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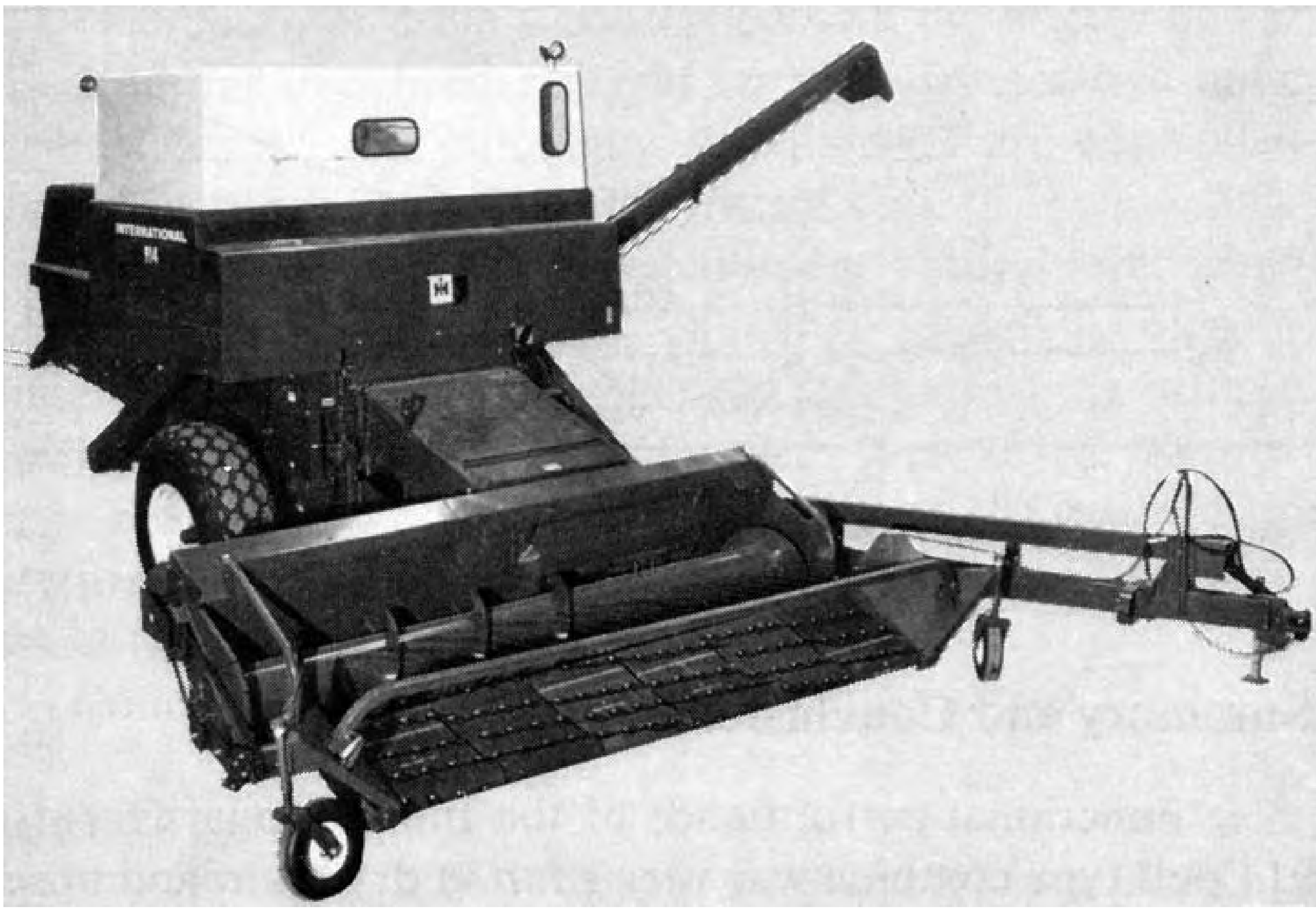
Evaluation Report 25



International Harvester 914 Pull-Type Combine

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

International Harvester 914 Pull-Type Combine

Manufacturer:
International Harvester Company
East Moline, Illinois 61244
U.S.A.

Distributor:
International Harvester of Canada
660 Wall Street
Winnipeg, Manitoba
R3C 2W8

Retail Price:
$22,569.00 [July, 1977, f.o.b. Humboldt, with 3810 mm (12.5 ft) table, 3350 mm (132 in) belt pickup, straw chopper, stone retarder bar, and grain pan sidehill attachment].

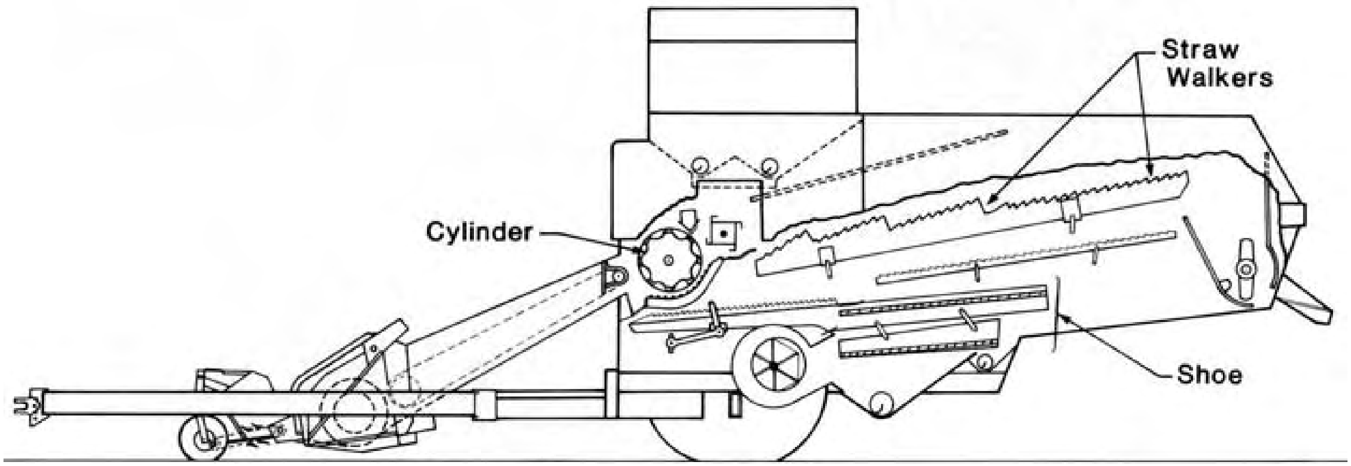


Figure 1. Schematic View of International Harvester 914.

Summary and Conclusions

Functional performance of the International Harvester 914 pull-type combine was very good in dry grain and oilseed crops. Functional performance was good to fair in tough and damp crops.

The MOG feedrate at 3% total grain loss varied from 8.30 t/h (305 lb/min) in 3.36 t/ha (50 bu/ac) Neepawa wheat to 5.65 t/h (208 lb/min) in 3.56 t/ha (66 bu/ac) Bonanza barley. The capacity of the IH 914 was greater than the capacity of the PAMI reference combine for a similar total grain loss. Straw walker loss limited the capacity of the IH 914 in most crops. A reduction in grain loss over the straw walkers would have permitted higher combining rates. Cylinder and shoe losses usually were small, in comparison to straw walker loss.

In dry wheat, at rated capacity, average PTO power requirements were 45 kW (60 hp). Although the manufacturer recommends a minimum 67 kW (90 hp) tractor, a minimum 82 kW (110 hp) was needed when combining damp crops in soft or hilly fields. Fuel consumption, when powered with an International Hydro 100 tractor, varied from 20 to 25 L/h (4.5 to 5.5 Imp. gal/h).

The IH 914 was very maneuverable. It was easier to pick corners, formed by self-propelled windrowers, with the IH 914 than with most self-propelled combines. Header visibility and handling depended upon the type of tractor used while feedrate control depended upon the type of tractor transmission and its available range of ground speeds.

For example, when using the IH Hydro 100 tractor, header visibility was restricted by the rear corner post of the tractor cab but feedrate control was excellent. The infinitely variable hydrostatic transmission was ideally suited for controlling a pull-type combine. The IH Hydro 100 was slightly under-powered when using a straw chopper in damp heavy crops.

All controls were very convenient to operate from the tractor seat. Grain tank visibility was good as the front of the tank contained two windows to indicate grain level. The unloading auger had sufficient reach for efficient unloading on-the-go. As is common with pull-type combines, modern tractor cabs create a better environment for the operator than most cabs on self-propelled combines but, as a result, operator feel for combine performance is eliminated and suitable monitoring instruments become more important.

The IH 914 was easy to adjust for specific field conditions if a second person was available. As is normal with pull-type combines, adjusting by one person was more difficult. Return tailings were easy to inspect. Changing cylinder speed was inconvenient since it necessitated changing sprockets on either the cylinder or beater shaft. Adjusting the shoe was hazardous, especially when windrowing straw, due to the exposed rotor on the straw chopper. Ease of servicing was very good. All grease fittings were accessible and identified with decals indicating location and frequency of lubrication.

The table auger, feeder and cylinder all had excellent capacity and plugging was infrequent. Both the cylinder and table auger were equipped with rocking hubs for easy unplugging. Cylinder access was relatively inconvenient.

The stone trap stopped most stones before they entered the cylinder and was fairly accessible. The stone trap door sometimes was difficult to open or close as the locking chains jammed in their retainers.

The pickup had poor feeding characteristics in all crops, delivering the windrow into the centre of the table auger rather than under it. Running the pickup flat with the ground resulted in good feeding but this was not possible in stony fields.

The hitch was convenient to swing into transport or field position. It was difficult to secure the grain auger in field position as there was no suitable place to stand when locking the hand wheel.

The IH 914 transported well at speeds up to 32 km/h (20 mph). Transport width was narrow enough for safe and easy movement on most roads. Due to its high centre of gravity, the IH 914 was unstable with a full grain tank. The hitch load became negative when travelling up slopes greater than 4 degrees. Caution had to be exercised when travelling with a full grain tank or when attempting to completely fill the grain tank in hilly fields.

Except for the exposed straw chopper rotor, when windrowing straw, no serious safety hazards were encountered when operating according to manufacturer’s recommended procedures. The operator’s manual was clear and well illustrated, containing much useful information on servicing and adjustments for most

crops.
No major durability problems occurred during the test, although problems were experienced with the pickup drive.

Recommendations

It is recommended that the manufacturer consider:

1. Modifying the pickup to improve feeding into the table auger.
2. Modifying the pickup drive to eliminate drive line problems.
3. Providing an optional variable speed control for the pickup drive, adjustable from the tractor seat.
4. Modi cations to improve the ease of removing the stone trap door support chains from their retainers.
5. Providing a shaft rotation indicator for the clean grain elevator.
6. Modi cations to improve the ease of placing the grain unloading auger in eld or transport position.
7. Providing an additional light for the grain unloading auger.
8. Installing hinges on at least one straw walker inspection door to aid in sampling straw to determine cylinder performance.

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

The Manufacturer States That

With regard to recommendation number:

1. We are currently working to improve material ow from the pickup to the auger.
2. For 1977 and subsequent machines the pickup is driven by a simpler and more reliable drive on the left side.
3. Changing speeds with the new drive (above) is a little easier than previously. A tractor controlled variable drive is being studied.
4. We still study this.
5. Grain ow from the elevator and the end of the distribution auger are visible to the operator through the grain tank window while the tank is lling the lower level. As the tank lls further, the continued rise of the grain gives indication that the system is working.
6. We will study this.
7. There are two lights in the grain tank. One is meant to light the interior of the tank to monitor lling and the second to light the unloading operation. Lighting of the header is meant to come from the tractor. Our setup instructions, which will be modi ed, do not clearly state where to place the lights.
8. Hinged straw walker inspection doors are included in 1977 and subsequent machines.

Additional comments are as follows:

1. We do not recommend and in our current operator's manuals warn against road transport with grain in the grain tank.
2. The 1976 and 1977 concaves are interchangeable.

General Description

The International Harvester 914 is a power take-off driven pull-type combine with a 3350 mm (132 in) two roller belt pickup mounted on a 3810 mm (12.5 ft) off-set header. A minimum 67 kW (90 hp) tractor, with 1000 rpm power takeoff and one hydraulic outlet, is needed.

The separator drive is controlled with the tractor power take-off clutch and header height with the tractor hydraulic system. Header and unloading auger drives are controlled through electric clutches from the tractor seat.

Concave clearance is adjusted with a ratchet lever while cylinder speed is adjusted by changing sprockets on the cylinder or beater shaft. Fan speed adjustment is with a hand wheel controlling a variable speed belt drive. Return tailings may be inspected through a slide at the bottom of the return elevator. The chaffer and sieve are adjusted with levers at the rear of the shoe.

Complete speci cations are given in Appendix I.

Scope of Test

The International Harvester 914 was powered with an International Hydro 100 tractor and was operated in a variety of Saskatchewan and Alberta crops (Tables 1 and 2) for 227 hours while harvesting about 436 ha (1077 ac). It was evaluated for ease of operation, ease of adjustment, power requirements, rate of work, grain loss characteristics, operator safety, and suitability of the operator's manual. Throughout the test, comparisons were made to the PAMI reference combine.

Table 1. Operating Conditions

Crop	Variety	Yield t/ha	Yield bu/ac	Swath Width m	Swath Width ft	Hours	Field Area ha	Field Area ac
Wheat	Neepawa	2.7	40	4.6-6.1	15-20	97	205	507
Wheat	Manitou	2.6	38	5.5	18	34	65	160
Wheat	Park	3.4	50	4.9	16	11	11	26
Barley	Betzes	2.7	50	5.5-6.1	18-20	38	54	134
Barley	Bonanza	3.1	57	6.1-7.3	20-24	12	20	49
Oats	Harmon	3.1	80	4.9	16	7	8	20
Flax	Noralta	1.3	20	4.9	16	6	12	30
Flax	Linott	1.3	20	4.9	16	10	21	52
Rapeseed	Midas	0.8	15	4.9	16	12	40	99
Total						227	436	1077

Table 2. Operation in Stony Fields

Field Conditions	Hours	Field Area ha	Field Area ac
Stone Free	84	175	431
Occasional Stones	54	80	197
Moderately Stony	67	121	300
Very Stony	22	60	149
Total	227	436	1077

Results and Discussion

EASE OF OPERATION

Hitching: A tractor with 1000 rpm power take-off with a standard 35 mm (1.38 in) spline was needed to power the IH 914. When attaching the IH 914 to a tractor for the first time, several tractor modifications and combine adjustments had to be made. The combine control box, which contained the controls for the header, unloading auger, combine lights and the straw walker warning horn, had to be installed at a convenient location on the tractor. The header and unloading auger clutches were assembled for a 12V, negative ground, tractor electrical system but could easily be converted for a 12V positive ground system. The control box could be permanently attached to the tractor as it contained an extension with receptacle for quickly connecting the combine umbilical cord.

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

Once the above adjustments had been made, attaching the IH 914 to the tractor was safe and convenient. A convenient hitch jack was attached to the drawpole. The drive line was connected to the tractor power take-off with a bolted split spline coupler while the umbilical cord contained a pronged plug for attaching to the control box receptacle. Although the hitch pin must be secured, to prevent falling out during operation, pin diameter should be about 6 mm (0.25 in) less than the diameter of the hole in either the hitch or the tractor drawbar, to provide flexibility on uneven terrain. A hitch safety chain was supplied with the IH 914.

Maneuverability: The IH 914 was very maneuverable. As is common with most pull-type combines, picking windrows around tight corners was easier with the IH 914 than with most self-propelled combines as the tractor could be turned to pivot the combine about the centre of the pickup. The maximum permissible tractor wheel spacing depended on the size of the windrower and the width of the windrow. It was easy to feed the windrow directly into the feed throat opening with the IH 914 in all crops (Figure 2), since the drawpole position permitted a maximum outside tractor wheel width of 3350 mm (132 in) even in wide fluffy windrows such as rapeseed. The minimum width of swather to permit passing between windrows on back-and-forth combining was 4875 mm (16 ft) when combining fluffy windrows with a 2440 (96 in) tractor width.

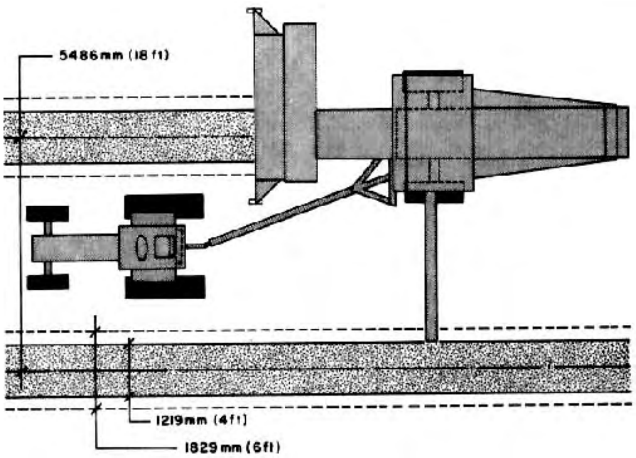


Figure 2. Schematic View Showing Tractor Wheel Spacing and Windrow Spacing needed for In-Line Feeding with the IH 914.

Operator Location: With a pull-type combine, operator comfort, and visibility depends mainly on the type of tractor used. With most modern tractors, operator comfort is better than on self-propelled combines because of lower noise levels and less dust, due to the location of the tractor away from the combine, and better cabs. At the same time, operator feel for combine performance is nearly eliminated and combine monitoring equipment becomes more important. No grain loss or shaft speed monitoring equipment were available with the IH 914, however, a straw walker plugging horn was supplied as standard equipment.

Header visibility: When powered with an IH Hydro 100 tractor, header visibility was restricted by the cab corner post. The rotation indicator on the upper return elevator shaft could easily be seen. There was no rotation indicator for the clean grain elevator but grain tank visibility was very good through the two windows in the front of the grain tank.

Controls: The main separator drive was controlled with the tractor power take-off clutch while header height was controlled with one bank of the tractor hydraulics. The combine control box had a switch and warning light for the grain unloading auger, and a switch for the header drive. It also contained the combine light switch as well as the straw walker warning horn. Feedrate control was entirely dependent upon the tractor used, its type of transmission and its selection of suitable ground speeds. Feedrate control, when powered with the IH Hydro 100 tractor, was excellent since it provided an infinitely variable range of suitable ground speeds without gear shifting.

Lights: The IH 914 was equipped with three lights to supplement tractor lighting, one each for the header, the grain tank, and the straw chopper. An additional light for the unloading auger would be beneficial.

The IH 914 was equipped with warning lights and suitable reflectors for safe transport on public roads.

Stability: The IH 914 was quite stable with an empty grain tank, however, its high centre of gravity and large grain tank created stability problems with a full tank in rough or hilly land. Any irregular driving, such as crossing washouts or suddenly changing forward speed, caused severe rocking of the combine. The centre of gravity with a full grain tank was about 2210 mm (87 in) above ground, 203 mm (8 in) ahead of the combine axle and 76 mm (3 in) to the left of the combine centreline. The hitch load, with a full grain tank, became negative when travelling up hills with a slope greater than 4°. In rough, hilly fields, the tractor should be properly ballasted and only partial filling of the grain tank should be attempted.

Grain Tank: The grain tank held 4t (148 bu) of wheat. Unloading a full hopper of dry wheat took 123 seconds. With proper adjustment of the levelling auger, the grain tank filled evenly in all crops. The unloading auger had ample reach and clearance for easy on-the-go unloading. It was difficult to secure the unloading auger in field position as there was no suitable place to stand when locking the handwheel.

On one occasion, the unloading auger drive belt and clutch slipped when attempting to unload a full tank of high dockage rapeseed.

Straw Chopper: The straw chopper performed well in all crops. Length of cut could be adjusted by varying the clearance between the rotor and the concave blades.

Although the straw deflectors were adjustable to control spreading width, maximum width was about 5 m (16 ft) and varied depending on straw and wind conditions.

It was very convenient to adjust the chopper for windrowing straw. The concave was swung ahead to allow the straw to pass between the rotor and the concave. Since this exposed the rotor, extreme care had to be taken to ensure that the combine was stopped before attempting to service or adjust the shoe.

Plugging: The table auger and feeder were very aggressive. When properly adjusted, table auger plugging was infrequent, even in damp crops. Occasional table auger plugging occurred in tough bunchy rapeseed or in damp heavy Betzes and Bonanza barley. In such crops, increasing the table auger clearance and feeding the windrow in line with the feed throat opening were important. Table auger unplugging was easy as the cylinder rocking wrench could be used on the table auger drive hub. The feeder conveyor never plugged during the test.

The cylinder was very aggressive. Plugging seldom occurred and cylinder back-feeding occurred only in damp wild oat wads. If the cylinder plugged, it could usually be unplugged by lowering the concave and starting the separator with the feeder drive disengaged. A rocking hub was provided on the cylinder shaft if severe plugging should occur. Cylinder access was inconvenient, through both the front door and the lower door at the stone trap.

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

Plugging of the straw walker grids with barley awns (Figure 3) occurred twice during the test.

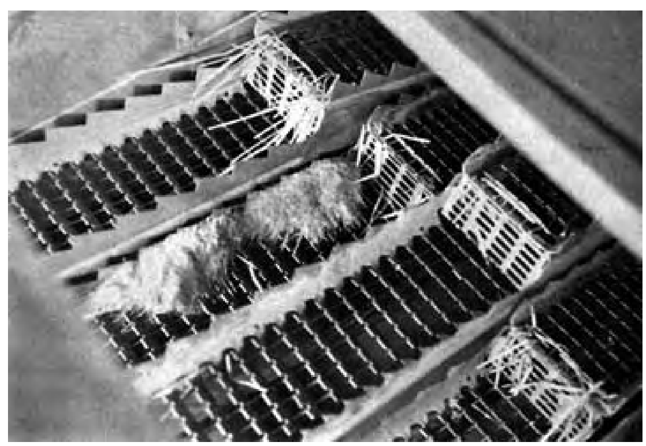


Figure 3. Straw Walker Grid Plugged with Barley Awns.

In damp Betzes and Bonanza barley, the front seven segments of the concave plugged with wet material, reducing total open area by about 25% (Figure 4). The rear six segments of the concave did not plug as they had wider wire spacings. Plugging did not occur in other crops.

Stone Trap: The IH 914 was equipped with a stone trap in front of the cylinder. The stone trap was quite effective, capturing most roots or stones before they entered the cylinder. One concave bar was bent by a stone during the test. As with most combines, if a large stone was inadvertently picked, it could damage the table auger or feeder before being stopped by the stone trap.

The stone trap (Figure 5) was quite accessible. For cleaning, the header had to be raised and secured and two support chains removed from the access door. The support chain links frequently jammed in their retainers making opening or closing difficult.

Pickup: The IH 914 was equipped with a 3350 mm (132 in) two roller belt pickup with nylon teeth. Pickup performance was good, however, it had to be operated with the belts parallel to the ground for satisfactory feeding. If the pickup was not parallel with the ground, it fed straw into the centre of the table auger rather than under it. Although maintaining the pickup parallel with the ground was possible in heavy windrows, where the gauge wheels could be adjusted to hold the pickup off the ground, this was more difficult in light crops in stony fields, where the pickup had to be run close to the ground. The entry angle of the pickup changed as the header was raised or lowered. A modification, such as lowering the rear pickup roller, is recommended to improve the feeding characteristics of the pickup.

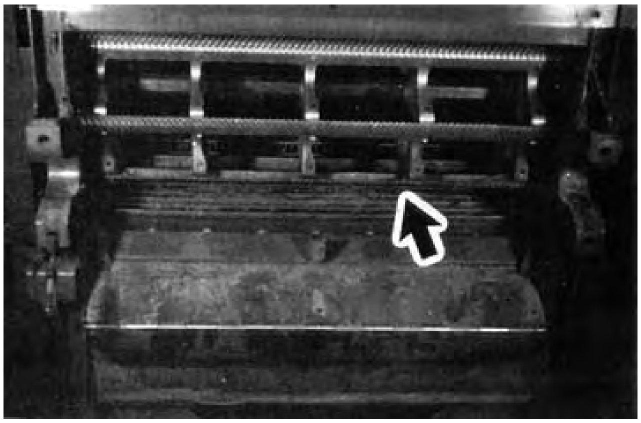


Figure 4. Plugging of Front Concave Grate in Damp Barley.

Figure 5. Stone Trap Access on the IH 914.

Throughout the test, tough straw such as wild oats wrapped between the front pickup roller and the right support bearing. This did not occur in dry crops.

Pickup speed could be varied by changing the drive sprockets. Although this was satisfactory in uniform windrows, an optional variable speed pickup drive, adjustable from the tractor seat, would be very beneficial in non-uniform crops.

Straw Walker Inspection Doors: The straw walker inspection doors on top of the IH 914 were fastened with screws. Since inspection of straw through these doors, during operation, is the only way of determining cylinder performance if a combine is equipped with a straw chopper, it is recommended that at least one door be hinged for easy access.

Machine Cleaning: When operating in tough or damp crops, the grain pan steps occasionally built up with an accumulation of dirt. The grain pan steps could be cleaned from the rear of the combine with a suitably fabricated cleaning poker.

As with most combines, completely cleaning the IH 914 for combining seed grain was a laborious, time consuming job. To thoroughly clean the store trap, three bolts had to be removed. The chaffer and sieve were easily removed for cleaning the tailings and clean grain augers. The grain tank contained many ledges and obstructions to retain grain and weed seeds. A clean out door was located under the unloading auger.

Transporting: Swinging the hitch, to place the IH 914, in and out of transport position, was an easy one man job. The hitch locking wedge had to be removed by hand and the tractor either backed or driven ahead to allow the drawpole to pivot.

The IH 914 transported well at speeds up to 32 km/h (20 mph). Rear visibility in transport position was restricted, however, the combine was adequately equipped with reflectors, warning lights and a slow moving vehicle sign for safe transport on public roads. Due to its high centre of gravity, care had to be exercised when transporting the IH 914 with a full grain tank.

Lubrication: The IH 914 had 47 pressure grease fittings. Eleven needed greasing every 10 hours, ten needed greasing every 50 hours, twenty-five needed greasing every 100 hours, while one had to be greased every 500 hours. Most grease fittings were very accessible. In addition, decals were attached above each lubrication point, indicating the location and frequency of lubrication. Two fittings (100 hour) required a grease gun with a flexible hose.

The main drive gear box oil level needed checking every 50 hours while the wheel bearings needed repacking every 250 hours.

EASE OF ADJUSTMENT

Field Adjustments: The IH 914 was easy to adjust. As with all pull-type combines, having a second person available when setting was very beneficial. As with other pull-type combines, it was difficult to determine when to change settings during the day as return tailings and clean grain could not easily be inspected by the operator.

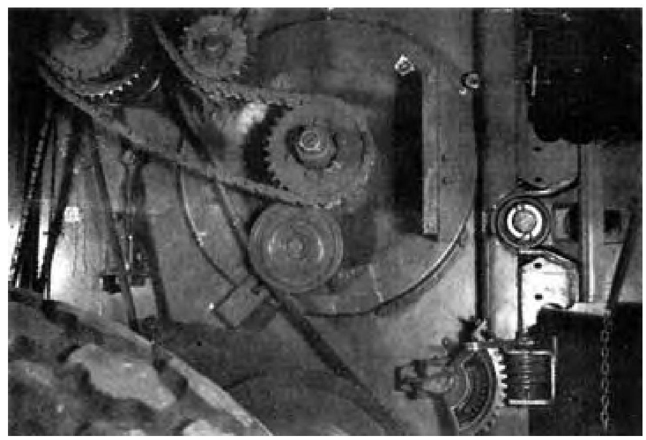


Figure 6. Cylinder and Concave Adjustments on the IH 914.

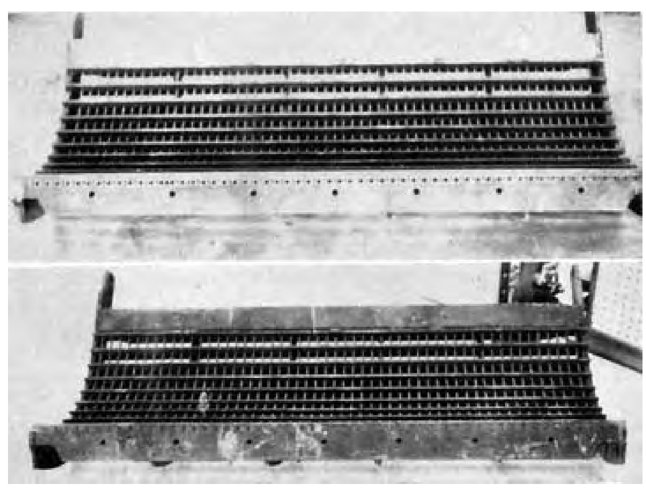


Figure 7. 1977 Low Wire Concave (top) and 1975 and 1976 High Wire Concave (bottom).

Concave Adjustment: The IH 914 had a single segment concave. The concave could be levelled and initially set with two draw bolts at the rear and a stop bolt at the front, on the concave adjusting ratchet. A clearance gauge for levelling and initially setting the concave was supplied with the IH 914. Both front and rear clearances could be gauged through two inspection holes on each side of the combine. Concave clearance was easily adjusted with a reversible hand ratchet assembly on the side of the combine (Figure 6). The rear concave clearance was set at 1.6 mm (0.06 in) while the front opening could be adjusted from 3 to 54 mm (0.12 to 2.12 in). A clearance indicator was attached to the concave adjusting shaft. The indicator was calibrated in numbers from 0 to 17 with each interval corresponding to 3 mm (0.12 in).

The IH 914 evaluated in this report was equipped with the low wire, bar and grate concave (Part No. 633 581 R93) as described in Appendix I. The low concave (Figure 7) is now standard equipment on 1977 models, and is different than the high wire, bar and grate concave (Part No. 177 385 C91) supplied with 1975 and 1976 models. The high concave had coarser 6.4 mm (0.25 in) wires and larger 16 mm (0.63 in) spaces, and additional wires could not be added to reduce the spacing.

It was critical to keep a proper balance between concave clearance and cylinder speed. Hard to thresh bottom kernels, especially in Neepawa wheat, were difficult to remove and critical adjustments were necessary to avoid excessive cylinder loss without undue crackage. Suitable front concave clearances were from 6 to 12 mm (0.24 to 0.48 in) for dry wheat. In rapeseed a suitable front clearance was 41 mm (1.63 in). In flax an optimum front clearance of 3 mm (0.12 in) allowed about 2% unthreshed bolls to enter the grain tank.

Cylinder Adjustment: Cylinder speed could be adjusted by changing the cylinder sprocket or the beater sprocket (Figure 6). The drive sprocket, on the cylinder shaft, could be changed by removing six bolts. Changing the drive sprocket on the beater shaft was more difficult as it required removal of an outer drive sprocket and chain before the beater sprocket could be reached. With the supplied sprockets, thirteen speeds were available. Five of these, 874, 921, 942, 1074 and 1156 rpm, were suitable for most common grains.

Suitable cylinder speeds were 874 and 921 rpm in flax, wheat and barley and 612 rpm in rapeseed. Typical grain crackage varied from 0.5 to 2% when properly adjusted.

The cylinder rasp bars were in good condition at the end of test, showing negligible wear. Shoe Adjustments: The shoe was convenient to adjust.

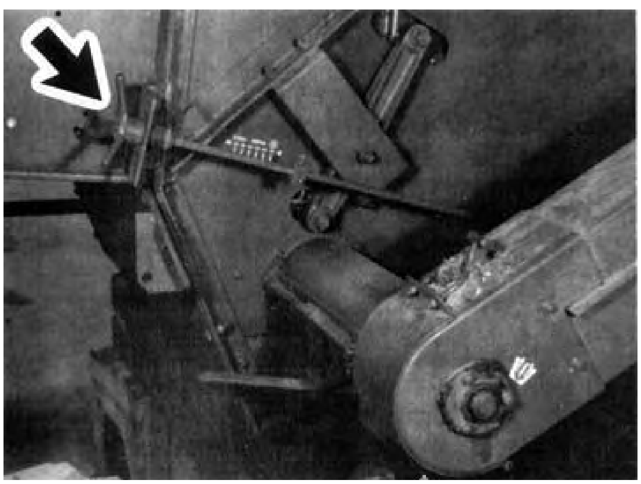


Figure 8. Fan Adjustment on the IH 914.

Fan speed was varied with a calibrated hand wheel (Figure 8) while the chaffer and chaffer extension were adjusted with levers at the rear of the shoe. Access to the clean grain sieve adjusting lever was through a door at the rear of the shoe. Return tailings could easily be sampled from a sliding gate under the lower tailings auger.

The shoe was easy to set and performed well in most crops encountered. Total dockage in the grain tank, including cracks, whitecaps and chaff usually varied from 1 to 3% when properly adjusted. It was difficult to obtain a clean grain sample in wheat. When the clean grain sieve was closed to exclude whitecaps, excessive cracking occurred. The clean grain sieve had no lip in front of the first set of louvres (Figure 9). This may have allowed whitecaps and partial heads to fall through at the front of the sieve.

As is common with most combines, the shoe was difficult to set in non-uniform crops of some varieties of rapeseed due to the large variation in seed size and amount of shoe load between heavy and light windrows. It was found best to set the shoe for optimum performance in the heavy windrow sections and to increase feed rate in light windrow sections to maintain a fairly uniform shoe load.

In normal conditions, shoe plugging never occurred. In late fall combining in extremely wet conditions, the chaffer and sieve plugged with wet material and combining could not take place unless the temperature was well below freezing.

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

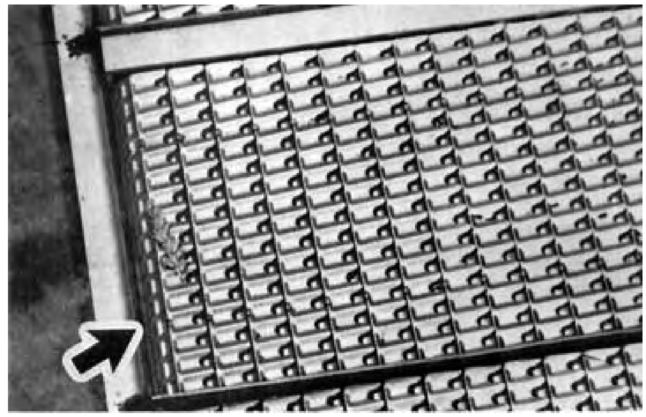


Figure 9. Opening at the Front of the Clean Grain Sieve on the IH 914.

Header Adjustments: The IH 914 was evaluated only with a pickup attachment for windrowed crops. Straight combining attachments were not evaluated. Header removal necessitated repositioning the hitch jack at the rear of the combine, as the combine would tip backward when the header was removed. The table could be removed from the feeder, or installed by one man in about ten minutes. The complete header and feeder assembly could also be removed from the combine. Removal or replacement took two men about 15 minutes.

The table auger was easy to adjust both vertically and horizontally. Adjustment was seldom required.

Slip Clutches: Individual slip clutches protected the table auger, feeder conveyor and the return and clean grain elevator drive.

RATE OF WORK

Average Workrates: Table 3 presents the average workrates for the IH 914, at acceptable loss levels, in all crops harvested during the test. Average workrates are affected by crop conditions in a specific year and should not be used for comparing combines tested in different years. In some crops, workrates were reduced by bunchy and sunken windrows, muddy or rough ground, irregular shaped fields with many corners and driving the combine empty to unload grain at a central location. During the 1976 harvest, average workrates varied from 5.6 t/h (208 bu/h) in 2.4 t/ha (40 bu/ac) Neepawa wheat to 2.4 t/h (92 bu/h) in 1.3 t/ha (20 bu/ac) Noralta flax.

Table 3. Average Workrates for the IH 914

Crop	Variety	Average Yield		Average Speed		Average Workrate			
		t/ha	bu/ac	km/h	mph	ha/h	ac/h	t/h	bu/h
Wheat	Neepawa	2.7	40	4.3	2.7	2.1	5.2	5.6	208
Wheat	Manitou	2.6	38	4.5	2.8	1.9	4.7	4.9	179
Wheat	Park	3.4	50	3.2	2.0	1.0	2.5	3.4	125
Barley	Betzes	2.7	50	3.9	2.4	1.4	3.5	3.8	175
Barley	Bonanza	3.1	57	3.5	2.2	1.7	4.1	5.2	234
Oats	Harmon	3.1	57	2.9	1.8	1.3	3.1	4.0	251
Flax	Noralta	1.3	20	5.5	3.4	1.9	4.6	2.4	92
Flax	Linott	1.3	20	6.5	4.1	2.4	5.9	3.1	118
Rapeseed	Midas	0.8	15	7.0	4.4	3.3	8.2	2.8	123

Maximum Feedrate: The workrates given in Table 3 represent average workrates at acceptable loss levels. The tractor had ample power to achieve much higher workrates in normal crops, while in heavy crops, the IH Hydro 100 tractor was slightly underpowered. In most light crops the maximum acceptable feedrate was limited by pickup performance.

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

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

The weight of straw and chaff passing through a combine per unit time is called the MOG Feedrate. MOG is an abbreviation for “material-other-than grain” and represents the weight of all plant material passing through the combine except for the grain or seed.

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

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

Capacity of the IH 914: Table 4 presents capacity results for the IH 914 in four different crops. MOG Feedrates for a 3% total grain loss varied from 8.30 t/h (305 lb/min) in a field of Neepawa wheat to 5.65 t/h (208 lb/min) in a field of Bonanza barley. In flax, the total loss level was only 2% at a maximum feedrate of 5.9 t/h (216 lb/min). In this crop, capacity was limited by pickup performance at higher speeds.

GRAIN LOSS CHARACTERISTICS

The grain loss characteristics for the IH 914, in the four crops described in Table 4 are presented in Figures 10 to 13.

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

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

Cylinder Loss: Cylinder Loss was low in most dry and well matured crops. In difficult-to-thresh crops, cylinder and concave adjustments were important and cylinder loss could make a significant contribution to total loss. In damp Neepawa and Park wheat it was difficult to remove the bottom kernels in the head, even with the concave closed tight. Figures 10 and 11 show little difference in cylinder loss for wheat of 12 and 14.7% grain moisture content.

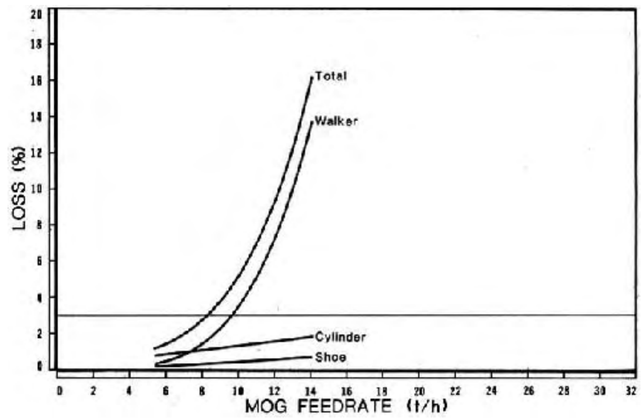


Figure 10. Grain Loss for the IH 914 in Neepawa Wheat at 14.7% Grain Moisture Content.

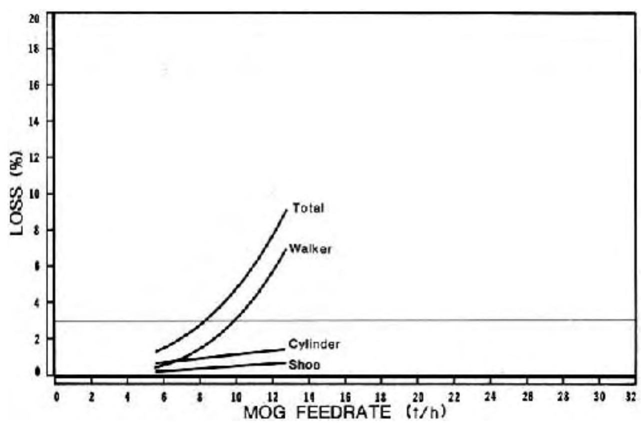


Figure 11. Grain Loss for the IH 914 in Neepawa Wheat at 12% Grain Moisture Content.

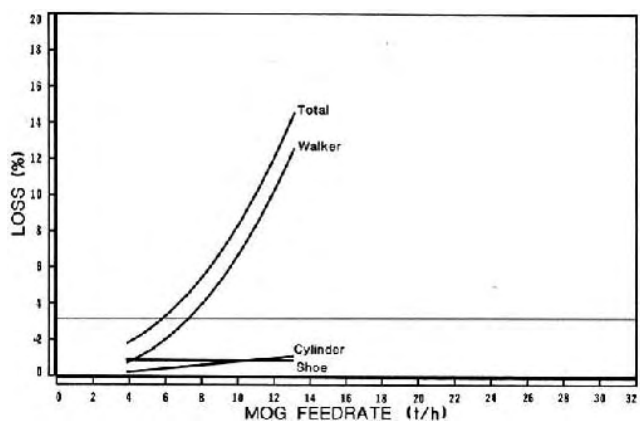


Figure 12. Grain Loss for the IH 914 in Bonanza Barley.

Body Loss: Slight seed leakage occurred at the stone trap access door and from access holes in the combine sides at front of the clean grain sieve. Total grain leakage from the combine body in a 1.3 t/ha (20 bu/ac) crop of Linott flax was only 0.1% of yield.

Comparison to Reference Combine: Comparing the capacities of two combines is complex because crop and growing

Table 4. Capacity of the IH 914 at a Total Grain Loss of 3% of Yields*

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

*In flax, maximum total loss was only 2% of yield.

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

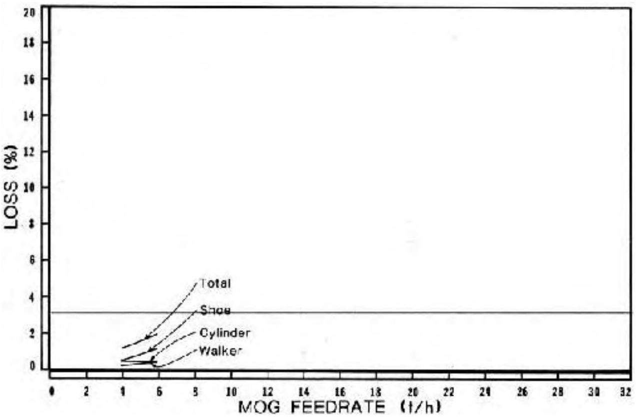


Figure 13. Grain Loss for the IH 914 in Linott Flax.

Figures 14 to 17 compare the total grain losses of the IH 914 and the PAMI reference combine in the four crops described in Table 4. The shaded areas on the figures are the 95% confidence belts. If the shaded areas (confidence belts) overlap, the loss characteristics of the two combines are not significantly different whereas if the shaded areas do not overlap, the losses are significantly different. The capacity of the IH 914 was greater than the capacity of the reference combine and the IH 914 usually had lower grain losses when operating at the same feedrate.

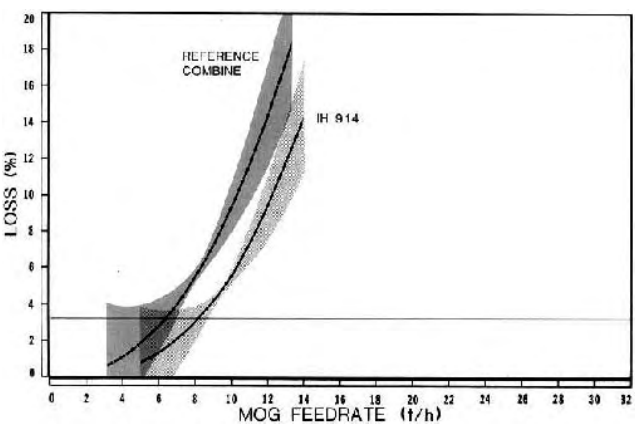


Figure 14. Total Grain Losses for the IH 914 and the PAMI Reference Combine in Neepawa Wheat at 14.7% Grain Moisture Content.

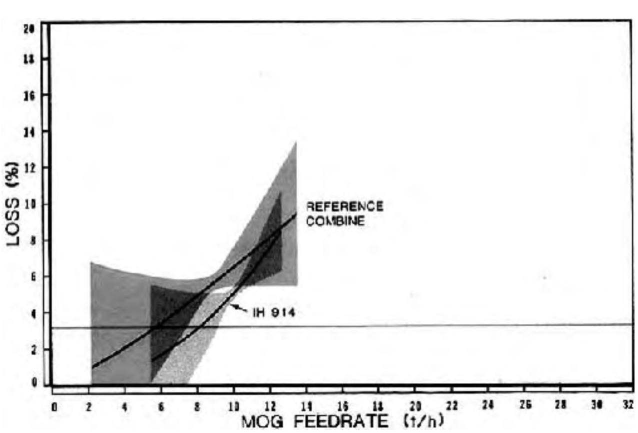


Figure 15. Total Grain Losses for the IH 914 and the PAMI Reference Combine in Neepawa Wheat at 12% Grain Moisture Content.

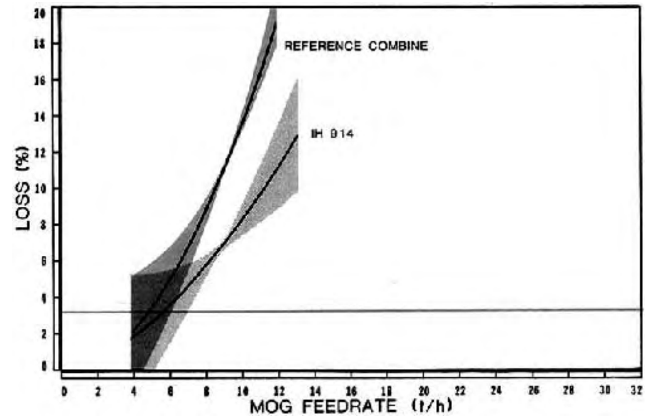


Figure 16. Total Grain Losses for the IH 914 and the PAMI Reference Combine in Bonanza Barley.

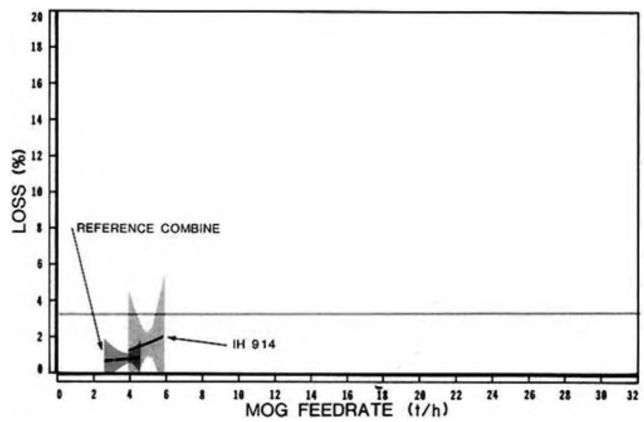


Figure 17. Total Grain Losses for the IH 914 and the PAMI Reference Combine in Linott Flax.

POWER REQUIREMENTS

The manufacturer recommended a minimum tractor size of 67 kW (90 hp). This tractor size was suitable for all normal combining however, when using a straw chopper in damp crops in soft or hilly fields, a minimum tractor size of about 82 kW (110 hp) was needed. Power consumption was measured only in one field. In a 3 t/ha (45 bu/ac) crop of dry Neepawa wheat the average power take-off input was 45 kW (60 hp).

The IH Hydro 100 tractor, which was used to power the IH 914 during the test, had ample power for normal crops but was underpowered in heavy damp crops. Average fuel consumption varied from 20 to 25 L/h (4.5 to 5.5 Imp. gal/h).

OPERATOR SAFETY

The operator's manual emphasized operator safety precautions.

The IH 914 had adequate warning decals. It was also equipped with a slow-moving-vehicle sign, warning lights and reflectors for safe road transport.

The IH 914 was well shielded, giving good protection from most moving parts. All shields were easy to remove and install. More adequate shielding could have been provided for the pickup drive chains, the table jackshaft drive belt tightener and the grain pan crank drive. Although the main body shrouding was aesthetically pleasing, it made servicing more difficult and increased repair time.

The IH 914 was equipped with a header lock and its proper use was emphasized in the operator's manual. The header lock must be used when working beneath the feeder, such as when cleaning the stone trap.

A rocking wrench was provided for safe unplugging of the cylinder or the feeder auger. Care had to be taken to remove the wrench from the rocking hub before starting the combine.

Extreme caution was necessary to be certain that the straw chopper rotor had completely stopped before attempting to adjust the shoe when the chopper concave was moved ahead for straw windrowing.

Care had to be exercised when climbing the combine ladder, with the unloading auger in transport position, to avoid striking the head on the unloading auger.

The IH 914 was quite unstable with a full grain tank. Partial filling of the tank and careful driving is recommended in rough, hilly fields. The tractor hitch load became negative when going up slopes greater than 4 degrees.

The hitch jack was safe and easy to use. The operator is cautioned to place the hitch jack at the rear of the combine before removing the header to prevent the combine from tipping rearward. A hitch safety chain was supplied with the IH 914.

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

Table 5. Mechanical History

Item	Operating Hours	Field Area ha	(ac)
Drives			
-The lock collar on the clean grain elevator drive loosened causing the drive coupling to disengage and was repositioned at	27	52	(129)
-The right shoe crankshaft bearing failed and was replaced at	60	117	(289)
-The left elevator drive jackshaft bearing began rotating on its shaft as no lock collar had been installed at assembly. A lock collar was installed at	60	117	(289)
-The right bearing support for the pickup drive deformed, causing drive misalignment and was repaired at	130	276	(683)
-The cylinder, elevator jackshaft, table auger and pickup drive chains were worn requiring replacement at	End of Test		
Cylinder and Concave			
-One concave bar was bent, requiring straightening, when a stone entered the cylinder at	End of Test		
Miscellaneous			
-The wheel bolts loosened and were retightened to recommended torque at	133	277	(686)
-The grain tank front cross auger bearing set screws loosened allowing the auger to move to the left striking the grain tank side sheet. The auger was positioned at	220	423	(1044)
-The fabric cylinder stripper bar had worn requiring replacement at	End of Test		

OPERATOR'S MANUAL

The operator's manual was clearly written, well illustrated and contained much useful information on servicing, adjustments and suggested settings in various crops.

DURABILITY RESULTS

Table 5 outlines the mechanical history of the International Harvester 914 combine during 227 hours of operation while combining about 436 ha (1077 ac). The intent of the test was evaluation of functional performance. The tabulated failures represent those, which occurred during functional testing. An extended durability evaluation was not conducted.

Discussions of Mechanical Problems

Pickup Drive: Deformation of the pickup drive bearing support was noticed when the drive pin failed in fatigue. No cause was determined for the deformation. After realignment, no further problems occurred.

APPENDIX I
SPECIFICATIONS

Make:	International Harvester Pull-Type Combine
Model: 914	
Serial Number:	Header 914 B 12.5, Combine Body 1440007U020266
Manufacturer:	International Harvester Company East Moline, Illinois 61244 U.S.A.
Windrow pickup:	
-type	belt
-pickup width	3350 mm (132 in)
-number of belts	6
-teeth per belt	32
-type of teeth	nylon
-number of rollers	2
-height control	castor wheels
-speed control	change sprockets
-speeds (standard)	267, 297, 334 and 365 rpm
-speeds (optional)	171 and 217 rpm
Header:	
-type	off-set, quick-attach
-width	3810 mm (12.5 ft)
-auger diameter	508 mm (20 in)
-feeder	3 roller chains, undershot slatted conveyor
-speed of chain	2.65 m/s (521 ft/min)
-range of picking height	-241 to 1422 mm (-9.5 to 56 in)
-number of lift cylinders	1
-raising time (with IH Hydro 100 tractor)	3 s
-lowering time (with IH Hydro 100 tractor)	6.5 s
-options	header cutting equipment
Cylinder:	
-type	rasp bar
-number of bars	8
-diameter	559 mm (22 in)
-width	1229 mm (48.38 in)
-speeds (standard)	417, 486, 524, 598, 612, 644, 750, 874, 921, 942, 1074, 1156 and 1350 rpm
-speeds (optional)	13 additional speeds from 221 to 1200 rpm
-stripper bar	10 mm (0.38 in) fabric belting
-options	cylinder smooth angle bars, cylinder notched angle bars, cylinder filler bars
Cylinder Beater:	
-type	4-wing, box
-diameter	341 mm (13.44 in)
-speed	750 rpm
Concave:	
-type	bar and wire grate (low wire)
-number of bars	14
-configuration - front:	seven intervals with 4.8 mm (0.19 in) wires and 4.8 mm (0.19 in) spaces
-rear:	six intervals with 4.8 mm (0.19 in) wires and 14.3 mm (0.56 in) spaces
-every second wire removable and replaceable with 1/2, 3/4 or full wires	
-area	0.63 m² (983 in²)
-transition grate area	0.42 m² (646 in²)
-wrap	111 degrees
-grain delivery to shoe	grain pan
-options	filler bars, stone retarder bar
Straw walkers:	
-type	rotary, fin & wire
-number	5
-length	3378 mm (133 in)
-width of body	1178 (46.38 in)
-separating area	3.98 m² (6168 in²)
-crank throw	152 mm (6 in)
-speed (standard)	139 rpm
-speed (optional)	160 rpm
-grain delivery to shoe	one piece oscillating grain pan
-options	straw walker rear end flap, straw walker risers
Shoe:	
-type	opposed action
-speed (standard)	280 rpm
-speed (optional)	265 rpm
-chaffer sieve	adjustable lip, 1.64 m² (2540 in²) with 76 mm (3 in) throw
-clean grain sieve	adjustable lip, 1.22 m² (1897 in²) with 45 mm (1.75 in) throw
-options	grain pan finger cover, perforated screens and doors, grain pan side hill parts, round hold sieves

Cleaning Fan:	
-type	6 blade undershot
-diameter	584 mm (23 in)
-width	843 mm (33.20 in)
-drive	crank controlled variable pitch belt
-speed range (standard)	200 to 680 rpm
-speed range (optional)	350 to 750 rpm
Elevators:	
-type	roller chain with rubber flights and top delivery
-clean grain (top drive)	203 x 203 mm (8 x 8 in)
-tailings (top drive)	152 x 203 mm (6 x 6 in)
-options	steel flights
Grain tank:	
-capacity	5.4 m³ (148 bu)
-unloading time	123 s
Straw chopper:	
-type	28 blades mounted solidly to rotor
-speed	2725 rpm
-options	straw spreader
Number of chain drives:	14
Number of belt drives:	8
Number of prelubricated bearings:	48
Lubrication points:	
-10 h lubrication	11
-40 h lubrication	10
-100 h lubrication	25
-500 h lubrication	1
Clutches:	
-header	electromagnetic
-unloading auger	electromagnetic
Tires:	2, 18.4 x 26, 6-ply
Overall dimensions:	
-wheel tread	2590 mm (102 in)
-transport height	3490 mm (138 in)
-transport length	10230 mm (403 in)
-transport width	4720 mm (186 in)
-field height	3730 mm (147 in)
-field length	10230 mm (403 in)
-field width	7890 mm (311 in)
-unloader discharge height	3390 mm (134 in)
-unloader clearance height	2960 mm (117 in)
-unloader reach	2270 mm (89 in)
Weight (with empty grain tank and hitch in field position):	
-right wheel	2635 kg (5810 lb)
-left wheel	1855 kg (4090 lb)
-hitch	375 kg (830 lb)
Total	4865 kg (10730 lb)

APPENDIX II
STATISTICAL SIGNIFICANCE OF CAPACITY RESULTS

The following data are presented to illustrate the statistical significance of the capacity results shown in Figures 10 to 13. This information is intended for use by those who may wish to check results in greater detail. Sufficient information is presented to permit calculation of confidence belts.

In the following table for the International Harvester 914 pull-type combine, C =cylinder loss in percent of yield, S =shoe loss in percent of yield, W = straw walker loss in percent of yield, F = the MOG feedrate in t/h, while ℓn is the natural logarithm. Sample size refers to the number of loss collections. Limits of the regressions may be obtained from Figures 10 to 13 while crop conditions are presented in Table 4.

Crop	Variety	Fig. No.	Regression Equation	Simple Correlation Coefficient	Standard Error of Slope	Residual Mean Square	Mean Feedrate	Sample Size
Wheat	Neepawa	10	$\ell n C = -1.86 + 0.93 \ell n F$	0.95	0.13	0.01	9.41	8
			$\ell n S = -4.93 + 1.69 \ell n F$	0.86	0.41	0.11		
			$\ell n W = -7.98 + 4.01 \ell n F$	0.98	0.30	0.06		
Wheat	Neepawa	11	$C = 0.06 + 0.11F$	0.85	0.03	0.04	10.16	7
			$S = -0.20 + 0.07F$	0.68	0.04	0.05		
			$\ell n W = -6.48 + 3.31 \ell n F$	0.98	0.27	0.04		
Barley	Bonanza	12	$C = -0.18 + 0.10F$	0.78	0.03	0.07	8.78	7
			$S = 0.88 - 0.003F$	0.09	0.01	0.01		
			$\ell n W = 3.49 + 2.34 \ell n F$	0.97	0.28	0.08		
Flax	Linott	13	$C = 0.48 - 0.01F$	0.12	0.05	0.01	4.87	5
			$\ell n S = -3.40 + 1.98 \ell n F$	0.50	2.01	0.43		
			$\ell n W = -3.50 + 1.50 \ell n F$	0.63	1.06	0.12		

APPENDIX III
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

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

APPENDIX IV
METRIC UNITS

In keeping with the Canadian metric conversion program, this report has been prepared in SI Units. For comparative purposes, the following conversions may be used:

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

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