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Evaluation Report 287

Sperry New Holland TR95 Self-Propelled Combine

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

SPERRY NEW HOLLAND TR95 SELF-PROPELLED COMBINE

MANUFACTURER:
Sperry New Holland
Division of Sperry Rand Corporation
New Holland, Pennsylvania 17557

DISTRIBUTORS:
Sperry New Holland
-- Box 777, Winnipeg, Manitoba R3C 2L4
-- Box 1907, Regina, Saskatchewan S4N 2S3
-- Box 1616, Calgary, Alberta T2P 2M7

RETAIL PRICE:
$125,750.00 (April, 1982, f.o.b. Humboldt, with 4 m header, 3.2 m Melroe pickup, straw chopper, 30.5 L x 32 R1 front tires, 14.9 x 24 R3 rear tires, hillside kit, grain loss monitor, starting fluid injector kit, block heater, radio and cab heater).

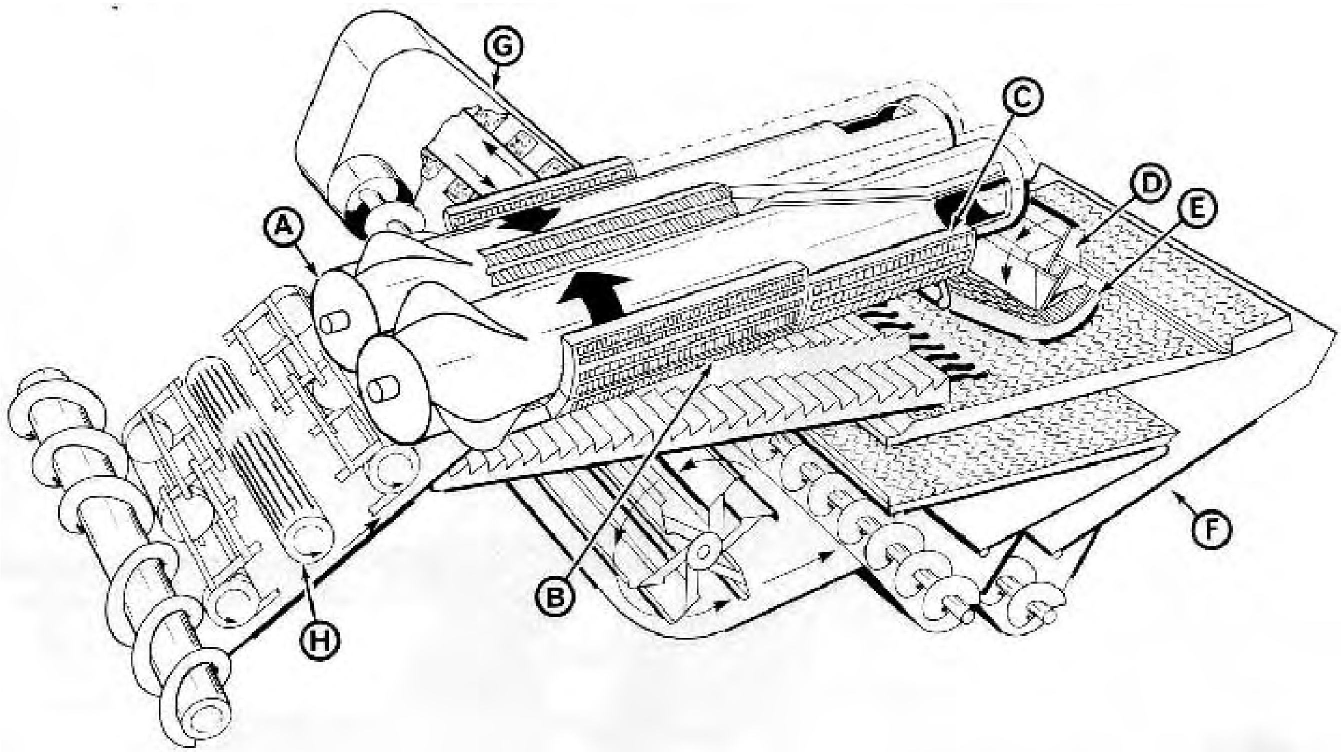


FIGURE 1. Sperry New Holland TR95: (A) Rotors, (B) Threshing Concave, (C) Separating Concave, (D) Back Beater, (E) Beater Grate, (F) Shoe, (G) Tailings Return, (H) Stone Ejection Roller.

SUMMARY AND CONCLUSIONS

Functional performance of the Sperry New Holland TR95 self-propelled combine was very good in dry grain crops and fair in rapeseed and tough grain crops.

The MOG feedrate* at 3% total grain loss varied from 14.7 t/h (539 lb/min) in 3.7 t/ha (55 bu/ac) Neepawa wheat to 21.2 t/h (777 lb/min) in 3.4 t/ha (50 bu/ac) Neepawa wheat.

For similar total grain loss, capacity of the Sperry New Holland TR95 was much greater than the capacity of the Machinery Institute reference combine. Rotor and shoe losses limited capacity in dry barley, while in dry wheat total loss was about 3% of yield when operating at the engine power limit. Cylinder loss was usually low over the full operating range.

The engine had adequate power for harvesting under dry conditions but was underpowered for tough or damp crops. Fuel consumption varied from 35 to 40 L/h (7.5 to 9 gal/h).

The Sperry New Holland TR95 was convenient to operate. Forward and side visibility was very good while rear visibility was restricted. Steering and brakes were responsive making the combine very maneuverable in the field and while transporting. Lighting for night time operation was good. Most instruments and controls were conveniently located, easy-to-use and responsive. The air conditioner and heater provided comfortable cab temperatures in all conditions. The cab was relatively dust free. Operator station sound level was about 84 dBA.

The Sperry New Holland TR95 was fairly easy to set and adjust. Rotor speed, pickup speed, fan speed, and concave clearance were adjusted from within the cab. Fan speed could also be adjusted on the machine. The return tailings could not be sampled while harvesting.

The pickup fed evenly and uniformly in all crops. The table auger plugged frequently in bunchy windrows and was difficult to clear. The feeder performed well in most crops. The rotors plugged occasionally in tough or bunchy windrows. Unplugging the rotors was difficult and time consuming. The stone ejection roller effectively stopped most roots and stones from entering the rotors. The unloading auger had ample reach, but an excessive discharge height and scattered grain discharge made unloading on-the-go very difficult. Most lubrication points were easy to service. Accessibility for cleaning and repair was good.

The Sperry New Holland TR95 was safe to operate as long as the manufacturer's safety instructions were followed. The combine transported well at speeds up to 26 km/h (16 mph).

The operator's manual was well illustrated, clearly written and contained much useful information. Only minor durability problems occurred during the test.

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

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Supplying a rear view mirror to improve depth perception to the left.
2. Improving the ease of shifting the transmission.
3. Relocating the digital display to the lower instrument console.
4. Modifications to eliminate erratic hour meter and warning indicator behaviour caused by electrical interference.
5. Relocating the loss monitor display to improve meter visibility.
6. Modifying the unloading auger to reduce discharge height and grain scatter.
7. Providing a wrench and hub to facilitate table auger unplugging.
8. Modifications to the variable speed rotor drive to provide adequate drive belt tension over the entire speed range.
9. Improving crop flow into the rotor chambers.
10. Modifications to facilitate removal of the concave extension modules and operation of the rotor slug wrench,
11. Modifications to prevent return tailings from bridging the openings to the rotors.
12. Supplying a safe, convenient mechanism to permit sampling the return tailings while harvesting.
13. Supplying suitable gauges for checking the clearance at the leading edge of the threshing concaves.
14. Modifications to improve access to the shoe adjusting levers and to eliminate interference between the shoe hanger bolts and the latches on the sieve access door.
15. Improving the ease of adjusting the fan wind boards.
16. Modifications to eliminate the concave deflectors or to make concave deflector adjustment more convenient.
17. Revising the suggested chaffer and sieve settings for rapeseed and wheat.
18. Improving the durability of the retractable table auger fingers.
19. Modifications to prevent the main separator shaft seals from coming loose and exposing the bearing.

Senior Engineer -- G. E. Frehlich

Project Technologist -- R. M. Zwarich

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Different types and configurations of mirrors are being evaluated.
2. A new transmission and revised linkage is being used on present production machines.
3. This is being considered for future machines.
4. Erratic hour meter behaviour has been eliminated on present production machines. We are investigating different monitors for future machines.
5. This is being evaluated for future machines.
6. A flexible downspout option is available to reduce grain scatter in windy conditions and to lower effective discharge height.
7. This is under consideration.
8. Different designs are being evaluated.
9. Revisions to the rotor inlet were made for 1982 production machines to improve feeding performance.
10. Modifications to the concave extension modules are being evaluated. A new rotor slug wrench design is being tested.
11. A change is being made on present production machines.
12. No planned change.
13. We will investigate the possibility of supplying gauges for checking concave clearances.
14. No changes are planned to improve access to the shoe adjusting levers. The latches on the sieve access door have been changed.
15. Improvements are presently being tested.
16. Adjustable deflectors under the separating grates have been added on new production machines.
17. This will be changed in the next printing of the operator's manual,
18. A new model header has been introduced.
19. A change has been made in the shaft seals and all field units have been reworked.

GENERAL DESCRIPTION

The Sperry New Holland TR95 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 separation 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 168 kW (225 hp) eight cylinder, turbocharged, diesel engine, a 4 m (13 ft) header, a 3.2 m (127 in) Melroe 378 pickup, a straw chopper, and the optional equipment listed on page 2.

The Sperry New Holland TR95 has a pressurized operator 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, pickup and cleaning fan speeds, and concave clearance are adjusted from within the cab. Shoe settings are adjusted on the machine and cleaning fan speed may also be adjusted externally. 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 Sperry New Holland TR95 was operated in the conditions shown in TABLES 1 and 2 for 103 hours while harvesting about 412 ha (1018 ac). It was evaluated for ease of operation, ease of adjustment, rate of work, grain loss characteristics, operator safety and suitability of the operator's manual. Throughout the test, comparisons were made to the Machinery Institute reference combine.

TABLE 1. Operating Conditions

Crop	Variety	Average Yield t/ha	Swath Width m	Hours	Field Area ha
Barley	Betzes	1.9	7.6	2.0	5
Barley	Bonanza	3.1	6.1 to 7.6	10.0	42
Barley	Elrose	2.8	7.3	8.0	20
Barley	Klages	1.6	7.6	2.5	12
Rapeseed	Altex	1.5	5.6	3.0	12
Rapeseed	Candle	0.7	7.3	4.0	12
Rapeseed	Regent	1.3	6.1	14.5	64
Rye	Frontier	1.9	6.1	5.5	17
Rye	Puma	2.0	5.5 to 9.1	4.5	12
Wheat	Canthatch	2.8	12.2	2.5	11
Wheat	Manitou	2.4	7.5	12.0	56
Wheat	Neepawa	2.4	6.1 to 8.6	32.5	140
Wheat	Park	3.2	6.1	2.0	9
Total				103	412

TABLE 2. Operation in Stony Fields

Field Condition	Hours	Field Area (ha)
Stone Free	20	68
Occasional Stones	66	270
Moderately Stony	17	74
Total	103	412

RESULTS AND DISCUSSION

EASE OF OPERATION

Operator Location: The Sperry New Holland TR95 was equipped with an operator's cab as standard equipment. The cab was positioned ahead of the grain tank and centered on the combine body. Forward and side visibility was very good while rear visibility was completely obstructed. The rear view mirrors improved rear visibility but distorted the actual distance of objects. This was a problem especially during transport. It is recommended that the manufacturer consider supplying a rear view mirror to improve depth perception to the left. Header visibility was very good for most operators when leaning slightly to the right (FIGURE 2). The grain level was visible through the rear window until the tank was nearly full.

(A)

(B)
FIGURE 2. View of Incoming Windrow (A) Normal Seated Position, (B) Leaning Forward and Right.

The seat and steering column were adjustable, providing a comfortable combination for most operators. Incoming air was effectively filtered while the fans pressurized the cab to reduce dust leaks. The air conditioner and heater provided suitable cab (A) temperatures. Operator station sound level was about 84 dBA. The sound level increased significantly while harvesting at combine capacity.

Controls: The control arrangement is shown in FIGURE 3. Most controls were conveniently located and easy to use.

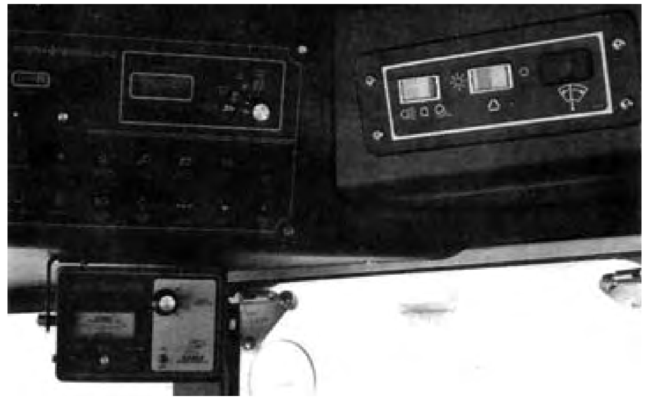
The gear selector lever was difficult to shift. The hydrostatic speed control lever usually had to be momentarily activated to aid shifting. It is recommended that the manufacturer consider improving the ease of shifting the transmission.

The fan and rotor speed adjustment responded slowly. Header lift was quick enough to suit all conditions while header drop rate was adjustable.

The hydraulically controlled variable speed pickup drive was responsive and easy to adjust with a foot-operated control (FIGURE 4).

Instruments: The lower instrument console (FIGURE 3C) contained gauges for engine oil pressure, coolant temperature, battery charging and fuel level, and indicator lights for transmission oil pressure, battery charging and the engine circuit breaker. The upper console (FIGURE 3A) contained an engine hour meter, a digital display for ground, engine, fan and rotor speeds, and an optional grain loss monitor. Warning lights and audio alarm warned of air filter restriction, low coolant level, excessive coolant temperature, low engine oil pressure, full grain tank, open stone trap, parking brake engagement, and a speed reduction of the major combine drives. The digital readout and warning systems were very useful; however, the digital display was inconvenient to observe and switch while harvesting. It is recommended that the manufacturer consider relocating the digital display to the lower console.

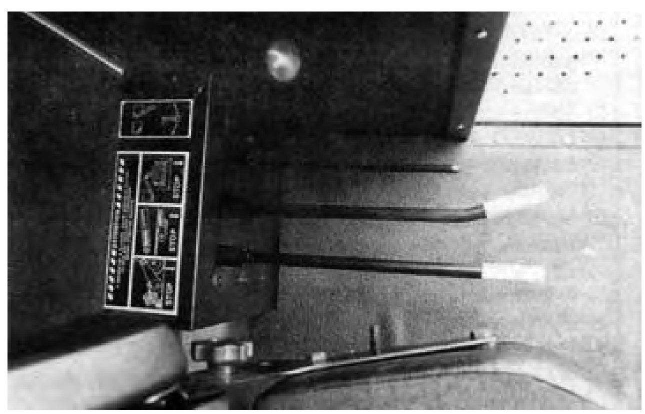
Electrical interference from fan and rotor speed adjustment, separator engagement and citizen band radio transmission, increased the engine hour meter reading and triggered the warning indicators. It is recommended that the manufacturer consider modifications to eliminate erratic hour meter and warning indicator behaviour caused by electrical interference.



(A)

(B)

(C)



(D)
FIGURE 3. Instruments and Control Consoles. (A) Upper Right (B) Upper Left (C) Lower Right (D) Lower Left.

Loss Monitor: Two loss monitor sensors were located behind the chaffer; sensors were not provided for the rotor. The loss monitor indicated changes in mechanical shoe loss but was ineffective in detecting airborne loss. Rotor loss was usually low. The monitor reading was meaningful only if it was compared to actual loss and if the response was set for each crop condition. The loss monitor display was inconvenient to observe while harvesting and it is recommended that the manufacturer consider relocating the loss monitor display to improve meter visibility.

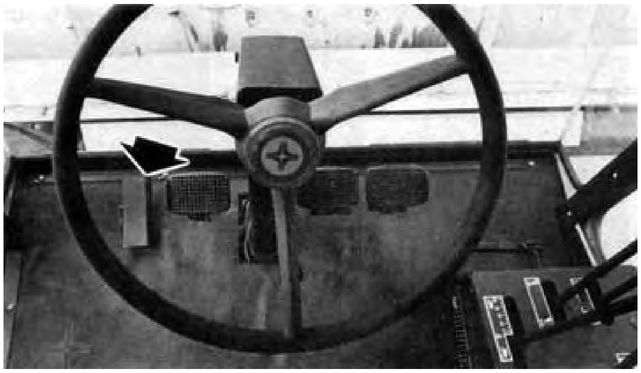


FIGURE 4. Pickup Speed Control Pedal.

Lights: Lighting was good for night time harvesting. There were six front lights, two grain tank lights, an unloading auger light and one rear light that could be switched to red for night travel. The warning and tail lights were adequate for safe road transport. Control and instrumentation lighting were good.

Engine: The engine started easily and ran well. It had adequate power for harvesting dry crops but was underpowered for harvesting tough or damp crops.

Average fuel consumption varied from 35 to 40 L/h (7.5 to 9 gal/h). Oil consumption was insignificant. The fuel tank inlet was located 2.4 m (8 ft) above ground which made filling from average height gravity fuel tanks difficult.

The rotary screen was very effective in preventing radiator plugging.

The engine air intake used a screen pre-cleaner, an aspirated pre-cleaner and two dry filter elements. Under severe conditions the screen pre-cleaner plugged frequently. The outer dry filter element required periodic cleaning.

Maneuverability: The Sperry New Holland TR95 was very maneuverable. The steering was smooth and responsive, and the wheel brakes positive. The turning radius was about 6.2 m (20.5 ft) making it unnecessary to use wheel brakes for picking around most corners. The hydrostatic drive made backing up easy on difficult-to-pick corners.

Stability: The Sperry New Holland TR95 was very stable in the field even with a full grain tank. Normal caution was needed on hillsides. The combine transported well at speeds up to 26 km/h (16 mph).

Grain Tank: Grain tank volume was 8.5 m^3 (240 bu). The tank filled evenly and completely in all crops. The grain level could be observed through the rear window until the tank was nearly full. A warning light and audio alarm signalled a full grain tank.

Unloading a full tank of dry wheat took about 235 seconds. The unloading auger had ample reach but an excessive discharge height and a scattered discharge (FIGURE 5), which made unloading on-the-go very difficult and caused excessive grain loss in windy conditions. Operating the unloading auger only partial extended reduced discharge height but was very inconvenient. It is recommended that the manufacturer consider modifying the unloading auger to reduce the discharge height and grain scatter.

Pickup: The Sperry New Holland TR95 was equipped with a 3215 mm (126 in) Melroe 378 two roller draper pickup with steel teeth, an intermediate transfer draper and windguard. Picking height was set by caster wheel adjustment and picking angle by the support chains and header height. The pickup was belt driven and the pickup speed was varied by a variable speed belt drive, hydraulically controlled from the cab. Pickup speed change was responsive.

The pickup performed well in most crops at speeds up to 8 km/h (5 mph). However, at the higher speeds, more mechanical failures occurred. In rapeseed the windguard had to be removed to prevent bunching and excessive shelling.

Stone Protection: The Sperry New Holland TR95 is equipped with a stone ejection roller located in the feeder housing (FIGURE 6). A spring loaded trap door, below the ejection roller, opens to eject large wads or foreign objects that pass under the roller. A cab monitor warns the operator when the trap door is open; the trap door has to be manually reset.

FIGURE 5. Unloading.

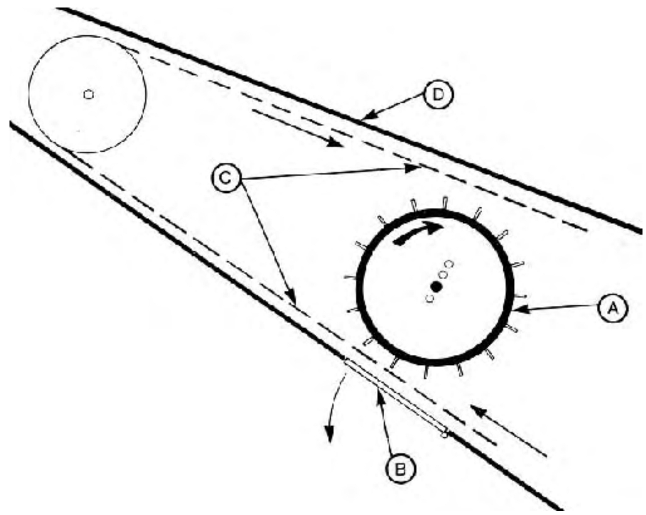


FIGURE 6. Stone Protection (A) Stone Ejection Roller (B) Door, (C) Feeder Chain, (D) Feeder Housing.

The ejection roller was effective, ejecting most roots, stones and wads before they entered the rotors. There was negligible damage to the rotors, concaves or rotor housings during the test. In bunchy rapeseed windrows, raising the stone ejection roller to increase feeder capacity reduced the stone protection.

Straw Chopper: The optional straw chopper attachment performed well in most crops. Average spreading, width was about 4.6 m (15 ft). Spreading was affected by straw and wind conditions (FIGURE 7).

FIGURE 7. Straw Chopper Operation.

Straw occasionally bridged between the feed assist roll and the straw hood baffle (FIGURE 8) causing the straw to fall ahead of the chopper instead of passing through the chopper.

The straw could be easily windrowed by repositioning the straw hood baffle and reversing the rotation of the feed assist roll. As is common with rotary combines, the straw was generally less suitable for baling than straw from a conventional combine.

FIGURE 8. Bridging Between Feed Roll and Straw Hood Baffle.

Plugging: The table auger plugged frequently in rapeseed and in damp or bunchy windrows. Unplugging was difficult as the table auger could not easily be reversed. It is recommended that the manufacturer consider supplying a wrench and hub to facilitate table auger unplugging.

The feeder conveyor was aggressive and did not plug during the test.

The stone ejection system frequently prevented rotor plugging by ejecting large wads of straw as they passed under the stone roller. Although the rotors were aggressive they frequently plugged when operating at rotor speeds less than 1100 rpm due to slipping of the rotor drive. The variable speed rotor drive failed to maintain adequate belt tension at low speeds. It is recommended that the manufacturer consider modifications to the variable speed rotor drive to provide adequate belt tension over the entire speed range.

Rotor plugging was also caused by material wedging between the rotor intake flighting and the transition between the feed plate and the concaves. Occasionally the slug could be "powered out" by lowering the concaves and engaging the separator. Usually the concave extension modules had to be removed and the rotors turned, with the wrench provided, until the obstruction could be removed by hand. The concave extension modules were inconvenient to remove and it was difficult to turn the rotors as access to the rocking hub was restricted (FIGURE 9) and the rotor slug wrench easily slipped off the hub. It is recommended that the manufacturer consider improving crop flow into the rotor chambers. It is also recommended that the manufacturer consider modifications to facilitate removal of the concave extension modules and more convenient operation of the rotor slug wrench.

FIGURE 9. Limited Access to the Rotor Drive Rocking Hub.

The tailings return frequently plugged in rapeseed even though the volume of tailings was low. The plugging was caused by pods and stems bridging the openings to the rotors and plugging the top cross auger. Unplugging was difficult and time consuming. It is recommended that the manufacturer consider modifications to prevent return tailings from bridging the openings into the rotors.

Machine Cleaning: Cleaning the Sperry New Holland TR95 for combining seed grain was laborious and time consuming. In some crops the concave extension modules had to be removed to clean out the accumulated material (FIGURE 10). It was not necessary to remove the chaffer and sieve as the tailings and clean grain auger troughs could be cleaned by removing the pans beneath the augers. The grain tank was easy to clean if the auger discharge covers were fully raised. A large amount of chaff that accumulated on the rotor housings beneath the grain tank and engine was very difficult to remove. The exterior of the combine was easily cleaned.

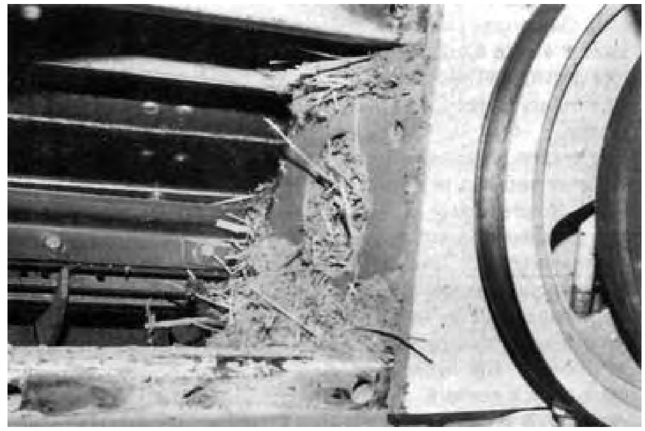


FIGURE 10. Material Accumulated in a Concave Extension Module.

Lubrication and Service: The Sperry New Holland TR95 had sixty-seven pressure grease fittings. Seventeen required greasing every 10 hours, thirty-three every 50 hours, and seventeen every 100 hours. Two bearing hubs required repacking every 500 hours or once a season. Engine, gearboxes and hydraulic oil levels required regular checking. Lubrication points were easily accessible, except for the grease fittings on the coupler connecting the rotor and gearbox. Most routine servicing and adjustments were easily made.

EASE OF ADJUSTMENT

Field Adjustment: The Sperry New Holland TR95 was fairly easy to adjust and could be set by one person. Rotor speed and concave clearance were adjusted from the cab, while fan speed could be adjusted from the cab or the side of the machine. Chaffer and sieve openings were adjusted on the machine. The return tailings could be inspected (FIGURE 11) only if the combine was stopped quickly while under load. A method of sampling return tailings while harvesting would be beneficial when setting the combine. It is recommended that the manufacturer consider supplying a safe, convenient mechanism to permit sampling the return tailings while harvesting.

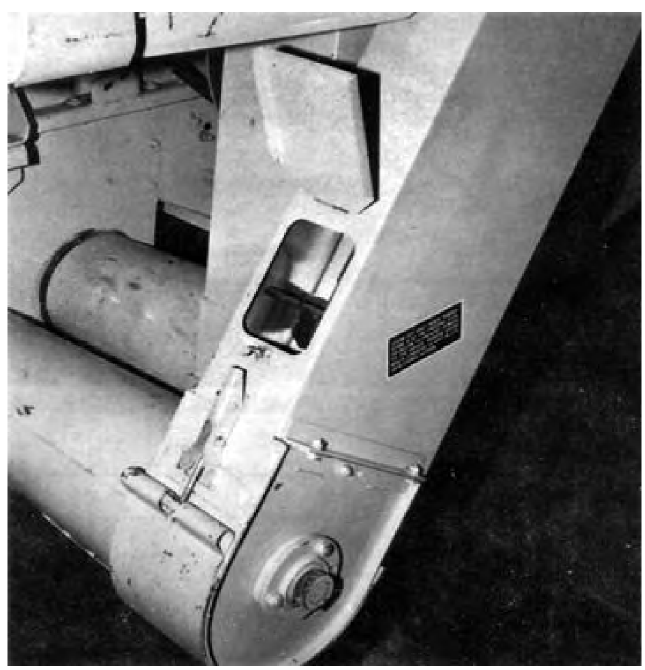
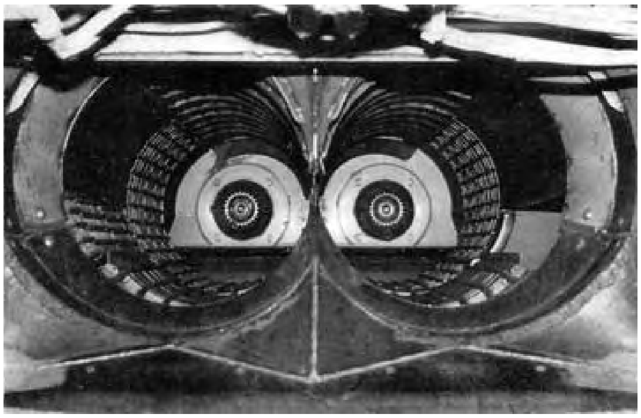
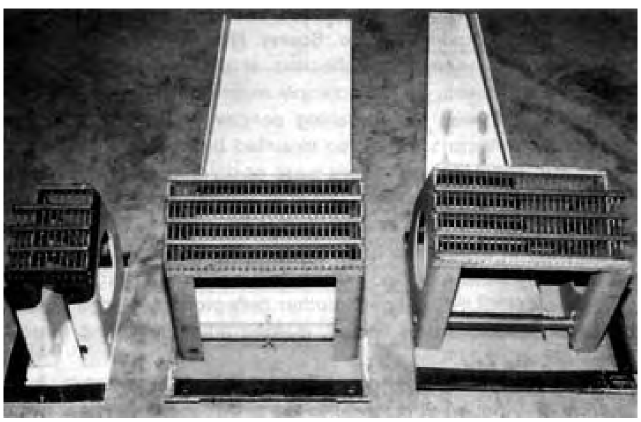


FIGURE 11. Tailing Return Elevator Inspection Door.

Concave Adjustment: Each rotor was equipped with an adjustable threshing concave, three stationary concave extension modules and a stationary separating concave (FIGURE 12). The concave extension modules had to be removed to gain access to the threshing concaves. Levelling and adjustment of initial concave clearance was very difficult and was possible only after fabricating special gauges to check the clearance at the leading edge of the threshing concaves. It is recommended that the manufacturer consider supplying suitable gauges for checking concave clearance. The initial concave clearances were 6 mm (0.25 in) at the leading edge and 1 mm (0.04 in) at the trailing edge with the control lever set at position 2.



(A)



(B)

FIGURE 12. Concaves: (A) Threshing and Separating Concaves (19) Removable Concave Extensions Modules and Deflectors.

Once the concaves had been initially set, concave clearance could be easily adjusted by the ratchet lever in the cab, which opened the leading bars faster than the trailing bars. Leading edge clearance could be varied from about 6 to 36 mm (0.25 to 1.5 in) while trailing edge clearance varied from about 1 to 18 mm (0.04 to 0.75 in).

Suitable concave indicator settings for harvesting were number 1 in tough wheat, number 1 to 3 in dry wheat, number 2 in tough barley, number 3 to 7 in dry barley, number 7 in tough rapeseed, number 8 to 11 in dry rapeseed, number 4 in tough fall rye and number 5 to 10 in dry fall rye. In hard threshing crops, concave clearance was reduced to get maximum threshing and separation while in easier threshing crops clearance was increased to reduce straw break up and shoe loading.

Rotor Adjustment: The rotors (FIGURE 13) were powered through two gear boxes and a variable speed belt drive. Rotor speed was adjusted from within the cab. The drive provided an adequate speed range from 635 rpm to 1630 rpm.

Suitable rotor speeds were 1500 rpm in tough wheat, 1200 to 1400 rpm in dry wheat and barley, 1000 to 1200 rpm in fall rye and 800 to 1200 rpm in rapeseed.

Back Beater Adjustment: The back beater and grate provide additional separation of grain from straw. The mid-position setting for the beater grate was satisfactory for most crops.

FIGURE 13. Rotors: (A) Intake Flighting (19) Rasp Bars (C) Separation Fins.

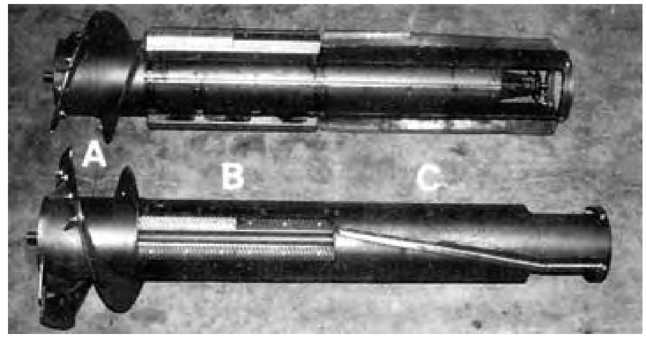


FIGURE 13. Rotors: (A) Intake Flighting (19) Rasp Bars (C) Separation Fins.

Shoe Adjustment: The cleaning shoe was difficult and inconvenient to adjust. The six levers for adjusting the chaffer and sieve openings were difficult to reach and operate (FIGURE 14). Frequently the shoe hanger bolts interfered with the latches on the sieve access door (FIGURE 15). It is recommended that the manufacturer consider modifications to improve access to the shoe adjusting levers and to eliminate shoe hanger bolt interference with the latches on the sieve access door.

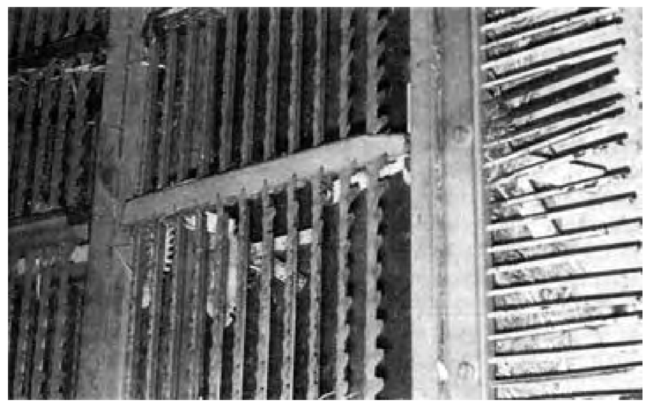


FIGURE 14. Poor Access to Shoe Adjustment Levers.

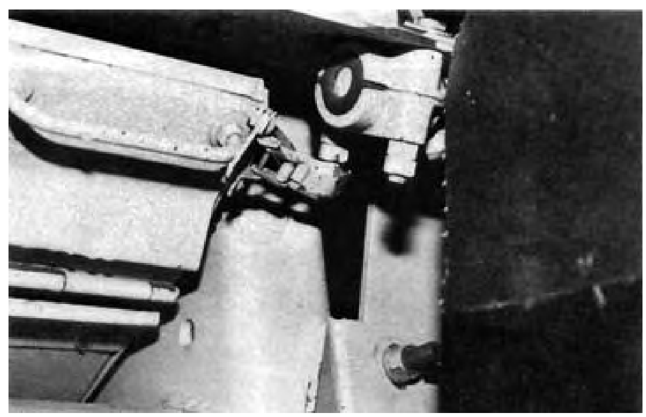


FIGURE 15. Interference of Sieve Access Door Latch and Shoe Hanger Bolts.

The fan speed was adequate for all crops and could be electrically adjusted from within the cab or at the rear of the machine. The four wind boards were usually set to direct air to the front of the shoe and could only be adjusted by crawling under the machine. It is recommended that the manufacturer consider improving the ease of adjusting the wind boards.

Deflector Adjustment: The Sperry New Holland TR95 was equipped with adjustable deflectors at the outer edges of the threshing concaves, on the concave extension modules (FIGURE 12B), and between the threshing concaves (FIGURE 16). Non-adjustable deflectors were also mounted between the separating concaves. The outer deflectors were easily adjusted with rods at the side of the combine while the concave extension modules had to be removed to permit inner deflector adjustment. The deflectors between the separating concaves were inadequate for some crops. They were modified by the manufacturer to provide some adjustment (FIGURE

16) and another deflector was added. Access to these deflectors was limited, making adjustment and removal very difficult.

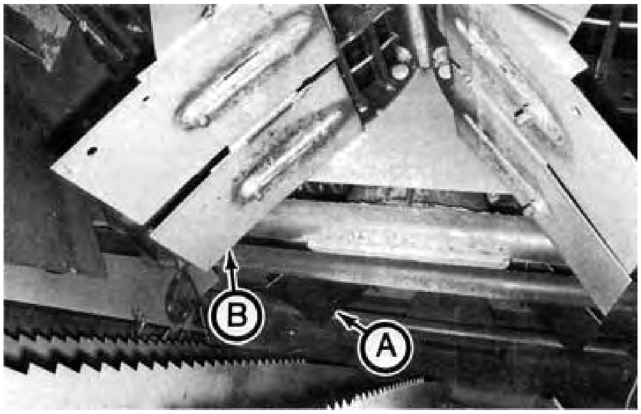


FIGURE 16. (A) Threshing Concave Inner Deflectors and (B) Modified Separator Concave Deflectors.

The deflectors were adjusted for each crop condition to provide uniform distribution of material to the shoe. The material distribution on the shoe was checked by "kill-stalling" the combine while under load (to prevent damage to the turbo-charger the separator should be disengaged and the engine restarted immediately). Proper adjustment of the deflectors greatly improved shoe performance but was very time consuming and inconvenient. It is recommended that the manufacturer consider modifications to eliminate the deflectors or to make deflector adjustment more convenient.

Header Adjustment: The Sperry New Holland TR95 was tested only with a windrow pickup attachment. The header table or the complete header and feeder assembly could be easily removed by one man in 10 minutes.

Adjustments were provided for header levelling, feeder chain tension, front drum position, stone ejection roller position, stone trap door trip sensitivity, table auger clearance and auger finger timing.

Slip Clutches: Slip clutches protected the table auger, feeder conveyor and tailings return elevator.

RATE OF WORK

Average Workrates: TABLE 3 presents average workrates for the Sperry New Holland TR95 in all crops harvested during the test. Average workrates are affected by crop condition, windrow quality, field conditions and availability of grain handling equipment, and should not be used to compare combines tested in different years. Average workrates varied from 4.0 t/h (157 bu/h) in 1.9 t/ha (30 bu/ac) Frontier rye to 13.6 t/h (623 bu/h) in 3.1 t/ha (58 bu/ac) Bonanza, barley.

Maximum Feedrate: The workrates in TABLE 3 represent average workrates at acceptable loss levels. In most crops higher feedrate could be attained when operating at the engine power limit. The maximum acceptable feedrate was limited by either grain loss or engine power while the maximum feedrate was limited by engine power in average to heavy crops and by pickup performance in light crops. The maximum feedrate was greatly reduced in tough crops.

When the Sperry New Holland TR95 was operated near its maximum feedrate a loud shuddering noise could be heard. The vibration came from the rotor and concave assembly but no apparent cause was found.

Capacity: Combine capacity is the maximum rate at which a combine, adjusted for optimum performance, can harvest a crop at a specified total loss level. Many crop variables affect combine capacity. Crop type and variety, grain and straw yield and moisture content, local climatic conditions and windrow quality can cause capacity variations.

MOG Feedrate, MOG/G Ratio and Percent Loss: When determining combine capacity, combine performance and crop conditions must be expressed in a meaningful way. The loss characteristics of a combine depend mainly on two factors, the quantity of the straw and chaff being processed and the quantity of grain being processed. The mass of straw and chaff passing through a combine per unit time is called MOG Feedrate. MOG is an abbreviation for "Material-Other-than-Grain" and represents the mass of all plant material passing through the combine except for the grain or seed.

TABLE 3. Average Workrates

Crop	Variety	Average Yield t/ha	Average Speed km/h	Average Workrate ha/h	Average Workrate t/h
Barley	Betzes	1.9	3.6	2.7	5.1
Barley	Bonanza	3.1	7.0 & 5.7	4.3	13.6
Barley	Elrose	2.8	3.6	2.6	7.4
Barley	Klages	1.6	6.3	4.8	7.6
Rapeseed	Altex	1.5	6.6	3.7	5.4
Rapeseed	Candle	1.4	4.2	3.1	4.3
Rapeseed	Regent	1.3	7.0	4.3	5.7
Rye	Frontier	1.9	4.0 & 2.4	2.2	4.0
Rye	Puma	2.0	6.4	3.9	7.8
Wheat	Canthatch	2.8	3.6	4.4	13.3
Wheat	Manitou	2.4	6.4	4.8	11.4
Wheat	Neepawa	2.4	7.0 & 5.1	4.3	10.3
Wheat	Park	3.2	6.9	4.2	13.3

The mass of grain or seed passing through the combine per unit time is called Grain Feedrate. The ratio of MOG Feedrate to the Grain Feedrate, abbreviated as MOG/G, indicates how difficult a crop is to separate. For example, if a combine is used in two wheat fields of identical yield, one with long straw and one with short straw, the combine will have better separation ability in the short crop and will be able to operate faster. This crop variable is expressed as the MOG/G ratio. MOG/G ratios for prairie wheat crops vary from about 0.5 to 1.5.

Grain losses from the combine are of two main types, unthreshed grain still in the head and threshed grain, which is discharged with the straw and chaff. Unthreshed grain is called cylinder loss. Free grain in the straw and chaff is called separator loss and consists of shoe and walker (or rotor) loss. Losses are expressed as a percent of total grain passing through the combine.

Combine capacity is expressed as the maximum MOG Feedrate at which total grain loss (cylinder loss plus separator loss) is 3% of the total grain yield.

Capacity of the Sperry New Holland TR95: TABLE 4 presents capacity results for the Sperry New Holland TR95 in five different crops. MOG Feedrates for a 3% total grain loss varied from 14.7 t/h (539 lb/min) in 3.7 t/ha (55 bu/ac) Neepawa wheat to 21.2 t/h (777 lb/min) in 3.4 t/ha (50 bu/ac) Neepawa wheat.

GRAIN LOSS CHARACTERISTICS

The grain loss characteristics for the Sperry New Holland TR95 in the five crops described in TABLE 4 are presented in FIGURES 17 to 21.

Rotor Loss: Rotor loss was low over the entire operating range in most crops and did not limit combine capacity.

To fully utilize the capacity of both rotors the rotors must be fed equally. Therefore, parallel windrows should be fed, centered on the feeder housing, and angled windrows should be fed slightly off-center to provide even rotor feeding. Optimum rotor capacity could be expected in double windrows laid side-by-side.

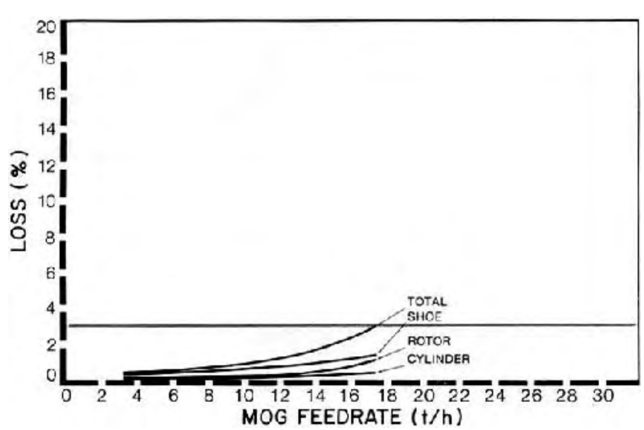


FIGURE 17. Grain Loss in Bonanza Barley.

Shoe Loss: In most crops, shoe and deflector adjustments were critical in preventing excessive shoe loss. At first, uneven material distribution and non-uniform air blast caused overloading of the center of the shoe (FIGURE 22), which caused high shoe

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

Crop Conditions							Capacity Results			
				Grain Moisture						
Crop	Variety	Width of Cut m	Crop Yield t/ha	Straw %	Grain %	MOG/G	MOG Feedrate t/h	Grain Feedrate t/h	Ground Speed km/h	Loss Curve
Barley	Bonanza	7.4	3.5	8.0	12.9	0.66	17.3	25.4	9.9	Fig. 17
Barley	Klages	7.3	3.7	9.8	12.6	0.65	19.3	29.7	11.1	Fig. 18
Wheat	Manitou	7.4	3.9	9.0	14.0	0.87	19.3	22.2	7.8	Fig. 19
Wheat	Neepawa	8.2	3.4	5.5	11.6	0.88	21.2	24.1	8.6	Fig. 20
Wheat	Neepawa	7.4	3.7	9.5	14.7	0.83	14.7	17.7	6.5	Fig. 21

loss in most crops. The manufacturer's modifications and addition of deflectors (FIGURE 16) improved material distribution and provided satisfactory shoe performance in most crops. However, in rapeseed it was still difficult to maintain low shoe loss and a clean grain sample without overloading the tailings return.

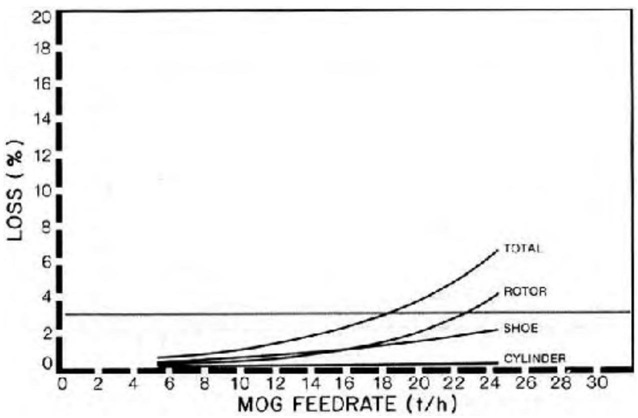


FIGURE 18. Grain Loss in Klages Barley.

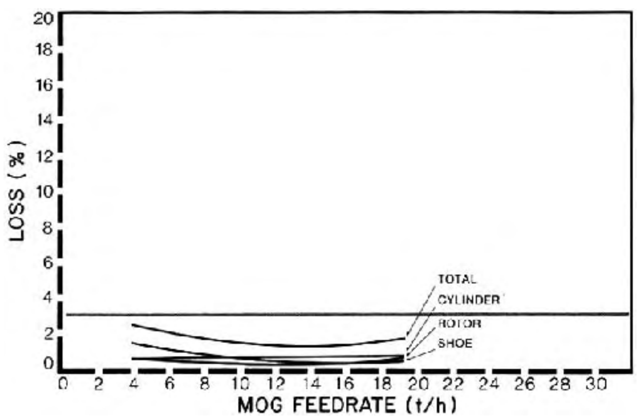


FIGURE 19. Grain Loss in Manitou Wheat.

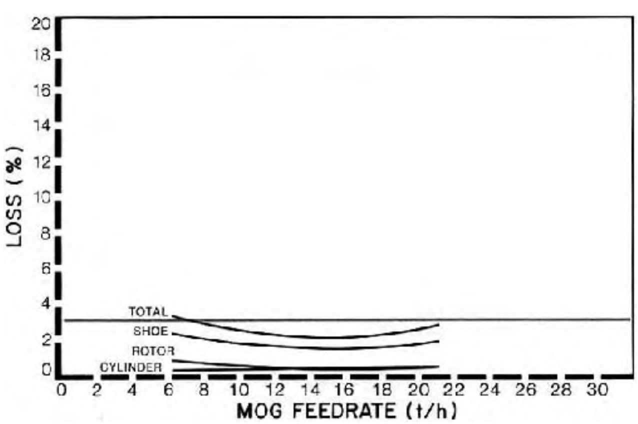


FIGURE 20. Grain Loss in Neepawa Wheat.

Cylinder Loss and Grain Damage: Cylinder loss was low in all crops tested (FIGURES 17 to 21), while grain cracks were approximately 1.5% in wheat crops and less than 0.5% in barley crops. Cylinder loss and grain damage for the Sperry New Holland TR95 were lower than for the reference combine.

Body Loss: Leakage of seed from the combine body was negligible in both grain crops. In rapeseed, some losses occurred from the feeder housing, elevators and the grain tank loading auger seal. Losses were low and most were eliminated by adding suitable packing material.

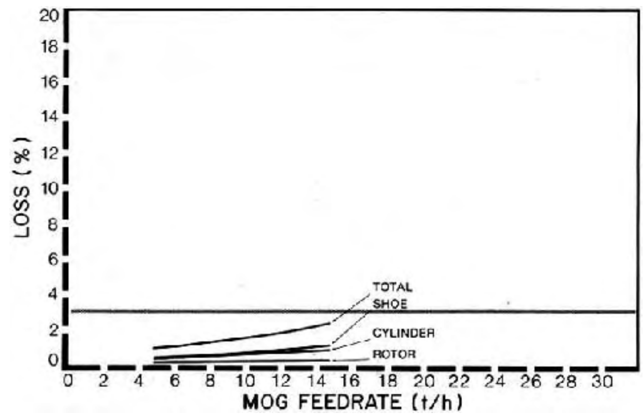


FIGURE 21. Grain Loss in Neepawa Wheat.

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

FIGURES 23 to 27 compare the total grain losses of the Sperry New Holland TR95 and the Machinery Institute reference combine in the five crops described in TABLE 4. The shaded areas on the figures are 95% confidence belts. If the shaded areas overlap, the loss characteristics of the two combines are not significantly different, whereas if the shaded areas do not overlap, losses are significantly different. The capacity of the Sperry New Holland TR95 was much greater than the reference combine capacity in wheat and barley.

FIGURE 22. Over Loading of the Center of the Shoe.

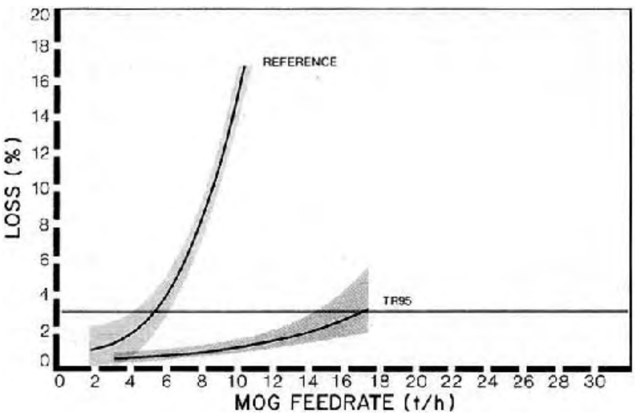


FIGURE 23. Total Grain Loss in Bonanza Barley.

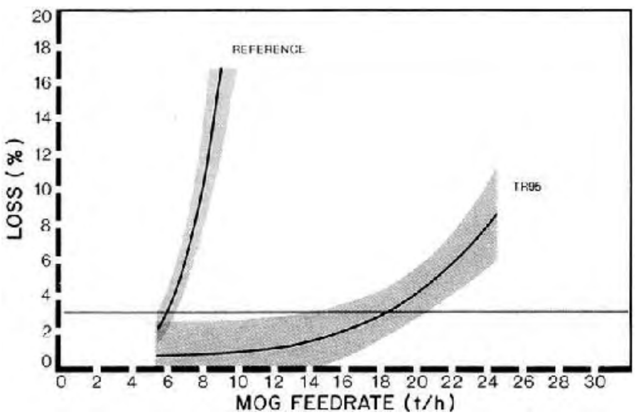


FIGURE 24. Total Grain Loss in Klages Barley.

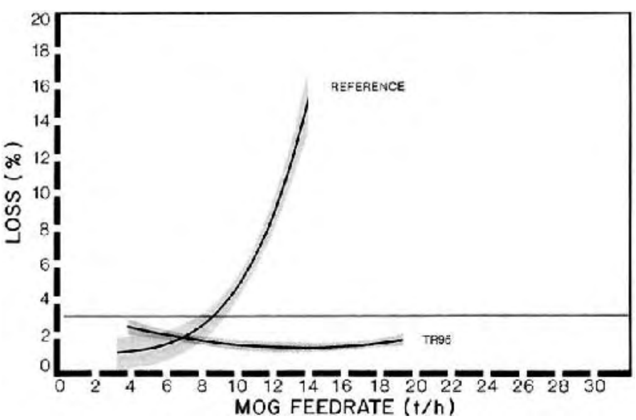


FIGURE 25. Total Grain Loss in Manitou Wheat.

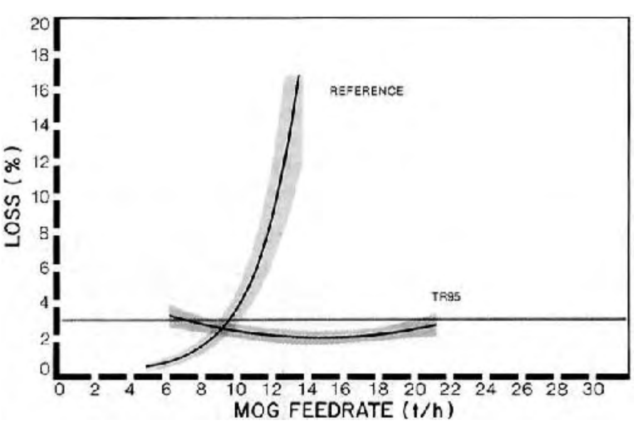


FIGURE 26. Total Grain Loss in Neepawa Wheat.

OPERATOR SAFETY

The operator's manual emphasized operator safety. The Sperry New Holland TR95 had adequate warning decals to warn of dangerous areas. Moving parts were well shielded and most shields were hinged to allow easy access.

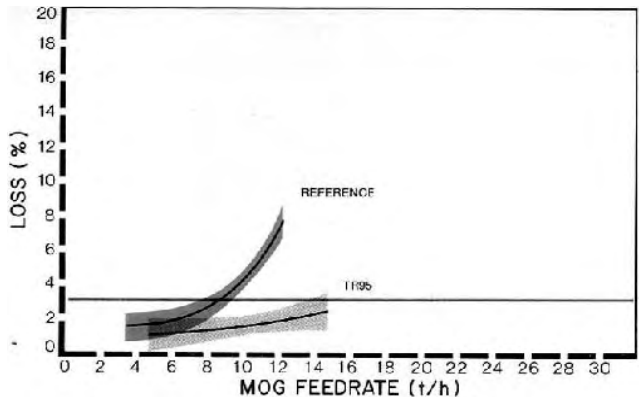


FIGURE 27. Total Grain Loss in Neepawa Wheat.

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

A rocking wrench and hubs were not provided for unplugging the table auger, which invites an operator to work in a potentially dangerous area. All clutches should be disengaged and the engine shut off before clearing obstructions.

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

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

OPERATOR'S MANUAL

The operator's manual was clearly written, well illustrated and well organized. It contained much useful information on safe operation, controls, adjustments, crop setting, servicing, trouble shooting, and machine specifications.

The suggested chaffer settings in the operator's manual were inadequate for all rapeseed crops encountered. Also, the suggested chaffer and sieve settings for wheat were interchanged. It is recommended that the manufacturer consider revising the suggested chaffer and sieve settings for rapeseed and wheat.

DURABILITY RESULTS

MECHANICAL HISTORY

TABLE 5 outlines the mechanical history of the Sperry New Holland TR95 during 103 hours of field operation while harvesting about 413 ha (1020 ac). The intent of the test was functional performance evaluation. Extended durability testing was not conducted.

Table Auger Fingers: Two auger fingers broke and one bent during the test. It is recommended that the manufacturer consider improving the durability of the table auger fingers.

Separator Main Shaft Seals: The left bearing seal of the main separator shaft came loose, exposing the bearing to dust and moisture. It is recommended that the manufacturer consider modifying the separator main shaft seals to prevent loosening and bearing exposure.

TABLE 5. Mechanical History

Item	Operating Hours	Field Area ha
Drives		
-The cylinder variable speed drive belt wore excessively from slipping and was replaced at	21	84
-The flighting of the top return tailing auger was damaged and repaired at	84	337
-The feeder clutch jaws cracked, seizing the clutch to the shaft. The clutch was repaired at	85	341
-A pin failure caused misalignment and severe wear of the feeder intermediate drive sprocket	during the tests	
Electrical		
-The stone trap door warning switch failed and was replaced at	48	192
Miscellaneous		
-The brakes were bled at	11	44
-Seven feeder chain slats were straightened at	67	269
-The separator engaging linkage failed and was repaired at	97	389
-The safety clips for the header pins were missing and were replaced at	end of test	
-Several pickup teeth attaching rods failed	during the test	
-Two table auger fingers broke and one was bent	during the test	

APPENDIX I
SPECIFICATIONS

MAKE:	Sperry New Holland Self-Propelled Combine
MODEL:	TR95
SERIAL NUMBER:	Header 419246 Body 500144 Engine 3700995 JD8
MANUFACTURER:	Sperry New Holland Division of Sperry Rand Corporation New Holland, Pennsylvania 17557
WINDROW PICKUP:	
-- make	Melroe 378
-- type	draper
-- pickup width	3215 mm
-- number of belts	7
-- teeth per belt	40
-- number of rollers	
- pickup	2
- transfer	2
-- height control	castor gauge wheels
-- speed control	hydraulically controlled variable pitch sheaves
-- speed range	0 to 2.2 m/s
HEADER:	
-- type	centre feed
-- width	3970 mm
-- auger diameter	502 mm
-- feeder conveyor	3 roller chains, undershot slatted conveyors
-- conveyor speed	2.8 m/s
-- range of picking height	-490 to 1330 mm
-- number of lift cylinders	2
-- raising time	2.7 s
-- lowering time	2.3 s
STONE PROTECTION:	
-- type	stone roller in feeder housing
-- ejection	door with adjustable spring loaded catch; door manually reset upon tripping
ROTOR:	
-- crop flow	axial
-- number of rotors	2
-- type	feeding fins, closed tube, 3 stage-inlet, thresh, separate; 4 parallel rasp bars front section, 2 separating bars rear section
-- diameter	
- tube	304 mm
- feeding portion	683 mm
- threshing portion	427 mm
- separating portion	424 mm
-- length	
- feeding portion	375 mm
- threshing portion	715 mm
- separating portion	1070 mm
- total	2160 mm
-- drive	electrically controlled variable pitch belt through two 90 degree gearboxes
-- speeds	635 to 1630 rpm
CONCAVES (THRESHING):	
-- number	
- concaves	2
- concave extension	6
-- type	bar and wire grate
-- number of bars	
- concave	11 each
- concave extension	5 each
-- configuration	
- concave	10 intervals with 3.6 mm wires and 6.5 mm spaces
- concave extension	4 intervals with 3.6 mm wire and 6.5 mm spaces
-- area	
- concave total	0.650 m^2
- concave open	0.255 m^2
- concave extensions total	0.202 m^2
- concave extensions open	0.103 m^2
-- wrap	
- concave	100 degrees
- concave plus extensions	130 degrees
-- grain delivery to shoe	grain pan
CONCAVES (SEPARATING):	
-- number	2
-- type	bar and wire grate
-- number of bars	11 each
-- configuration	10 intervals with 6.4 mm wires and 51 mm spaces
-- area total	1.339 m^2
-- area open	0.946 m^2
-- wrap	210 degrees of each cage
-- grain delivery to shoe	grain pan

BACK BEATER:	
-- type	4 wing box
-- speed	820 rpm
BACK BEATER GRATE:	
-- type	wire and bar grate
-- configuration	54 intervals with 6.5 mm wires and 18.8 mm spaces
-- area total	0.560 m^2
-- area open	0.268 m^2
-- grain delivery to shoe	gravity
-- option	beater grate covers
SHOE:	
-- type	opposed action
-- speed	335 rpm
-- chaffer sieve	adjustable lip, 1.67 m^2 with 45 mm throw
-- chaffer extension	adjustable lip, 0.59 m^2
-- rake extension	wire rake
-- cleaning grain sieve	adjustable lip, 1.67 m^2 with 30 mm throw
-- options	chaffer sieve small seed sieve
CLEANING FAN:	
-- type	6 blade undershot
-- diameter	680 mm
-- width	1160 mm
-- drive	variable pitch belt
-- speed range	520 to 1020 rpm
-- options	cleaning fan speed reduction kit cleaning fan bottom shield kit
ELEVATORS:	
-- type	roller chain with rubber flights
-- clean grain (top drive)	195 x 290 mm
-- tailings (bottom drive)	130 x 290 mm
GRAIN TANK:	
-- capacity	8.5 m^3
-- unloading time	234 s
-- options	full bin sensor
STRAW SPREADER:	
-- type	rotor with 30 freely swinging flails
-- speed	2930 rpm
ENGINE:	
-- make	Caterpillar
-- model	3208
-- type	4 stroke, turbocharged diesel
-- number of cylinders	8
-- displacement	10.42 L
-- governed speed (full throttle)	2514 rpm
-- manufacturer's rating	168 kW @ 2400 rpm
-- fuel tank capacity	379 L
-- options	water jacket heater kit starting fluid injector
CLUTCHES:	
-- header	V-belt
-- separator	dry friction disc
-- unloading auger	V-belt
NUMBER OF CHAIN DRIVES:	9
NUMBER OF BELT DRIVES:	15
NUMBER OF GEAR BOXES:	6
NUMBER OF PREL UBRICATED BEARINGS:	63
LUBRICATION POINTS:	
-- 10 h lubrication	17
-- 50 h lubrication	33
-- 100 h lubrication	17
-- 500 h lubrication	2 (repack bearings)
TIRES:	
-- front	2, 30.5 L x 32 R1, 10-ply
-- rear	2, 14.9 L x 24 R3, 6-ply
TRACTION DRIVE:	
-- type	hydrostatic
-- speed ranges	
- 1st gear	0 - 2.7 km/h
- 2nd gear	0 - 6.4 km/h
- 3rd gear	0 - 11.6 km/h
- 4th gear	0 - 26.4 km/h
OVERALL DIMENSIONS:	
-- wheel tread front	3050 mm
-- wheel tread rear	2765 mm
-- wheel base	3270 mm
-- transport height	4200 mm
-- transport length	8895 mm
-- transport width	4450 mm
-- field height	4200 mm
-- field length	8645 mm
-- field width	4450 mm
-- unloader discharge height	4100 mm
-- unloader clearance height	3975 mm

-- unloader reach	3000 mm
-- turning radius	
-left	6310 mm
-right	6220 mm

WEIGHT: (With Empty Grain Tank)

-- right front wheel	3585 kg
-- left front wheel	4000 kg
-- right rear wheel	1970 kg
-- left rear wheel	1995 kg
TOTAL	10540 kg

APPENDIX II
REGRESSION EQUATIONS FOR CAPACITY RESULTS

Regression equations for the capacity results shown in FIGURES 17 to 21 are presented in TABLE 6. In the regressions, C = cylinder loss in percent of yield, S = shoe loss in percent of yield, R = rotor loss in percent of yield, F = the MOG feedrate in t/h, while $\ln$ is the natural logarithm. Sample size refers to the number of loss collections. Limits of the regressions may be obtained from FIGURES 17 to 21 while crop conditions are presented in TABLE 4.

TABLE 6. Regression Equations

Crop - Variety	Fig. No.	Regression Equations	Simple Correlation Coefficient	Variance Ratio	Sample Size
Barley - Bonanza	17	$\ln C = -2.76 + 0.09F$ $\ln S = -1.53 + 0.11F$ $\ln R = -4.28 + 0.26F$	0.81 0.96 0.88	11.29[1] 75.23[2] 20.48[2]	8
Barley - Klages	18	$C = 0.04 + 0.01F$ $S = 0.27 + 0.003F$ $\ln R = -2.47 + 0.16F$	0.83 0.65 0.90	15.25[2] 5.05 29.30[2]	9
Wheat - Manitou	19	$\ln C = -0.93 + 0.21 \ln F$ $S = 1.29 - 0.06F$ $R = 0.72 - 0.06F + 6.9 \times 10^{-6}F^4$	0.65 0.85 0.92	4.29 15.67[2] 13.10	8
Wheat - Neepawa	20	$C = 0.14 + 0.014F$ $S = 3.86 - 0.32F + 0.01F^2$ $R = 1.54 - 0.16F + 0.005F^2$	0.85 0.85 0.92	15.16[2] 16.36 13.84[2]	8
Wheat - Neepawa	21	$C = 0.09 - 0.05F$ $S = 0.35 + 0.004F^2$ $R = 0.15 + 6.8 \times 10^{-4}F^2$	0.77 0.49 0.71	8.56 1.86 5.97	8

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

APPENDIX III
MACHINERY INSTITUTE REFERENCE COMBINE CAPACITY RESULTS

TABLE 7 and FIGURES 28 and 29 present the capacity results for the Machinery Institute reference combine in wheat and barley harvested from 1977 to 1981.

FIGURE 28 shows capacity differences in Neepawa wheat for the five years. Most 1981 Neepawa wheat crops shown in TABLE 7 were of average straw yield and better than average grain yield. Most of the crops were average to hard-to-thresh while grain and straw moisture content were average.

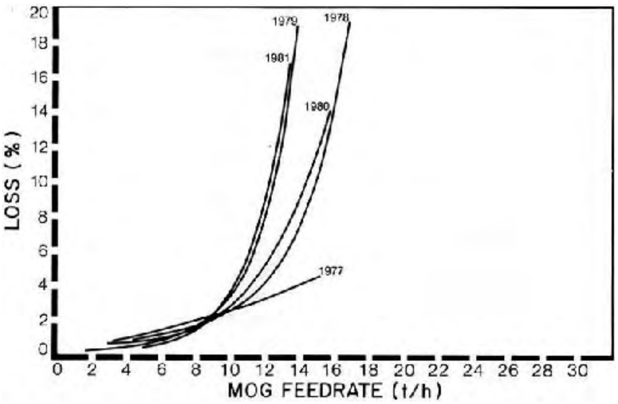


FIGURE 28. Total Grain Loss for the Reference Combine in Neepawa Wheat.

FIGURE 29 shows the capacity differences in six-row Bonanza barley for 1977 to 1978 and for 1981, two-row Fergus barley for 1979 and two-row Hector barley for 1980. The 1981 Bonanza barley crop shown in TABLE 7 was of average straw and grain yield, easy-to-thresh, and had average straw and moisture content.

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

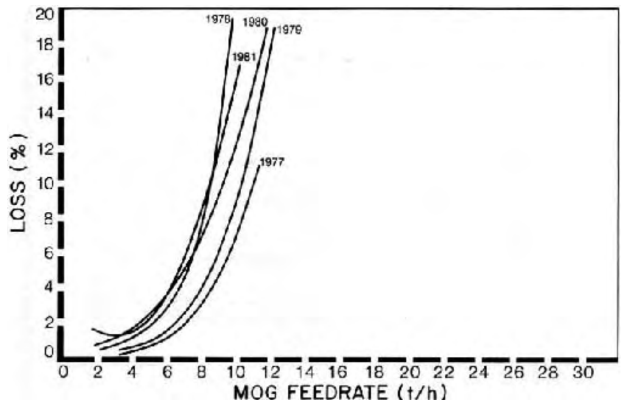


FIGURE 29. Total Grain Loss for the Reference Combine in Barley.

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

	Crop Conditions							Capacity Results			
					Grain Moisture			MOG Feedrate	Grain Feedrate	Ground Speed	
Year	Crop	Variety	Width of Cut m	Crop Yield t/ha	Straw %	Grain %	MOG/G	t/h	t/h	km/h	Loss Curve
1981	Barley	Bonanza	7.2	3.33	7.2	12.6	0.67	5.6	8.4	3.5	Fig. 29
	Barley	Klages	7.4	2.86	7.1	12.0	0.68	6.0	8.8	4.2	
	Wheat	Manitou	7.4	3.46	8.3	13.8	0.96	6.5	8.9	3.5	
	Wheat	Neepawa	8.2	3.69	6.4	11.9	0.85	9.5	11.2	3.7	Fig. 28
	Wheat	Neepawa	7.4	3.29	8.2	13.7	0.93	9.2	9.9	4.1	
1980	Barley	Hector	6.1	3.48	13.8	14.5	0.69	5.5	8.0	3.8	Fig. 29
	Barley	Hector	6.1	3.16	13.4	14.4	0.68	5.8	8.5	4.4	
	Wheat	Neepawa[1]	12.2	2.87	7.2	13.2	0.88	9.4	10.6	3.0	
	Wheat	Neepawa	6.1	3.12	6.0	11.4	0.98	10.1	10.3	5.4	Fig. 28
	Wheat	Neepawa[1]	12.2	3.09	6.2	12.2	1.02	10.2	10.0	2.7	
	Wheat	Neepawa	6.1	3.00	4.9	10.8	0.91	10.3	11.3	6.2	
1979	Barley	Klages	6.1	3.67	dry	11.7	0.64	6.8	10.6	4.7	
	Wheat	Neepawa	7.3	2.77	dry	14.1	1.21	9.5	7.8	3.9	
	Wheat	Neepawa	6.1	2.67	dry	14.3	1.09	9.7	8.9	5.4	Fig. 28
	Barley	Fergus	7.3	3.46	dry	12.5	0.77	7.3	9.5	3.7	Fig. 29
1978	Wheat	Canuck	7.3	2.54	7.1	12.1	1.15	11.8	10.3	5.6	
	Wheat	Lemhi[1]	11.0	2.13	6.6	12.0	0.75	10.9	14.5	6.2	
	Wheat	Neepawa	6.1	4.37	10.4	15.9	1.04	9.3	8.9	4.5	Fig. 28
	Barley	Bonanza	6.1	4.06	7.7	13.5	0.68	6.1	9.0	3.6	Fig. 29
1977	Wheat	Neepawa	6.1	3.97	13.4	14.6	0.79	11.1	14.1	5.8	Fig. 28
	Barley	Bonanza	7.3	4.74	25.7	14.6	0.84	7.9	9.4	2.7	Fig 29

APPENDIX IV
MACHINE RATINGS

The following rating scale is used in Machinery Institute Evaluation Reports:

(a) excellent
(b) very good
(c) good
(d) fair
(e) poor
(f) unsatisfactory

APPENDIX V
CONVERSION TABLE

1 kilometre/hour (km/h)	= 0.6 miles/hour (mph)
1 hectare (ha)	= 2.5 acres (ac)
1 kilogram (kg)	= 2.2 pounds (lb)
1 tonne (t)	= 2200 pounds mass (lb)
1 tonne/hectare (t/ha)	= 0.5 ton/acre (ton/ac)
1 tonne/hour (t/h)	= 37 pounds/minute (lb/min)
1 kilowatt (kW)	= 1.3 horsepower (hp)
1 litre/hour (L/h)	= 0.2 Imperial gallons/hour (gal/h)
1 metre (m)	= 3.3 feet (ft)
1 millimetre (mm)	= 0.04 inches (in)

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