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Group 9c

Evaluation Report 406

Concord Air Seeder
(Model AS1002 Air System With Model ATD 2012 Air Till Drill)

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

CONCORD AIR SEEDER (MODEL AS1002 AIR SYSTEM WITH MODEL ATD 2012 AIR TILL DRILL)

MANUFACTURER AND DISTRIBUTOR:

Concord Inc.
2800 - 7 Avenue North
Fargo, North Dakota 58102

RETAIL PRICE:

(January, 1985, f.o.b. Lethbridge, Alberta.)

a. Concord model AS1002 air system complete with seed boots and distribution system to feed 20 shanks. ($17,217.00)
b. Concord model ATD 2012 air till drill consisting of a 20 ft (6.0 m) intermediate duty cultivator, packers and land levellers. ($18,612.30)

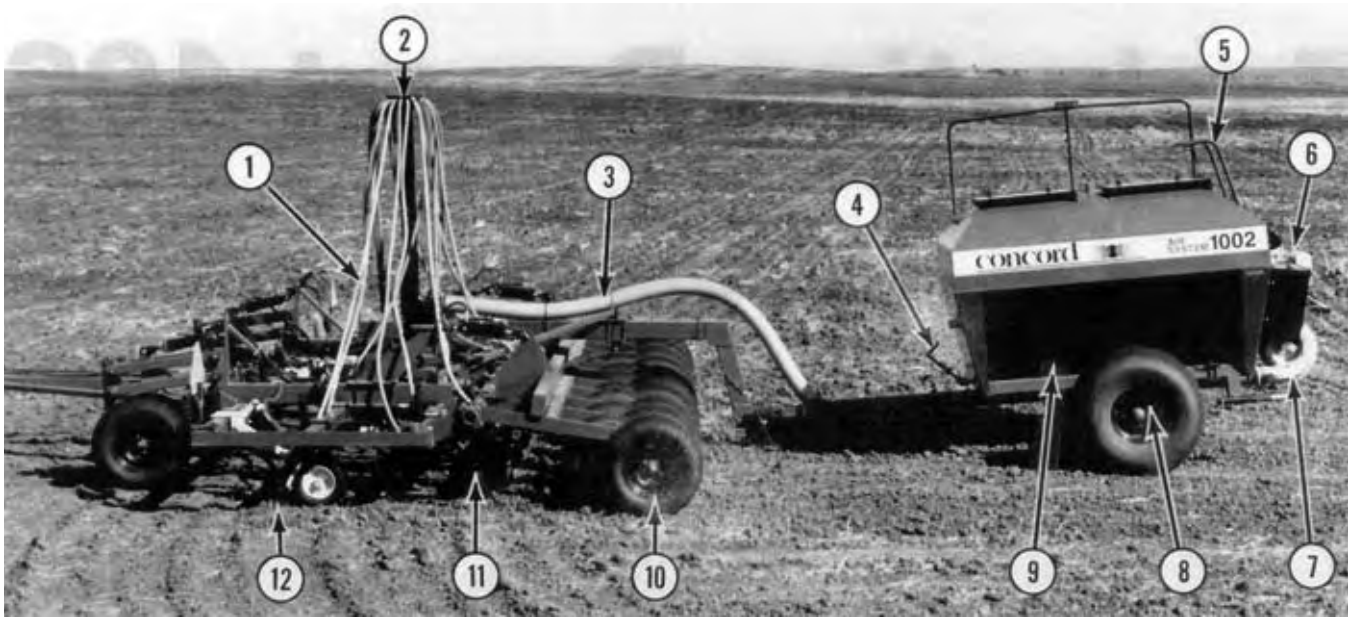

FIGURE 1. Concord Air Seeder: (1) Secondary Hose, (2) Primary Header, (3) Primary Hose, (4) Meter Hand Crank, (5) Ladder, (6) Engine, (7) Fan, (8) Clutch, (9) Metering System (10) Packing Wheels, (11) Land Levellers, (12) Seed Boot.

SUMMARY

Functional Performance: Performance of the Concord model AS1002 was good for seeding and fertilizer banding in secondary and light primary field conditions. Suitability, for seeding and banding fertilizer was reduced in heavy primary tillage due to light shank spring characteristics of the Concord model ATD 2012 air till drill. The Concord model AS1002 was suitable for banding fertilizer in secondary and light primary field conditions at application rates up to 200 lb/ac (226 kg/ha) at 5.5 mph (9.0 km/h).

Meter Calibrations: The manufacturer's metering system calibration charts were fairly accurate in wheat, barley, oats and fertilizer. There were differences between front and rear tank rates. The manufacturer's calibration chart was accurate in canola for both meters. The manufacturer's calibration chart for 11-51-0 fertilizer was accurate for the rear meter but inaccurate for the front meter.

Distribution Uniformity: Distribution uniformity across the seeding width was acceptable in wheat, barley, oats and canola. Distribution uniformity in fertilizer was acceptable at rates up to 200 lb/ac (226 kg/ha).

Effect of Field Variables: Field bounce had little effect on metering rates. Field slope and ground speed had only a small effect on metering rates. Distribution uniformity was only slightly affected by field slope.

Grain Damage: Grain damage by the metering and distribution system was within acceptable limits at normal fan speeds.

Seed Placement: Seed placement was good in most conditions. Variation in seed depth was similar to a conventional hoe drill when measured in the same fields under the same seeding conditions. Row spacing and seed band width behind each seed boot provided ample stubble for good windrow support, providing light crops were laid across the rows rather than parallel to them. Good cultivator frame levelling was critical in obtaining a uniform seed depth and subsequent good crop emergence.

Ease of Adjustment and Operation: Seeding rate was difficult to adjust. Tank and meter cleanout convenience was good. Tank filling required the use of a drill fill or auger. Eleven grease fittings on the applicator and forty-nine on the cultivator required greasing.

Since the applicator was towed behind the cultivator, operator visibility of the cultivator was not obstructed by the tanks. The Concord model AS1002 and Concord model ATD 2012 air till drill could be placed in transport position in less than five minutes.

Rate of Work: The rate of work usually ranged from 10 to 14 ac/hr (4 to 5.6 ha/hr). About 90 ac (36 ha) could be seeded before refilling both tanks when seeding wheat at a normal seeding rate. Using only one tank, 45 ac (18 ha) could be seeded before refilling.

Power Requirements: Tractor size depended on soil conditions, seeding depth, ground speed, cultivator width and soil finishing attachments. In light primary tillage at a 3 in (75 mm) depth and 5 mph (8 km/h), an 84 hp (61 kW) tractor was needed to operate the applicator-cultivator combination. In light secondary tillage, at the same depth and speed, a 60 hp (45 kW) tractor was needed.

Safety: Operator care was required when mounting the applicator because of the engine exhaust from the applicator gas engine being directed onto the ladder. The Concord model AS1002 was otherwise safe to operate, providing normal safety precautions were observed.

Operator's Manual: The operator's manual contained useful information on safety, adjustment, assembly, operations, lubrication and maintenance. A detailed parts list was also included.

Mechanical Problems: A number of mechanical problems occurred during the evaluation. Problems included failure of the front pivot point on the cultivator and of the cultivator hitch tongue. A number of cultivator and applicator frame modifications were made by the manufacturer to brace and strengthen both units.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Providing improved metering calibration charts and ensuring front and rear tank metering rates are the same.

2. Modifications to ensure a proper supply of fuel to the engine at all field slopes encountered in normal seeding operations.
3. Providing a suggested setting for the fan speed on the fan damper to reduce crackage when seeding canola.
4. Modifications to the hitching of the applicator to ensure a more even distribution of the applicators weight over the entire width of the cultivator.
5. Supplying a jack capable of lifting heights to accommodate varying tractor hitch heights.
6. Improving the lid stops to provide for easier and safer closing of the tank lids.
7. Providing, as optional equipment, a monitoring system to monitor material flow.
8. Improving the accessibility of the grease fitting on the meter drive line.
9. Providing for convenient draining and collecting of oil from the fan engine.
10. Improving the metering door and flow control adjustments to allow for easier application rate setting.
11. Redirecting the engine exhaust away from the access ladder to improve operator safety.
12. Supplying a slow moving vehicle sign as standard equipment.
13. Modifications to the mainframe pivot joints to eliminate breaking of the pivot plates.

Station Manager/Senior Engineer: E. H. Wiens
Project Technologist: G. A. Magyar

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Changes have been made to balance the air pressure head between compartments and new tooling, fabrication, and inspection procedures are in use for manufacturing the metering roll drive, thereby minimizing the product rate variation.
2. The engine manufacturer has corrected this deficiency.
3. A note will be added to the owner's manual for fine seeds and seeds more readily susceptible to shattering. The note will indicate for the operator to start with the engine at reduced rpm and the fan dampener closed and then to increase the air rate as required for the product, rate desired and size of the Air Till Drill.
4. A gauge wheel has been centrally located on the Air Till Drill to eliminate the minimal drafting tendencies about the hinge.
5. The standard tongue jack provides a drawpole hitch height of up to 24". This is more than adequate for any tractors we have encountered.
6. This area has been upgraded completely in design, tooling, and procedures of fabrication and assembly. A lid limit opening safety chain has been added.
7. A monitor is standard equipment in the tractor cab for fan speed, engine oil pressure, metering roll drive indicator and its clutch engagement switch, plus bin level indicators. A complete product distribution monitor system is available from various manufacturers at the dealer level.
8. Will be reviewed and handled.
9. Oil drain hoses have been made standard equipment.
10. The metering roll drive assembly has been upgraded in design, tooling and manufacturing procedures and corrosion resistant materials have been introduced.
11. The muffler has been upgraded and a heat shield and exhaust deflector is now standard.
12. This will be standard equipment.
13. A new design is now standard.

GENERAL DESCRIPTION

The Concord air seeder consists of a model AS1002 air system and a model ATD 2012 air till drill. The air system is supported by two wheels on a single axle and tows behind the air till drill system. The air system can also be used with other makes and models of cultivators.

Seed and fertilizer are pneumatically distributed from two tanks through a network of tubes to seed boots attached to the rear of the cultivator shanks. The air system can be used for seeding, for combined seed and fertilizer application, and for fertilizer banding.

Seed and fertilizer are metered through large adjustable fluted rolls mounted below each tank. The meters are driven by a gear box which is engaged by a clutch driven off of the left wheel of the air system.

An air cooled gasoline engine powered fan forces the metered material through the distribution system. The distribution system consists of one main primary header feeding twenty secondary tubes which connect to individual seed boots.

The Concord model ATD 2012 air till drill is a 20 ft (6.0 m) wide intermediate cultivator consisting of two 10 ft (3.0 m) sections. It was equipped with 20 spring shanks, spaced at 12 in (305 mm), arranged in three rows. The air till drill is supported at the front by two tandem caster wheels and at the rear by 20 pneumatic rubber packing tires. The packing tires are arranged in two gangs, with 10 tires per gang.

A tractor with one remote hydraulic control was required to operate the Concord model AS1002 air system with the Concord model ATD 2012 air till drill.

Detailed specifications for the air system and air till drill are given in APPENDIX I, while FIGURE 1 shows the location of major components.

SCOPE OF TEST

The Concord air seeder was operated in loam, clay and sandy soils in the field conditions show in TABLE 1 for approximately 138 hours while processing about 1505 ac (602 ha). It was evaluated for quality of work, ease of operation and adjustment, rate of work, power requirements, safety and suitability of the operator's manual.

RESULTS AND DISCUSSION

QUALITY OF WORK

Metering Accuracy: The grain and fertilizer metering system was calibrated in the laboratory and compared with the manufacturer's calibration. Since actual seeding rates for certain settings depended on things such as seed size, density and moisture content, it is not possible for a manufacturer to present charts to include all the varieties of seed. Field calibration checks may be necessary for seed with properties differing from those used in establishing the manufacturer's charts. Research has, however, shown that small variations in seeding rates will not significantly affect grain crop yields.

TABLE 1. Operating Conditions.

CROP	FIELD TILLAGE CONDITIONS	STONE CONDITIONS	FIELD AREA		HOURS
			ac	ha	
Spring wheat on stubble	Primary	Occasional stones	120	48	13
Spring wheat on summerfallow	Secondary	Occasional stones	610	244	54
Duram wheat on stubble	Primary	Occasional stones	150	52	14
Duram wheat on summerfallow	Secondary	Stone free	80	32	8
Winter wheat on stubble	Primary	Occasional stones	60	24	6
Winter wheat on summerfallow	Secondary	Occasional stones	320	128	27
Banding fertilizer	Primary	Stone free	75	30	7
Banding fertilizer	Secondary	Occasional stones	90	36	9
TOTAL			1505	602	136

The metering rate was varied by adjusting the metering door to the correct setting as determined from the calibration charts provided. Four replaceable fluted feed rolls for various products and application rates were supplied. Only the standard fluted roll was used and provided adequate meter rate adjustments for all products used during the test. The seed densities used by the manufacturer for meter calibration were supplied.

Calibration curves for wheat, barley, oats, canola and fertilizer are given in FIGURES 2 to 6. PAMI's calibration curves are compared to curves based on the manufacturer's calibration charts. Differences in calibration were noticed between the front and rear meters. When set for a seeding rate of 60 lb/ac (67 kg/ha), PAMI's measured rates were similar to the manufacturer's calibration in

wheat for the rear meter but 10% lower for the front meter. For barley, when set for a seeding rate of 60 lb/ac (67 kg/ha), PAMI's measured rates were 28% and 12% lower than the manufacturer's rate for the front and rear meters, respectively. For oats, at a similar seeding rate, PAMI's measured rates were 8% and 15% higher for front and rear meters, respectively. At a seeding rate of 6 lb/ac (6.7 kg/ha), PAMI's measured rate in canola was similar to the manufacturer's for both meters. At an application rate of 60 lb/ac (67 kg/ha), PAMI's measured rates in 11-51-00 fertilizer were 13% higher for the rear meter and 33% lower for the front meter while at an application rate of 130 lb/ac (147 kg/ha) the measured rate was similar for the rear meter and 30% lower for the front meter. It is recommended that the manufacturer provide improved calibration charts and ensure front and rear metering rates are the same.

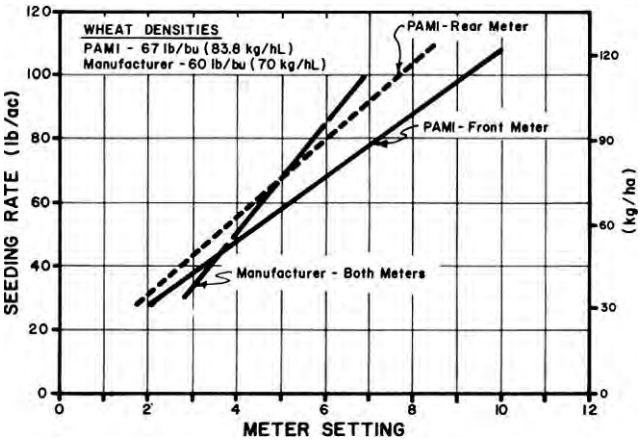

FIGURE 2. Metering Accuracy in Wheat.

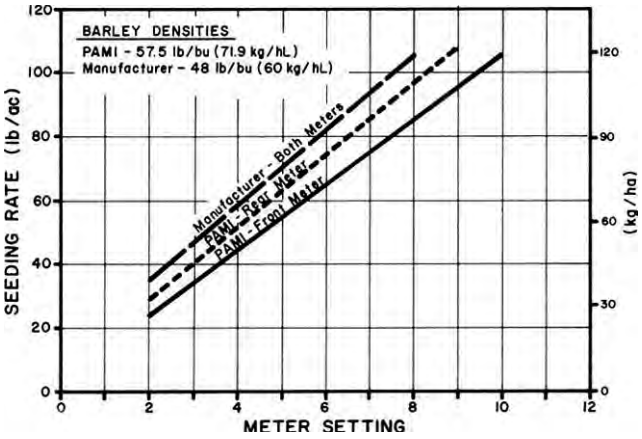

FIGURE 3. Metering Accuracy in Barley.

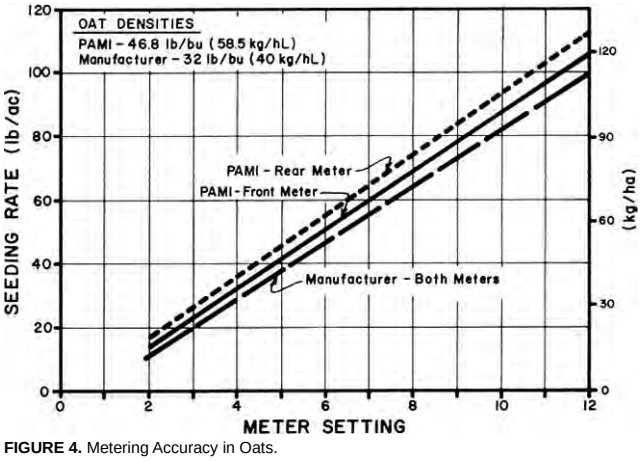

FIGURE 4. Metering Accuracy in Oats.

Operating on slopes, up to 10 degrees, had little effect on metering rates. However, operating on slopes greater than 5 degrees resulted in the carburetor float reducing gas flow to the engine, thus causing a reduction in engine speed below the rated speed. It is recommended that the manufacturer consider modifications to ensure a proper supply of fuel to the engine at all field slopes encountered in normal seeding operations.

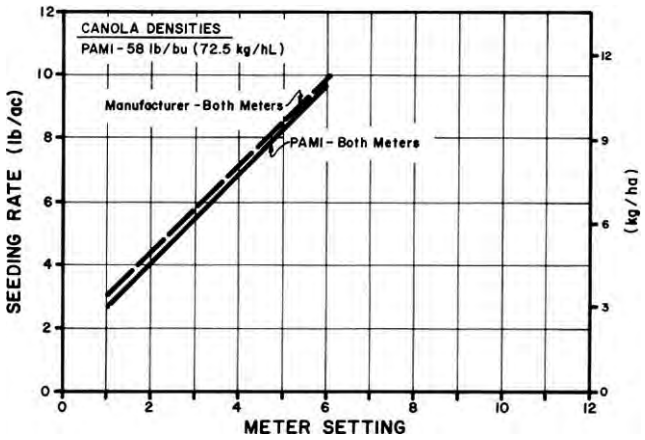

FIGURE 5. Metering Accuracy in Canola.

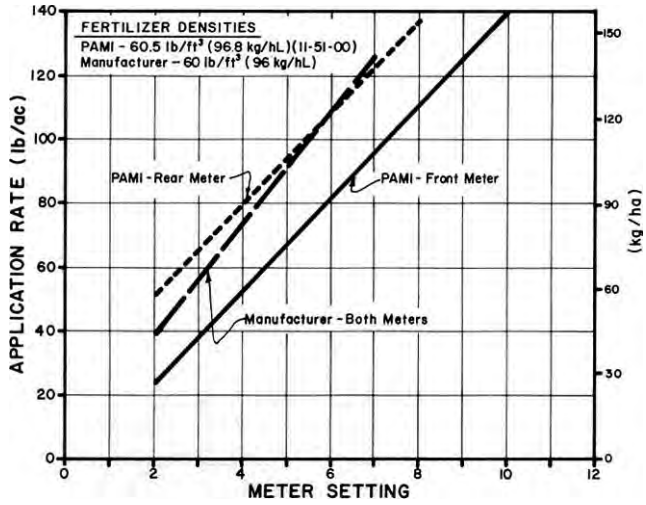

FIGURE 6. Metering Accuracy in Fertilizer.

An increase in ground speed from 3 to 7.5 mph (5 to 12 km/h) decreased the metering rate by up to 8% for wheat and fertilizer. Although wheel slippage is common with many ground driven applicators, no ground drive wheel slippage of the large diameter wheel was experienced with the Concord model AS1002. Field bounce had little effect on metering rates.

Distribution Uniformity: FIGURE 7 gives seeding distribution uniformity for the Concord model AS1002 in wheat, barley and oats. Distribution was uniform over the full range of seeding rates at a fan speed of 4650 rpm. For example, at a seeding rate of 70 lb/ac (85 kg/ha), the coefficient of variation[1] (CV) was 8.6% for wheat, 8.8% for barley and 10.3% for oats. FIGURE 8 shows a typical seeding distribution pattern obtained in wheat at a seeding rate of 70 lb/ac (78 kg/ha). The application rate from each shank across the width of the air seeder varied from 59 to 80 lb/ac (67 to 90 kg/ha). This resulted in acceptable distribution uniformity with a CV of 8.6%

FIGURE 9 shows a typical distribution pattern obtained in canola at a seeding rate of 6.8 lb/ac (7.6 kg/ha) at a fan speed of 4500 rpm. The application rate across the width of the air seeder varied from 5.8 to 8.3 lb/ac (6.6 to 9.4 kg/ha), which resulted in acceptable distribution uniformity with a CV of 9.3%. Distribution uniformity was acceptable over the full range of canola seeding rates with CV's ranging from 9.3 to 13.5% (FIGURE 10).

Distribution uniformity in 11-51-00 fertilizer was acceptable for metering rates up to 200 lb/ac (244 kg/ha), with CV's ranging

[1]The coefficient of variation (CV) is the standard deviation of seeding rates from individual shanks expressed as a percent of the average seeding rate. An accepted variation for seeding grain or applying fertilizer is a CV value not greater than 15%. If the CV is less than 15%, distribution is acceptably uniform, whereas if the CV is greater than 15%, the variation in application rate among individual shanks is excessive.

from 11 to 15% (FIGURE 11). At higher rates, uniformity became unacceptable with the CV increasing to 19% at a metering rate of 235 lb/ac (266 kg/ha).

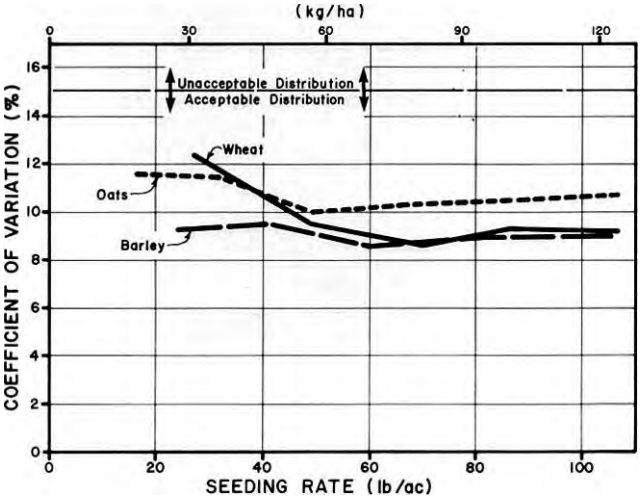

FIGURE 7. Distribution Uniformity in Cereal Grains over a Range of Seeding Rates at 5.5 mph (9 km/h) and a Fan Speed of 4650 rpm.

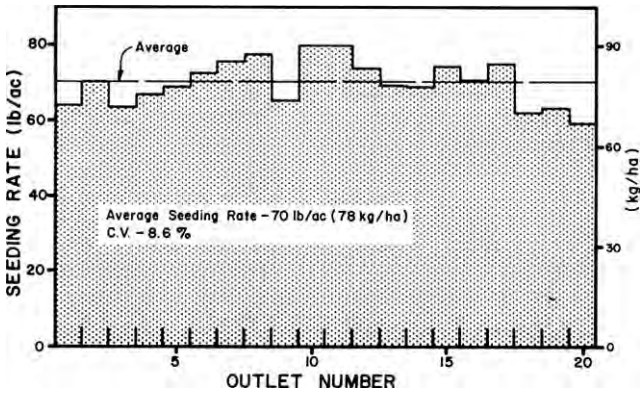

FIGURE 8. Distribution Uniformity Pattern in Wheat at 70 lb/ac (78 kg/ha) at a Fan Speed of 4650 rpm.

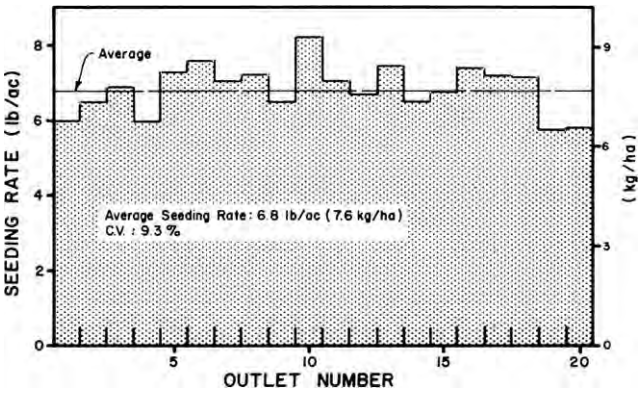

FIGURE 9. Distribution Uniformity Pattern in Canola at 6.8 lb/ac (7.6 kg/ha) at a Fan Speed of 4500 rpm.

Changes in distribution pattern uniformity could occur at different forward speeds or for different machine widths due to different volumes of material being introduced into the constant volume of air supplied by the fan.

Changes in fan speed and operation in hilly terrain had only a small effect on distribution uniformity.

Grain Damage: Grain damage by the metering and distribution system was within acceptable limits for cereal grains at a fan speed of 5000 rpm or lower. For example, in dry Neepawa wheat, at an 11% moisture content and a fan speed of 4800 rpm, only 0.4% crackage occurred. Grain crackage in canola was significantly higher than in cereal grains. For example, in dry canola at a moisture content of 7%, 4% crackage occurred. Reduced fan speed would result in reduced canola crackage. It is recommended that the manufacturer provide a suggested setting for fan speed or the fan damper to reduce crackage when seeding canola.

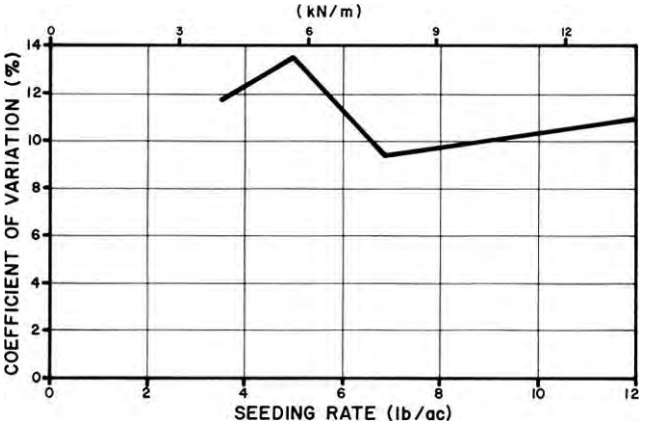

FIGURE 10. Distribution Uniformity in Canola Over a Range of Seeding Rates at 5.5 mph (9 km/h) at a Fan Speed of 4500 rpm.

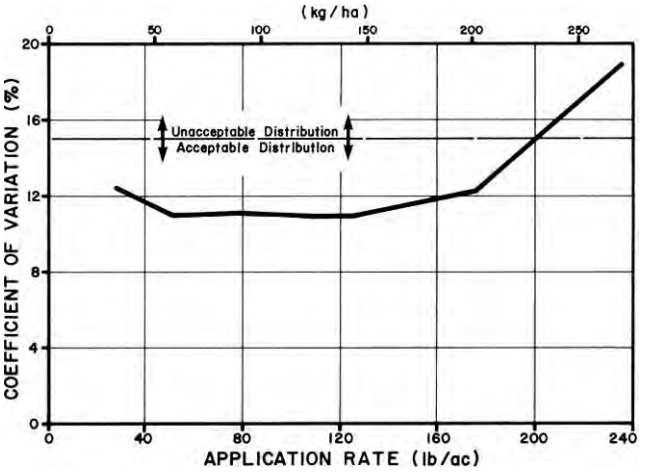

FIGURE 11. Distribution Uniformity in Fertilizer Over a Range of Application Rates at 5.5 mph (9 km/h) at Different Fan Speeds.

Seed Placement: The Concord seed boot (FIGURE 12) was equipped with two tubes in a V-shape to spread the seed behind each cultivator sweep. Plants emerged in distinct rows in band widths ranging from 3.5 to 6.5 in (89 to 165 mm) (FIGURE 13). With 12 in (305 mm) cultivator shank spacing, distances between rows varied from 5.5 to 8.5 in (140 to 216 mm). This row spacing provided adequate windrow support providing light crops were laid across the rows rather than parallel to them.

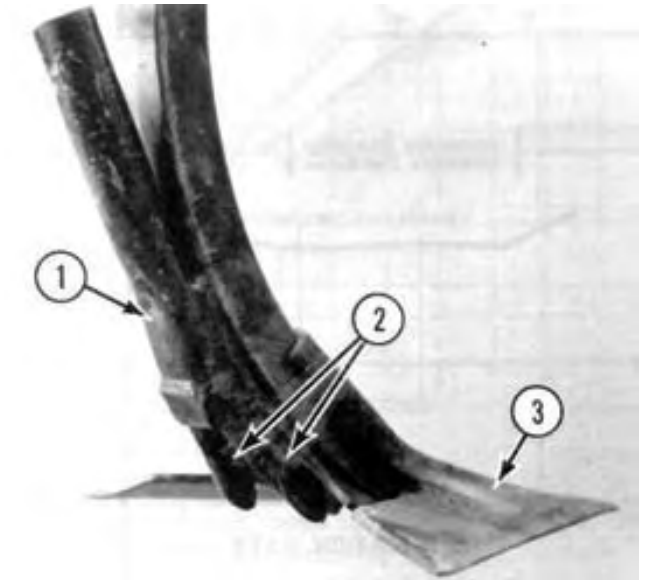

FIGURE 12. Concord Seed Boot: (1) Seed Boot, (2) V-Shaped Spreader, (3) Sweep.

Variation in seed depth depended on field conditions. Although seed placement was adequate in all secondary field conditions, the intermediate duty shanks on the Concord model ATD 2012 air till drill were not sufficiently rigid to maintain a uniform sweep pitch throughout the full range of soil forces encountered in all primary tillage conditions (FIGURE 14).

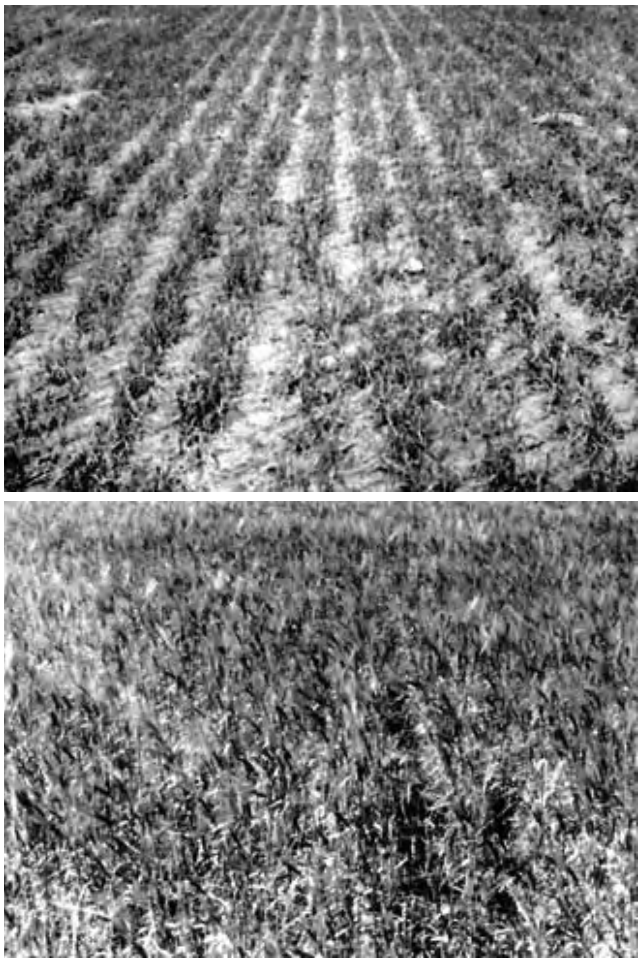

FIGURE 13. Uniform Wheat Emergence in Summerfallow (Upper: 30 Days After Seeding; Lower: At Harvest).

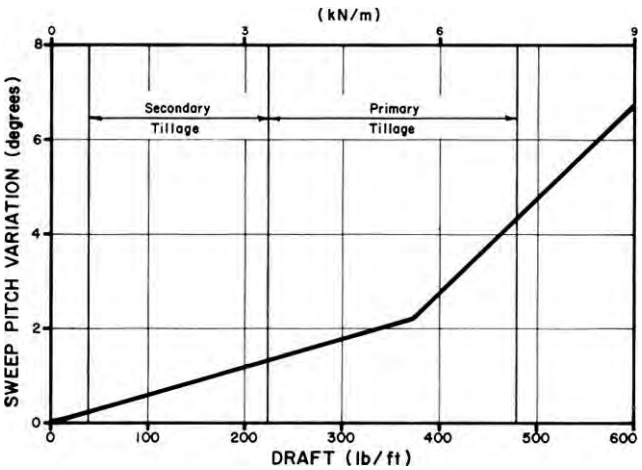

FIGURE 14. Sweep Pitch Variation Over a Normal Range of Draft with 12 in (305 mm) Shank Spacing.

Although seeds were usually placed on the furrow bottom at the working depth of each individual cultivator sweep, depth across the width of the machine varied due to cultivator frame geometry and non-uniform field surfaces. On level and gently rolling fields, when seeding in secondary or light primary field conditions, variation in seed depth was quite uniform. For example, at an average seeding depth of 2 in (50 mm), seeding depth across the width of the machine varied from 1.4 to 3.0 in (35 to 75 mm) with most of the seeds placed within 0.5 in (13 mm) of the average cultivator working depth. This compares to seed being placed from 0.5 to 0.6 in (12 to 15 mm) from average seeding depth for a hoe drill in similar conditions.

In fields with sharp hill crests or gullies, seed depth variation became much greater than for a hoe drill, due to the greater distances between shank rows on a cultivator than on a hoe drill.

In heavy primary tillage conditions, seed depth variation increased due to soil forces exceeding the shank spring preload setting. Therefore, seeding in heavy primary tillage conditions with an air seeder and the Concord model ATD 2012 air till drill is not recommended.

Plant Emergence: As with most seeding implements, time and uniformity of plant emergence depended on seedbed preparation, soil moisture and seed placement. Uniform emergence resulted as long as machine settings were carefully adjusted to place seed in moist soil at the correct depth and providing loose seedbeds were packed after seeding. FIGURE 13 shows good wheat emergence when wheat was seeded directly into summerfallow as the first spring operation.

With the applicator being towed behind the cultivator, the applicator wheels packed the seedbed firmly in the wheel tracks. The applicator wheels did not over pack the seedbed in normal seeding conditions encountered during the test. Packing on moist clay soils could possibly be a problem.

Careful cultivator frame levelling was important in obtaining uniform emergence across the cultivator width. Due to the rigidity of cultivator frames, improper sideways levelling and fore-and-aft levelling can both result in rows of shanks operating at different depths. With the hitch weight of the applicator being supported where the two cultivator sections join, levelling adjustments were not possible to compensate for the weight of the applicator. It is recommended that the manufacturer consider modifications so that the applicator hitch weight does not affect the levelling of the cultivator frame.

Seeding Depth: It is very important to seed deep enough to obtain uniform seed coverage. Correct cultivator adjustments for air seeding were best obtained by comparing the depth of seeds placed by several shanks across the cultivator width and from both the front and rear shank rows. This permitted adequate frame levelling to obtain uniform seed coverage. Seeding shallower than 2 in (50 mm) is not recommended for an intermediate duty cultivator due to poor seed coverage and generally poor cultivator performance at shallow tillage depths.

Frame levelling had to be checked and appropriate depth adjustments made when changing fields to ensure adequate, uniform seed coverage.

Soil Finishing: The Concord model ATD 2012 air till drill was equipped with eight furrow levellers and 20 pneumatic tires used for packing. The furrow levellers were effective in smoothing the soil surface but ineffective in breaking soil lumps or when operating in heavy loose trash.

The packing wheels did an adequate job of packing the seedbed. The packing force exerted by each packing wheel ranged from 220 to 295 lbs (979 to 1313 N) with the applicator tanks empty and from 200 to 390 lbs (890 to 1735 N) with the applicator tanks full. Resulting packing forces were somewhat similar to those of most hoe drills. Packing wheel ridges ranged from 0.6 in to 1.8 in (15 to 46 mm) (FIGURE 15). The uneven distribution of the packing forces was attributed to the transfer of weight from the applicator hitch to the cultivator and to the difference in how each packing arm was welded to the packer framework.

The packing wheels left a very rough surface condition which was evident when travelling perpendicular to the seeding direction. A follow-up harrowing operation improved surface roughness. Care had to be used in moist field conditions to avoid over packing the seedbed.

Shank Characteristics: The Concord model ATD 2012 air till drill was equipped with adjustable spring cushioned shank holders. During the evaluation it was used with 14 in (356 mm) wide Adam's sweeps with a 43 degree stem angle, giving a no-load sweep pitch of 2 degrees. Sweep pitch (FIGURE 14) varied 1.3 degrees over the range of draft (drawbar pull) normally encountered in secondary field conditions.

Cushioning spring preload was exceeded at drafts greater than 375 lb/ft (5.5 kN/m), occurring midway in the range of normal

primary tillage. This shows that the Concord model ATD 2012 air till drill is suitable for secondary tillage and for light primary tillage. In heavy primary tillage, sweep pitch increased, which could result in non-uniform seeding depth and furrow bottom ridging.

FIGURE 15. Seedbed after Seeding into Summerfallow.

Penetration: When equipped with 43 degree, 14 in (356 mm) sweeps, penetration was very good in secondary and light primary tillage and it was easy to obtain correct seeding depth. However, due to increased sweep pitch at higher draft, effectiveness of the Concord model ATD 2012 air till drill would be reduced for heavy primary tillage. Penetration tended to be deeper in the middle portion of the cultivator due to the added weight of the applicator hitch on the cultivator.

The cultivator caster wheels were positioned in the front at the center of each section so that each set of caster wheels supported about 20% of the total cultivator weight, while the packing tires supported 60% of the total cultivator weight, providing good flotation in soft ground. In addition, each set of center wheels supported about 20% of the total suction force while each packing gang supported 30%. Cultivator or applicator sinking was not a problem in moderately soft soils. The applicator was supported by the cultivator, which did contribute to cultivator sinking in soft soils.

Trash Clearance: The Concord model ATD 2012 air till drill had very good trash clearance. In heavy, loose trash it was necessary to raise the furrow levellers to allow trash to clear. However, with the levellers adjusted properly, trash clearance was better than with conventional hoe drills.

Skewing and Stability: The Concord model AS1002 air system and model ATD 2012 air till drill combination was very stable and sideways skewing occurred only in very hilly conditions. The cultivator shank pattern was symmetrical and did not impose any side forces on the cultivator during normal tillage. When equipped with 14 in (355 mm) sweeps, the cultivator had to skew more than 1.5 degrees to miss weeds. Throughout the evaluation period, in normal seeding conditions, skewing was never serious enough to cause weeds to be missed.

Reasonable care had to be observed on steep hillsides due to the high centre of gravity of the air system, especially with full grain and fertilizer tanks.

Weed Kill: Weed kill was good when equipped with 14 in (355 mm) sweeps. The 12 in (305 mm) shank spacing resulted in 2 in (50 mm) sweep overlap. Considerable sweep wear could occur before weeds were missed. However, to ensure adequate sweep lift is maintained for proper seed placement, sweeps should be replaced before significant wear is evident.

The packing wheels had a tendency to replant weeds in moist field conditions. Care had to be taken to ensure that seeding was not done when field conditions were too moist.

Fertilizer Banding: The Concord air seeder could be used for two types of fertilizer applications. It could be used for normal fertilizer application at seeding time by metering fertilizer from one tank and grain from the other and applying both through the same seed boots. When equipped with chisel points and the supplied fertilizer boots (FIGURE 16), it could also be used for fertilizer banding.

Banding is a relatively new method of fertilizer application on the prairies. Experimental results suggest that placing fertilizer in compact bands from 1.5 in (35 mm) below seed depth to twice seeding depth is desirable for fall fertilizer application. This requires the use of chisel points or banding knives to obtain sufficient depth and minimize soil disturbance and banding boots to minimize fertilizer spreading.

Due to the intermediate duty characteristics of the Concord Model ATD 2012 air till drill shanks, banding suitability of the unit was restricted to use in secondary and light primary field conditions. The Concord worked well for fertilizer banding in these conditions. Fertilizer granules were placed in a band about 1 in (25 mm) wide. Vertical fertilizer distribution generally ranged from chisel tip depth to 0.4 in (10 mm) above chisel tip depth.

Wider fertilizer bands were obtained in lumpy soil conditions.

When using the front or rear meter only, fertilizer application rates of 169 lb/ac (188 kg/ha) were possible. When using both meters, the air supply at maximum fan speed was adequate for a maximum application rate of 263 lb/ac (297.0 kg/ha) with the 20 ft (6.0 m) cultivator at 5.5 mph (9.0 km/h). Higher rates resulted in plugging.

Banding suitability at 5.5 mph (9 km/h) was reduced for application rates greater than 200 lb/ac (226 kg/ha) due to unacceptable distribution uniformity at higher rates (FIGURE 11).

The Concord model AS1002 tanks and metering system were sealed against moisture entry. However, when exposed to driving rain some moisture entered the metering system, causing the fertilizer to cake. The metering system should be checked after rainfall for any caking of fertilizer to avoid errors in application rates. To prevent corrosion, all unprotected components should be cleaned and oiled periodically when applying fertilizer.

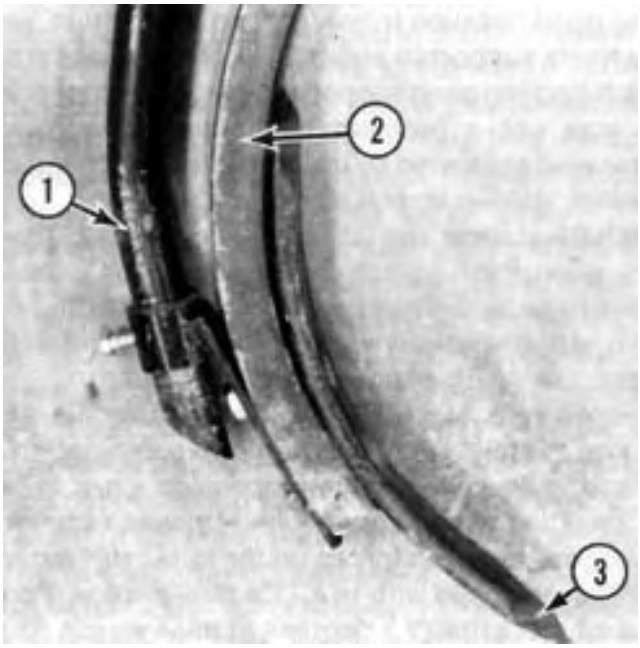

FIGURE 16. Concord Banding Boot: (1) Banding Boot, (2) Cultivator Shank, (3) Chisel Point.

EASE OF OPERATION

Dual Purpose Operation: The applicator, since it towed behind, could be detached in less than 15 minutes, providing the primary header and hoses were left on the cultivator, allowing the cultivator to be used as a dual purpose machine for both seeding and seasonal tillage. However, with the packing wheels as part of the cultivator, tillage work in moist conditions is not recommended due to replanting of weeds and poor weed kill. If all hoses and the header were removed from the cultivator, it took two men about 2 hours to detach the applicator from the cultivator. A hoist or front end loader was required to remove the header stand from the cultivator.

Hitching: The hitch jack provided was not capable of lifting high enough to enable hitching to all tractors encountered during the test (FIGURE 17). It is recommended that the manufacturer consider supplying a jack capable of lifting heights to accommodate varying tractor hitch heights.

Hitching also required hook-up of two hydraulic lines with quick couplers and an electronic coupler for the electronic monitoring

system.

Filling: A drill fill or grain auger was needed to fill the applicator tanks. Because the filler openings were located 7 ft (2.1 m) above ground level, hand filling was impractical as it necessitated carrying the grain or fertilizer up the access ladder. The large 20 x 30 in (508 x 762 mm) front and rear tank openings gave ample room for auger filling.

The filler lids were hinged and were latched by a simple toggle latch. The lid stops mounted on the hinge rod tended to slip out of position, allowing the lids to open completely (FIGURE 18). Closing of the lids was then inconvenient. It is recommended that the manufacturer consider improving the lid stops to provide for easier and safer closing of the tank lids.

Each tank held 50 bu (1820 L).

FIGURE 17. Inadequate Lifting Height of Hitch Jack.

FIGURE 18. Inconvenient Tank Lid Closing.

Visibility: Since the applicator towed behind, visibility of the cultivator was unobstructed by the applicator. This was considered a desirable feature of the Concord air seeder.

Maneuverability: The applicator-cultivator combination manoeuvred quite well in the forward direction. Some packer wheel skidding was evident during sharp turns. Because of the additional pivot point at the hitch between the applicator and the cultivator, the cultivator-applicator combination was difficult to manoeuvre while backing up.

Monitoring: The test machine was not supplied with a material flow monitoring system. Two warning lights for power on and meter operation were included in an electrical box which was placed in the tractor cab. A warning light connected to a flutter switch to indicate low fan rpm was located on the air seeder. Because plugging of the distribution system was difficult to detect from the tractor seat, it is recommended that a flow monitoring system be made available as optional equipment.

Seed and Fertilizer Boots: The occasional seed boot plugged with wet soil while seeding in moist conditions. No boot plugging problems were encountered while banding fertilizer.

Cleaning: Access to the fluted metering rolls for cleaning was possible with full tanks, by closing the tank metering door above each meter. Complete meter removal took one man approximately half an hour. Each tank was equipped with a four inch opening at the end of the seed cup metering door to allow for easy clean out. The meter hand crank (FIGURE 1) was also a convenient aid for meter clean out. Access to the tanks was possible through the tank filler openings by removal of the tank opening screens. The screens could be removed without tools.

Area Meter: The Concord Model AS1002 was equipped with a meter drive shaft revolution counter for area measurement. The operator's manual gave a constant for calculating the number of acres covered, based on the starting and ending readings from the revolution counter, for various machine widths. The constant, when used with the 20 ft (6.0 m) cultivator, gave area reading about 5 percent low.

Transporting: The Concord Model AS1002 and Concord Model ATD 2012 air till drill were easily placed in transport position in less than five minutes. Four hydraulic cylinders raised the cultivator out of the ground. The cultivator was locked in transport position by installing stop collars on the back two hydraulic cylinders. The clip pin for the jaw clutch on the meter drive had to be removed for transporting.

The assembly towed well in transport position. Overall transport height and width were 11.0 ft (3.4 m) and 20.3 ft (6.2 m) respectively, requiring care when travelling on public roads.

EASE OF ADJUSTMENT

Lubrication: Lubrication was inconvenient with poor access to the grease fittings on the meter drive line. It is recommended that the manufacturer consider improving accessibility to the grease fittings on the meter drive line.

Eleven fittings on the applicator and forty nine on the cultivator required servicing. One gear box required checking every 100 hours. A service schedule was supplied in the operator's manual.

Engine Servicing: The engine was conveniently located at the rear of the applicator for easy access. The recommended oil change interval for the engine was 25 hours. Collecting of the oil when changing was difficult due to the location of the oil drain plug (FIGURE 19). It is recommended that the manufacturer consider modifications to provide for convenient draining and collecting of oil from the fan engine.

Engine fuel consumption was about 0.67 gal/hr (3.0 L/hr). The engine could run about 18 hours on one filling of the 12 gal (54.6 L) tank.

FIGURE 19. Engine: (1) Oil Drain Plug.

Application Rate: Application rate was changed using a wrench, by turning the gear on each meter door for the amount of opening required above each meter flute. The flow control plate was set to the same position as the metering door. Changing of the metering door and control plate was difficult due to binding of the metering door and interference between the control plate and meter opening. It is recommended that the manufacturer consider improving metering door and control plate adjustment.

The gate opening adjustment was calibrated in increments of 0.25 from 0 to 16 (FIGURE 20). Calibration charts, in pounds per acre, were shown in the operator's manual. Additional meter flutes were available for speciality crops an higher application rates.

The metering scale allowed relatively precise seeding rate adjustment. For example, changing the meter setting by 0.25 in Tower canola, changed seeding rate by only 0.33 lb/ac (0.36 kg/ha).

Depth Adjustment: Seeding depth was conveniently adjusted by changing the cylinder stop collars on the rear two hydraulic cylinders on the cultivator. A cylinder collar stop chart was provided to indicate the number of collars required to seed at a desired depth.

As is common with series hydraulic systems, to maintain the two winged sections at the same height, periodic synchronization of the cylinders by completely extending them to the fully raised position was necessary.

The Concord air till drill frame was levelled from front to back by positioning the hitch stop bolt in one of five positions and from side to side by adjusting threaded connectors on each depth cylinder. These adjustments required the use of tools.

FIGURE 20. Application Rate Adjustment: (1) Meter Door, (2) Gate Opening Scale, (3) Flow Control.

RATE OF WORK

The Concord air seeder was operated at speeds ranging from 3 to 6 mph (5 to 10 km/h). Overall best performance in terms of weed kill and seed placement was obtained at speeds of 4.5 to 5.5 mph (7 to 9 km/h). This resulted in field work rates for the 20 ft (6 m) unit ranging from 10 to 14 ac/hr (4 to 5.6 ha/hr). Using both tanks when seeding wheat at a rate of 75 lb/ac (85 kg/ha), about 80 ac (32 ha) could be seeded before refilling. Using only the front tank, about 40 ac (16 ha) could be seeded before refilling. This compares to 23 to 35 ac (9.2 to 14 ha) between refills for most conventional drills of similar widths.

POWER REQUIREMENTS

Draft Characteristics: Attempting to compare draft (drawbar pull) requirements of different makes of intermediate duty cultivators usually is unrealistic. Draft requirements for the same cultivator, in the same field, may vary by as much as 30 percent in two different years, due to changes in soil conditions. Variations in soil conditions affect draft much more than variation in machine make, usually making it impossible to measure any significant draft difference between makes of intermediate duty cultivators. The power requirements given in TABLES 2, 3 and 4 are based on average draft requirements of 17 makes of cultivators in 52 different field conditions. Additional draft due to the Concord Model AS1002 applicator with full tanks has been included.

Tractor Size: TABLES 2 to 4 show tractor sizes needed to operate the Concord Model AS1002 applicator and Concord Model ATD 2012 air til drill in light and heavy secondary tillage as well as in primary tillage. Tractor sizes have been adjusted to include tractive efficiency and represent a tractor operating at 80 percent of maximum power on a level field. The sizes presented in the tables are the maximum power take-off rating as determined by Nebraska tests or as presented by the tractor manufacturer. Selected tractor sizes will have ample power reserve to operate in the stated conditions.

TABLE 2. Tractor Size (Maximum Power Take-off Rating, Hp (kW)) to Operate the Concord Model AS1002 Applicator, with 20 ft (6 m) Concord Model ATD 2012 air till drill in Light Secondary Tillage.

DEPTH		SPEED mph (km/h)							
in	(mm)	4	(6.4)	5	(8)	6	(9.6)	7	(11.2)
2	(50)	31	(23)	42	(32)	66	(42)	71	(53)
3	(75)	45	(34)	60	(45)	77	(58)	96	(72)
4	(102)	59	(44)	78	(59)	99	(74)	121	(91)

TABLE 3. Tractor Size (Maximum Power Take-off Rating, hp (kW)) to Operate the Concord Model AS1002 Applicator, with 20 ft (6 m) Concord Model ATD 2012 air till drill in Heavy Secondary or Light Primary Tillage.

DEPTH		SPEED mph (km/h)							
in	(mm)	4	(6.4)	5	(8)	6	(9.6)	7	(11.2)
2	(50)	46	(35)	62	(47)	81	(61)	101	(76)
3	(75)	63	(47)	84	(63)	106	(80)	131	(98)
4	(102)	81	(61)	105	(79)	132	(99)	161	(121)

TABLE 4. Tractor Size (Maximum Power Take-off Rating, hp (kW)) to Operate the Concord Model AS1002 Applicator, with 20 ft (6 m) Concord Model ATD 2012 air till drill in Heavy Primary Tillage.

DEPTH		SPEED mph (km/h)							
in	(mm)	4	(6.4)	5	(8)	6	(9.6)	7	(11.2)
2	(50)	45	(34)	60	(45)	77	(58)	96	(72)
3	(75)	80	(60)	104	(78)	130	(98)	157	(118)
4	(102)	115	(86)	147	(110)	182	(137)	218	(164)

Tractor size may be determined by selecting the desired tillage depth and speed from the appropriate table. For example, in light secondary tillage at 3 in (75 mm) depth and 5 mph (8 km/h), a 60 hp (45 kw) tractor is needed to operate the seeding unit. In heavy secondary or light primary tillage at the same depth and speed, an 84 hp (63 kW) tractor is needed, while in heavy primary tillage a 104 hp (78 kW) tractor is required.

OPERATOR SAFETY

Although the ladder provided convenient access to the tank openings, caution had to be used. The gas engine exhaust was directed towards the ladder (FIGURE 21), causing the ladder to become hot enough to result in injury to the operator. It is recommended that the manufacturer consider redirecting the engine exhaust to improve operator safety.

FIGURE 21. (1) Engine Exhaust, (2) Applicator Ladder.

Extreme caution is needed in transporting most cultivators, to avoid contacting power lines. Minimum power line heights vary in the three prairie provinces. In Saskatchewan the energized line may be as low as 17 ft (5.2 m) over farm land or over secondary roads. In Alberta and Manitoba, the neutral ground wire may be as low as 15.7 ft (4.8 m) over farmland. In all three provinces, power lines in farmyards may be as low as 15 ft (4.6 m).

Transport height of the 20 ft (6.0 m) wide test machine was 11 ft (3.4 m), permitting safe transport under prairie power lines. However, larger models of the cultivator may be high enough to contact prairie power lines. The legal responsibility for safe passage under utility lines rests with the machinery operator and not with the power utility or the machinery manufacturer. All provinces have regulations governing maximum permissible equipment heights on various public roads. If height limits are exceeded, the operator must contact power and telephone utilities before moving.

The Concord Model AS1002 with Concord Model ATD 2012 air till drill was 20.3 ft wide in transport position. This necessitated caution when towing on public roads, over bridges and through gates.

Sufficient depth cylinder stops could be placed around the cylinder shafts to lock the cylinder in the raised position. A slow moving vehicle sign was not provided on the rear of the applicator for transport. It is recommended that a slow moving vehicle sign be supplied as standard equipment.

The Concord Model AS1002 with Concord Model ATD 2012 air till drill, towed well at speeds up to 17 mph (28 km/h).

The Concord Model AS1002 applicator was pulled behind the cultivator and the fan engine was located at the rear of the applicator. Due to the remote fan engine location, the operator station noise level in most modern tractor cabs was virtually unaffected by fan or fan engine noise.

OPERATOR'S MANUAL

The operator's manual for the Concord Model AS1002 applicator contained useful information on safety, assembly, adjustment, specifications, maintenance and operation. A detailed parts list was also included. Calibration charts, calibrated in pounds per acre, were included in the operator's manual. A conversion chart in SI (metric) units was also included.

A detailed parts list was provided for the model ATD 2012 air till drill but no operating instructions were included.

MECHANICAL HISTORY

TABLE 5 outlines the mechanical history of the Concord Model AS1002 air seeder during 138 hours of operation while processing about 1505 ac (602 ha). The intent of the test was evaluation of functional performance. An extended durability evaluation was not conducted.

TABLE 5. Mechanical History

ITEM	OPERATING HOURS	EQUIVALENT FIELD AREA ac	(ha)
Applicator			
-the throttle cable on the gas engine worked loose and was fixed at	70.5	835	(343)
-the latch on the tank lid broke and was replaced at	123, 130, 138	1265, 1320, 1445	(510, 534, 578)
-the support bracket for the engine failed due to vibration and was rewelded at	130	1320	(534)
-the fan belt on the gas engine failed and was replaced at	135, 138	1400, 1445	(560, 578)
-the electrical wiring on the gas engine failed and was replaced at	138	1445	(578)
-new rubber wipers were supplied and installed above both meters at	end of test		
-a frame reinforcing kit was supplied and installed at	end of test		
Cultivator			
-chisel points and banding boots were installed at	21	220	(88)
-frame reinforcing was installed at	54	560	(224)
-a new adjustable hitch was installed at	54	560	(224)
-all sweeps were replaced at	100	1050	(420)
-the bolt on the hitch tongue was worn and replaced at	123	1265	(510)
-the front pivot plate broke and was replaced at	135	1400	(560)

Manufacturer's Modifications to the Applicator: Two modification packages were supplied at the end of the test, but were not evaluated. New rubber wipers and rubber deflectors were supplied to prevent material from leaking past the meters. A frame reinforcing kit, consisting of two gussets, was supplied to strengthen the area where the hitch attaches to the applicator tanks.

Manufacturer's Modifications to the Cultivator: Modifications performed during the evaluation included replacing the cultivator hitch tongue and reinforcing of the packing wheel frame and cultivator frame. The hitch tongue was replaced with an adjustable hitch consisting of five positions with a 12 in (305 mm) total height adjustment (FIGURE 22). Strengthening of the packing wheel included welding gussets on the packing wheel arms and welding 4 x 4 in (102 x 102 mm) tubing between each arm (FIGURE 23).

The cultivator frame was reinforced by welding gussets between the lift members and the lateral members of the cultivator (FIGURE 24). In addition, 4 x 4 in (102 x 102 mm) tubing was welded between the lateral members of the cultivator frame (FIGURE 25).

Hitch Tongue: The latch holding the pin in position on the rear hitch tongue broke off, allowing the pin to turn freely. This caused the pin to wear. The pin was replaced and a grease fitting added. No further problems were encountered.

Front Pivot Plate: There were two pivot locations between the cultivator wings which allowed the cultivator to follow land contours. The front pivot plate failed (FIGURE 26) due to metal fatigue and was rewelded. It is recommended that the manufacturer consider modifications to eliminate pivot plate failure.

FIGURE 22. New Cultivator Hitch.

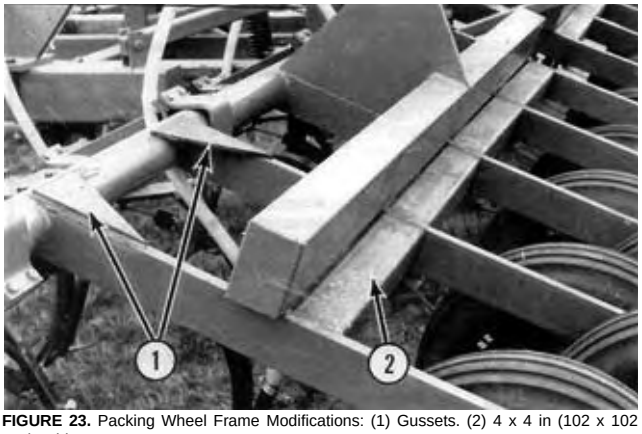

FIGURE 23. Packing Wheel Frame Modifications: (1) Gussets. (2) 4 x 4 in (102 x 102 mm) Tubing.

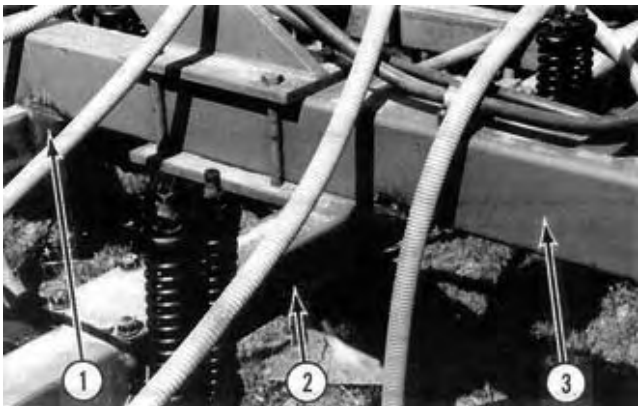

FIGURE 24. Cultivator Frame Reinforcing: (1) Gussets, (2) Lift Member, (3) Lateral Members.

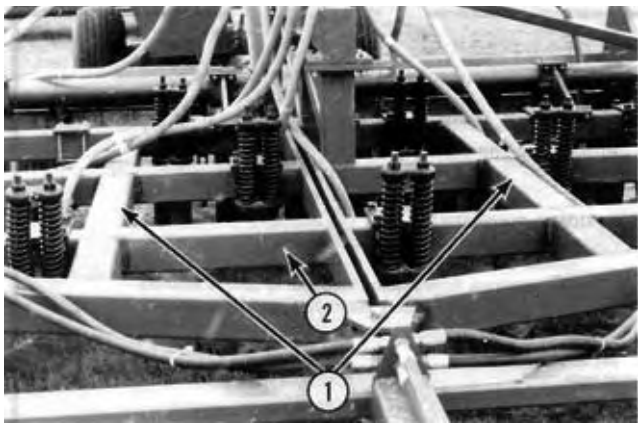

FIGURE 25. Cultivator Frame Reinforcing: (1) 4 x 4 in (102 x 102 mm) Tubing, (2) Lateral Members.

FIGURE 26. Front Pivot Joint Failure.

APPENDIX I

SPECIFICATIONS

(A) AIR SYSTEM

MAKE:	Concord Air System
MODEL:	AS1002
SERIAL NUMBER:	SAS0040
MANUFACTURER:	Concord Inc. 2800 - 7 Avenue North Fargo. North Dakota 58102 Tel. 701-280-1260
DIMENSIONS:	
-width	8.0 ft (2438 mm)
-length	15.0 ft (4572 mm)
-height	9.75 ft (2972 mm)
-maximum ground clearance	1.20 ft (356 mm)
-wheel tread	6.60 ft (2012 mm)
METERING SYSTEM:	
-type	steel fluted roller
-number of meters	2
-drive	gearbox driven by electric clutch off of left applicator wheel
-adjustment	vary gate opening above fluted roller
-airstream loading	pressurized tanks transfer to openers pneumatic conveyance through divider headers and hoses
TANK CAPACITIES:	
-front	50 bu (1820 L)
-rear	50 bu (1820 L)
TOTAL	100 bu (3640 L)
FAN:	
-type	forward curve centrifugal
-make	Crary
-maximum operating speed	4800 rpm
-drive double	V-belt
ENGINE:	
-make	Tecumseh air cooled 4-cycle gas
-model	OH 180
-starting system	12-volt electric
-fuel tank capacity	12 gal (55 L)
HITCH:	
-vertical adjustment range	7.5 in (191 mm) in 4 positions
WHEELS:	
-single wheels	2, 16.5L - 16.1 - SL, 10 Ply
NUMBER OF LUBRICATION POINTS:	11 grease fittings 2 wheel bearings

OPTIONAL EQUIPMENT:
- -hydraulic fan drive from tractor remote
- -remote diesel fan drive
- -1-1/2 inch hose from primary manifold to ground openers
- -1 inch hose from primary manifold to ground openers*

*Supplied on test machine

(B) CULTIVATOR

MAKE:	Concord Air Tilt Drill
MODEL:	ATD 2012
SERIAL NUMBER:	TP0062
MANUFACTURER:	Concord Inc. 2800 - 7 Avenue North Fargo, North Dakota 58102 Tel. 701-280-1260
SHANKS:	
-number	20
-lateral spacing	12 in (805 mm)
-trash clearance (sweep to frame)	24 in (610 mm)
-number of shank rows	3
-shank cross section	1-1/4 in x 2 in (81.8 x 50 mm)
-shank stem angle	43°
-sweep hole spacing	2-1/2 in (64 mm)
-sweep bolt size	1/2 in (13 mm)
HITCH:	
-vertical adjustment range	12 in (305 mm) in 5 positions
DEPTH CONTROL:	hydraulic
FRAME:	
-cross section	4 x 4 in (1 02 x 102 mm), 3/4 x 4 in (19 x 102 mm)
-thickness	1/4 in (6.4 mm)
TIRES:	
-packing wheels	20, 6.70 - 15, 4 ply
-caster wheels	4, 6.70 - 15, 4 ply
NUMBER OF LUBRICATION POINTS:	49
HYDRAULIC CYLINDERS:	
-depth control	2, 3 x 8 in (76 x 203 mm) 2, 3-1/4 x 8 in (83 x 203 mm)

OPTIONAL EQUIPMENT:
- -eleven width options ranging from 20 to 40 ft (6 to 12.2 m)
- -frame mounted land levellers

(C) OVERALL SPECIFICATIONS FOR APPLICATOR-CULTIVATOR ASSEMBLY

DIMENSIONS:	**FIELD POSITION**	**TRANSPORT POSITION**
-width	20.3 ft (6187 mm)	20.3 ft (6187 mm)
-length	40.6 ft (12375 mm)	40.6 ft (12375 mm)
-height	11.0 ft (8858 mm)	11.0 ft (8858 mm)
-maximum ground clearance	14.0 in (856 mm)	14.0 in (856 mm)
-wheel tread	19.0 ft (5791 mm)	19.0 ft (5791 mm)
-effective seeding width	20.0 ft (6096 mm)	

WEIGHTS:	**TANKS EMPTY**	**TANKS FULL OF WHEAT**
APPLICATOR:		
-left wheel	1500 lb (675 kg)	4900 lb (2205 kg)
-right wheel	1520 lb (684 kg)	4950 lb (2228 kg)

CULTIVATOR (with applicator attached)	**FIELD POSITION**	**TRANSPORT POSITION**
-hitch	210 lb (95 kg)	210 lb(95 kg)
-left front caster wheels	1900 lb (855 kg)	2000 lb (900 kg)
-right front caster wheels	1800 lb (810 kg)	1930 lb (869 kg)
-left packer gang	2620 lb (1179 kg)	1850 lb (833 kg)
-right packer gang	2680 lb (1206 kg)	2400 lb (1080 kg)
TOTAL, TANKS EMPTY	12230 lb (5504 kg)	
TOTAL, TANKS FULL OF WHEAT		18240 lb (8210 kg)

APPENDIX II

MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

Excellent	Very Good
Good	Fair
Poor	Unsatisfactory

SUMMARY CHART

CONCORD AIR SEEDER

SEEDING	
-secondary field conditions	**good**
-light primary field conditions	**good**
-heavy primary field conditions	not recommended
FERTILIZER BANDING	
-secondary field conditions	**good**
-light primary field conditions	**good**
-heavy primary field conditions	not recommended
-application rate (acceptable CV)	up to 200 lb/ac (244 kg/ha)
METER CALIBRATION	front and rear tank meters differed
-wheat chart accuracy	**good**
-barley chart accuracy	**good**
-oats chart accuracy	**good**
-fertilizer chart accuracy	**good**
-canola chart accuracy	**very good**
DISTRIBUTION UNIFORMITY	
-wheat	acceptable
-barley	acceptable
-oats	acceptable
-fertilizer	acceptable up to 200 lb/ac (244 kg/ha)
-canola	acceptable
EFFECT OF FIELD VARIABLES	field bounce, ground speed, and field slope had little effect on metering rates
GRAIN DAMAGE	within acceptable limits
SEED PLACEMENT	**good**
EASE OF ADJUSTMENT	seeding rate difficult to set
RATE OF WORK	10 to 14 ac/hr (4 to 5.6 ha/hr)
POWER REQUIREMENTS	
-light primary tillage at 3 in (75 mm) and 5 mph (8 km/h)	= 84 hp (61 kW)
-light secondary tillage at 3 in (75 mm) and 5 mph (8 km/h)	= 60 hp (45 kW)

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