speed could have been used. This may have decreased the unthreshed loss and hence reduced the total loss at lower feedrates. However, it would have had little effect at higher feedrates where walker loss made up most of total loss. As such, capacity would not have been changed. Shoe loss was very low over the range of feedrates. Total loss was low and stable at feedrates below 450 lb/min (12.3 t/h). Straw walker loss increased rapidly at higher feedrates, which would make it difficult to operate at a controlled loss at feedrates over about 500 lb/min (13.6 t/h) MOG.

The Katepwa "B" wheat crop came from a crop stand that was uniform and very heavy. The crop was very mature, and was windrowed just prior to testing. This resulted in a large, bushy windrow. The windrow was much wider than the feeder, and the heads were uniformly distributed across the full width of the windrow. Both the straw and grain moisture were in the tough range, which made threshing difficult and kept straw break-up relatively low. The above average straw and grain yield produced a MOG/G ratio slightly above average, which in turn resulted in lower grain feedrates than might normally occur.

In the Katepwa "B" wheat crop, capacity at 3% total loss was 535 lb/min (14.6 t/h) MOG. Straw walker loss limited capacity. In this crop the unthreshed loss was considerably lower than in the first wheat crop due to the use of more aggressive adjustment. Shoe loss was again very low over the entire feedrate range. Total losses were very low at feedrates up to about 400 lb/min (10.9 t/h) MOG but increased rapidly at higher feedrates indicating that it would be difficult to maintain stable loss rates at feedrates over about 450 lb/min (12.3 t/h) MOG.

Average Workrates: TABLE 4 shows the range of average workrates achieved during day-to-day operation in the various crops encountered. The table is intended to give a reasonable indication of the average rates most operators could expect to obtain, while acknowledging the effects of crop and field variables. For any given crop, the average work rate may vary considerably. Although a few common variables such as yield and width of cut are included in TABLE 4, they are by no means the only or most important factors. There are many other crop and field conditions which affect workrates. As well, operating at different loss levels, availability of grain handling equipment, and differences in operating habits can have an important effect. The effect of the variables as indicated in TABLE 4, explains why even the maximum average workrates may be considerably lower than the capacity results, which are instantaneous workrates.

Note that TABLE 4 should not be used to compare performance of combines. The factors affecting average workrates are simply too numerous and too variable to be duplicated for each combine tested.

Comparing Combine Capacities: The capacity of combines tested in different years or in different crop conditions should be compared only by using the PAMI reference combines. Capacity ratios comparing the test combine to the reference combine are given in the following section. For older reports where the ratio is not given, a ratio can be calculated by dividing the MOG feedrate listed in the capacity table by the corresponding MOG feedrate of the reference combine listed in APPENDIX II for that particular crop.

Once capacity ratios for different evaluation combines have been determined for comparable crops, they can be used to approximate capacity differences. For example, if one combine has a capacity ratio of 1.2 times the reference combine and another combine has a capacity ratio of 2.0 times the reference combine, then the second combine is about 67% larger [(2.0 - 1.2) - 1.2 x 100 = 67%]. An evaluation combine can also be compared to the reference combine at losses other than 3%. The total loss curves for the test combine and reference combine are shown in the graphs in the following section. The shaded bands around the curves represent 95% confidence belts. Where the bands overlap, very little difference in capacity exists. Where the bands do not overlap a significant difference can be noticed.

TABLE 4. Field Workrates

Crop	Average Workrate	Grain Feedrate		Correspond-ing Area Rate		Associated Conditions				
						Width of Cut		Yield		Variety
		bu/h	t/h	ac/h	ha/h	ft	m	bu/ac	t/ha	
Barley	High	570	12.4	10.5	4.2	25	7.6	54	2.9	Johnson
	Low	270	5.9	7.9	3.2	21	6.4	34	1.8	Harrington
	Avg.	460	10.0	8.5	3.4			54	2.9	
Canola	High	205	4.7	9.1	3.7	21	6.4	13	0.7	Westar
	Low	115	2.6	9.2	3.7	21	6.4	13	0.7	Tobin
	Avg.	130	3.0	7.6	3.1			17	1.0	
Flax	High	250	6.4	12.2	4.9	30	9.1	20	1.3	Norlin
	Low	240	6.1	10.6	4.3	30	9.1	23	1.4	Norlin
	Avg.	245	6.2	11.5	4.7			21	1.3	
Rye	High	280	7.1	6.9	2.8	21	6.4	40	2.5	Musketeer
	Low	225	5.7	6.4	2.6	21	6.4	35	2.2	Musketeer
	Avg.	250	6.4	8.4	3.4			30	1.9	
Wheat	High	520	14.2	10.3	4.2	30	9.1	50	3.4	Katepwa
	Low	230	6.3	5.0	2.0	30	9.1	47	3.2	Katepwa
	Avg.	315	8.6	8.0	3.2			39	2.6	

PAMI recognizes that the change to the Reference II combine may make it difficult to compare test machines, which were compared to Reference I. To determine a relative size it is necessary to use a ratio of the two reference combines. Tests indicated that Reference II had about 1.50 to 1.60 times the capacity of Reference I in wheat and about 1.40 to 1.50 times Reference I's capacity in barley.

Capacity Compared to Reference Combine: The capacity of the John Deere 9500 was greater than that of the PAMI Reference II combine in both wheat and barley. At 3% total loss, the John Deere 9500 had about 1.3 times the Reference II's capacity in the Harrington barley, and 1.1 and 1.3 times its capacity in the Katepwa "A" and Katepwa "B" wheat crops, respectively.

FIGURES 5 to 7 compare the total loss of both combines over their practical operating range of feedrates. The graphs show that in most crops the John Deere 9500 had significantly greater capacity than the Reference II Combine at losses above 1%. This difference in capacity would usually be easily noticed if both machines were working in the same field. At loss less than 1%, the confidence belts overlap indicating that the difference in capacity may not be statistically significant. When operating at these very low loss levels differences would generally be much harder to distinguish in the field.

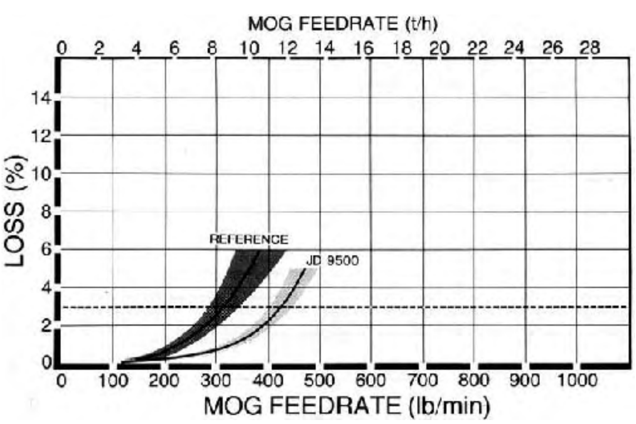

FIGURE 5. Total Grain Loss in Harrington Barley.

QUALITY OF WORK

Picking: Pickup performance was very good.

The pickup was normally operated at about a 30 angle to the ground with the gauge wheels adjusted so the teeth just touched the ground. The picking speed was set slightly faster than ground speed. With these settings, well supported windrows were picked cleanly at speeds up to 7 mph (11 km/h). Picking aggressiveness was increased in poorly supported windrows by increasing pickup speed and reducing pickup angle. As with many other draper pickups, in poorly supported conditions, some crop was not picked, even when using very aggressive settings. A few smaller stones were occasionally picked. The three roller pickup provided smooth crop flow to the table auger in all conditions. The wind guard was effective, and could be adjusted to provide adequate clearance for large canola windrows.

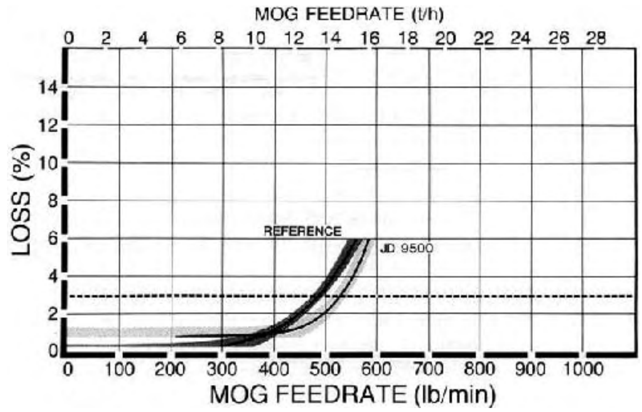

FIGURE 6. Total Grain Loss in Katepwa Wheat "A".

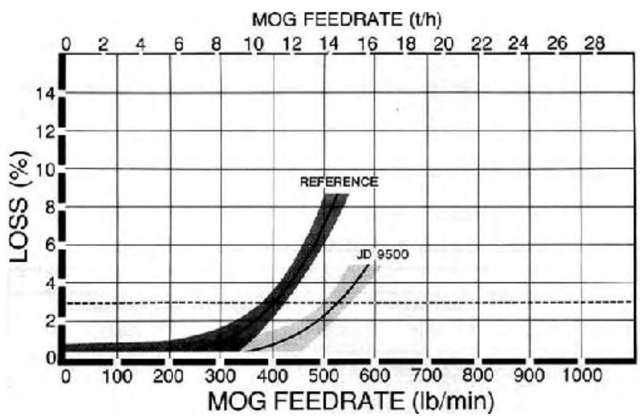

FIGURE 7. Total Grain Loss in Katepwa Wheat "B".

In rough fields, flexing of the pickup windguard support brackets caused them to strike the ends of the wind guard. This made a loud noise, which was annoying and was beginning to wear the mating parts. PAMI installed rubber bumpers between the wind guard and the brackets to minimize the noise and reduce wear. It is recommended that the manufacturer consider modifications to eliminate the noise and wear caused by the windguard end support flexing. The pickup was wide enough for picking around most windrow corners.

Feeding: Feeding was very good.

The table auger was very aggressive and seldom plugged. Crop fed smoothly under the table auger into the feeder. As with all conventional combines, to fully utilize the threshing and separating ability of the cylinder and concave, it was necessary to feed windrows that were at least as wide as the cylinder and that had the heads evenly distributed across the width. In narrower windrows and windrows with the heads concentrated in one area, it was best to center the heads on the feeder opening.

The feeder conveyor was aggressive. Some backfeeding was occasionally noticed. This caused a few feeder plugs.

Stone Protection: Stone protection was very good.

The stone trap, located directly in front of the concave, was effective, stopping most stones and roots. Hard objects were driven into the pocket when contacted by the cylinder rasp bars. Objects up to 3 in (75 mm) in diameter were emptied from the trap. The stone trap was most effective if emptied regularly to prevent grain and dirt from hardening in the trap. No evidence of cylinder or concave damage was apparent at the end of the test.

Threshing: Threshing was good.

The crop fed smoothly into the cylinder and concave in all conditions. There was no evidence of back feeding around the cylinder, and plugging did not occur. In most crops, cylinder speeds were slower than those used by many conventional combines, but the larger diameter, ten-bar cylinder of the John Deere 9500 provided equal or greater rasp bar velocity at these slower speeds.

PAMI found that in most crops, more aggressive threshing settings than recommended by the manufacturer were required to obtain adequate threshing. In hard threshing crops, such as flax and wheat, PAMI used concave blanking plates in addition to high cylinder speeds and tight concave clearances. FIGURE 8 shows the unthreshed loss in a tough wheat crop with and without concave blanking plates when using identical cylinder and concave settings. The difference in unthreshed loss shows that concave blanking plates were essential to maintain acceptable unthreshed loss at the higher feedrates. Even in easy-to-thresh crops such as barley, although concave blanking plates were not needed, faster cylinder speed and closer concave settings than suggested were required to minimize unthreshed loss.

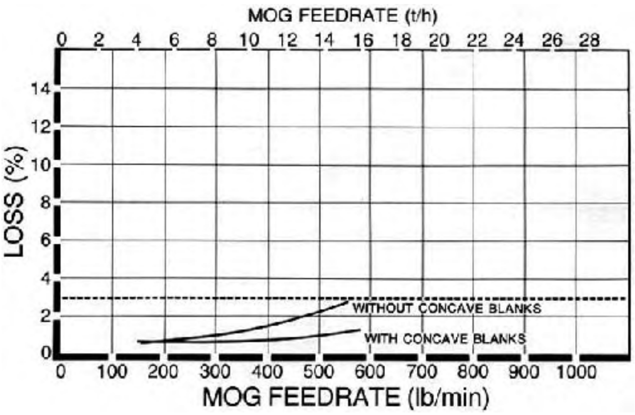

FIGURE 8. Unthreshed Loss With and Without Concave Blanking Plates.

Although unthreshed loss was similar or slightly higher than that of the Reference II combine, grain damage was slightly lower in the easy-to-thresh crops and much lower in the hard-to-thresh crops.

Harvest conditions in the 1989 test season demanded very aggressive threshing adjustment for all combines. However, these conditions are not uncommon in Western Canada and can often be even more demanding. Although adequate threshing for the John Deere 9500was obtained, it required using high cylinder speeds, repositioning the concave to attain smaller clearance and using concave blanking plates.

TABLE 5 shows the settings PAMI found to be suitable for different crops.

Separating: Separating was good.

In all crops, material flowed smoothly over the concave and straw walkers. No plugging or bridging occurred.

In both barley and wheat, grain loss over the straw walkers limited capacity, even when aggressive cylinder and concave settings were used. Typical of many conventional combines, the straw walker loss was very low up to a certain feedrate when separating capacity was reached, then loss increased very rapidly.

Installation of concave blanking plates to improve threshing also reduced concave open area. Normally this would hinder separation. FIGURE 9 shows the 9500's straw walker loss in a tough, hard-to-thresh wheat crop with and without concave blanking plates. The curves indicate that separation was actually improved greatly by adding the concave blanking plates. This suggests that the more thorough threshing provided by the blanking plates enabled the concave to separate more efficiently. Owners should be aware that concave blanking plates may increase both threshing and separating in some hard-to-thresh crops.

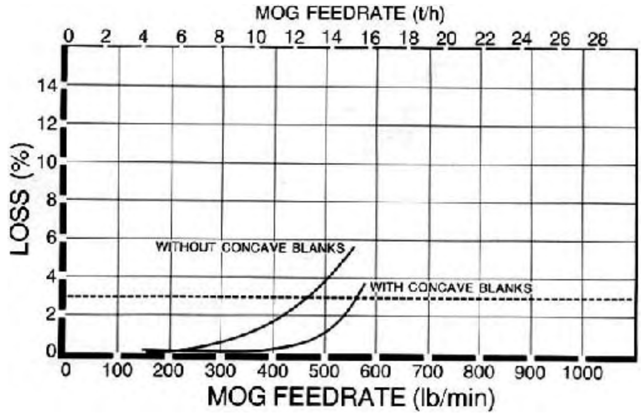

FIGURE 9. Straw Walker Loss With and Without Concave Blanking Plates.

In canola, reasonable feedrates were obtained with moderate threshing settings, but walker loss was still the greatest portion of total loss.

In flax, loss over the straw walkers was low and did not limit capacity, even with concave blanking plates installed. Using the concave blanking plates in tough flax caused material to harden in the section of the concave over the blanks. This made it important for the operator to check for concave plugging after removing the blanks, as concave blanking plates or a plugged concave could reduce separation in some crops such as barley.

Settings used in the different crops are shown in TABLE 5.

Cleaning: Cleaning shoe performance was excellent.

Shoe loading was usually even except when harvesting narrow windrows or feeding off center. Uneven loading appeared to have little effect on performance.

In all crops, shoe loss was usually very low over the entire operating range even at high grain feedrates. In all crops, the John Deere 9500 produced a very clean sample when set for minimal shoe loss.

TABLE 5 shows the settings PAMI found suitable for the crops encountered.

Clean Grain Handling: Grain handling was very good.

The open grain tank filled evenly in most crops. The grain tank loading auger deflector could be adjusted to distribute the load to one side or the other.

A full grain tank held about 197 Imp bu (7.2 m³) of dry wheat. An adjustable sensor in the tank warned the operator when the grain level was nearly full. In addition, a window between the grain tank and the cab allowed the operator to visually monitor grain flow and tank level while operating. If overfilled, grain spilled over the left side of the tank first.

The unloading auger had ample reach and clearance for all trucks encountered (FIGURE 10). The unloading auger was hydraulically positioned for unloading to the left, and would unload in any position. The two position throttle switch only allowed the combine to unload either at full speed or idle. At the maximum unloading speed, the auger discharged the grain in a reasonably compact stream, unloading a full tank of dry wheat in about 95 seconds. This was generally too fast for topping loads. Switching the engine to an idle reduced unloading speed greatly, and was

TABLE 5. Crop Settings.

Crop	Cylinder Speed	Concave Clearance*				Sieve Openings								Fan Speed
		Front		Rear		Precleaner		Chaffer		Tailings		Cleaning		
	rpm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	rpm
Barley	760 - 860	1/4	6	3/16	5	0	0	5/8	19	3/4	20	1/4	6	920 - 1000
Canola	450 - 500	1/2	13	11/32	9	0	0	7/16	11	1/2	13	1/8	3	740 - 760
Flax	850 - 900	3/16B	4	5/32	4	0	0	3/8	10	5/8	19	1/16	2	730 - 780
Rye	740 - 770	11/32	9	9/32	7	0	0	1/2	13	3/4	20	1/8	3	900 - 1060
Wheat	820 - 900	3/16B	4	5/32	4	0	0	5/8	19	3/4	20	3/16	5	1050 - 1090

*As Gauged at Concave Inspection Holes on 6th and 13th Concave Bars
BConcave Blanking Plates Installed at Front of Concave

too slow to be practical. It is recommended that the manufacturer consider adding an engine speed setting, which would provide a more suitable unloading rate for topping loads. Optional grain tank auger covers could be installed to reduce unloading rate if desired.

Straw and Chaff Spreading: Straw spreading was good and chaff spreading was very good.

FIGURE 10. Unloading.

The straw chopper on the John Deere 9500 was equipped with an adjustable stationary knife, which permitted setting for varying lengths of cut.

Width of straw spread was set by adjusting the tail plate angle and the fin angle. Under ideal conditions, straw was evenly spread over widths up to 25 ft (7.6 m) (FIGURE 11).

FIGURE 11. Typical Straw Spread.

The chaff spreader could be adjusted for spread widths up to 20 ft (6.1 m), and provided easy access to the cleaning shoe for making adjust-merits. The straw chopper and the chaff spreader were easily converted to allow windrowing of straw and chaff.

EASE OF OPERATION AND ADJUSTMENT

Operator Comfort: Operator comfort was very good.

The John Deere 9500 was equipped with a center mounted operator's cab positioned ahead of the grain tank.

The cab was easily accessed. The cab was spacious and easily accommodated a passenger on the optional seat located beside the operator's seat. The cab was very quiet. A pressurizing fan was activated directly from the ignition key, which ensured that the cab was pressurized to minimize dust leaks at all times. Incoming air was effectively filtered. The heater and air conditioner provided comfortable cab temperatures. The seat and steering column provided adequate adjustment for most operators.

The operator had a clear view forward and to the sides. The large convex rear view mirrors provided adequate rear visibility. For most operator's, view of the incoming windrow was partially obstructed by the steering wheel, regardless of seat or steering wheel position (FIGURE 12). Dust from the feeder (FIGURE 13) often reduced visibility of the feeder area especially in low light conditions, such as at dusk. Grain entering the tank was clearly visible through the rear cab and grain tank windows. The unloading auger was easily viewed when swung fully forward but the operator had to lean forward to see the auger if it was swung back to less than 90 from the combine body.

Instruments: Instrumentation was very good.

The instruments were located in the right front cab pillar (FIGURE 14) and in a panel above the windshield (FIGURE 15). The instruments in the pillar included gauges for fuel level and engine coolant temperature, and a digital display to selectively show engine RPM, cylinder RPM, cleaning fan RPM, ground speed, and engine hours, or separator hours. The overhead panel contained an alarm and color coded indicator lamps for parking brake engagement, separator drive filter obstruction, separator drive oil temperature, hydraulic oil temperature, improper battery voltage, engine air filter obstruction, plugged straw walkers, full grain tank, low hydrostatic charge pressure, low separator drive pressure, excessive engine coolant temperature, and inadequate oil pressure, as well as reduced speed of the engine and key machine components. All warning lamps worked very well and were clearly labelled for easy identification. However, some operators found the location inconvenient to check alarms source at a glance.

FIGURE 12. View of Incoming Windrow.

FIGURE 13. Dust From Feeder.

Controls: The John Deere 9500 controls were good.

Most of the machine function controls were located to the right of the operator in an integrated control console and armrest (FIGURE 16). The accessory controls were located in the overhead panel, steering column, and to the left of the operator's seat back rest. Most controls were conveniently placed and easy to use. Color coding and clear symbol labelling aided control identification.

A neutral start system prevented the engine from cranking unless the hydrostatic control lever and unloading auger swing control were in neutral, and the header, separator, and unloading auger engagement controls were off. Fuel shutoff was electrically controlled from the ignition key. The throttle control consisted of a two-position rocker switch so that the engine could only be operated at either idle or full governed speed. The gear shift was located in the right front corner of the cab extending from the cab floor. The lever was easily shifted, but the inline shift pattern made it difficult to select and identify the neutral and second gear positions. It is recommended that the manufacturer consider modifications to improve the ease of identifying the gear shifter position especially for neutral and second gear.

The park brake was activated with a rocker switch and also was engaged automatically when the engine was shut off. The hydrostatic control lever was located in the armrest/console, which provided a convenient operating position regardless of seat adjustment. The hydrostatic control was smooth and positive to operate.

FIGURE 14. Instruments in Cab Pillar.

FIGURE 15. Instruments in Overhead Console.

FIGURE 16. Integrated Control Console and Arm Rest.

The separator and header drives were engaged with toggle switches. These switches were protected from accidental engagement with detents, which required the switch to be lifted before it could be activated. The header reverser was controlled with a rocker pedal on the cab floor and was convenient to use. The header height control switch was located in the handle of the hydrostatic control lever, and was positioned horizontally in the top of the handle (FIGURE 16) rather than vertically on the handle's side as they are on many other combines. This location permitted switch operation with either the thumb or a finger, however, the direction of activation was somewhat confusing at first for operators accustomed to other combines. After a period of time, most operators found the control logical, and convenient to use. The automatic header height control consisted of a rotary switch, which allowed the operator to select one of three preset pickup angles. This system worked well and effectively maintained pickup position, even over widely varying ground contours.

The pickup speed could be either adjusted manually with a rocker switch, or set to automatically maintain a selected pickup to ground speed ratio. However, the automatic pickup speed control was inconvenient to use as minimum pickup speed had to be reset each time the header was disengaged. In addition, the automatic control was designed to shut off at speeds below 1.3 mph (2.9 km/h) and responded slowly to changes in ground speed. This was a problem in instances such as slowing suddenly to pick apart a bunch in a windrow. The pickup didn't have time to slow down before the automatic function locked out. As a result, the pickup remained running too fast for appropriate picking. The manual mode then had to be used to set the appropriate speed. It is recommended that the manufacturer consider modifications to make the automatic pickup speed control more convenient to use and to provide more appropriate response for varying windrow conditions.

Unloader engagement was controlled with a convenient pull-on push-off type switch. Cylinder speed, concave spacing, cleaning fan speed, and unloading auger swing were all controlled with rocker switches. Adjusting the unloading auger positioning with the rocker switch was not as convenient as with a lever control. The rocker switch did not automatically return to its neutral position. When making small adjustments, such as when topping a load, extreme care was required to quickly activate and deactivate the switch to prevent over adjustment. It is recommended that the manufacturer consider modifications to make the unloading auger adjustment more suitable for small adjustments.

Loss Monitor: The loss monitor was very good.

Two grain loss sensor pads were located at the rear of the straw walkers and two at the rear of the chaffer sieve. The meter display was located in the right front cab pillar, and was very easy to observe. Calibration and sensor controls were located in the overhead console.

Once set, the grain loss monitor provided a very useful and reliable indicator of grain loss. As with all loss monitors, meter readings had to be regularly compared to actual loss observed behind the combine for appropriate calibration.

Lighting: Lighting was good.

Lighting for nighttime harvesting was provided by six field lights, one grain tank light, an unloading auger light, as well as two optional "row finder" lights. The field lights provided medium and short range forward lighting, as well as header lighting. However, at times the lights did not penetrate the dust at the feeder inlet and visibility of the incoming windrow was obscured. The unloading auger light illuminated the auger, the side of the truck, and the grain stream while unloading, regardless of auger position. It also provided lighting at the rear of the combine when in the retracted position. The "row finder" lights were helpful, providing additional lighting to the side for checking adjacent windrows or for extra light when unloading. The grain tank light enabled easy viewing into the grain tank from the cab.

All instruments were well lit. A colored lamp in the cab ceiling illuminated the control console and overhead panel, but some operators complained that the illumination was inadequate, even when adjusted to maximum intensity. The interior light and the road lights were adequate. The two tail lights and four warning lights aided in safe road transport.

Handling: Handling was very good.

The John Deere 9500 was easy to drive and very maneuverable. Both the steering and the hydrostatic ground drive operated smoothly and easily, even when the engine was at low idle. The wheel brakes aided in cornering, but were not usually required for picking around most windrow corners. The hydrostatic ground drive was very convenient for matching ground speed to crop conditions. It also made backing up on hard to pick corners quick and easy. The speed ranges in the various gears were appropriate with most harvesting being done in second gear.

The combine was very stable in the field even with a full grain tank. Normal caution was required when operating on hillsides and when traveling at transport speeds. The combine transported well at speeds up to its maximum of 18.3 mph (29.4 km/h).

Adjustment: Ease of adjusting the combine components was good.

Pickup speed, cylinder speed, concave spacing, and fan speed were adjusted from the cab. Sieve settings were adjusted at the rear of the machine.

Table auger clearance and auger stripper bar clearance were easily adjusted to suit crop conditions, and once set, did not have to be readjusted. Table auger finger timing was not adjustable.

The adjustment bolts for leveling and proportioning the concave with respect to the cylinder were easily accessed. Concave inspection ports on either side of the combine body allowed cylinder-to-concave clearance to be gauged at two points, but the minimum clearance actually occurred at a point between the two inspection ports. Consequently, minimum concave clearance could not be measured, and proportioning the concave for "zero" clearance was a trial and error process. Very close concave proportioning was necessary to achieve adequate threshing in many crops. To attain the tighter concave clearance, the factory-installed rear concave hanger spacer had to be removed and the actuator repositioned. Even with these modifications the adjustment was barely adequate. It is recommended that the manufacturer consider modifications that allow the concave to beset for more aggressive threshing and provide more convenient inspection of the tightest cylinder-to-concave clearance.

Although concave clearance was easily adjusted from the cab, the indicator was too coarse to be useful as an accurate reference for adjustment. The pointer was large and blunt, and the gauge divisions were very wide. It is recommended that the manufacturer consider modifications to the concave position indicator to provide a more precise indication of concave clearance.

In hard-to-thresh crops, concave blanking plates were used to reduce unthreshed loss. These plates were easily installed through an access door below the concave, and each one was retained with a spring loaded "J" hook.

Cylinder and fan speed adjustments were very convenient, however sieve adjustments were often inconvenient. The special tool required to adjust the linkage on each sieve was awkward to use.

Field Setting: Ease of setting to suit crop conditions was good.

Once familiar with the combine's threshing characteristics, and once the concave's initial adjustment was set more aggressively, optimum settings could usually be determined quickly. In most crops, little fine tuning was required once the basic settings had been established.

The straw chopper was easily disengaged to drop the straw for easier checking of unthreshed and walker loss. Setting for proper threshing was not too difficult once the concave was properly adjusted to obtain minimal clearance, but concave proportioning was critical. Although the manufacturer's suggested initial settings often covered a wide range of adjustment, in most conditions encountered, only the most aggressive settings provided adequate performance. The settings that provided optimum threshing were usually the settings that provided optimum separation.

Setting the shoe for optimum performance was very easy. Shoe effluent was easy to sample, even with the chaff spreader attached. Simply reducing the speed of the spreader, from the control outside the cab door, provided an easy to catch sample on both sides. Tailings could be sampled through an access panel just outside the cab door. Clean grain could not be sampled until approximately 10 bu (350 L) of grain had been harvested to fill the cavity below the bottom of the tank loading auger and behind the clean grain elevator. Grain was then conveyed up the tank loading auger, and a chute brought a sample back down by an access door located just outside the cab door. The delay of the clean grain was somewhat inconvenient when first adjusting.

The manufacturer's suggested shoe settings were usually appropriate and the shoe handled varying loads with little effect on loss.

Unplugging: Ease of unplugging was very good.

Table auger and feeder obstructions were usually easy to clear using the mechanical feeder reverser. The cylinder did not plug during the test, however, the operator's manual explained how to "power" unplug the combine. It also described manually reversing the cylinder but no tool or tool description was provided for reversing the cylinder.

The concave plugged above the filler plates after harvesting flax with green material admixed. Cleaning was possible from above and below, but was not convenient.

The tailings did not plug during the test.

Machine Cleaning: Ease of cleaning the John Deere 9500 completely was good.

Cleaning the grain tank was easy. Very little grain was retained in the tank, and the corners and auger troughs were easily accessed. Approximately 0.3 bu (11 L) of grain remained in the sump. Doors at the bottom of the sump allowed the grain to drain out. However, the grain fell directly onto the tailings elevator. PAMI fabricated a deflector shield to permit catching the grain from the sump in a pail or bag.

The sieves were easy to remove and provided access to the lower tailings and clean grain auger troughs for cleaning. The shoe supply auger troughs were accessible from the back and front, and could be cleaned with a vacuum cleaner or water hose. The grain pan under the straw walkers was not accessible but could be cleaned with water. There was very little build up of chaff on the exterior of the machine. The engine bay remained free of trash build-up throughout the test.

Cleaning the stone trap was sometimes difficult, as material tended to bridge across the opening of the trap. Often, a stick or tool had to be used to loosen the material for removal.

Lubrication: Ease of lubrication was very good.

Daily lubrication was quick and easy, requiring only about five minutes. There were only a few grease points, and most were easily accessed. The combine had sixty-one pressure grease fittings. Five required greasing at 10 hours, fourteen at 50 hours, six at 200 hours, and thirty-six at 400 hours. Engine, gearbox and hydraulic oil levels required regular checking. Lubrication decals on the sides of the combine greatly aided greasing at the specified intervals, and grease banks were used wherever practical.

The fuel inlet was 8.4 ft (2.6 m) above the ground and was difficult to fill from some gravity fuel tanks. Changing engine oil and filters was easy.

Maintenance: Ease of performing routine maintenance was very good.

Large access shields on both sides of the combine were easily opened and were supported with gas charged cylinders. Most belts and chains were then easily accessed for lubrication or adjustment. Tension of most belts and chains was maintained with spring loaded idlers which greatly simplified maintenance. The engine and radiator were both easily accessed for inspection and service. Slip clutches protected the feeder conveyor, table auger, conveyor augers, and tailings system.

Switching headers or complete header and feeder removal was fairly easy. Once the feeder was removed, there was ample access to the cylinder and concave for repair or replacement.

ENGINE AND FUEL CONSUMPTION

The John Deere 6076Tdiesel engine started easily and ran well. The engine had ample power to achieve harvest rates within a practical loss range for all crops and conditions encountered.

Average fuel consumption was about 5.7 gal/h (25.9 L/h). Oil consumption was insignificant.

OPERATOR SAFETY

No safety hazards on the John Deere 9500 were apparent. However, normal safety precautions were required and warnings had to be heeded.

The operator's manual emphasized safety. The John Deere 9500 had warning decals to indicate dangerous areas. All moving parts were well shielded, and most shields were hinged or easily removed for access.

A neutral start system ensured that all drives were disengaged and controls were in neutral before the starter would engage. A horn was provided and the operator's manual advised its use as a warning to bystanders before starting the engine. When cranking the engine, an audible alarm in the cab signalled low engine oil pressure until after the engine had started. This alarm overpowered any outside noises that may have been occurring, including the sound of the engine cranking. It is recommended that the manufacturer consider modifications to eliminate the alarm while the engine is cranking during start-up.

The combine was equipped with a feeder shutoff circuit that was activated by a switch in the seat. This system ensured that the header and feeder were disengaged whenever the operator left the cab. The John Deere 9500 also had a unique parking brake that was activated automatically whenever the engine was shut down. If the operator must make adjustments or work in dangerous areas, it is important that all clutches be disengaged and the engine shut off.

The combine was equipped with a slow moving vehicle sign, warnings lights, signal lights, tail lights, side marker lights, road lights, and rear view mirrors to aid safe road transport.

While these safety features were effective, PAMI still emphasizes the importance of conscientious maintenance and operating practices to prevent accident or injury. A header cylinder safety stop was provided and should be used when working near the header or when the combine is left unattended.

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

OPERATOR'S MANUAL

The operator's manual was very good.

Information in the operator's manual was clearly written and well organized. The manual contained a table of contents at the front and a master index at the back, which allowed most information to be easily located.

A few incomplete instructions and incorrect references were noted. The operator's manual provided useful information on safety, controls, adjustment, troubleshooting, and machine specifications.

MECHANICAL HISTORY

The intent of the test was evaluation of functional performance. Extended durability testing was not conducted. However, TABLE 6 outlines the mechanical history of the John Deere 9500 for the 117 hours of operation during which about 970 ac (393 ha) of crop were harvested.

TABLE 6. Mechanical History

Item	Operating Hours	Field Area ac	Field Area (ha)
– The rubber bushings in the chaff pan support arms slipped allowing the arms to migrate off the mounting belts. The arms were replaced with improved parts at	36	327	(132)
– An O-ring in the park brake hydraulic cylinder was installed incorrectly at the factory causing it to leak hydraulic oil. The cylinder was disassembled and the O-ring replaced at	39	358	(145)
– The header shut off safety switch in the operators seat activated with lightweight operators several times	throughout the test		
– The table auger finger crank rotated inside the auger, resulting in several broken fingers and damage to the header bottom sheet and front feeder shields at	72	641	(259)
– The pickup speed control valve seized in its housing, causing loss of pickup speed control at	78	689	(279)
– The flange on the end of the top feeder shaft broke away from the shaft. The entire shaft was replaced at	the end of test		
– An excessive number of the plastic pickup teeth broke under normal use	throughout the test		

Rotated Table Auger Finger Crank: Upon disassembly, it was discovered that a half moon key which fixes the crank in position was not installed at the factory. After the failure, the damaged parts were replaced and a half moon key was installed. No further problems occurred.

Seized Pickup Speed Control Valve: No cause was determined for the seized control valve. The rotary valve was lubricated and freed with a wrench, and no further sticking occurred.

Auto-Header Shut Off: The seat switch which shut off the header if the operator left the cab without disengaging the header drive was examined. It was found that if the seat was alternately pressed and released the switch "ratcheted" towards the contacts rather than resetting. Eventually, contact was made and the header shut off unexpectedly. This only occurred when a lighter weight person was operating. It is recommended that the manufacturer consider modifications to the safety switch in the seat to make it function appropriately for all operators.

APPENDIX I
SPECIFICATIONS

MAKE:	John Deere
MODEL:	9500 Maximizer
MODEL:	Header-H00914B630363 Body- H09500X631420 Engine- RG6076T102734
MANUFACTURER:	John Deere Harvester Works 1100 - 13th Avenue East Moline, Illinois 61244 USA
WINDROW PICKUP:	
-- make and model	John Deere 214
-- type	draper (belt)
-- pickup width	13.0 ft (4.0 m)
-- number of drapers	7
-- type of teeth	plastic
-- number of rollers	3
-- height control	castoring gauge wheels
-- speed control	electro-hydraulic
-- speed range	0 to 10.2 ft/s (0 to 3.1 m/s)
HEADER:	
-- type	914 pickup platform - center feed
-- width	
- table	13.2 ft (4.0 m)
- feeder house	54 in (1375 mm)
-- auger diameter	24 in (610 mm)
-- feeder conveyor	3 roller chain with staggered T slatted conveyor
-- conveyor speed	450 ft/min (2.3 m/s)
-- pickup height range	- 41.2 to 43.8 in (-1.0 to 1.1 m)
-- number of lift cylinder	2
-- raising time	5.5 seconds
-- lowering time	adjustable
STONE PROTECTION:	
-- type	sump
-- cleaning	manual access door
CYLINDER:	
-- type	transverse mounted-hardened and chromed rasp bars
-- number of rasp bars	10
-- diameter	25.9 in (660 mm)
-- width	53.7 in (1365 mm)
-- drive	dual speed range, hydraulically controlled variable pitch, torque sensing belt drive
-- speed range	
- low	235 - 495 rpm
- high	460 - 920 rpm
CONCAVE:	
-- type	bars & wire
-- number of bars	14
-- number of wires	50
-- configuration	13 intervals with 0.25 in (6 mm) wires and 0.75 in (19 mm) spaces
-- width	54.5 in (1385 mm)
-- radial length	23.1 in (585 mm)
-- wrap	99 degrees
-- total area	1259 in² (0.812 m²)
-- open area	778 in² (0.502 m²) - 62%
-- grain delivery to shoe	6 augers
BEATER:	
-- type	8 wing angle bats
-- diameter	15.5 in (396 mm)
-- speed	same as cylinder
-- grate	
- type	cell
- total area	545 in² (0.351 m²)
- open area	406 in² (0.263 m²) - 75%
STRAW WALKERS:	
-- type	8 step formed metal spread steel oval opening
-- number	4
-- length	
- extension in	14.7 ft (4.5 m)
- extensions out	15.6 ft (4.7 m)
-- walker housing width	52.9 in (1395 mm)
-- separating area	67.3 ft² (6.3 m²)
-- crank throw (radius)	29 in (74 mm)
-- speed	168 rpm
-- grain delivery to shoe	reciprocating pan
-- straw curtain	2 w/adjustable positions
SHOE:	
-- type	chaffer & cleaning sieves in unison - opposed to pre-cleaner
-- speed	280 cpm
-- pre-cleaner	
- type	regular tooth - adjustable
- tooth depth	0.4 in (10 mm)
- louvre spadng	1.2 in (30 mm)
- area	1525 in² (0.984 mm²)
- travel	2.1 in (53 mm) horizontal 1.5 in (38 mm) vertical
-- chaffer sieve	
- type	regular tooth - adjustable
- tooth depth	0.9 in (22 mm)
- louvre spacing	1.2 in (30 mm)
- area	1541 in² (0.994 m²)
- travel	1.7 in (44 mm) horizontal 1.0 in (26 mm) vertical
-- tailings sieve	
- type	regular tooth - adjustable
- area	477 in² (0.308 mm²) 83 in² (0.054 mm²)
-- cleaning sieve	
- type	regular tooth - adjustable
- tooth depth	0.4 in (10 mm)
- louvre spacing	1.1 in (28 mm)
-- area	2163 in² (1395 mm²)
-- travel	1.9 in (49 mm) horizontal 0.4 in (10 mm) vertical
CLEANING FAN:	
-- type	centrifugal forward curved blades
-- number of fans	4
-- diameter	13.7 in (348 mm)
-- width	5.9 in (150 mm)
-- drive	belt - variable pitch sheave
-- speed range	740 to 1355 rpm
ELEVATORS:	
-- type	roller chain-rubber paddles
-- clean grain (top drive)	6.3 x 11.5 in (1 59 x 291 mm)
-- railings (bottom drive)	6.3 x 9.3 in (1 59 x 236 mm)
GRAIN TANK:	
-- capacity	197 Imperial bushels (7.2 m³)
-- unloading time	92 seconds
-- unloading auger diameter	11.1 in (283 mm)
-- unloading auger length	17.1 ft (5.2 m)
ENGINE:	
-- make	John Deere
-- model	6076 T
-- type	4 stroke in line turbo-charged diesel
-- number of cylinders	6
-- displacement	466 in³ (7.6 L)
-- governed speed (full throttle)	2310 rpm
-- manufacturer's rating	190 hp (142 kW)
-- fuel tank capacity	530 L
CLUTCHES:	
-- header	electro-hydraulic
-- separator	electro-hydraulic
-- unloading auger	electro-hydraulic
NUMBER OF CHAINS:	5
NUMBER OF BELT DRIVES:	13
NUMBER OF GEAR BOXES:	6
LUBRICATION POINTS:	
-- 10 h	1
-- 50 h	8
-- 200 h	6
-- 400 h	37
TIRES:	
-- front	24.5 x 32 RI (12-ply)
-- rear	11.0 x 24.5 L (8-ply)
TRACTION DRIVE:	
-- type	hydrostatic
-- speed range	
- 1st gear	0 to 3.7 mph (0 to 5.9 km/h)
- 2nd gear	0 to 6.9 mph (0 to 11.1 km/h)
- 3rd gear	0 to 18.3 mph (0 to 29.4 km/h)
OVERALL DIMENSION:	
-- wheel tread (front)	10.2 ft (31 m)
-- wheel tread (rear)	9.6 ft (29 m)
-- wheel base	12.3 ft (37 m)
-- transport height	13.1 ft (40 m)
-- transport length	35.9 ft (110 m)
-- transport width	16.4 ft (50 m)
-- field height	13.1 ft (40 m)
-- unloader discharge height	13.1 ft (40 m)
-- unloader reach	10.4 ft (32 m)
-- unloader clearance	12.6 ft (38 m)
WEIGHT: (empty grain tank)	
-- right front wheel	10,250 lb (4650 kg)
-- left front wheel	10,140 lb (4600 kg)
-- right rear wheel	3460 lb (1570 kg)
-- left rear wheel	3460 lb (1570 kg)
TOTAL	27,310 lb (12,390 kg)

APPENDIX II

PAMI REFERENCE II COMBINE CAPACITY RESULTS

TABLE 7 and FIGURES 17 and 18 present the capacity results for the PAMI Reference II Combine in barley and wheat crops for 1984 and 1986 to 1989.

FIGURE 17 shows capacity differences in barley crops for the different years. The Harrington barley Crop shown in Figure 17 had average grain and straw yield and typical grain and straw moisture. Capacity was, however, lower than that attained in all other years,

FIGURE 18 shows capacity differences in the wheat crops. In 1989, the Katepwa wheat crop selected had better than average yield and an accompanying high yield of straw. The grain and straw were in the tough moisture range. Wheat capacity in 1989 also was considerably lower than previous years.

The reduction in capacity of the Reference II Combine in the 1989 season indicates that the test combines tested alongside would also likely have had a similar reduction in capacity. Results show that the Reference combine is important in determining the effect of crop variable and in comparing capacity results of combines evaluated in different years.

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

	CROP CONDITIONS										RESULTS								
			Width of Cut		Crop Yield		Moisture Content			MOG Feedrate		Grain Feedrate		Total Feedrate		Grain Cracks	Dockage	Foreign Material
Year	Crop	Variety	ft	m	bu/ac	t/ha	Straw %	Grain %	MOG/G Ratio	lb/min	t/h	bu/h	t/h	lb/min	t/h	%	%	%
1989	Barley	Bonanza	30	9.1	64	3.4	10.8	10.5	0.60	330	9.0	690	15.0	880	24.0	0.8	0.7	0.4
	Barley	Harrington	30	9.1	70	3.8	10.0	13.4	0.64	320	8.7	625	13.6	820	22.3	1.7	0.1	0.1
	Wheat	Katepwa "A"	20	6.1	55	3.7	8.8	16.2	1.00	490	13.4	490	13.4	980	26.8	3.1	0.7	0.4
	Wheat	Katepwa "B"	30	9.1	57	3.9	11.5	15.4	1.10	405	11.0	370	10.1	775	21.1	2.8	0.5	0.3
	Wheat	Katepwa "C"	30	9.1	66	4.4	14.8	15.8	1.13	470	12.8	415	11.3	885	24.1	3.1	0.5	0.3
1988	Barley	Ellice	30	9.1	68	3.7	12.9	11.4	0.75	400	10.9	665	14.5	930	25.4	1.3	0.6	0.1
	Wheat	Katepwa"A"	30	9.1	35	2.4	4.7	12.4	0.93	540	14.7	580	15.8	1120	30.5	1.7	2.0	0.3
	Wheat	Katepwa"B"	30	9.1	43	2.9	9.5	13.7	1.20	570	15.5	475	12.9	1045	28.4	2.3	3.3	1.3
1987	Barley	Argyle	24	7.2	69	3.5	12.6	13.0	0.82	395	10.8	600	13.1	876	23.8	0.5	1.5	1.2
	Barley	Harrington	20	6.4	79	4.3	7.7	10.8	0.81	370	10.1	570	12.4	825	22.5	1.5	3.0	0.1
	Wheat	Columbus	25	7.6	43	2.9	5.0	13.4	1.16	540	14.7	465	12.7	1005	27.4	1.5	3.5	0.1
	Wheat	Katepwa "A"	40	12.2	31	2.2	6.9	12.9	0.65	520	14.2	800	21.8	1320	35.9	1.5	2.5	0.2
	Wheat	Katepwa "B"	60	18.3	37	2.6	8.3	14.5	0.64	580	15.8	905	24.6	1485	40.4	2.0	2.0	0.1
	Wheat	Katepwa "C"	60	18.3	31	2.1	12.8	16.0	1.07	630	17.2	590	16.1	1220	33.2	1.5	1.5	0.1
1986	Barley	Harrington	56	17.0	62	3.3	10.5	10.8	0.64	424	11.6	828	18.1	1090	29.7	0.4	0.3	0.2
	Wheat	Columbus	56	17.0	51	3.4	8.8	16.7	1.14	647	17.7	568	15.5	1210	33.0	1.5	4.6	3.5
	Wheat	Katepwa	29	8.9	49	3.3	6.5	14.0	1.32	644	17.6	488	13.3	1135	31.0	1.8	1.7	1.0
1984	Barley	Bonanza	42	12.8	52	2.8	15.0	11.2	0.70	363	9.9	648	14.1	875	23.8	0.5	1.0	
	Barley	Bonanza	24	7.3	77	4.1	11.3	11.6	0.66	352	9.6	687	14.6	880	24.0	0.5	1.0	
	Wheat	Neepawa	44	13.4	36	2.4	6.3	10.9	1.32	539	14.7	408	11.1	950	25.9	1.1	5.5	
	Wheat	Neepawa	22	12.8	44	3.0	8.7	10.2	1.18	601	16.4	509	13.9	1110	30.3	4.5	7.0	

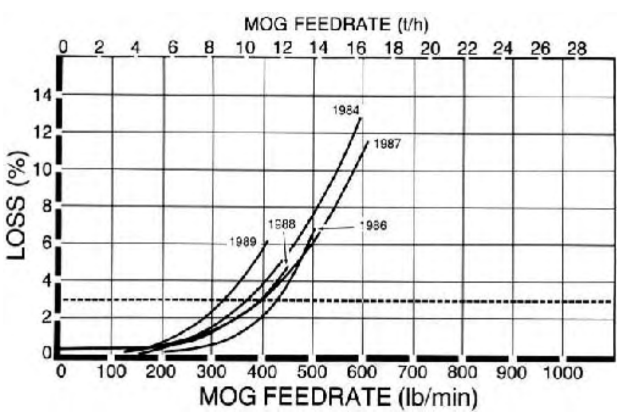

FIGURE 17. Total Grain Loss for the PAMI Reference II Combine in Barley.

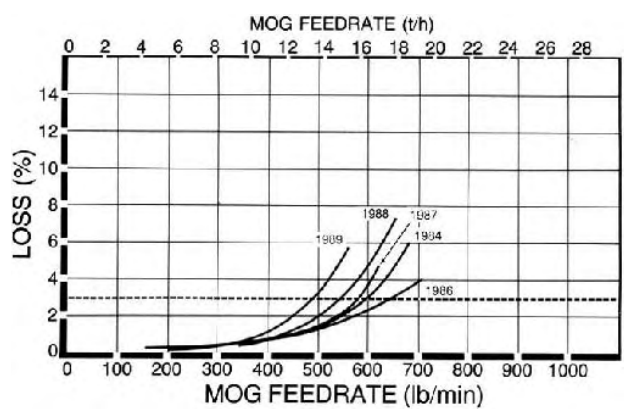

FIGURE 18. Total Grain Loss for the PAMI Reference II Combine in Wheat.

APPENDIX III

REGRESSION EQUATIONS FOR JOHN DEERE 9500 CAPACITY RESULTS

Regression equations for the capacity results shown in FIGURES 2 to 4 are presented in TABLE 8. In the regressions, U = unthreshed loss in percent of yield, S = shoe toss in percent of yield, W = walker loss in percent of yield, F = the MOG feedrate in lb/min, while $\ln$ is the natural logarithm. Sample size refers to the number of loss collections. Limits of the regressions may be obtained from FIGURES 2 to 4 while crop conditions are presented in TABLE 3.

TABLE 8. Regression Equations

Crop - Variety	Figure Number	Regression Equations	Simple Correlation Coefficient	Variance Ratio	Sample Size
Barley - Harrington	2	$U = 0.01 + 4.77 \times 10^{-7} \times F^2$ $S = -0.02 + 2.62 \times 10^{-7} \times F^2$ $\ln W = -4.92 + 1.41 \times 10^{-2} \times F$	0.89 0.88 0.99	22.00[2] 19.99[2] 224.12[2]	8
Wheat - Katepwa	3	$U = 0.66 + 1.02 \times 10^{-14} \times F^5$ $S = 0.09 - 3.57 \times 10^{-5} \times F$ $W = 0.15 + 5.12 \times 10^{-25} \times F^9$	0.89 0.25 0.95	26.98[2] 0.46 62.38[2]	10
Wheat - Katepwa	4	$U = 0.27 + 5.17 \times 10^{-15} \times F^5$ $S = 0.12 + 1.08 \times 10^{-4} \times F$ $\ln W = -5.23 + 1.11 \times 10^{-2} \times F$	0.86 0.23 0.95	19.85[2] 0.45 69.49[2]	9

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

APPENDIX IV
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

Excellent	Fair
Very Good	Poor
Good	Unsatisfactory

SUMMARY CHART

JOHN DEERE 9500 SELF-PROPELLED COMBINE

RETAIL PRICE	$143,800.00 (February, 1990, f.o.b. Humboldt, Sask.)
CAPACITY	
Compared to Reference II Combine	
- barley	1.3 x Reference II
- wheat	1.1 and 1.3 x Reference II
MOG Feedrates	
- barley - Harrington	425 lb/min (11.6 t/h) at 3% total loss, FIGURE 2
- wheat - Katepwa "A"	530 lb/min (14.5 t/h) at 3% total loss, FIGURE 3
- wheat - Katepwa "B"	535 lb/min (14.5 t/h) at 3% total loss, FIGURE 4
QUALITY OF WORK	
Picking	**Very Good;** picked well in all crops
Feeding	**Very Good;** aggressive table auger, seldom plugged
Stone Protection	**Very Good;** trapped most stones
Threshing	**Good;** aggressive settings required, concave blanking plates needed in wheat
Separating	**Good;** walker loss limited capacity in most crops
Cleaning	**Excellent;** shoe loss low in all crops
Grain Handling	**Very Good;** fast unloading
Straw and Chaff Spreading	**Good Straw Spreading;** spread evenly up to 25 ft (7.6 m) **Very Good Chaff Spreading;** spread up to 20 ft (6.1 m)
EASE OF OPERATION AND ADJUSTMENT	
Comfort	**Very Good;** roomy cab, very quiet
Instruments	**Very Good;** all functions monitored, pillar mount instruments convenient to observe
Controls	**Good;** well placed and easy to use, the auto pickup speed control didn't function effectively in some conditions
Loss Monitor	**Very Good;** provided reliable response
Lighting	**Good;** more light required for feeder area
Handling	**Very Good;** easy to drive, smooth and responsive
Adjustment	**Good;** concave gauge too coarse, sieve adjustment required special tool
Field Setting	**Good;** easy to sample, little fine tuning required
Unplugging	**Very Good;** header reverser worked well, no other plugging
Machine Cleaning	**Good;** most areas accessible
Lubrication	**Very Good;** only a few daily grease points
Maintenance	**Very Good;** easy access and little care required
ENGINE AND FUEL CONSUMPTION	
Engine	Started quickly and ran well
Fuel Consumption	5.7 gal/h (25.9 L/h)
OPERATOR SAFETY	Well shielded and many safety features
OPERATOR'S MANUAL	**Very Good;** well organized and easy to find information
MECHANICAL HISTORY	A few mechanical problems occurred

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