SUMMARY AND CONCLUSIONS

Capacity: In the capacity tests, the MOG feedrates* at 3% total grain loss were 352 and 363 lb/min (9.6 and 9.9 t/h) in Bonanza barley, and in Neepawa wheat, 539 and 601 lb/min (14.7 and 16.4 t/h).

At 3% total loss the 7720 Titan II had approximately 1.5 times the capacity of the Machinery Institute reference combine in barley and approximately 1.7 times its capacity in wheat.

Quality of Work: Pickup performance was very good in all crops. It picked cleanly at speeds up to 5 mph (8 km/h) in average windrows. The pickup fed the crop evenly under the table auger. Feeding was excellent. The table auger and feeder handled all crops well and plugged only in very severe conditions. The stone trap provided good stone protection.

Threshing was very good. The John Deere 7720 Titan II threshed aggressively in all crops. Under normal harvest conditions in easy-to-thresh crops, unthreshed losses were minimal, in hard-to-thresh crops, unthreshed losses reached about 1.0% at the higher feedrates, while grain damage varied from 1 to 4.5% of the clean grain.

The John Deere Titan II had good separation in all crops encountered. However, grain loss over the straw walkers usually limited capacity in wheat and barley crops.

Cleaning shoe performance was very good for most crops, but poor to fair in ax. In ax, shoe capacity was limited by blanketing of the lower sieve, seed loss over the chaffer sides, and leakage between the chaffer side and combine body. In most crops the grain sample was very clean, with most dockage consisting of undersized kernels.

Grain handling was very good. The 185 Imp. bu (6.7 m³) grain tank filled evenly but could not be filled completely in canola as the seeds leaked through the screened tank walls. The unloader had adequate reach and clearance and unloaded a full tank of dry wheat in about 115 seconds. It discharged the grain in a compact stream.

Straw spreading was very good. In most crops the John Deere 7720 Titan II spread the straw evenly over 30 ft (9 m) and in ideal conditions, up to 35 ft (10.7 m).

Ease of Operation and Adjustment: Operator comfort was very good. The cab was quiet and relatively dust free. The heater and air conditioner provided comfortable cab temperatures. The seat and steering column could be adjusted to suit most operators. The operator had a good view forward, to the left side, and of the incoming windrow. View to the right and directly behind was restricted. Instrumentation was very good. Most instruments were clearly visible and provided useful information and/or warnings for all major functions. Controls were very good. They were colour coded, clearly marked, and conveniently located. Most controls were responsive and easy to use. The optional automatic pickup height control was very convenient.

Loss monitor performance was good. Both the walkers and shoe were monitored. The display was conveniently located for easy viewing. To obtain the maximum benefit, actual losses had to be compared to meter readings and calibrated accordingly for each crop. Meter response was good for wheat and barley but less meaningful in canola and ax.

Lighting for nighttime harvesting was very good. Combine handling was good. The steering was smooth and responsive.

*MOG refers to Material-Other-than-Grain and consists of straw, chaff, and plant residue.
however, the wheel brakes were required for picking around most windrow corners. Transport speed was slow. Ease of adjusting combine components was good. Ease of setting them to suit crop conditions was also good, for most crops. Return tailings were easily inspected from inside the cab.

Ease of unplugging the table auger and feeder was very good. The header reverser quickly and easily backed out slugs. Ease of unplugging the cylinder was fair. Unplugging the cylinder could occasionally be done by powering the slug through, but, in severe plugs the cylinder had to be rotated backwards and the crop removed by hand.

Ease of cleaning was fair. The grain tank sump was diff cult to clean, the shoe delivery augers were inconvenient to clean, the sieves were diff cult to quickly remove, and the complete header assembly was inconvenient and time consuming to remove. Ease of lubrication was very good as most diff cult to reach points were connected to grease banks. The fuel tank inlet accepted large volume nozzles and could be filled from average height gravity connected to grease banks. The fuel tank inlet accepted large sieves were diff cult to quickly remove, and the complete header clean, the shoe delivery augers were inconvenient to clean, the potential hazards. However, adjusting the fan speed on-the-go was potentially hazardous. Operator Safety: The John Deere 7720 Titan II was safe to operate if normal safety precautions were taken and warnings heeded. However, adjusting the fan speed on-the-go was potentially hazardous.

Operator’s Manual: The operator’s manual was clearly written and provided much useful information.

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

RECOMMENDATIONS
It is recommended that the manufacturer consider:
1. Modifications to improve shoe sealing to prevent grain leaks.
2. Modifications to prevent small seeds from leaking through the screen sides of the grain tank.
3. Installing a full grain tank warning device.
4. Modifications to improve the convenience of fan speed adjustment.
5. Modifications to permit more convenient cleaning sieve adjustment.
6. Modifications to carry the full width of shoe material over the rear axle to provide easier more representative checking of shoe loss.
7. Supplying a cylinder slug wrench.
8. Modifications to eliminate the potential hazard associated with adjusting the fan speed on-the-go.
9. Modifications to ensure that torque sensing hubs are adequately lubricated before shipment.

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Project Manager: L.G. Hill

PROJECT TECHNOLOGIST: W.A. Beckett

THE MANUFACTURER STATES THAT
With regard to recommendation number:
1. Improvements are being implemented to provide better sealing at the front and rear of the cleaning shoe.
2. Grain tank extension screens are used to allow good visibility. Other screens with smaller openings are being investigated.
3. A full grain tank warning indicator is being evaluated.
4. This is being considered for the future.
5. There are no current plans for change in this area.
6. This is being considered for the future.
7. Dimensions for making a cylinder slug wrench (cylinder breaker bar) are contained in the operator’s manual.
8. It is recommended that cleaning fan speed not be adjusted on-the-go, This should never be attempted. Changes will be made to the operator’s manual to state this more clearly.
9. Procedures have been implemented to prevent any further problems in this area.

RESULTS AND DISCUSSION

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

The MOG/G ratio which is the MOG Feedrate divided by the Grain Feedrate is given for various crops. This is being considered for the future.

MOG Loss, Grain Damage and Dockage: Grain loss from a combine can be of two main types; Unthreshed Loss, consisting of grain left in the head and discharged with the straw and chaff, or Separator Loss which is free (threshed) grain discharged with the straw and chaff. Separator Loss can be further divided as shoe and walker (or rotor) loss depending where it came from. Loss is expressed as a percentage of the total amount of grain being processed.
Damaged or cracked grain is also a form of grain loss. In this report the cracked grain is determined by comparing the weight of actual damaged kernels to the entire weight of a sample taken from the grain tank.

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

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

**Reference Combine:** It is well recognized that a combine’s capacity may vary considerably due to crop and weather conditions (APPENDIX II). Since these conditions affect combine performance, it is impossible to compare combines that are not tested under identical conditions. For this reason, the Machinery Institute uses a reference combine. It is simply one combine that is tested each time that an evaluation combine is tested. Since conditions are similar, the combine can be compared directly to the reference combine and a relative capacity determined. Combines tested in different years and conditions can then be indirectly compared using their relative capacities.

**Rate of Work**

**Capacity Test Results:** The capacity test results for the John Deere 7720 Titan II at 3% loss are summarized in TABLE 2. The performance curves for the capacity tests are presented in FIGURES 2 to 5. The curves in each graph indicate the effect of increased feedrate on walker loss, shoe loss, unthreshed loss, and total loss. From the graphs, combine capacity can also be determined for loss levels other than 3%. These results were obtained with the combine set for optimum performance at a reasonable feedrate. The crops for the 1984 tests suffered from extreme heat during the filling stage. Although the bushel weights were not significantly reduced, the large amount of small kernels increased the dockage.

### TABLE 2: Capacity of the John Deere 7720 Titan II at a Total Loss of 3% of Yield.

<table>
<thead>
<tr>
<th>Crop Conditions</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop</td>
<td>MOG Feedrate</td>
</tr>
<tr>
<td>Barley (A)</td>
<td>363 9.9 648 14.1</td>
</tr>
<tr>
<td>Barley (B)</td>
<td>352 9.6 667 14.6</td>
</tr>
<tr>
<td>Wheat (C)</td>
<td>539 14.7 408 11.1</td>
</tr>
<tr>
<td>Wheat (D)</td>
<td>601 16.4 509 13.9</td>
</tr>
</tbody>
</table>

In the barley tests, there was little difference in combine capacity between single and double windrows. This was due to the wide single swath using most of the available separating width. The difference in capacities between the two wheat tests (C and D) is attributed to the normal crop variations.

**Average Workrates:** TABLE 3 indicates the average workrates obtained in each crop over the entire season. These values are considerably lower than the capacity test results in TABLE 2. This is because the results in TABLE 2 represent instantaneous rates while...
average workrates take into account operation at lower loss levels, variable crop and field conditions, availability of grain handling equipment, and differences in operating habits. Most operators could expect to attain average rates within this range, while some daily rates may approach the capacity test values.

**TABLE 3. Average Workrates**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Variety</th>
<th>Average Yield</th>
<th>Average Workrates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>bu/ac t/ha ac/h</td>
<td>ha/h bu/ac t/h</td>
</tr>
<tr>
<td>Barley</td>
<td>Bonanza</td>
<td>68</td>
<td>3.7  5.7  2.3  388  8.5</td>
</tr>
<tr>
<td>Canola</td>
<td>Westar</td>
<td>33</td>
<td>1.9  6.6  2.7  218  5.0</td>
</tr>
<tr>
<td>Flax</td>
<td>Dufferin</td>
<td>21</td>
<td>1.3  7.0  2.8  147  3.7</td>
</tr>
<tr>
<td>Rye</td>
<td>Musketeer</td>
<td>25</td>
<td>1.6  8.0  3.2  200  5.1</td>
</tr>
<tr>
<td>Rye</td>
<td>Puma</td>
<td>25</td>
<td>1.6  8.0  3.2  200  5.1</td>
</tr>
<tr>
<td>Wheat</td>
<td>Katepawa</td>
<td>38</td>
<td>2.6  7.6  3.1  289  7.9</td>
</tr>
<tr>
<td>Wheat</td>
<td>Neepawa</td>
<td>37</td>
<td>2.5  8.5  3.4  315  8.6</td>
</tr>
</tbody>
</table>

The values from the average workrates should not be used to compare combines. The factors, which affect workrates are too variable and cannot be duplicated for all combine tests.

**Comparing Combine Capacities:** The capacity of combines tested in different years or in different crop conditions can only be compared using the Machinery Institute reference combine. This is done by dividing the test combine capacity (MOG Feedrate at 3% loss), as shown in TABLE 2, by the corresponding capacity for the reference combine, found in TABLE 6. The resulting number (capacity ratio) can be used to compare capacities of combines in different years.

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

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

**Capacity Compared to Reference Combine:** The capacity of the John Deere 7720 Titan II was significantly greater than that of the reference combine. At 3% loss the John Deere 7720 Titan II had about 1.5 times the capacity of the reference combine in barley and about 1.7 times its capacity in wheat. FIGURES 6 to 9 compare the total loss curves of both combines.

**QUALITY OF WORK**

**Picking:** Windrows were picked using a John Deere 7-belt, three roller windrow pickup mounted on a 214 header platform. The pickup gage wheels were adjusted to allow the pickup teeth to just contact the ground. Pickup angle was either manually or automatically controlled from within the cab. Pickup speed was manually controlled with a flow control valve in the cab.

**Feeding:** The table auger fed the crop to the slatted conveyor, which delivered it to the cylinder. Feeding was excellent in all crops encountered. The table auger was very aggressive and there was very little restriction at the feeder opening. In bunchy crops, the table auger usually rode...
over the slug and fed it through. Plugging occurred only in very severe conditions.

**Stone Protection:** Hard objects, such as stones and roots, contacting the cylinder were driven into a stone trap in front of the cylinder. The stone trap had to be regularly cleaned out by hand to prevent dirt and grain from hardening in the pocket. This was a very dirty job.

**Threshing:** Threshing was accomplished by the 8 rasp bar cylinder and 13 bar concave.

The dual range cylinder drive was positive and did not slip. It provided adequate speed ranges for all crops encountered. The low range was especially useful as it provided extra torque to handle bunched canola windrows at low cylinder speed.

The cylinder provided very good threshing in most crops. In easy-to-thresh crops, such as barley, threshing was nearly complete with very little kernel damage. Faster cylinder speeds were used in hard-to-thresh Neepawa wheat to maintain acceptable unthreshed loss. This caused slightly higher grain damage. In the tests, cylinder speeds of 1100 to 1150 rpm resulted in kernel damage of 1.0 to 4.5% in the clean grain. The cylinder speeds used in the various crops are given in **TABLE 4**.

Two rows of concave blanker blanks were added to increase threshing in ax. However, this did not prevent immature unthreshed bolls from getting into the tank.

Very little wear could be seen on the hardened and chromed rasp bars after one season of use.

**Separating:** Grain separation occurred at the concave, beater grate, and straw walkers.

In most crops, maximum separation was achieved using as small a concave clearance, and as fast a cylinder speed as possible without causing excessive grain damage. The concave settings used in the various crops are shown in **TABLE 4**.

**TABLE 4. Crop Settings**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Cylinder Speed (rpm)</th>
<th>Concave Clearance (in mm)</th>
<th>Chaffer Extension (in mm)</th>
<th>Chaffer (in mm)</th>
<th>Sieve</th>
<th>Fan Speed (rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>830</td>
<td>3/4</td>
<td>6 1/8</td>
<td>3</td>
<td>4/4</td>
<td>16 2/3 825</td>
</tr>
<tr>
<td>Canola</td>
<td>900</td>
<td>3/4</td>
<td>6 1/8</td>
<td>3</td>
<td>4/4</td>
<td>16 2/3 800</td>
</tr>
<tr>
<td>Flax</td>
<td>1000</td>
<td>3/4</td>
<td>6 1/8</td>
<td>3</td>
<td>4/4</td>
<td>16 2/3 700</td>
</tr>
<tr>
<td>Fall Rye</td>
<td>900</td>
<td>3/4</td>
<td>6 1/8</td>
<td>3</td>
<td>4/4</td>
<td>16 2/3 825</td>
</tr>
<tr>
<td>Wheat</td>
<td>1000</td>
<td>3/4</td>
<td>6 1/8</td>
<td>3</td>
<td>4/4</td>
<td>16 2/3 825</td>
</tr>
</tbody>
</table>

Although separation was good, grain loss over the straw walkers limited capacity in both barley and wheat. Increasing separation would have increased total capacity. Adding straw walker risers and extending the adjustable walker extension pans may slightly increase separation.

To fully utilize the separating capacity of the John Deere 7720 Titan II, it is recommended that it be operated in double or very wide single windrows which have the heads uniformly distributed across the windrow.

**Cleaning:** Chaff and debris were cleaned from the grain using a combination of sieving action and air. The air blast was supplied by a variable speed, paddle type fan with forward curved blades. The chaffer sieve and cleaning sieve moved in opposed motion. The tailings were returned to the cylinder for refreshing.

The chaffer sieve and cleaning sieve on the John Deere 7720 Titan II were each 6 in (152 mm) longer than previous models. The chaffer also had removable corner sections (FIGURE 10), which could be removed to retain grain, which might be lost when combining on side slopes.

The tailings were returned to the cylinder for refreshing using a sump type elevator (FIGURE 17). This allowed a heavier return to be handled without plugging, when operating with the chaffer corner sections removed.

The fan supplied an adequate air blast and the chaffer and sieve could be adjusted to suit most crops and conditions encountered. The shoe settings used for the various crops are given in **TABLE 4**. Very good shoe performance was obtained in most crops. Minimal loss and a clean grain sample could be maintained at reasonable feedrates. In the test results, dockage of 3 to 7% appears high; however, the largest portion consisted of undersized kernels caused by hot dry weather during the crop filling stage.

**FIGURE 10. Chaffer Insert Removed.**

In wheat and barley, the chaffer had to be set almost completely open to prevent grain loss. As the chaffer was closed, grain loss increased significantly. Operating the chaffer almost fully open resulted in some straw spearing at the front of the chaffer sieve. To minimize straw spearing, it was necessary to use as high a fan speed as possible, without blowing out grain or causing excessive return tailings.

In dry canola, similar setting techniques were used. In tough canola crops, MOG break-up decreased causing higher losses. Thus, the large chaffer openings were not suitable. The shoe had to be reset and harvesting speeds reduced.

Shoe performance in ax was poor to fair. In dry conditions, the lower sieve blanketed with material, causing grain to spill into the fan housing. Raising the front of the sieve prevented grain from entering the fan housing but did not eliminate blanketing. Also, material built up behind the rubber dectors on the front auger troughs causing straw to bridge and wrap (FIGURE 11).

**FIGURE 11. Flax Straw Wrapped on Outer Shoe Supply Augers.**

Green unthreshed ax bolls could not be removed from the clean grain even though the cleaning sieve was nearly closed and concave cover strips were added to improve threshing. In addition, grain loss was high over the outside chaffer edges when picking up a narrow windrow. However, this loss was greatly reduced by removing the corner sections of the chaffer extension.

Finally, ax seed leaked between the combine body and the left side of the shoe. Grain may have been able to get between these two components by rst passing between the top front of the chaffer frame and the chutes from the shoe supply augers. Wear patterns on the metal seal between the supply augers and fan housing indicated a considerable amount of grain had been moving via this route. It is recommended that the manufacturer consider modifications to improve shoe sealing to prevent grain loss.

**Clean Grain Handling:** The clean grain elevator had adequate capacity for all the crops encountered.
The open grain tank on the John Deere 7720 Titan II held evenly and completely and held approximately 185 Imp bu (6.7 m³) of dry wheat. The unloading auger had ample reach and clearance for unloading into trucks and grain trailers (FIGURE 12). The grain discharged in a compact stream and a full tank of dry wheat was unloaded in about 115 seconds. Unloading rates could be increased by opening the adjustable control gates.

FIGURE 12. Unloading.

Occasionally, the folding tank extensions blew down. If not detected, grain spilled over. In canola, the seed leaked through the grain tank screen. Therefore, the grain tank could only be partly filled unless additional screening or paint was used to block the holes. It is recommended that the manufacturer consider modifications to prevent small seeds from leaking through the screen.

Even with a lighting brush located near the end of the unloading auger, some grain was lost if the auger was swung back when full. Grain spillage was insignificant if the tank was allowed to completely empty and the auger to clean out.

The hydraulic swing was very convenient for unloading on-the-go and topping off loads.

Straw Spreading: The John Deere 7720 Titan II was equipped with a straw chopper with the extended tail plate and large deflectors. The straw chopper generally spread the straw evenly over about 30 ft (9 m). In optimum conditions, in double windrows, spreads of up to 35 ft (10.7 m) were attained (FIGURE 13). Tail plate angle was critical with the optimum angle being 10 to 15 degrees up from the horizontal. Wind reduced spreading effectiveness.

FIGURE 13. Straw Spreading.

The straw chopper had to be removed from the machine to permit dropping the straw. This was difficult as the straw chopper was very heavy and awkward to handle.

EASE OF OPERATION AND ADJUSTMENT

Operator Comfort: The John Deere 7720 Titan II was equipped with an operator’s cab positioned ahead of the grain tank and to the left of the engine compartment. Operator comfort was very good. The cab was easily accessible and relatively quiet. Operator station sound level while harvesting was about 81 dBA.

Incoming air was effectively filtered while the fans pressurized the cab to reduce dust leaks. The heater and air conditioner worked well and provided comfortable cab temperatures in all conditions.

The seat and steering column were adjustable. The seat adjusted fore-and-aft independent of the vertical adjustment. This increased operator comfort and permitted better header visibility for shorter operators.

Visibility forward and to the left was very good. Visibility to the right was fair. Rear visibility was fair to the left but restricted directly behind. Rear view mirrors were provided. The convex mirror on the right was too far away and too small to be effective. The rear view mirror on the left provided a good view of traffic approaching from the rear but did not permit full view of the left side. An extra convex mirror on the left side and a larger one on the right would improve rear visibility. View of the incoming windrow was only partially blocked by the steering column (FIGURE 14). The grain in the tank could be viewed until the tank was 3/4 full. The operator had to leave the cab to determine when the tank was full. It is recommended that the manufacturer consider installing a full grain tank warning device.

FIGURE 14. View of Incoming Windrow.

Instruments: The instruments were located on a console to the right of the operator (FIGURE 15), while the loss monitor display was located on the pillar in the front left corner of the cab. Cylinder speed was indicated by a dial tachometer, while a digital readout selectively displayed engine speed, fan speed, and ground speed. Gauges indicated engine water temperature, engine oil pressure, battery voltage, and fuel level. In addition, warning lights indicated air filter restriction, park brake engagement, hydraulic and hydrostatic high oil temperatures, decrease in transmission oil pressure, plugged straw walkers, and reduced speed of major combine drives. Also located on the console was an engine hour meter.

FIGURE 15. Instruments and Controls.

The cylinder tachometer, independent of the digital display, was very convenient. The digital readouts were very easy to read and were not affected by direct sunlight.
Controls: All the controls in the cab were color coded, distinctively shaped, and clearly marked for easy identification. Most of the controls were conveniently located and easy to operate (FIGURE 15). However, the park brake lever and header reverser control were located close together which created a pinch point for the operator’s hand (FIGURE 16).

FIGURE 16. Pinch Point Between Brake Lever and Header Reverser.

The original pickup speed control was faulty and was replaced with an updated valve. The new control valve worked well, although it was moderately stiff to adjust. The automatic header height control was convenient and greatly reduced the adjustment required by the operator. This was especially beneficial while unloading on-the-go.

The three preset pickup angles which could be selected were adequate for most windrow conditions, while header response could be adjusted to suit terrain conditions.

Loss Monitor: Two grain loss sensor pads were located at the rear of the walkers and at the rear of the chaffer sieve. The meter display was convenient to observe and easy to read. The operator could set the meter response and also select the readout for shoe loss, walker loss or both combined. The monitor detected mechanical shoe loss but not airborne shoe loss. Grain loss readings were meaningful only if compared to actual losses observed behind the combine. The monitor system effectively indicated changes in loss rates in wheat and barley, but was less representative in canola.

Lighting: Lighting was very good for nighttime harvesting and transporting. The combine was equipped with seven front lights, a grain tank light, an unloading auger light, one tail light, and two warning/signal lights. A small colored light in the ceiling provided adequate lighting for most instruments and controls. All gauges were backlit. The steering wheel lights were meaningful only if compared to actual losses observed behind the combine. The interior light provided extra light when required.

Handling: The John Deere 7720 Titan II was very maneuverable. The steering was smooth and responsive. The wheel brakes were positive and were required when picking around most windrow corners.

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

The combine was very stable in the field even with a full grain tank. However, normal caution was required when operating on hillsides. The combine transported well at speeds up to a maximum 16.0 mph (25.7 km/h).

Adjustment: Pickup speed, cylinder speed, and concave clearance could be easily adjusted from within the cab. Fan speed and sieve adjustments were located on the machine.

Table auger clearance and auger stripper adjustment were easily made to suit crop conditions and, once set, seldom had to be readjusted. Concave adjustment would be more convenient if the concave opening indicator was visible from inside the cab.

The fan speed adjustment, although not difficult to operate, would be more convenient if it was possible to observe the fan speed readout while adjusting. It is recommended that the manufacturer consider modifications to improve the convenience of fan speed adjustment.

The chaffer and chaffer extension sieves were easily adjusted at the rear of the combine. Adjusting the cleaning sieve was difficult. It was not possible for the operator to reach the sieve adjusting levers and still see through the top chaffer to determine the sieve openings. It is recommended that the manufacturer consider modifications to permit more convenient cleaning sieve adjustment.

Field Setting: The John Deere 7720 Titan II was easy to set for most crops and conditions encountered. Once initial settings were determined for the various crops, very little change was required when moving from one field to another.

While setting, it was easy for the operator to check the clean grain sample and return tailings from the cab. Straw condition and unthreshed loss could be checked by shutting down quickly and checking the material on the straw walkers, thus eliminating the need of removing the straw chopper. Checking shoe loss was more difficult. The shaker pan over the rear axle diverted material from the centre of the shoe to either side. This made it difficult to determine loss patterns and to collect material coming off the shoe. It is recommended that the manufacturer consider modifications to carry the full width of shoe material over the rear axle to enable easier, more representative checking of shoe loss.

Unplugging: The header reverse made unplugging the table auger and feeder quick and easy. Caution was required when reversing as crop material could lift the tin sheet between the pickup and table, allowing the auger to damage it.

The cylinder, if not plugged severely, could be unplugged by lowering the concave, shifting the cylinder drive to low range, and powering the slug through. This, however, if not effective, could cause more severe plugging and/or breaking of the beater drive belt. To clear severe plugs, it was necessary to reverse the cylinder manually and remove the debris through the access doors. The upper cylinder access door was very difficult to remove once the cylinder was plugged. A cylinder slug wrench was not provided. It is recommended that the manufacturer consider supplying a cylinder slug wrench.

Machine Cleaning: Cleaning the John Deere 7720 Titan II for harvesting seed grain was time consuming and laborious. The unloading auger sump retained a considerable amount of grain. Cleaning the sump was inconvenient. Cleaning the shoe delivery auger troughs required dropping the rear of the troughs and opening the front cleanout ports and washing them with water. Removal of the chaffer and sieve required two people and was time consuming. With the chaffer and sieve removed, the return tailings cross auger was accessible. The clean grain cross auger had cleanout doors on the bottom of the auger housing. The exterior of the combine was easy to clean.

Lubrication: The fuel tank inlet was located 6.5 ft (2 m) above the ground, making it easy to fuel from most gravity fuel tanks. The fuel tank also had a large inlet opening, which permitted the use of a large volume nozzle.

The combine had 40 pressure grease fittings. Four required greasing at 10 hours, an additional twenty-four every 50 hours, six more at 200 hours, and another six at 400 hours. The use of grease banks greatly improved the ease of lubrication. Daily lubrication was quick and easy because of the few number of lubrication points. Engine and hydraulic oil levels required regular checking. Changing engine oil and filters was not difficult.

Maintenance: Routine maintenance was easy to perform. The rotary radiator screen could be easily swung out of the way to provide access to the front of the radiator for inspection or cleaning.

The outer dry element air filter had to be cleaned or changed when indicated by the restriction warning. It was accessible through the grain tank.

The tension on most chains and belts was maintained through spring-loaded tensioners, and required very little adjustment.

Slip clutches protected the table auger, feed conveyor, straw walkers, shoe supply augers, and the tailings return elevator. The operator had to be careful not to over-grease any slip clutches. Excessive grease in the slip clutches allows grease to work its way into the jaw faces and greatly reduces their effectiveness.

The header platform could be easily removed by one person in approximately 5 minutes. Complete removal of the header platform and feeder house assembly was time consuming. Jack stands were not provided to support the complete assembly when disengaging it from the machine.

Adjustments were provided for levelling and proportioning
the concave to the cylinder. These were difficult to reach, making adjustments very inconvenient.

ENGINE AND FUEL CONSUMPTION
The John Deere diesel engine started easily and ran well. The engine had adequate power for all crops and conditions encountered. Average fuel consumption based on separator hours was about 5.7 gal/hr (25.9 L/h). Oil consumption was insignificant.

OPERATOR SAFETY
The operator’s manual emphasized operator safety. The John Deere 7720 Titan II had warning decals indicating most dangerous areas. Moving parts were well shielded. Most shields were hinged or were easily removed and replaced. A header lock was provided and should always be used when working near the header or when the combine is left unattended. The combine could be safely adjusted if the recommended procedures were used. However, the operator had to position himself in front of the rear tire when adjusting the cleaning fan speed (FIGURE 17). This was potentially hazardous, especially if adjusting on-the-go. It is recommended that the manufacturer consider modifications to eliminate the potential hazard associated with adjusting the fan speed on-the-go.

The combine was equipped with a slow moving vehicle sign, warning lights, tail light, signal lights, and rear view mirrors to aid in safe 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 and well illustrated. It contained much useful information on safe operation, controls, adjustments, crop setting, servicing, troubleshooting, and machine specifications.

MECHANICAL HISTORY
TABLE 5 outlines the mechanical history of the John Deere 7720 Titan II during the 141 hours of field operation while harvesting about 1100 ac (445 ha). The intent of the test was functional performance evaluation. Extended durability testing was not conducted.

<table>
<thead>
<tr>
<th>Item</th>
<th>Operating Hours</th>
<th>Field Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drives:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The separator drive belt was damaged and replaced at</td>
<td>11</td>
<td>131 (53)</td>
</tr>
<tr>
<td>- The cylinder variable speed drive belt broke and was replaced at</td>
<td>22, 26</td>
<td>253, 292 (102, 118)</td>
</tr>
<tr>
<td>Miscellaneoal:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The hydraulic accumulator valve started leaking and was replaced at</td>
<td>11</td>
<td>131 (53)</td>
</tr>
<tr>
<td>- The variable speed pickup control valve stuck and the control knob came loose</td>
<td>Throughout the season</td>
<td></td>
</tr>
<tr>
<td>- The centre pickup support tube broke loose and damaged one pickup belt at</td>
<td>95</td>
<td>743 (301)</td>
</tr>
</tbody>
</table>

Separator Drive Belt: The separator drive belt was glazed due to slipping while power unplugging the cylinder. It was replaced even though it had not broken.

Cylinder Drive Belts: The cylinder variable speed drive belt “turned over” twice in bunched rye windrows, causing the cylinder to plug. The belts were damaged and had to be replaced. The only possible cause determined was the lack of grease in the torque sensing hub. Apparently it was not adequately packed during assembly and regular servicing did not provide sufficient lubrication. Once properly lubricated no further problems occurred. It is recommended that the manufacturer consider modifications to ensure that the torque sensing hubs are adequately lubricated before shipment.

Pickup Speed Control: The control valve seized when the oil temperature increased. Trying to adjust the valve when it was stuck caused the linkage to slip and the entire adjusting knob and stem to come off the valve. An updated valve and stem assembly were installed near the end of the season. No further problems were encountered.

Pickup Support Tube: The support tube broke loose from the left side of the pickup because of a poor weld. This caused two pickup belts to become misaligned, damaging the belt on the left end of the pickup.

FIGURE 17. Fan Speed Adjustment and Tailings Return Elevator Sump.

APPENDIX I

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEASUREMENTS</td>
<td></td>
</tr>
<tr>
<td>- Length</td>
<td>17 ft (5.2 m)</td>
</tr>
<tr>
<td>- Height</td>
<td>8 ft (2.4 m)</td>
</tr>
<tr>
<td>- Width</td>
<td>17 ft (5.2 m)</td>
</tr>
<tr>
<td>- Depth</td>
<td>9 ft (2.7 m)</td>
</tr>
</tbody>
</table>

STONE PROTECTION:
- type: sump
- cleaning: manually opened and reset

CYLINDER:
- type: rasp bar, hardened and chromed
- number of bars: 8
- diameter: 22 in (560 mm)
- width: 54 in (1372 mm)
- drive: dual range, hydraulically controlled variable pitch torque-sensing belt drive
- speed range: 350 to 750 rpm
- low: 600 to 1230 rpm
- high: 13.5 in (343 mm)
- speed: 150% of cylinder speed
- grate: adjustable bar
- options: adjustable raker bar

SEATER:
- type: drum with 6 triangular bars
- diameter: 13.5 in (343 mm)
- speed: 150% of cylinder speed
- grate: adjustable bar
- options: adjustable raker bar
CONCAVE:
-- type: bar and wire
-- number of parallel bars: 13
-- configuration: 12 intervals with 0.25 in (6.3 mm) wires and 0.75 in (19 mm) spaces
-- wrap: 108 degrees
-- total area: 1100 ft² (0.710 m²)
-- open area: 604 ft² (0.390 m²) (55%)
-- beater grate: 409 ft² (0.284 m²)
-- grain delivery to shoe: augers
-- options: cover strips, stone trap cover, spiked tooth concave

STRAW WALKERS:
-- type: formed metal, rectangular openings
-- number: 5
-- length: 150 in (3810 mm)
-- walker housing width: 55 in (1397 mm)
-- separating area: 8250 ft² (5.32 m²)
-- crank throw (radius): 3 in (76 mm)
-- speed: 167 rpm
-- grain delivery to shoe: augers
-- straw curtains: 2, adjustable
-- options: lip type, risers

SHOE:
-- type: opposed action
-- speed: 328 rpm
-- chaffer sieve: 1.1 in regular tooth adjustable lip, 3535 ft² (2.28 m²) including chaffer extension, 2884 ft² (1.86 m²) less chaffer extension adjustable lip with nonadjustable removable inserts at rear corners 652 ft² (0.42 m²)
-- clean grain sieve: regular tooth adjustable lip, 2787 ft² (1.80 m²)
-- options: regular tooth 1.6 in (41 mm) space, deep tooth 1.8 in (41 mm) space, deep tooth cleaning sieve

CLEANING FAN:
-- type: 4 blade undershot
-- diameter: 19.9 in (505 mm)
-- width: 53.5 in (1360 mm)
-- drive: variable speed belt
-- speed range: 370 to 1100 rpm
-- options: fan bottom protection shields

ELEVATORS:
-- type: roller chain with rubber paddles
-- clean grain (top drive): 3.25 x 6 in (83 x 152 mm)
-- tailings (bottom drive): 3.25 x 6 in (83 x 152 mm)
-- options: perforated parts, steel paddles, bucket elevator

GRAIN TANK:
-- capacity: 185 Imp bu (6.7 m³)
-- unloading time: 115 s
-- unloading rate: 1.6 bu/s (0.058 m³/s)
-- unloading auger diameter: 12 in (305 mm)
-- unloading auger length: 14 ft (4.3 m)
-- options: 17 ft (5.2 m) auger

TIRES:
-- front: 24.5 - 32 R1, 10-ply
-- rear: 14.9 - 24 R1, 8-ply, cleated

TRACTION DRIVE:
-- type: hydrostatic
-- speed ranges:
  - 1st gear: 0-1.7 mph (0-2.7 km/h)
  - 2nd gear: 0-3.8 mph (0-6.1 km/h)
  - 3rd gear: 0-6.9 mph (0-11.1 km/h)
  - 4th gear: 0-16 mph (0-25.7 km/h)
-- options: posi-torque drive, wheel spacers, tracks powered rear axle, heavy duty axle

OVERALL DIMENSIONS:
-- wheel tread (front): 9.4 ft (2.9 m)
-- wheel tread (rear): 9.4 ft (2.9 m) (adjustable)
-- wheel base: 12.8 ft (3.9 m)
-- transport height: 12.5 ft (3.8 m)
-- transport length: 30 ft (9.1 m)
-- transport width: 12.4 ft (3.8 m)
-- unloader reach: 7.6 ft (2.3 m)
-- unloader clearance: 11.8 ft (3.6 m)

WEIGHT (EMPTY GRAIN TANK):
-- right front wheel: 9094 lb (4125 kg)
-- left front wheel: 9513 lb (4315 kg)
-- right rear wheel: 2285 lb (1036 kg)
-- left rear wheel: 2285 lb (1036 kg)
TOTAL: 23177 lb (10512 kg)

ENGINE:
-- make: John Deere
-- model: 6466TH-02
-- type: 4 stroke turbocharged diesel
-- number of cylinders: 6
-- displacement: 466 ft³ (7.64 L)
-- governed speed (full throttle): 2385 rpm
-- manufacturers rating: 165 hp (123 kW) at 2200 rpm
-- fuel tank capacity: 83 Imp. gal (380 L)
-- options: rotary screen trash shield

CLUTCHES:
-- header: electro-magnet
-- separator: mechanical V-belt tightener
-- unloading auger: mechanical V-belt tightener

NUMBER OF CHAIN DRIVES:
9

NUMBER OF BELT DRIVES:
19

NUMBER OF GEARBOXES:
5

LUBRICATION POINTS:
-- 10 h: 4
-- 50 h: 24
-- 200 h: 6
-- 400 h: 6
TABLE 6. Capacity of the Machinery Institute Reference Combine at a Total Grain Loss of 3% Yield

<table>
<thead>
<tr>
<th>Crop</th>
<th>Variety</th>
<th>Width of Cut</th>
<th>Crop Yield</th>
<th>Grain Moisture</th>
<th>MOG/G Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ft m</td>
<td>bu/ac</td>
<td>t/ha</td>
<td>Straw %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1   Barley</td>
<td>Bonanza</td>
<td>42</td>
<td>12.8</td>
<td>68.0</td>
<td>3.7</td>
</tr>
<tr>
<td>9   Barley</td>
<td>Bonanza</td>
<td>24</td>
<td>7.3</td>
<td>85.0</td>
<td>4.6</td>
</tr>
<tr>
<td>8   Wheat</td>
<td>Neepawa</td>
<td>44</td>
<td>13.4</td>
<td>42.0</td>
<td>2.8</td>
</tr>
<tr>
<td>4   Wheat</td>
<td>Neepawa</td>
<td>42</td>
<td>12.8</td>
<td>41.0</td>
<td>2.8</td>
</tr>
<tr>
<td>Wheat</td>
<td>Neepawa</td>
<td>42</td>
<td>12.8</td>
<td>23.0</td>
<td>1.6</td>
</tr>
<tr>
<td>1   Barley</td>
<td>Bonanza</td>
<td>28</td>
<td>8.5</td>
<td>71.9</td>
<td>3.3</td>
</tr>
<tr>
<td>9   Barley</td>
<td>Bonanza</td>
<td>24</td>
<td>7.4</td>
<td>72.5</td>
<td>3.6</td>
</tr>
<tr>
<td>8   Wheat</td>
<td>Neepawa</td>
<td>27</td>
<td>8.2</td>
<td>40.3</td>
<td>2.9</td>
</tr>
<tr>
<td>3   Wheat</td>
<td>Columbus</td>
<td>41</td>
<td>12.5</td>
<td>36.7</td>
<td>2.7</td>
</tr>
</tbody>
</table>

TABLE 6 had slightly above average straw yield, grain yield, and straw moisture with average grain moisture.

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 19 shows capacity differences in Neepawa wheat for the five years. In 1984 the wheat crop had slightly greater than average straw yield, slightly below average grain yield, and average straw and grain moisture contents.


APPENDIX III

REGRESSION EQUATIONS FOR CAPACITY RESULTS

Regression equations for the capacity results shown in FIGURES 2 to 5 are presented in TABLE 7. In the regressions, \( U \) = unthreshed loss in percent of yield, \( S \) = shoe loss in percent of yield, \( W \) = walker loss in percent of yield, \( F \) = the MOG feedrate in lb/min, while \( ln \) is the natural logarithm. Sample size refers to the number of loss collections. Limits of the regressions may be obtained from FIGURES 2 to 5 while crop conditions are presented in TABLE 2.

<table>
<thead>
<tr>
<th>Crop - Variety</th>
<th>Figure Number</th>
<th>Regression Equations</th>
<th>Simple Correlation Coefficient</th>
<th>Variance Ratio</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley - Bonanza</td>
<td>2</td>
<td>( U = -3.00 + 4.94 \times 10^{-3}F ) ( S = -2.86 + 4.28 \times 10^{-3}F ) ( W = -0.20 + 5.53 \times 10^{-8}F^3 )</td>
<td>0.88</td>
<td>52.01&lt;sup&gt;1&lt;/sup&gt;</td>
<td>9</td>
</tr>
<tr>
<td>Barley - Bonanza</td>
<td>3</td>
<td>( U = 0.06 + 2.28 \times 10^{-6}F^2 ) ( S = 0.10 + 7.43 \times 10^{-9}F^3 ) ( W = 0.04 + 4.16 \times 10^{-13}F^5 )</td>
<td>0.77</td>
<td>19.66&lt;sup&gt;1&lt;/sup&gt;</td>
<td>8</td>
</tr>
<tr>
<td>Wheat - Neepawa</td>
<td>4</td>
<td>( U = -3.73 + 5.83 \times 10^{-3}F ) ( S = -5.69 + 7.47 \times 10^{-3}F ) ( W = -0.21 + 1.55 \times 10^{-8}F^3 )</td>
<td>0.97</td>
<td>141.92&lt;sup&gt;2&lt;/sup&gt;</td>
<td>7</td>
</tr>
<tr>
<td>Wheat - Neepawa</td>
<td>5</td>
<td>( U = 0.18 + 3.45 \times 10^{-6}F^3 ) ( S = 0.03 + 2.61 \times 10^{-8}F ) ( W = -5.57 + 1.04 \times 10^{-10}F )</td>
<td>0.81</td>
<td>21.18&lt;sup&gt;1&lt;/sup&gt;</td>
<td>7</td>
</tr>
</tbody>
</table>

<sup>1</sup>Significant at \( P \leq 0.05 \)

<sup>2</sup>Significant at \( P \leq 0.01 \)

APPENDIX IV

Machine Ratings

The following rating scale is used in Machinery Institute Reports:

- excellent
- very good
- good
- fair
- poor
- unsatisfactory
### SUMMARY CHART

**JOHN DEERE 7720 TITAN II SELF-PROPELLED COMBINE**

<table>
<thead>
<tr>
<th>RETAIL PRICE</th>
<th>$143,048.00 (March, 1985, f.o.b. Humboldt, Sask.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAPACITY</strong></td>
<td></td>
</tr>
<tr>
<td>Compared to Reference</td>
<td>1.5 x reference at 3% total loss</td>
</tr>
<tr>
<td>Combine</td>
<td>1.7 x reference at 3% total loss</td>
</tr>
<tr>
<td>MOG Feedrates</td>
<td></td>
</tr>
<tr>
<td>-- barley</td>
<td>363 lb/min (9.9 t/h) at 3% total loss, FIGURE 2</td>
</tr>
<tr>
<td>-- wheat</td>
<td>352 lb/min (8.6 t/h) at 3% total loss, FIGURE 3</td>
</tr>
<tr>
<td>-- barley</td>
<td>539 lb/min (14.7 t/h) at 3% total loss, FIGURE 4</td>
</tr>
<tr>
<td>-- wheat</td>
<td></td>
</tr>
<tr>
<td><strong>QUALITY OF WORK</strong></td>
<td></td>
</tr>
<tr>
<td>Picking</td>
<td>Very Good; automatic header height control is convenient</td>
</tr>
<tr>
<td>Feeding</td>
<td>Excellent; very aggressive in all crops</td>
</tr>
<tr>
<td>Threshing</td>
<td>Very Good; chromed rasp bars show little wear</td>
</tr>
<tr>
<td>Separating</td>
<td>Good; straw walker loss limited capacity</td>
</tr>
<tr>
<td>Cleaning</td>
<td>Very Good; poor to fair in ax</td>
</tr>
<tr>
<td>Grain Handling</td>
<td>Very Good; full grain tank warning would be useful; grain tank screen leaked small seeds</td>
</tr>
<tr>
<td>Straw Spreading</td>
<td>Very Good; uniformly over 30 ft (9.1 m)</td>
</tr>
<tr>
<td><strong>EASE OF OPERATING AND ADJUSTMENT</strong></td>
<td></td>
</tr>
<tr>
<td>Comfort</td>
<td>Very Good; seat had good adjustments, visibility was good</td>
</tr>
<tr>
<td>Instruments</td>
<td>Very Good; easy to read</td>
</tr>
<tr>
<td>Controls</td>
<td>Very Good; color coded for quick identification</td>
</tr>
<tr>
<td>Loss Monitor</td>
<td>Good; easy to read, less representative in ax and rapeseed than in wheat and barley</td>
</tr>
<tr>
<td>Lighting</td>
<td>Very Good; exterior and interior</td>
</tr>
<tr>
<td>Handling</td>
<td>Good; brakes responsive, steering smooth, slow transport speed Adjustment Good; cleaning sieve dif cult to see while adjusting</td>
</tr>
<tr>
<td>Setting</td>
<td>Good; dif cult to get representative shoe sample</td>
</tr>
<tr>
<td>Unplugging</td>
<td>Good; power header reverser, no cylinder slug wrench was provided Cleaning Fair; many auger troughs to clean, time consuming</td>
</tr>
<tr>
<td>Lubrication</td>
<td>Very Good; grease banks are handy, few daily lubrication points</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Good; spring loaded tighteners reduced daily maintenance</td>
</tr>
<tr>
<td><strong>ENGINE AND FUEL CONSUMPTION</strong></td>
<td></td>
</tr>
<tr>
<td>Engine</td>
<td>Good; adequate power, started well</td>
</tr>
<tr>
<td>Fuel Consumption</td>
<td>5.7 gal/h (25.9 L/h), average for season</td>
</tr>
<tr>
<td><strong>OPERATOR SAFETY</strong></td>
<td></td>
</tr>
<tr>
<td>Well shielded, but accessible</td>
<td></td>
</tr>
<tr>
<td><strong>OPERATOR'S MANUAL</strong></td>
<td></td>
</tr>
<tr>
<td>Very Good; well written</td>
<td></td>
</tr>
<tr>
<td><strong>MECHANICAL HISTORY</strong></td>
<td></td>
</tr>
<tr>
<td>Cylinder torque sensing hubs not adequately lubricated</td>
<td></td>
</tr>
</tbody>
</table>

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