Printed: March, 1986
Tested at: Humboldt
ISSN 0383-3445
Group 4c

Evaluation Report 474

New Holland TR96 Self-Propelled Combine

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

NEW HOLLAND TR96 SELF-PROPELLED COMBINE

MANUFACTURER:
New Holland
500 Diller Avenue
New Holland, Pennsylvania 17557

RETAIL PRICE:
$163,616.00 [March, 1986, f.o.b. Humboldt, with a 13 ft (4.0 m) header, 10 ft (3.0 m) Melroe 388 pickup, fixed speed feeder, feeder jack stand, high speed rotor kit, Peterson chaffer, high speed fan kit, straw chopper, 30.5 L x 32 R1 drive tires, 14.9 x 24 steering tires, grain loss monitor, starting fluid injector kit, block heater, AM-FM radio, heater, large windshield wiper, and service floodlight].

DISTRIBUTORS:
New Holland
Box 1616 Main P.O.
Calgary, Alberta
T2P 2M7
(403) 273-6771

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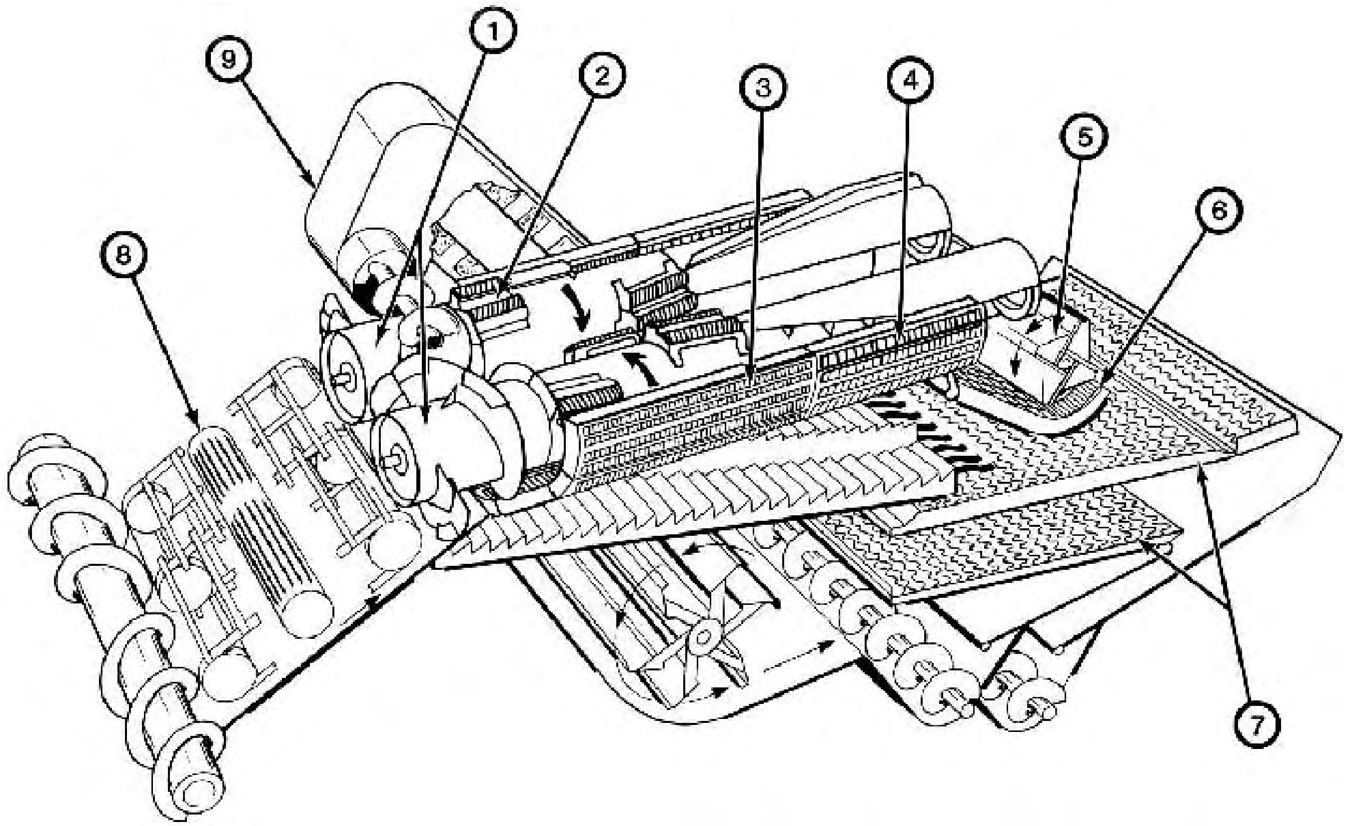

FIGURE 1. New Holland TR96: (1) Rotors, (2) Rasp Bars, (3) Threshing Concave, (4) Separating Concave, (5) Discharge Beater, (6) Beater Grate, (7) Cleaning Shoe, (8) Stone Ejection Roller, (9) Tailings Return.

SUMMARY AND CONCLUSIONS

Capacity: In the capacity tests, the MOG feedrate* at 3% total grain loss in Argyle barley was 629 lb/min (17.2 t/h). In Bonanza barley at power limit, total loss reached only 1.5% for a MOG feedrate of 664 lb/min (18.1 t/h). In wheat, total loss did not get above 1.5%. At engine power limit, combine capacity was 883 lb/min (24.1 t/h) in Katepawa wheat and 756 lb/min (20.1 t/h) in Neepawa wheat. In barley crops, the New Holland TR96 had approximately 2.3 times the capacity of the Machinery Institute reference combine at 3% total loss. In wheat the New Holland TR96, at less than 1.5% total loss, had about 2 times the capacity of the reference combine at 3% total grain loss.

Quality of Work: Pickup performance was good in all crops. It picked cleanly at speeds up to 6 mph (9.6 km/h) and fed the crop evenly under the table auger. Feeding was very good for all crops and conditions, however, the table auger plugged frequently in bunchy windrows.

The powered stone roller and trap door provided good protection from stones and roots entering the rotor.

Threshing was very good. The New Holland TR96 threshed aggressively and smoothly in all crops. Unthreshed losses and grain damage were low in most crops. Straw break-up was severe in dry conditions. In tough conditions, combine throughput was reduced.

Separation of grain from straw was very good. Rotor loss was low over the entire operating range and did not limit combine capacity.

Cleaning shoe performance was very good with the Peterson chaffer. When properly adjusted, grain toss over the shoe was low and did not limit combine capacity. The grain tank sample was clean in alt crops.

Grain handling was good. The 230 Imperial bu (8.37 m³) grain tank filled evenly and completely in all crops. Unloading was slow, taking about 170 seconds to unload a full tank of dry wheat. Unloader discharge height was high but the optional downspout prevented grain toss when unloading on windy days.

Straw spreading was fair. The straw was spread over about 15 ft (4.6 m) with most of the straw falling in two narrow windrows at the outer edges.

Ease of Operation and Adjustment: Operator comfort in

**MOG Feedrate (Material-Other-than-Grain Feedrate) is the mass of straw and chaff passing through the combine per unit time.*

the New Holland was very good. The cab was relatively dust free. The heater and air conditioner provided comfortable cab temperatures. The seat and steering column could be adjusted to suit most operators. The cab windows were tinted, Visibility was very good forward and to the sides. The view of the feed intake area was partially blocked by the steering wheel. The rearview mirrors provided good visibility to the rear.

Instrumentation was very good. Instrument bars located at eye level were very easy to see, except in direct sunlight. The instruments monitored all important functions and had built-in warning systems. Controls were very good. All controls were conveniently located, responsive, and easy to use.

Loss monitor performance was good. Only shoe loss was indicated. However, since shoe loss did not limit combine capacity, the toss monitor was used very little. The reading was meaningful only if compared to actual losses.

Lighting for nighttime harvesting was excellent.

Handling was very good. The combine was easily maneuverable and stable both in the field and while transporting. Steering was smooth and responsive.

Ease of adjusting the combine components was good. However, it was difficult to measure the opening on the cleaning sieve Ease of setting the components to suit crop conditions was very good.

Ease of unplugging was good. The feeder reverser worked very well and was easy to use for unplugging the table auger and feeder. The operator seldom had to leave the cab to clear a slug. The rotors did not plug during the season. Ease of cleaning the combine was good. Clean-out doors were provided for the clean grain and return elevator cross augers.

Ease of lubrication was good. Few grease points made daily lubrication quick and easy. The fuel inlet was high making it difficult to fill from most gravity flow fuel tanks. Ease of performing general maintenance and repair was fair. Specifications outlined in the operator's manual for tensioning certain chains was confusing.

Engine and Fuel Consumption: The engine started easily and ran well. In most conditions, the combine was run at or near power limit. When harvesting in damp or tough conditions, MOG feedrate at power limit was reduced. Average fuel consumption for the year was 8.0 gal/h (36.4 L/h). Oil consumption was insignificant.

Operator Safety: The operator's manual emphasized operator safety. All moving parts were well shielded. The New Holland TR96 was safe to operate if normal safety precautions were taken and warnings heeded.

Operator's Manual: The operator's manual was well written and contained useful information on safety, servicing, lubrication, trouble shooting, setting, and specifications.

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

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Reducing the grease frequency interval in the operator's manual for the feeder slip clutch.
2. Modifications to increase the grain unloading rate.
3. Modifications to the straw chopper to give a wider, more uniform spread pattern.
4. Supplying a safe, more convenient apparatus for sampling return tailings while harvesting.
5. Modifications to provide better access for tightening the return elevator chain.
6. Replacing the faulty seat in the rotor speed control valve to prevent rotor speed from dropping.
7. Clarifying the procedure recommended in the operator's manual for measuring the tension on certain chains and the separator clutch.
8. Modifications to the feeder house locking pins to allow for easier removal.
9. Improving the durability of the feed assist plates.

Senior Engineer: G.E. Frehlich
Project Manager: L.G. Hill
Project Technologist: W.A. Beckett

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. The grease interval for the feeder slip clutch will be changed from a 50 hour service to 100 hour service,
2. Changes to increase the unloading system rate are being evaluated.
3. This is under design consideration.
4. No planned changes.
5. Easier access for this adjustment is being evaluated.
6. A design change has been implemented to correct the units in the field and in production.
7. Simplified instructions will be included in the next printing of the operator's manual.
8. Design changes have been made in production to correct this.
9. Different materials are being investigated for longer fife.

GENERAL DESCRIPTION

The New Holland TR96 is a self-propelled combine with two longitudinally mounted rotors, threshing and separating concaves, discharge beater, and a cleaning shoe. Threshing occurs mainly at the front section of the rotors while separation of grain from straw occurs throughout the full length of the threshing and separating concaves, and at the rear beater grate. The grain is cleaned at the shoe and the return tailings delivered to the front of the rotors. A stone ejection roller is mounted within the feeder housing.

The test machine was equipped with a 240 hp (179 kW) eight cylinder, turbocharged diesel engine, a 13 ft (4.0 m) header, a 10 ft (3.0 m) Melroe pickup, a straw chopper and other optional equipment as listed on Page 2.

The New Holland TR96 has a pressurized operator's cab, power steering, hydraulic wheel brakes, and a hydrostatic traction drive. The separator, header, and unloading auger drives are manually engaged. Header height and unloading auger swing are hydraulically controlled. Rotor rpm, pickup speed, cleaning fan rpm, and concave clearance are adjusted from with the cab. Cleaning shoe settings are adjusted on the machine. There is no provision to safely and conveniently inspect the return tailings while operating. Important component speeds, and machine and harvest functions are displayed on electronic monitors.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The New Holland TR96 was operated for 128 hours while harvesting about 1295 ac (524 ha) of various crops. The crops and conditions are shown in TABLES 1 and 2. During the harvest, it was evaluated for rate of work, quality of work, ease of operation and adjustment, operator safety, and suitability of the operator's manual. Mechanical failures were recorded.

TABLE 1. Operating Conditions

Crop	Variety	Average Yield		Width of Cut		Hours	Field Area	
		bu/ac	t/ha	ft	m		ac	ha
Barley	Argyle Bonanza Herrington	57 49 77	3.1 2.6 4.2	42, 60 21, 30, 44, 60 44, 60	12.8, 18.2 6.4, 9.1 13.4, 18.2 13.4, 18.2	9 18 2	90 167 11	36 66 4
Canola	Westar	38	2.1	22, 30	6.7, 9.1	18	138	56
Rye	Muskateer Puma	24 20	1.5 1.3	21, 44, 60 21, 44, 60	6.4, 13.4, 18.2 6.4, 13.4, 18.2	17 12	220 168	89 68
Wheat	Katepwa Neepawa	44 44	3.0 3.0	22, 44 22, 42, 44, 60,	6.7, 13.4, 6.7, 12.8, 13.4, 18.2	7 28	75 218	30 88
Flax	North Star Dufferin	21 20	1.4 1.3	50 22, 25	15.2 6.7, 7.6	12 5	158 50	64 20
Total						128	1295	524

RESULTS AND DISCUSSION

TERMINOLOGY

MOG, MOG Feedrate, Grain Feedrate, and MOG/G Ratio: A combine's performance is affected by two main factors; the amount of straw and chaff being processed, and the amount of grain or seed being processed. 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 called the "Grain Feedrate".

TABLE 2. Operation in Stony Conditions

Field Conditions	Hours	Field Area	
		ac	ha
Stone Free	15	152	62
Occasional Stones	85	860	348
Moderately Stony	28	283	114
Total	128	1295	524

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 0.5 MOG/G ratio, the combine has to handle 50 lb (22.7 kg) of straw for every 100 lb (45.4 kg) of grain harvested. However, in a crop with a 1.5 MOG/G ratio, for a similar 100 lb (45.4 kg) of grain harvested, the combine now has to handle 150 lb (68.2 kg) of straw -- 3 times as much. Therefore, the higher the MOG/G ratio, the more difficult it is to separate the grain.

Grain Loss, Grain Damage, and Dockage: 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 further defined as shoe and walker (or rotor) loss depending on 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, cracked grain is determined by comparing the weight of the actual damaged kernels to the entire weight of the sample taken from the grain tank.

Dockage is determined by standard Grain Commission methods. It 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 total sample taken.

Capacity: Combine capacity is the maximum rate at which a combine, adjusted for optimum performance, can process crop material at a certain total loss level. The Machinery Institute 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 considerably due to crop and weather conditions (APPENDIX II and FIGURES 19 and 20). Since these conditions affect combine performance, it is impossible to compare combines that are not tested under identical conditions. For this reason, the Machinery Institute uses a reference combine. It is simply one combine that is tested each time that an evaluation combine is tested. Since conditions are similar, the combine can be compared directly to the reference combine and a relative capacity determined. Combines tested in different years and conditions can then be compared indirectly using their relative capacities.

RATE OF WORK

Capacity Test Results: The capacity results for the New Holland TR96 are summarized in TABLE 3.

The performance curves for the capacity tests are presented in FIGURES 2 to 5. The curves in each figure indicate the effect of increased feedrate on rotor loss, shoe loss, unthreshed loss, and total loss. From the graphs, combine capacity can also be determined for loss levels other than 3%. These results were obtained with the combine set for optimum performance at a reasonable feed rate.

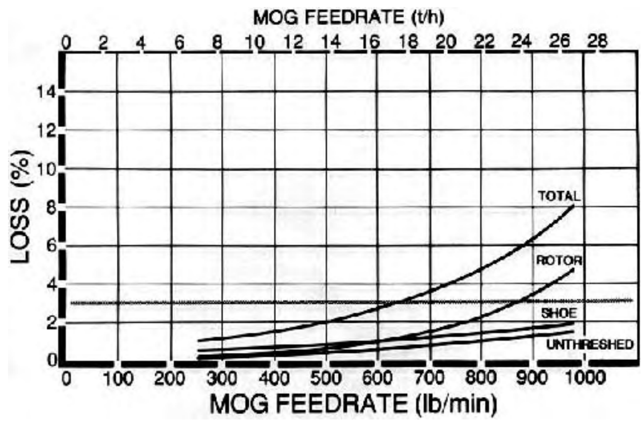

FIGURE 2. Grain Loss in Argyle Barley.

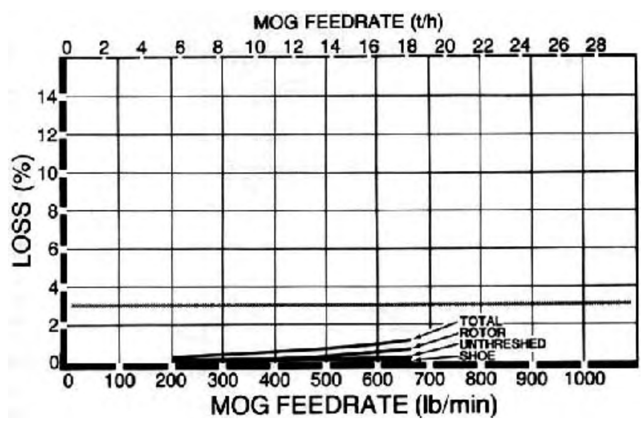

FIGURE 3. Grain Loss in Bonanza Barley.

The crops for the 1985 harvest suffered from excessive moisture and early frosts. This caused a reduction in bushel weight and grain quality. Crop yields were slightly above average. Poor drying conditions contributed to above average grain and straw moisture contents in most crops.

In the Argyle barley test, crop conditions were unstable. A high straw moisture made separating more difficult. Beards were very difficult to remove from the grain, which increased the unthreshed loss. In addition, the MOG/G ratio of 1.5 was unusually high for

TABLE 3. Capacity of the New Holland TR96 at a Total Loss of 3% of Yield

Crop Conditions									Results						
		Width of Cut		Crop Yield		Moisture Content			MOG Feedrate		Grain Feedrate		Grain Cracks %	Dockage %	
Crop	Variety	ft	m	bu/ac	t/ha	Straw %	Grain %	MOG/G	lb/min	t/h	bu/h	t/h			Loss Curve
Barley	Argyle***	60	18.0	43	2.3	28	11.4	1.5	629	17.2	524	11.4	1.5	1.3	Fig. 2
Barley	Bonanza*	55	16.8	73	3.9	23	15.7	0.86	664	18.1	965	21.0	1.5	1.5	Fig. 3
Wheat	Neepawa*	41	12.5	58	3.9	12	18.3	0.99	883	24.1	892	24.3	**	**	Fig. 4
Wheat	Neepawa*	42	12.8	51	3.4	15	17.6	1.08	756	20.1	713	19.5	5.3	1.7	Fig. 5

*Losses did not reach 3%.
**Data not available.
***Standard chaffer used for this test only.

barley crops. Because of this high MOG/G ratio, the grain feedrate was low even though the MOG feedrate was similar to the Bonanza barley test. For the conditions found in this particular barley crop, better cleaning shoe performance was obtained with the standard louvre chaffer.

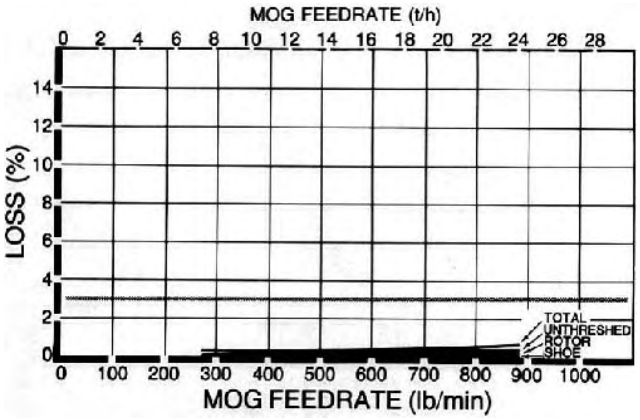

FIGURE 4. Grain Loss in Katepawa Wheat.

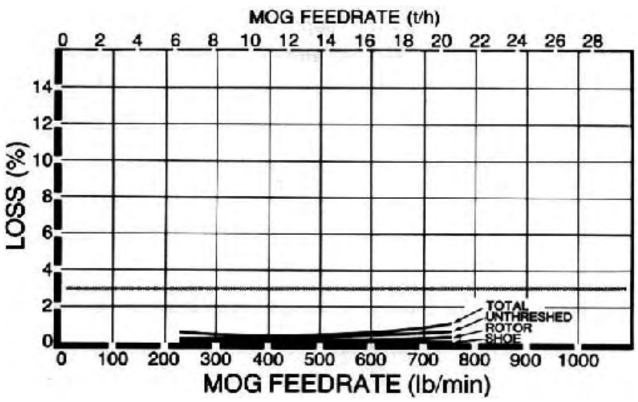

FIGURE 5. Grain Loss in Neepawa Wheat.

In the Bonanza barley test, crop conditions were more stable. The above average straw moisture required more power to thresh which reduced overall combine throughput.

For the two wheat tests, conditions were stable and losses were quite low. At maximum engine power, losses did not reach 3%. Capacity was slightly better in the Katepawa wheat because the crop was easier to thresh. Grain damage in the Neepawa wheat test was high because the grain had been damaged by frost and been in the windrow in adverse conditions for a long time.

Average Workrates: TABLE 4 indicates the average workrates obtained in each crop over the entire test season. These values are considerably lower than the capacity test results in TABLE 3. This is because the results in TABLE 3 represent instantaneous rates while average workrates take into account operation at lower loss levels, variable crop and field conditions, availability of grain handling equipment, and differences in operating habits. Most operators would expect to obtain average rates in this range, while some daily rates may approach the capacity test values. The average workrates should not be used to compare combines. The factors, which affect workrates are too variable and cannot be duplicated for all combine tests.

TABLE 4. Average Workrates

		Average Yield		Average Workrates			
Crop	Variety	bu/ac	t/ha	ac/h	ha/h	bu/ac	t/h
Barley	Argyle	57	3.1	11.0	4.5	627	13.7
	Bonanza	49	2.5	11.4	4.6	559	12.2
	Herrington	77	4.2	11.0	4.5	847	18.5
Flax	Dufferin	20	1.3	13.0	5.3	280	6.6
Canola	Westar	38	2.1	8.5	3.4	323	7.3
Rye	Musketeer	24	1.5	15.0	6.1	360	9.2
Rye	Puma	20	1.3	16.0	6.5	320	8.1
Wheat	Katepawa	44	3.0	10.0	4.0	440	12.0
Wheat	Neepawa	44	3.0	10.1	4.1	444	12.1
Wheat	North Star	21	1.4	18.0	7.3	378	10.3

Comparing Combine Capacities: The capacity of combines tested in different years or in different crop conditions can only be compared using the Machinery Institute reference combine. This is done by dividing the test combine capacity (MOG feedrate at 3% loss), as shown in TABLE 3, by the corresponding capacity for the reference combine, found in TABLE 7. The resulting number (capacity ratio) can be used to compare capacities of combines in different years.

For example, if the test combine has a capacity of 440 lb/min (12 t/h) MOG, and the reference a capacity of 367 lb/min (10 t/h) MOG, the test combine capacity is 1.2 times the reference combine capacity [440/367 = 1.2 (12/10 = 1.2)]. Comparing this combine to a second combine which has two times the capacity of the reference, it can be seen that the second combine has 67% more capacity [(2 - 1.2/1.2 x 100 = 67%].

A test combine can also be compared to the reference combine at losses other than 3%. The total loss curves for both machines are shown on the same graph in FIGURES 6 to 9. Shaded bands around the curves represent 95% confidence belts. Where the bands overlap, very little difference in capacity would be noticed; where the bands do not overlap, significant capacity differences existed.

Capacity Compared to Reference Combine: Capacity of the New Holland TR96 was much greater than that of the reference combine in both wheat and barley crops. At 3% total loss in the Argyle barley and power limit in the Bonanza barley, the TR96 had about 2.3 times the capacity of the reference combine loss. In wheat, the New Holland TR96 losses did not reach 3%. Its maximum capacity was about 2 times the capacity of the reference combine at 3% total loss. FIGURES 6 to 9 compare the total losses of both combines.

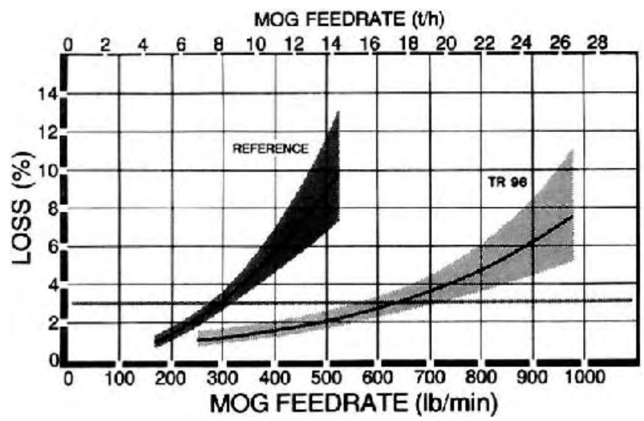

FIGURE 6. Total Grain Loss in Argyle Barley.

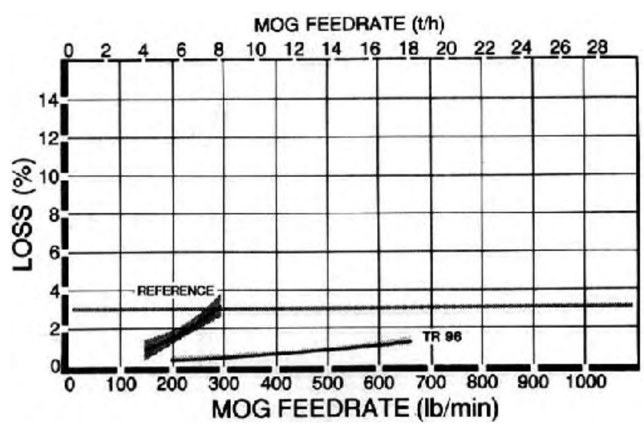

FIGURE 7. Total Grain Loss in Bonanza Barley.

QUALITY OF WORK

Picking: Pickup performance was good. Windrows were picked using a hydraulically driven 10ft (3.0 m) Melroe 388 pickup. Pickup height was adjusted with castor gauge wheels, while pickup speed was controlled from the cab. The speed control could be manually or automatically set. This was very convenient. The windguard was set to direct the crop under the table auger without restricting crop flow. It was removed for rapeseed crops. Even without the windguard, feeding in rapeseed swaths was acceptable.

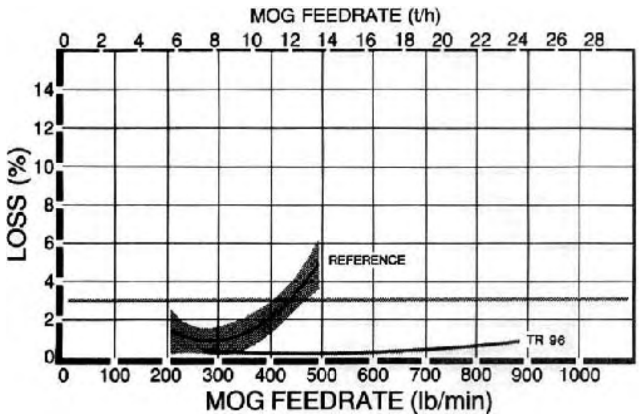

FIGURE 8. Total Grain Loss in Katepawa Wheat.

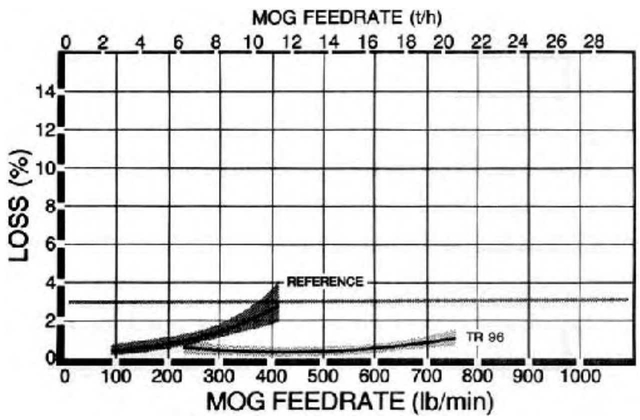

FIGURE 9. Total Grain Loss in Neepawa Wheat.

The pickup picked cleanly in all crops at speeds up to 6 mph (9.6 km/h). At speeds greater than 6 mph (9.6 km/h), pickup losses increased significantly. Crop material sometimes built up at the outer edges of the pickup, which reduced the effective picking width. Readjusting the stripper bar helped to correct this problem. Pickup width was too narrow for picking some side-by-side double windrows or while picking around corners.

Feeding: Feeding was very good in all crops and conditions. The table auger fed the material to the slatted conveyor chain, which carried the crop to the rotors.

The table auger plugged frequently in tough or bunchy windrows. This was caused by over greasing the feeder slip clutch. Although clutch tension was set properly, the grease on the jaw faces allowed it to slip easier. Slipping was reduced when the greasing frequency recommended by the manufacturer was reduced. It is recommended that the manufacturer consider reducing the grease frequency interval in the operator's manual for the feeder slip clutch.

Feeding was slightly restricted when the stone roller was set in its lowest position.

The overlapped flighting on the rotor intake provided smooth even feeding into both rotors in all conditions.

Stone Protection: Stone protection on the New Holland TR96 was good. Stones and other hard objects were removed as they travelled up the feeder house and passed between the powered stone ejection roller and the trap door (FIGURE 10). In stony conditions, the powered stone roller was adjusted to provide the maximum stone protection. In stone-free conditions, it was raised to provide unrestricted feeding.

Most stones and hard objects were ejected. As a result there was negligible rotor and concave damage. However, some small stones did get into the rotors, which damaged the wear plates and feed assist plates on the rotor flighting (see Mechanical History). No rasp bar or concave damage was noticed. With the stone roller in the lowest position, a dense wad of crop often caused the door to be "kicked" open. The door could be easily reset from inside the cab by fully raising the header.

Threshing: Threshing was very good. Threshing was accomplished by the twin counter-rotating rotors, adjustable threshing concaves, extension modules, and separating concaves (FIGURES 11 and 12). The rotors were powered through two gearboxes and a torque sensing variable speed belt drive. The drive was positive and provided a suitable range of speeds for all crops encountered. The concave had adequate adjustment. Rotor speeds and concave settings used for the various crops are given in TABLE 5.

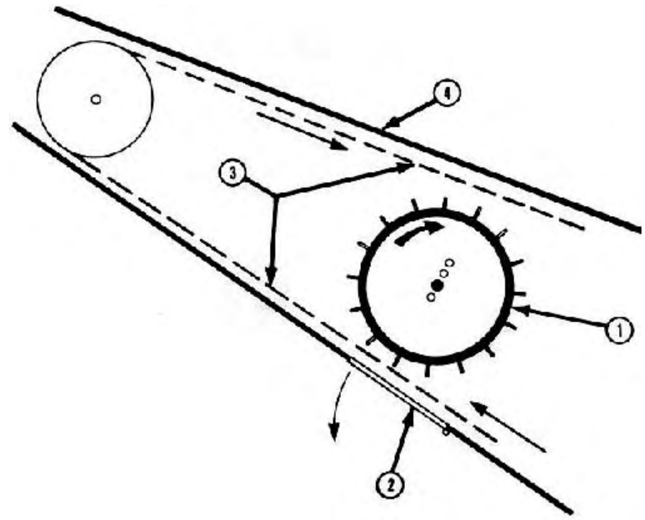

FIGURE 10. Stone Protection: (1) Stone Ejection Roller, (2) Trip Door, (3) Feeder Conveyor Chain, (4) Feeder House.

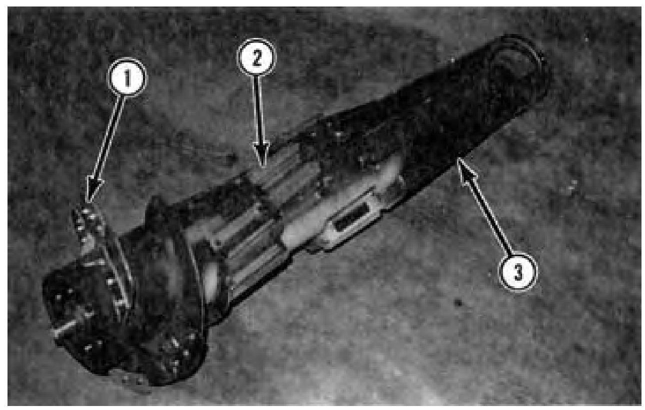

FIGURE 11. "S" Cubed Rotor: (1) Intake Flighting and Wear Plates, (2) Rasp Bars, (3) Separating Bars.

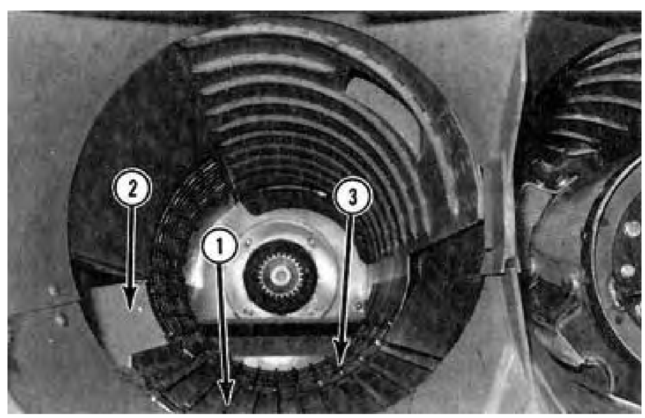

FIGURE 12. Concaves: (1) Threshing, (2) Extension Module Location, (3) Separating.

The rotors were aggressive and plugging was not a problem. Threshing was complete in most crops. In the Argyle barley test, beards were very difficult to remove which slightly increased unthreshed losses.

Suitable threshing in grain crops was obtained when using a minimum concave clearance after setting the rotor speed as high as possible without causing excessive grain damage.

Straw break-up was severe in dry conditions even before going through the straw chopper. The "S" cubed rotors greatly reduced threshing vibration and noise over previous New Holland twin rotor combines.

Separating: Separation was very good in all crops at the setting, which provided optimum threshing. Grain was separated from the straw at the concaves by gravity and centrifugal force.

In all crops, even barley, a typically hard to separate crop, rotor loss was low over the entire operating range and did not limit capacity.

Cleaning: Cleaning shoe performance was very good. Chaff and debris were cleaned from the grain using a combination of air and sieving action. The New Holland TR96 was equipped with an optional Peterson chaffer (FIGURE 13). Tailings were returned to the front of the rotors.

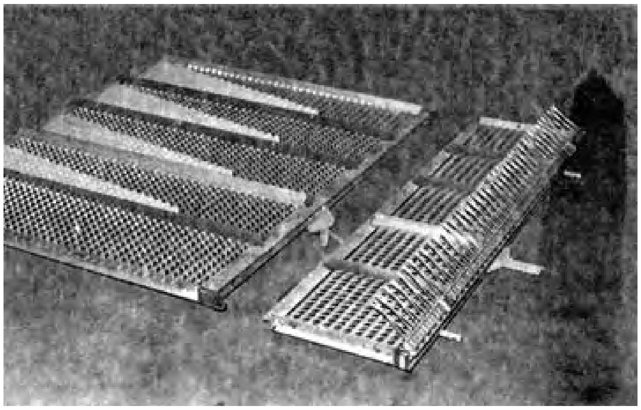

FIGURE 13. Peterson Chaffer, Chaffer Extension and Rake.

The single, variable speed, paddle-type fan (high speed kit) supplied a suitable air blast for all crops encountered. Changing the windboards from the factory set position was not required. The chaffer and cleaning sieve moved in opposite directions and could be adjusted to suit all crops encountered. Shoe settings used for the various crops are included in TABLE 5.

With the Peterson chaffer, cleaning shoe losses were low in all crops over the entire operating range. The grain sample was clean, although in hard-to-thresh wheat some clean grain had to be returned with tailings to get rid of "white caps". "Straw spearing" through the sieves did not occur. The Peterson chaffer could usually be opened wide for most crops while using fan speed for fine-tuning. The return had adequate capacity and did not plug. It could not be easily checked while harvesting.

Clean Grain Handling: The grain handling system on the TR96 was good.

The open grain tank filled evenly and completely in all crops. The tank held about 230 Imperial bu (8.37 m³) of dry wheat. The bin sensors warned the operator when the grain tank was full.

TABLE 5. Crop Settings

Crop	Rotor Speed	Concave Setting Position	Chaffer Sieve Setting*		Chaffer Extension Setting		Cleaning Sieve Setting		Fan Speed
	rpm		in	mm	in	mm	in	mm	rpm
Barley	1400-1500	1-5	wide open		1/2-3/4	13-19	1/4-3/8	5-10	700-800
Flax	1300-1500	2	1/2	13	1/2	13	1/8	3	600
Canola	850-900	3-8	wide open		1/2-5/8	13-16	1/8-1/4	3-6	550-720
Rye	1400-1550	3-6	wide open		1/2-3/4	13-19	1/4	6	650-700
Wheat	1450-1700	1-3	wide open		3/4-7/8	19-22	1/4	6	730-850

*Peterson chaffer used in all cases

The unloading auger had ample reach and clearance for unloading into trucks and grain trailers. The unloading auger discharged grain in a compact stream and could empty a tank of dry wheat in about 170 seconds. This was slow. Opening the control gates and removing cover plates over the grain tank discharge increased the unloading rate only slightly. It is recommended that the manufacturer consider modifications to increase the grain unloading rate. The optional downspout was effective in reducing grain loss in moderately windy conditions (FIGURE 14). Swinging the unloading auger back to reduce the discharge height reduced clearance and reach and also made it more difficult for the operator to see the spout.

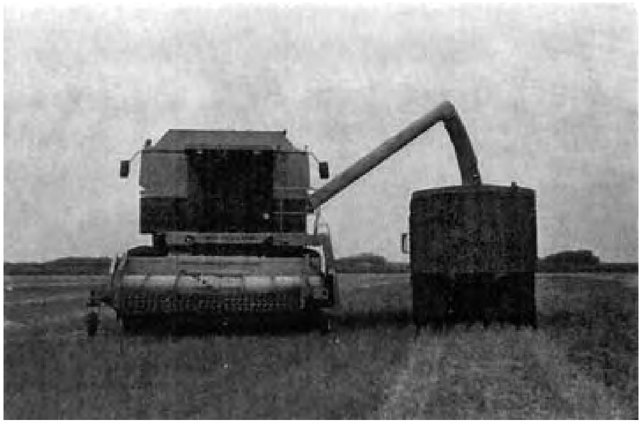

FIGURE 14. Unloading With Optional Spout.

Straw Spreading: The straw chopper had a poor straw spread pattern. Maximum spread was about 15 ft (4.6 m) with most of the straw falling in two narrow windrows at the outer edges. Changing the deflector fins did not improve the spread. It is recommended that the manufacturer consider modifications to the straw chopper to give a wider, more uniform spread pattern.

EASE OF OPERATION AND ADJUSTMENT

Operator Comfort: The New Holland TR96 was equipped with an operator's cab positioned ahead of the grain tank and centred on the combine body. Operator comfort was very good.

The cab was easily accessible. Incoming air was effectively filtered while the fans pressurized the cab to reduce the dust leaks. The heater and air conditioner provided comfortable cab temperatures. The seat and steering column were adjustable which provided a comfortable combination for most operators.

Forward and side visibility was very good. Rear visibility was restricted. The large convex rearview mirrors provided good rear visibility. The actual distance of objects was distorted. Therefore, caution had to be taken during transport.

View of the feed intake area was partially blocked by the steering column (FIGURE 15). The view was improved by leaning ahead and slightly to the right. This became uncomfortable after several hours of operating. Grain level was visible through the rear window until the tank was about 2/3 full.

FIGURE 15. View of Feed Intake Area.

Instruments: Instrumentation on the New Holland TR96 was very good. The instruments were located at eye level to the right of the operator on two separate panels (FIGURE 16). The horizontal panel contained gauges for coolant temperature, engine oil pressure, fuel level, and battery voltage. It also contained an engine hour meter, and audio visual warning lights for park brake engagement, hydraulic oil temperature, air filter restriction, coolant temperature, engine oil pressure, battery voltage, and drives engaged. The vertical instrument bar contained warning lights and an audio alarm for full grain bin, unloading auger position, open stone trap, and speed reductions of clean grain elevator, return elevator, discharge beater, straw chopper, cleaning fan, and rotors. A digital readout constantly monitored rotor rpm. A second digital readout selectively displayed cleaning fan rpm, engine rpm, or ground speed. Other functions included a grain loss monitor, a test light button, and a light indicating normal operation of all vital components.

The digital readout and warning systems were very useful and easy to read, except when the sun shone directly on the panels.

Controls: The controls on the New Holland TR96 were very good (FIGURES 16 and 17). They were conveniently located and easy to operate. The foot pedal control for the unloading auger position was very convenient to use. The header engaging lever could also be used to engage the header reverser. With the lever in the reverse position, a rocker switch would slowly rotate the feeder in either direction. This was very convenient. The header height switch located on the hydrostatic control lever was very convenient to use. Header lift and drop rate were adjustable.

FIGURE 16. Instrument Bars and Lower Right Controls.

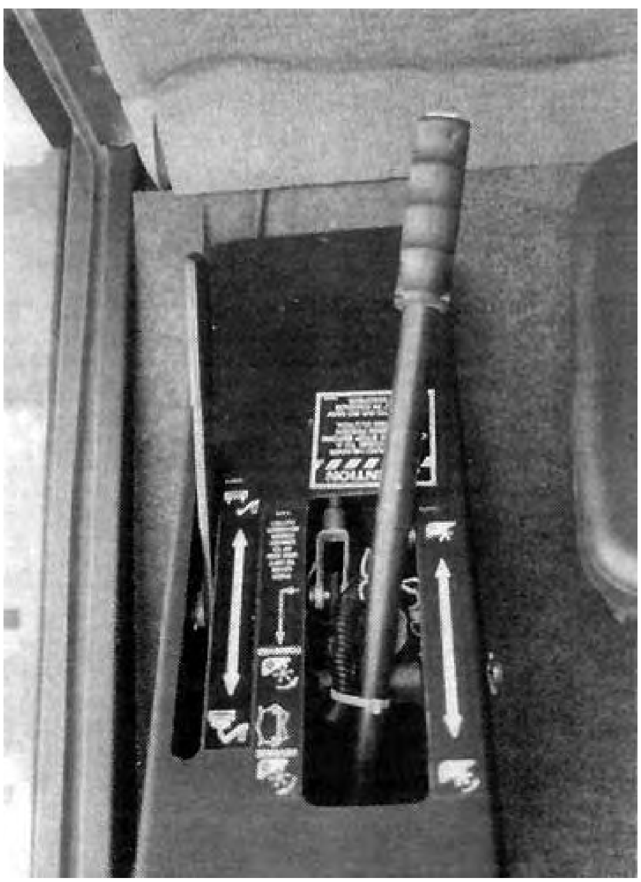

FIGURE 17. Lower Left Controls.

Lighting: Lighting for nighttime harvesting was excellent. The combine was equipped with seven field lights, two transport lights, two tail lights, a grain tank light, an unloading auger light, four warning/signal lights, and the optional service floodlight.

Interior lighting was supplied by a swivel light over the instrument bars which came on with the work lights. More light was available, if needed, by switching on the interior light. The warning lights and tail lights aided in safe road transport. The optional service food light was very convenient.

Handling: The New Holland TR96 was very maneuverable. The steering was smooth and responsive. The wheel brakes were positive and aided in turning, but were not needed for picking around most windrow corners.

The transmission was easy to shift. The hydrostatic drive was responsive, and made changing speed and reversing quick and easy.

The combine was very stable in the field, even with a full grain tank. Normal caution was needed when operating on hillsides and when travelling at transport speeds. The combine transported well up to its maximum speed of 16 mph (26 km/h).

Adjustment: Ease of adjusting combine components was good. Pickup speed, rotor speed, concave clearance, and fan speed could be adjusted from within the cab while operating. The table auger, stone ejection roller, windboards, and sieve adjustments are located on the machine.

Auger finger timing, auger clearance, and auger stripper adjustment were easily made to suit crop conditions, and once set seldom had to be readjusted. The stone ejection roller plate was inconvenient to adjust.

The windboards were not adjusted from the factory set position. Chaffer sieve and cleaning sieve adjustments were accessible through a door behind the cleaning sieve. The chaffer extension lever was located under the “thistle screen” which could be easily lifted out of the way. The index notches on the adjusting levers were very helpful. It was not possible for the operator to reach the cleaning sieve adjusting lever and still see through the top chaffer to determine the sieve openings.

Rotor speed would not stay at its set rpm. A faulty seat in the speed control valve allowed oil to leak past which caused the rotor speed to drop. A new style seat was installed and no further problems occurred. It is recommended that the manufacturer consider replacing the faulty seat in the stack valve to prevent rotor rpm from dropping.

Field Setting: Setting the New Holland TR96 to suit crop conditions was easy. Usually, very little “fine tuning” was required after initial adjustments were made. Checking the effluent from the rotors was very difficult. A hood could be let down to divert the straw out the opening in front of the straw chopper. If this was done, the straw mixed with the shoe effluent, making it difficult to determine where the losses were coming from. In heavy straw conditions, this opening could become plugged.

The return tailings could be examined only if the machine was quickly shut down under load. This was inconvenient. A more convenient method of sampling the return while harvesting would have been beneficial. It is recommended that the manufacturer consider supplying a safe, more convenient apparatus for sampling the return tailings while harvesting.

Unplugging: Ease of unplugging the table auger was very good. The power feeder reverser slowly backed out the slug onto the table. The slug could then usually be fed back into the feeder at the same slow speed at which it was discharged, using the rocker switch on the reverser lever.

The rotors on the New Holland TR96 did not plug during the test season. If the feeder slip clutch was working properly, a slug seldom reached the rotors. A slug wrench was provided.

Machine Cleaning: Cleaning the New Holland TR96 for harvesting seed grain was good. The grain tank was easy to clean if the cross auger grates were fully raised. The sieves were easily removed. Panels were easily removed to clean the tailings and clean grain auger troughs. Chaff collected on many ledges on the outside of the combine. Straw and chaff that collected beneath the engine and on the rotor housings beneath the grain tank were difficult to remove.

Lubrication: Ease of lubrication was good. The combine had 63 pressure grease fittings. Seventeen required greasing at 10 hours, an additional seventeen at 50 hours, and twenty-five more at 100 hours. Four other bearings required greasing every 250 hours or once a season. Engine, gearboxes, and hydraulic oil levels required regular checking.

Daily lubrication was quick and easy because there were only a few lubrication points and most were easily accessible. The fuel tank inlet was 8.0 ft (2.4 m) above the ground, making it difficult to fuel from gravity fuel tanks. Changing engine and hydraulic oils and filters was easy. Maintenance: Performing routine maintenance was fair if directions were closely followed from the operator's manual.

All chains and belts were easily tightened except for the return elevator chain. Access to the inside adjusting bolt was very limited. It is recommended that the manufacturer consider modifications to provide better access for tightening the return elevator chain.

The procedures outlined in the operator's manual for measuring tension on certain chains was confusing and inconsistent. Also, the procedure for measuring tension on the separator engaging clutch was confusing. It is recommended that the manufacturer consider clarifying the procedure recommended in the operator's manual for measuring the tension on certain chains and the separator clutch.

The radiator had to be cleaned periodically. The rotary screen swung out of the way to allow easy access to the front of the radiator, but access from the engine side was limited.

The engine air intake centrifugal dust bowl and outer dry element filter were easily accessible and required periodic cleaning. Jaw clutches protected the feeder conveyor, clean grain, and tailings return drives. All were easily adjusted.

The complete header and feeder house assembly was easily removed and installed. However, the locking pins, which hold the feeder house pivot blocks in place had to be shortened so they could be removed (FIGURE 18). It is recommended that the manufacturer consider modifying these locking pins to allow for easier removal.

Removing the rotors was fairly difficult. The intake section of the rotor with the flighting had to be screwed off before the rotor could be pulled out. The rotors were heavy and caution had to be taken when handling them. When installing the rotors, it was necessary to "time" them.

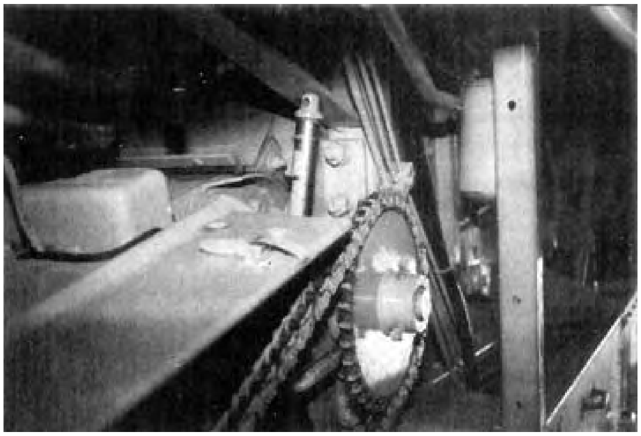

FIGURE 18. Feeder House Locking Pins Contacting Frame.

ENGINE AND FUEL CONSUMPTION

The Caterpillar 3208 diesel engine started very quickly and ran well. In most conditions, the combine was run at or near power limit. When harvesting in damp or tough conditions, the extra power required resulted in reduced MOG feedrates.

Average fuel consumption was about 8.0 gal/h (36.4 L/h). Oil consumption was insignificant.

OPERATOR SAFETY

The operator's manual emphasized operator safety. The New Holland TR96 had warning decals to indicate dangerous areas. Moving parts were well shielded and most shields were hinged to allow easy access.

A header cylinder safety stop was provided. The stop should be used when working near the header or when the combine is left unattended.

If the operator is required to work in the header or in other potentially dangerous areas, it is imperative that all clutches be disengaged and the engine shut off.

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

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

OPERATOR'S MANUAL

The operator's manual was very good. It was clearly written and well illustrated. It provided useful information on safe operation, controls, adjustments, crop settings, servicing, trouble shooting, and machine specifications.

Instructions for removing the rotors was not provided.

MECHANICAL HISTORY

TABLE 6 outlines the mechanical history of the New Holland TR96 during the 128 hours of field operation, while harvesting about 1295 ac (524 ha) of crop. The intent of the test was functional performance evaluation. Extended durability testing was not conducted.

TABLE 6. Mechanical History

Item	Operating Hours	Field Area ac	Field Area (ha)
Electrical:			
-An electrical failure stopped the combine momentarily (four times)	5	65	(26)
-The unloading auger position indicator switch was damaged and replaced at	12	145	(57)
-The starter solenoid for the engine failed and was replaced at	25	300	(121)
-A wire in the header reverser lever broke and was repaired at	41	492	(199)
-The monitor system short circuited when adjusting the rotor speed at	61	732	(296)
-The coolant level light came on intermittently	Throughout season		
Miscellaneous:			
-The valve seat in the rotor speed control valve leaked and was replaced at	12	145	(57)
-The O-ring in the 90 degree elbow near the hydraulic oil filter was changed at	12	145	(57)
-The Melroe pickup wheel mount bent after losing an axle nut at	12	145	(57)
-The arm rest on the operator seat came loose and fell off at	25	300	(121)
-Several bent feeder chain slats were straightened at	50	600	(243)
-A table auger finger broke at	100	1090	(441)
-The engine oil pressure sending unit failed and was replaced at	126	1200	(486)
-The feed assist plates were damaged by stones	During the season		

Electrical Failure: An electrical failure occurred momentarily four times. This caused the engine to lose power, but before it stopped completely, the problem subsided and the engine regained its power. Several checks were made, however, no cause was determined.

Monitor Failure: On one occasion, attempting to adjust the rotor speed or fan speed caused the monitor system to go blank and neither the rotor or fan speed would change. Again, no cause was determined, but it began working after making some diagnostic checks.

Rotor Speed Control Valve: Rotor speed slowed from its set rpm because of a faulty valve seat. The seat was replaced with an updated model, which corrected the problem.

Table Auger Finger: A finger on the table auger broke. The stub, which remained inside the auger tube punched several holes in the auger tube as it rotated.

Feed Assist Plates: The serrated feed assist plates on the rotor intake flighting were damaged by small stones. These thin plates appeared to be easily damaged. In addition, after one season of use, the leading edge was worn away and the plates had to be replaced. It is recommended that the manufacturer consider improving the durability of these feed assist plates.

APPENDIX I
SPECIFICATIONS

MAKE:	New Holland Self-Propelled Combine
MODEL:	TR96
SERIAL NUMBER:	Header - 506887 Body - 502201 Engine - 03204035
MANUFACTURER:	New Holland 500 Diller Avenue New Holland, Pennsylvania 17557

WINDROW PICKUP:

-- make	Melroe 388
-- type	rubber draper and transfer belts
-- pickup width	10 ft (3048 mm)
-- number of belts	7
-- type of teeth	steel
-- number of rollers	4
-- height control	castor gauge wheels
-- speed control	electric over hydraulic
-- speed range	0 - 434 ft/min (0 - 2.2 m/s)

HEADER:

-- type	centre feed
-- width	
- table	13 ft (4.0 m)
- feeder house	47 in (1194 mm)
-- auger diameter	16 in (406 mm)
-- feed conveyor	3 roller chains with undershot slatted conveyor
-- conveyor speed	543 ft/min (2.8 m/s)
-- range of picking height	-20 to 46 in (-508 to 1168 mm)
-- number of lift cylinders	2
-- raising time	adjustable
-- lowering time	adjustable
-- options	feeder stand kit, larger header lift cylinders

STONE PROTECTION:

-- type	stone roller in feeder housing
-- ejection	spring loaded door, reset by raising the header

ROTOR:

-- number of rotors	2
-- type	closed tube, 3 stage; inlet, thresh and separate; 6 pairs of rasp bars staggered around the tube; 2 spiralling bars on the rear section
-- diameter	
- tube	12 in (305 mm)
- feeding	26.75 in (680 mm)
- threshing	17 in (427 mm)
- separating	17 in (427 mm)
-- length	
- feeding	16.7 in (424 mm)
- threshing	28 in (710 mm)
- separating	42 in (1070 mm)
-- total	86.75 in (2204 mm)
-- drive	electro-hydraulic controlled variable pitch belt through two 90 degree gearboxes
-- speeds	730 - 1760 rpm
-- options	high speed rotor kit, threshing agitator kit, separating agitator kit

CONCAVE (THRESHING):

-- number	
- concave	2
- concave extensions	2 each side
-- type	bar and wire
-- number of bars	
- concave	11
- concave extension	5
-- configuration	
- concave	10 intervals with 0.15 in (3.6 mm) diameter wires and 0.25 in (6 mm) spaces
- concave extensions	4 intervals with 0.15 in (3.6 mm) diameter wires and 0.25 in (6 mm) spaces
-- area	
- concave total	837 in² (0.54 m²)
- concave open	372 in² (0.24 m²)
-- open area	44 percent
-- concave extensions total	279 in² (0.18 m²)
-- concave extensions open	124 in² (0.08 m²)
-- wrap	
- concave	85 degrees
- concave plus extension	125 degrees each side
-- grain delivery to shoe	grain pan
-- options	awning plates, corn and soybean concave modules, milo kit

CONCAVES (SEPARATING):

-- number	2
-- type	bar and wire
-- number of bars	22
-- configuration	21 intervals with 0.25 in (6.4 mm) diameter wires and 2.1 in (52 mm) spaces
-- area total	2046 in² (1.32 m²)
-- area open	1442 in² (0.93 m²) - 70 percent
-- wrap	204 degrees each side
-- grain delivery to shoe	grain pan

THRESHING AND SEPARATING CHAMBER:

-- number of spirals	10
-- pitch of spirals	13 degrees

DISCHARGE BEATER:

-- type	4 wing box
-- speed	830 rpm

DISCHARGE BEATER GRATE:

-- type	bar and wire
-- configuration	44 intervals with 0.25 in (6.4 mm) diameter wires and 0.75 in (19 mm) spaces
-- area total	744 in² (0.48 m²)
-- area open	635 in² (0.41 m²)
-- grain delivery to shoe	gravity
-- option	grate covers

SHOE:

-- type	opposed motion
-- speed	330 rpm
-- chaffer sieve	Peterson (adjustable 2480 in² (1.6 m²)
-- chaffer sieve extension	adjustable lip, 840 in² (0.54 m²)
-- rake extension	wire rake
-- clean grain sieve	adjustable lip, 1-1/8 in, 2576 in² (1.66 m²)
-- options	1-5/8 sieve, 1/10 in, or 1/2 in round hole screen, sieve frame kit

CLEANING FAN:

-- type	6 blade undershot
-- diameter	20 in (510 mm)
-- width	55 in (1400 mm)
-- drive	electrically controlled variable pitch belt
-- speed range	390 to 830 rpm
-- windboards	2 (adjustable)
-- options	slow speed and high speed kits, fan bottom shield

ELEVATORS:

-- type	roller chain with rubber paddles
-- clean grain (top drive)	7 x 4 in (180 x 100 mm)
-- tailings (bottom drive)	5 x 4 in (128 x 100 mm)
-- options	perforated auger bottoms and elevator covers, elevator scraper kit

GRAIN TANK:

-- capacity	230 Imperial bu (8.37 m³)
-- unloading time	170 s
-- unloading auger diameter	12 in (280 mm)
-- unloading auger length	14.3 ft (4.37 m)
-- options	flexible auger downspout, unloading auger spout extension

STRAW CHOPPER:

-- type	hammer and knife
-- width	55.5 in (1410 mm)
-- speed	2840 rpm
-- options	straw spreaders

ENGINE:

-- make	Caterpillar
-- model	3208
-- type	diesel, turbocharged
-- number of cylinders	8
-- displacement	636 CID (10.4 L)
-- governed speed (full throttle)	2520 ± 30 rpm
-- manufacturer's rating	240 hp (179 kW)
-- fuel tank capacity	82.5 gal (375 L)
-- options	block heater

CLUTCHES:

-- header	mechanical belt tightener
-- separator	mechanical dry friction disc
-- unloading auger	mechanical belt tightener

NUMBER OF CHAIN DRIVES:	8
NUMBER OF BELT DRIVES:	16
NUMBER OF GEARBOXES:	4

LUBRICATION POINTS:

-- 10 h	17
-- 50 h	17
-- 100 h	25
-- 250 h	4

TIRES:

-- front	30.5 L x 32, 10-ply, R1
-- rear	14.9 x 24, 8-ply

TRACTION DRIVE:	
-- type	hydrostatic, 4 speed transmission
-- speed ranges	
- 1st gear	0-1.9 mph (0-3.1 km/h)
- 2nd gear	0-4.3 mph (0-6.9 km/h)
- 3rd gear	0-7.5 mph (0-12.0 km/h)
- 4th gear	0-16 mph (0-25.7 km/h)
-- options	tire sizes, rear wheel assist
OVERALL DIMENSIONS:	
-- wheel tread (front)	120 in (3055 mm)
-- wheel tread (rear)	110 in (2795 mm)
-- wheel base	130 in (3295 mm)
-- transport height	186 in (4740 mm)
-- transport length	363 in (9245 mm)
-- transport width	181 in (4600 mm)
-- field height	186 in (4740 mm)
-- field length	346 in (8795 mm)
-- field width	181 in (4600 mm)
-- unloader discharge height	173 in (4400 mm)
-- unloader reach	101 in (2570 mm)
-- unloader clearance	145 in (3690 mm)
-- turning radius	
- left	253 in (6420 mm)
- right	248 in (6310 mm)
WEIGHT (EMPTY GRAIN TANK):	
-- right front wheel	8979 lb (4073 kg)
-- left front wheel	9669 lb (4386 kg)
-- right rear wheel	4089 lb (1855 kg)
-- left rear wheel	4078 lb (1850 kg)
TOTAL	26815 lb (12164 kg)

APPENDIX II

MACHINERY INSTITUTE REFERENCE COMBINE CAPACITY RESULTS

TABLE 7 and FIGURES 19 and 20 present the capacity results for the Machinery Institute reference combine in barley and wheat crops harvested from 1981 to 1985.

FIGURE 19 shows capacity differences in six-row Bonanza barley from 1981 to 1984. The 1985 Argyle barley crop shown in TABLE 5 had slightly above average straw yield, average grain yield, and above average straw moisture and average grain moisture.

FIGURE 20 shows capacity differences in Neepawa wheat for the five years. In 1985 the wheat crop had above average straw yield, average grain yield, and average straw and above average grain moisture contents.

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

TABLE 7. Capacity of the Machinery Institute Reference Combine at a total grain loss of 3% yield

	Crop Conditions									Capacity Results						
			Width of Cut		Crop Yield		Grain Moisture		MOG/G	MOG Feedrate		Grain Feedrate		Ground Speed		
	Crop	Variety	ft	m	bu/ac	t/ha	Straw %	Grain %	Ratio	lb/min	t/h	bu/h	t/h	mph	km/h	Loss Curve
1985	Barley	Argyle	60	18.0	75.0	4.0	25.5	11.4	0.94	293	8.0	390	8.5	0.7	1.1	Fig. 19
	Barley	Bonanza	55	16.8	83.0	4.5	21.0	15.0	0.76	285	7.7	469	10.2	0.9	1.4	
	Wheat	Neepawa	42	12.8	42.0	2.8	23.7	18.0	1.43	391	10.7	273	7.5	1.3	2.1	Fig. 20
	Wheat	Katepwa	41	12.5	62.0	4.2	24.8	18.5	0.95	435	11.9	458	12.5	1.5	2.4	
1984	Barley	Bonanza[1]	42	12.8	68.0	3.7	18.5	12.9	0.74	275	7.5	464	10.1	1.3	2.1	Fig. 19
	Barley	Bonanza	24	7.3	85.0	4.6	12.0	12.1	0.62	213	5.8	429	9.4	1.7	2.7	
	Wheat	Neepawa[1]	44	13.4	42.0	2.8	6.7	11.8	1.47	308	8.4	209	5.7	0.9	1.4	Fig. 20
	Wheat	Neepawa[1]	42	12.8	41.0	2.8	8.5	10.3	1.17	356	9.7	304	8.3	1.5	2.4	
	Wheat	Neepawa[1]	42	12.8	23.0	1.6	7.2	12.5	0.99	345	9.4	348	9.5	3.0	4.8	
1983	Barley	Bonanza	28	8.5	71.9	3.3	11.7	13.2	0.86	226	6.2	263	7.2	1.6	2.6	
	Barley	Bonanza	24	7.4	72.5	3.6	6.7	10.7	0.85	313	8.5	368	10.0	2.4	3.8	Fig. 19
	Wheat	Neepawa	27	8.2	40.3	2.9	5.1	10.0	1.01	340	9.3	337	9.2	2.6	4.2	
	Wheat	Columbus	41	12.5	36.7	2.7	7.9	11.3	1.36	425	11.6	313	8.5	1.6	2.6	Fig. 20
1982	Barley	Bonanza	28	8.5	75	4.09	22.3	10.6	0.79	205	5.6	325	7.1	1.3	2.0	
	Barley	Bonanza[2]	50	15.2	55	2.99	9.3	12.4	0.68	227	6.2	417	9.1	1.3	2.0	Fig. 19
	Wheat	Neepawa[1]	40	12.2	40	2.73	11.1	13.6	0.68	414	11.3	609	16.6	3.1	5.0	
	Wheat	Neepawa[1]	40	12.2	41	2.79	10.3	14.3	0.81	356	9.7	440	12.0	2.2	3.5	
	Wheat	Neepawa	25	7.6	47	3.21	6.0	7.9	0.89	326	8.9	367	10.0	2.6	4.1	
	Wheat	Neepawa	25	7.6	53	3.59	6.6	11.0	0.88	322	8.8	367	10.0	2.3	3.7	Fig. 20
1981	Barley	Bonanza	25	7.6	62	3.33	7.2	12.6	0.67	205	5.6	385	8.4	2.2	3.5	Fig. 19
	Barley	Klages	25	7.6	53	2.86	7.1	12.0	0.68	220	6.0	403	8.8	2.6	4.2	
	Wheat	Manitou	25	7.6	51	3.46	6.3	13.8	0.96	312	8.5	326	8.9	2.2	3.5	
	Wheat	Neepawa	27	8.2	55	3.69	6.4	11.9	0.85	348	9.5	410	11.2	2.3	3.7	Fig. 20
	Wheat	Neepawa	24	7.4	49	3.29	6.2	13.7	0.93	337	9.2	363	9.9	2.6	4.1	

[1]Side-by-side Double Windrows.
[2]Double Windrows Lapped By 1/3.

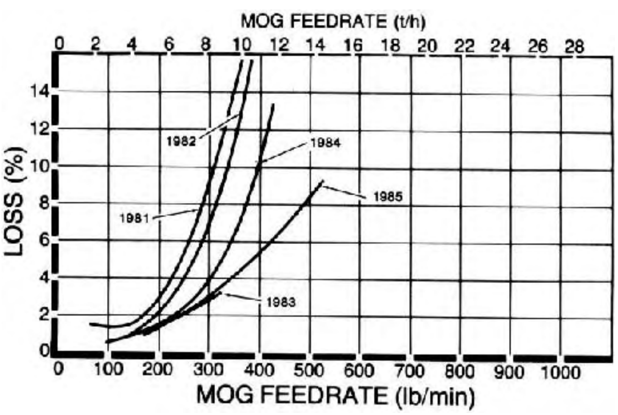

FIGURE 19. Total Grain Loss for the PAMI Reference Combine in Barley.

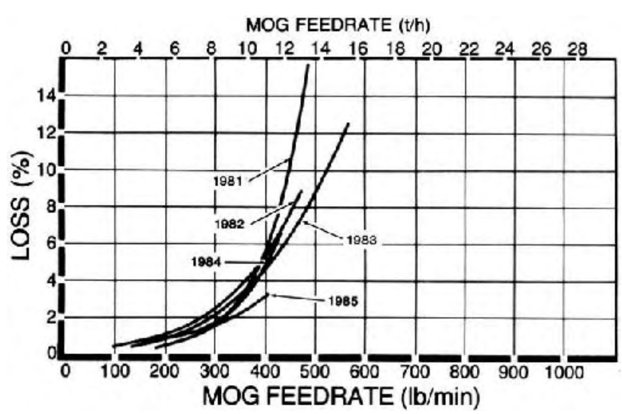

FIGURE 20. Total Grain Loss for the PAMI Reference Combine is Wheat.

APPENDIX III
REGRESSION EQUATIONS FOR CAPACITY RESULTS

Regression equations for the capacity results shown in FIGURES 2 to 5 are presented in TABLE 8. In the regressions, U = unthreshed loss in percent of yield, S = shoe loss in percent of yield, R = rotor 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 5 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 - Argyle	2	$U = 0.09 + 1.45 \times 10^{-6}F^2$ $S = 0.52 + 1.41 \times 10^{-6}F^2$ $\ln R = -2.42 + 4.06 \times 10^{-3}F$	0.88 0.94 0.98	14.03[2] 31.43[2] 84.67[2]	6
Barley - Bonanza	3	$U = 0.07 + 3.34 \times 10^{-4}F$ $\ln S = -2.42 + 9.48 \times 10^{-4}F^3$ $\ln R = -3.04 + 4.18 \times 10^{-2}F$	0.89 0.71 0.99	11.04[1] 2.98 1344.86[2]	5
Wheat - Katepwa	4	$U = 0.05 + 3.40 \times 10^{-4}F$ $S = 0.38 - 1.24 \times 10^{-3}F + 1.12 \times 10^{-4}F^2$ $\ln R = -3.25 + 1.60 \times 10^{-3}F$	0.79 0.91 0.75	8.37[1] 9.72[1] 6.30[1]	7
Wheat - Neepawa	5	$U = 0.23 + 1.04 \times 10^{-9}F^3$ $S = 0.43 - 1.36 \times 10^{-3}F + 1.90 \times 10^{-6}F^2$ $R = 0.36 + 1.55 \times 10^{-3}F + 1.97 \times 10^{-6}F^2$	0.83 0.89 0.94	10.95[1] 7.68[1] 14.30[2]	7

[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 Machinery Institute Reports:

excellent	fair
very good	poor
good	unsatisfactory

SUMMARY CHART

NEW HOLLAND TR96 SELF-PROPELLED COMBINE

RETAIL PRICE	$163,616.00 (March, 1986, f.o.b. Humboldt, Sask.)
CAPACITY	
Compared to Reference	
Combine - barley	2.3 x reference
- wheat	1.9 to 2.2 x reference
MOG Feedrates	
- barley - Argyle	629 lb/min (17.2 t/h) at 3% total loss, FIGURE 2
- Bonanza	664 lb/min (18.1 t/h) at 1.5% total loss, FIGURE 3
- wheat - Katepwa	883 lb/min (24.1 t/h) at 1.0% total loss, FIGURE 4
- Neepawa	756 lb/min (20.1 t/h) at 1.3% total loss, FIGURE 5
QUALITY OF WORK	
Picking	**Good;** pickup too narrow for some double windrows
Feeding	**Good;** feeder plugged in bunchy windrows
Stone Protection	**Good;** self-cleaning, easily reset from cab
Threshing	**Very Good;** "S" cubed rotors thresh aggressively and smoothly
Separating	**Very Good;** rotor loss was low
Cleaning	**Very Good;** clean sample
Grain Handling	**Good;** slow unloading
Straw Spreading	**Fair;** spread unevenly over 15 ft (4.6 m)
EASE OF OPERATING AND ADJUSTMENT	
Comfort	**Very Good;** quiet cab
Instruments	**Very Good;** easy to observe
Controls	**Very Good;** convenient and easy to use
Loss Monitor	**Good;** only shoe loss monitored
Lighting	**Excellent;** well lit interior and exterior, service light useful
Handling	**Very Good;** easy to manoeuvre
Adjustment	**Good;** cleaning sieve difficult to see while adjusting
Setting	**Very Good;** little fine-tuning required
Unplugging	**Very Good;** feeder reverser easy to use, rotors did not plug
Cleaning	**Good;** many ledges collected chaff
Lubrication	**Very Good;** all lubrication points were accessible
Maintenance	**Good;** very complicated procedure for measuring tension on belts and chains
ENGINE AND FUEL CONSUMPTION	
Engine	**Very Good;** started very quickly, adequate power
Fuel Consumption	8.0 gal/h (36.4 L/h)
OPERATOR SAFETY	All moving parts well shielded
OPERATOR'S MANUAL	Very Good; well written
MECHANICAL HISTORY	A few intermittent electrical problems

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