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Evaluation Report 39

Great Northern Model 902 CE Field Sprayer

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

Great Northern Model 902 CE Field Sprayer

Manufacturer and Distributor:

Richardson Manufacturing Limited
521 Golspie Street
Winnipeg, Manitoba
R2L 2A5

Retail Price:

The model 902 CE sprayer has been superseded by the model 904, which is 1016 mm (40 in) wider and has a polyethylene tank. Retail price of the model 904, April, 1977, f.o.b. Winnipeg is $2,319.00 (less nozzle tips).

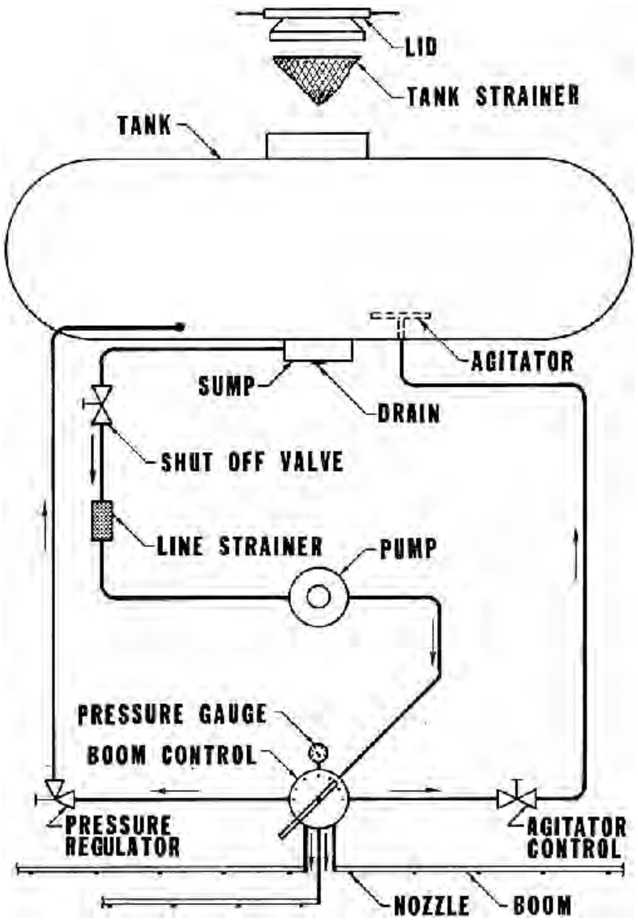

Figure 1. Flow Diagram for Great Northern 902 CE.

Summary and Conclusions

Functional performance of the Great Northern model 902 CE field sprayer was good. An extended durability test was not conducted. Durability of the 902 CE during the functional evaluation was fair.

The 902 CE performed satisfactorily at speeds up to 12 km/h (7.5 mph) resulting in a field capacity of 21 ha/h |(53 ac/ h). The tandem boom castor wheel assemblies performed well, especially on rough fields, however, castor wheel shimmy was excessive above 10 km/h (6 mph) unless the castor springs were over tightened. The boom ends were quite stable, however, considerable whip occurred at the centre of each boom.

The 902 CE is sold without spray nozzle tips and the operator's manual advises the user on nozzle tip selection for specific conditions. Nozzle distribution patterns were very uniform at pressures above 205 kPa (30 psi) if 80° nozzle tips were used. Distribution patterns for 65° tips were much less uniform. Low volume 65° tips had unacceptable distribution at pressures below 280 kPa (41 psi).

Pump capacity with the Hypro 7700 pump, supplied as standard equipment, was inadequate for some spraying conditions, depending on nozzle tip selection. The optional, larger Hypro 1700 pump would have sufficient capacity for most conditions. Pressure losses through the plumbing system were minimal. Filtering was adequate and strainer plugging was infrequent. In selecting nozzles, the user must select nozzle strainers, which match the nozzle tip size.

Controls could not be reached from most tractor seats. Boom angle was easily adjusted without the use of tools but boom height adjustment was inconvenient. Hitching to a tractor, folding into transport and servicing all were convenient. The 902 CE was quite maneuverable in transport. All lubrication points were accessible. The tank filler and tank drain plug were conveniently positioned. The operator's manual was excellent. It contained a very comprehensive discussion on selection of pumps and nozzle tips for various spraying conditions.

Several mechanical problems occurred during the test: The boom extension fittings and nozzles leaked. The hitch clevis deformed and the castor frames deformed, damaging the booms, boom support and boom extension hoses. The rocker arm grease fittings would not accept grease.

Recommendations

It is recommended that the manufacturer consider:

1. Supplying 80° nozzle tips as standard equipment for the Western Canadian market.
2. Modifications to reduce boom castor wheel shimmy.
3. Modifications to eliminate deformation of the boom castor wheel assembly.
4. Supplying a high capacity 100 mesh strainer at the tank filler opening.
5. Clarifying to purchasers the need to properly size nozzle strainers to the type of nozzle tips used and to select a pump of sufficient capacity to suit the type of nozzle tips used. Alternatively, for the Western Canadian market, supplying 100 mesh nozzle strainers and a 1.2 L/s (15 gal/min) pump as standard equipment as this will suit all commonly used nozzles.
6. Modifications to make pressure adjustments less sensitive.
7. Modifications so that controls can be reached from most tractor seats.
8. Modifications to prevent leakage at the boom extensions.
9. Modifications to reduce whip at the centre of the boom sections.
10. Modifications to eliminate hitch clevis deformation.
11. Modifications so that the rocker arm grease fittings accept grease.
12. Preparing the operator's manual in SI (metric) units as well as English units and including servicing instructions.
13. Supplying a pressure gauge calibrated in SI (metric) units.
14. Supplying a slow moving vehicle sign.

Chief Engineer: E.O. Nyborg
Senior Engineer: E.H. Wiens
Project Engineer: K.W. Drever

The Manufacturer States That:

With regard to recommendation number:

1. As a manufacturer we do not believe that it is advisable to supply tips with a sprayer. If we were supplying machines to a specific area that used the same type of chemical on the same crop, it would be advisable. We are selling across the prairies and into the United States and we could quite easily supply a tip that the farmer would not find satisfactory. We have taken the approach that we will provide the most information possible on choosing the correct tip. We have done this in our operator's manual and feel this is the correct approach.
2. We will be incorporating heavier springs in the 1978 production.
3. The castor wheel assembly has been strengthened for 1977 production.
4. We are planning to provide a stainless steel strainer for the tank .ller opening in 1978.
5. The proper selection of pumps and nozzles is completely

covered in the operator's manual.
6. This is being taken into consideration for 1978 models.
7. Suitable modifications, for moving the control valve stand and adjustment forward, have been made to the 1977 models.
8. Modifications to prevent leakage of the fittings have been made.
9. This recommendation is being taken under consideration.
10. The hitch has been strengthened on 1977 models.
11. The grease fittings on the rocker arms have been moved to the side.
12. We are inserting metric units as well as Imperial units in the 1977 operator's manual. We are also including servicing instructions.
13. Pressure gauges will be supplied in metric, as well as in pounds per square inch, as soon as they become readily available.
14. Consideration is being given to supplying a bracket so a slow moving vehicle sign can be attached.

General Description

The Great Northern model 902 CE is a trailing boom type sprayer. The trailer is mounted on tandem axles and each boom is equipped with a tandem walking beam castor assembly. The low profile 1818 L (400 gal) galvanized steel tank is equipped with hydraulic agitation and a fluid level indicator. The 902 CE has 35 nozzles spaced at 508 mm (20 in) resulting in a spraying width of 17,780 mm (58.3 ft). Boom height and spray angle are adjustable. The booms fold back for transport. Controls are mounted on a pedestal at the front of the trailer. The 540 rpm nylon roller pump is driven from the tractor power take-off.

Figure 1 shows the flow diagram for the 902 CE while complete specifications are given in Appendix I.

Scope of Test

The Great Northern 902 CE was operated for 50 hours in the conditions shown in Table 1, while spraying about 974 ha (2408 ac). It was evaluated for quality of work, distribution patterns, nozzle wear, pump capacity, ease of operation, operator safety and suitability of the operator's manual.

Table 1. Operating Conditions

Chemical Applied	Hours	Speed		Spraying Rate		Field Area	
		km/h	mph	ha/h	ac/h	ha	ac
2, 4-D	39	11	7	20	49	773	1911
Banvel	8	11	7	20	49	159	392
Water	3	8	5	14	35	42	105
TOTAL	50					974	2408

Results and Discussion

QUALITY OF WORK

Distribution Patterns: The 902 CE was not equipped with nozzle tips. TeeJet 6502 (65°) nozzles were purchased to match the 50 mesh nozzle strainers supplied with the sprayer. The nozzles had an orifice large enough to pass foreign material, which the 50 mesh strainers did not screen out.

Figures 2 and 3 show the spray distribution along the length of the boom when equipped with the 65° TeeJet 6502 brass nozzles and operated at 140 and 275 kPa (20 and 40 psi). The coefficient of variation[1] at 140 kPa (20 psi) was 21% with application rates along the boom varying from 54 to 115 L/ha (4.8 to 10.2 gal/ac) at 8 km/h (5 mph). High concentrations of spray occurred below each nozzle with low application between nozzles due to insufficient spray overlap. At a pressure of 275 kPa (40 psi) the spray overlap between nozzles improved, resulting in a coefficient of variation of 10% (Figure 3). Application rates along the boom varied from 88 to 130 L/ha (7.8 to 11.6 gal/ac) at a speed of 8 km/h (5 mph).

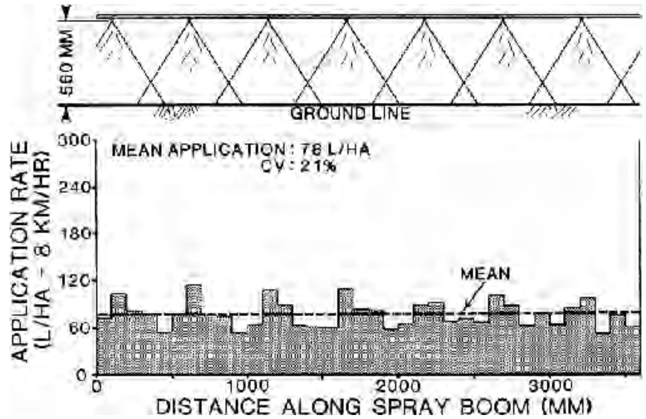

Figure 2. Distribution Pattern for a Section of Spray Boom at 140 kPa (20 psi) with TeeJet 6502 (65°) Nozzles, 560 mm (22 in) above the Ground.

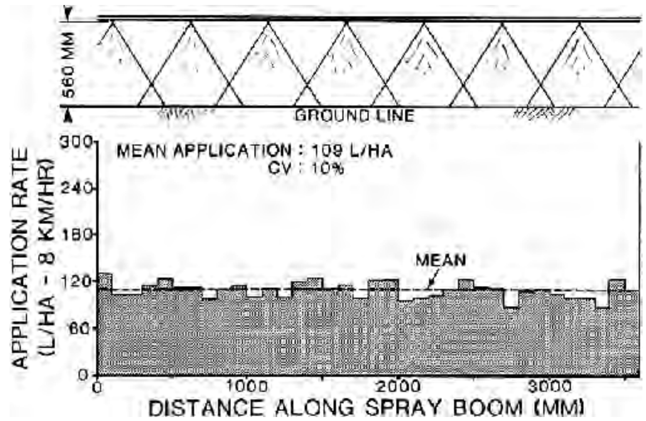

Figure 3. Distribution Pattern for a Section of Spray Boom at 275 kPa (40 psi) with TeeJet 6502 (65°) Nozzles, 560 mm (22 in) above the Ground.

Figure 4 compares the spray pattern uniformity of four different nozzles at various pressures. The TeeJet 6501 has the same 65° spray angle as the TeeJet 6502, but only half the capacity. The TeeJet 8001 and 8002 have corresponding capacities to the above but have a spray angle of 80°. The 65° nozzles were tested at 560 mm (22 in) above ground and the 80° nozzles at 460 mm (18 in) above ground. Acceptable uniformity was obtained with the 6502 nozzles at pressures above 175 kPa (25 psi), while the 6501 nozzles had to be operated at pressures above 280 kPa (41 psi) to obtain acceptable spray distribution. Using 80° nozzles the distribution was acceptable at pressures above 165 kPa (24 psi) for 8001 nozzles and acceptable at pressures above 150 kPa (22 psi) for the 8002 nozzles. It is evident that the selection of 80° nozzles would improve spray distribution and allow spraying at lower pressures to reduce drift.

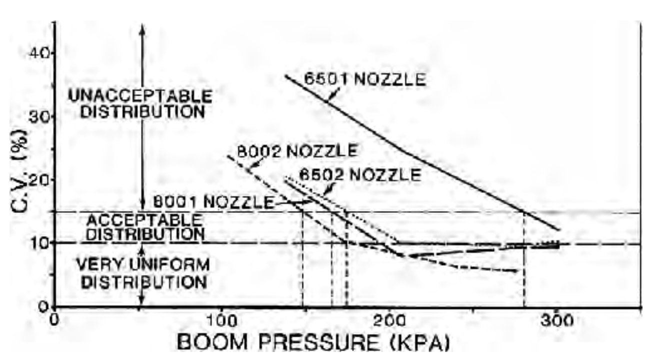

Figure 4. Spray Pattern Quality at Various Boom Pressures with 65° and 80° Nozzles.

[1]The coefficient of variation (CV) is a measure of distribution pattern uniformity. The lower the CV, the more uniform is the spray coverage. Some researchers claim that a CV below 10% indicates very uniform coverage while a CV above 15% indicates inadequate uniformity of coverage for chemicals having a narrow range of application rates. The CV 's shown in this report were determined in stationary laboratory trials. Field trials have shown that a CV in actual field conditions may be up to 10% higher than that obtained in stationary tests due to boom vibration and wind effects. Manufacturer recommendations for different chemicals vary as to the acceptable range of application rates. For example, 2,4-D solutions have a fairly wide range of acceptable rates (±14%) while chemicals such as Buctril M have a very narrow acceptable range.

Spray Drift: Research conducted by the Saskatchewan Research Council[2] indicates that drift at the edge of the spray pattern was about 3% for standard sprayer operation applying 56 L/ha (5 gal/ac) at 170 kPa (25 psi). Drift almost doubled when the spray pressure was increased to 275 kPa (40 psi). The drift was decreased by a factor of four when 112 L/ha (10 gal/ac) 65° nozzles were used. More recent tests indicate the 8002 nozzles are even more effective in reducing spray drift especially at higher wind speeds due to lower boom height and larger droplet size[3]. Therefore, for drift control and uniform distribution patterns either 80° nozzles or higher capacity 65° nozzles are desirable.

Use of End Nozzles: End nozzles could be used on the 902 CE. However, as stated in the operator's manual, this practice is not recommended since distribution patterns from end nozzles are poor and the drift hazard high. End nozzles should be restricted to use along roadsides, ditches and fence lines on calm days.

Use of Optional Nozzles: The nozzle clamp assembly (Figure 5) accepted a wide range of standard nozzle tips. Flat fan, flooding and cone type nozzles could be used, since boom height and angle were adjustable.

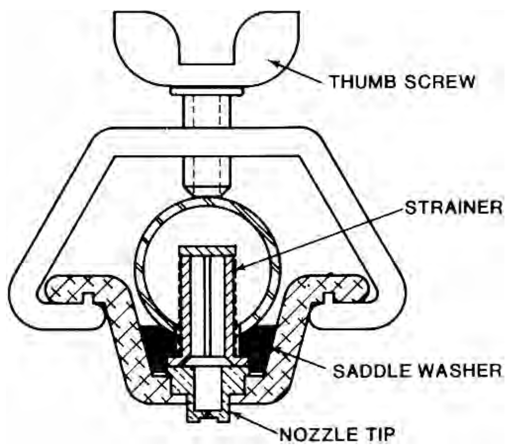

Figure 5. Cross Section of Nozzle.

Booms: The 902 CE was driven over a series of standard obstacles to determine boom stability. The obstacles were semi-circular in cross section with lifts of 40, 65 and 105 mm (1.6, 2.6 and 4.1 in). The boom castor wheels were driven over the obstacles at speeds of 6, 9 and 12 km/h (3.7, 5.6 and 7.5 mph). Horizontal boom movement in the direction of travel and vertical movement were measured at the boom end and midway between the castor wheels and trailer.

Figure 6 shows vertical boom movement (bounce) when the castor wheels were driven over the obstacles at 9 km/h (5.6 mph). The maximum vertical movement at the end of the boom was a lift of 140 mm (5.5 in) and a drop of 80 mm (3.1 in). This resulted in a variation in boom height above the ground from 480 mm (18.9 in) to 700 mm (27.6 in), compared to the correct boom height of 560 mm (22 in). Figure 7 compares the nozzle overlap at these three boom heights.

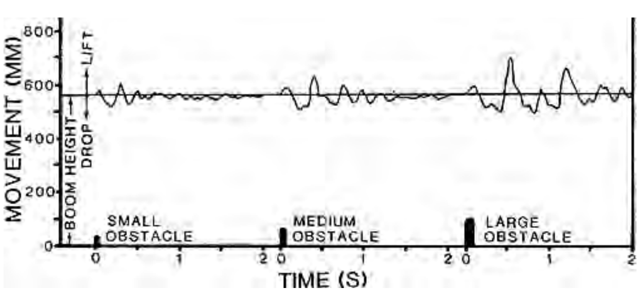

Figure 6. Vertical Boom Movement at Boom End (lift and drop) when the Boom Castor Wheels were Driven over Different Obstacles at a Forward Speed of 9 km/h (5.6 mph).

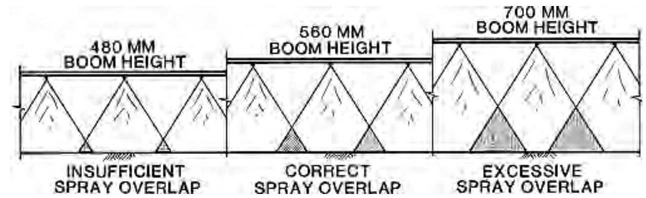

Figure 7. The Effect of Boom Lift and Drop on Spray Overlap.

The lift and drop at the centre of the boom were very similar to that at the boom end. Operation at 6 or 12 km/h (3.7 or 7.5 mph) caused vertical boom movements very similar to those at 9 km/h (5.6 mph).

Driving over an obstacle with the boom castor wheels also caused the forward speed of the boom to vary in relation to the tractor speed since the boom initially deflects rearward and then springs forward. Figure 8 shows the forward speed of the boom end relative to the ground when the boom wheels were driven over the standard obstacles. Boom forward speed is important since application rate is inversely proportional to speed (doubling the forward speed cuts the application rate in half). Assuming that the nozzle spray follows boom movement, the traces of speed in Figure 8 illustrate the resultant variation in application rates. High application rates occur at low speeds and low application rates occur at high speeds. Extremely high variations in application rates can result for short periods of time due to horizontal boom movement. For example, at a forward speed of 9 km/h (5.6 mph) driving over the 65 mm (2.6 in) obstacle caused boom speed to vary from 2 to 13 km/h (1.2 to 8.1 mph). Respective application rates would vary from 450 to 67 L/ha (40.1 to 6.0 gal/ac). This variation occurred in only 0.07 second during which time the sprayer travelled 156 mm (6 in). Speed changes due to horizontal movements were very similar on the 902 CE at all operating speeds.

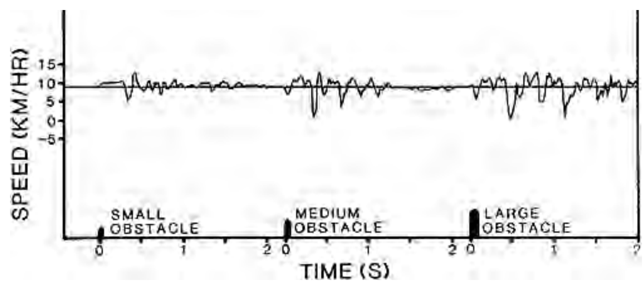

Figure 8. Variation in Boom End Speed when the Boom Castor Wheels were Driven over Different Obstacles at an Average Forward Speed of 9 km/h (5.6 mph).

The data presented in Figure 8 are based on the assumption that the nozzle spray output follows boom movement over very short periods of time (0.1 second). The extreme variations in application that are suggested due to boom movement indicate that more research is required on boom stability and its effect on nozzle discharge and spray distribution.

Measurements of boom stability and field observations indicated that the boom centers were weak, since boom movement was excessive at that point. The ends of the booms were relatively stable and the tandem castor assemblies were effective in reducing boom movement. The booms operated satisfactorily on rolling terrain and across gullies.

Radius Arm: The value of the safety release on the boom radius arms was questionable (Figure 9). Operation on rough fields caused the safety clamp to release. Operators then would over tighten the clamp so that it would not release. This rendered the safety release ineffective.

Castor Wheels: The castor wheels on the 902 CE operated satisfactorily only if the lock nut on the castor pivot was tightened so that the castor spring was completely compressed (Figure 10). If this was not done, the castors shimmied at speeds above 10 km/h (6 mph). A stronger spring would prevent castor shimmy.

The tandem castor wheel assembly operated well, especially when spraying rough fields.

Soil Compaction and Crop Damage: The trailer and boom wheels travelled, over about 2% of the total field area sprayed.

The wheel tread of the trailer was 1990 mm (6.5 ft) and matched

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[2]Maybank, J., Yoshida, K., "Droplet Deposition and Drift from Herbicide Sprays - Analysis of the 1973 Ground-Rig Trials", Saskatchewan Research Council Report No. P73-16, December, 1973, p. 65.

[3]Maybank, J., Yoshida, K., Shewchuk, S.R., "Comparison of Swath Deposit and Drift Characteristics of Ground-Rig and Aircraft Spray Systems - Report of the 1975 Field Trials", Saskatchewan Research Council Report No. P76-1, January, 1976, p. 16.

the wheel tread on most tractors used for spraying. The only crop damage, in addition to that caused by the tractor wheels, was that caused by the boom castor wheels. This was only 0.6% of the total area sprayed. The soil contact pressure beneath the boom castor wheels was about one-half that of an unloaded pickup truck. The average soil contact pressures under the sprayer wheels, with a full tank, are given in Table 2.

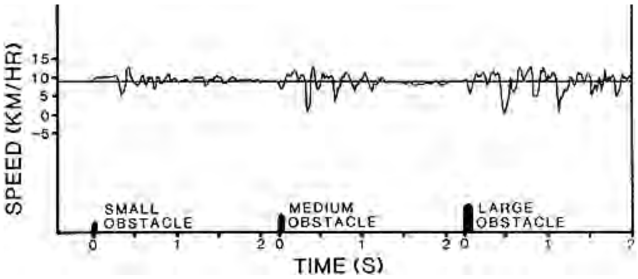

Figure 9. Safety Release on Radius Arm.

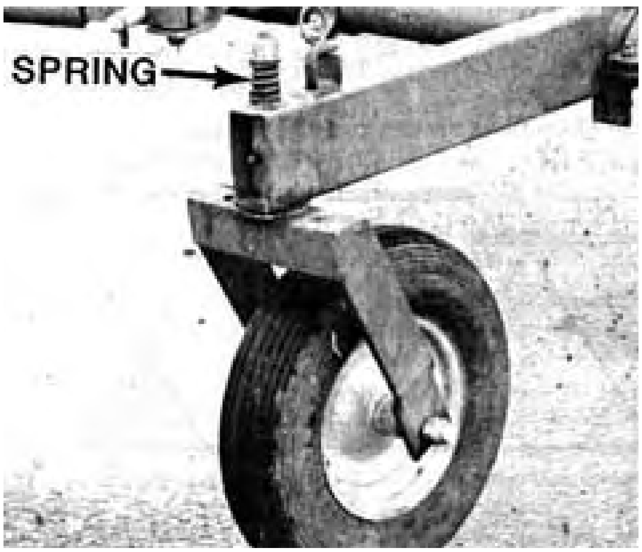

Figure 10. Castor Wheel Assembly.

Table 2. Soil Compaction by Sprayer Wheels

	Average Soil Contact Pressure* With Tank Full		Tire Track Width	
	kPa	psi	mm	in
Trailer Wheels Boom Castor Wheels	222 100	32 100	130 52	5.1 2.0

**For comparative purposes an unloaded pickup truck has an approximate soil pressure of 207 kPa (30 psi).*

Pressure Losses in Plumbing System: Pressures in the plumbing system were measured at the pump outlet, boom control, boom inlet and boom end. The pressure drop throughout the system was negligible, indicating that hose and fitting sizes were adequate.

Pressure Gauge: The pressure gauge read 14 kPa (2 psi) high at the beginning of the test and 28 kPa (4 psi) high at the end of the test. This was a significant error since calibration and nozzle spray patterns were affected.

The pressure gauge was calibrated in psi and kg/cm². The standard unit of pressure in the SI (metric) system is the pascal (Pa). Therefore, the metric calibration should be in Pa or kPa (kilopascal) to be consistent with the conversion to the SI system.

Tank Strainer: The nylon mesh tank strainer was adequate to remove large foreign material such as twigs, leaves or grass. However, a fine (100 mesh) high capacity strainer would be more desirable at this location to remove foreign particles before they entered the sprayer tank.

The wire hoop which held the tank strainer in place occasionally slipped through the tank filler opening causing the tank strainer to fall into the tank.

Line Strainer: The 80 mesh screen on the line strainer adequately removed most abrasive materials that could damage the pump. The plastic strainer bowl was easily removed for cleaning without the use of tools.

Nozzle Strainers: The 50 mesh nozzle strainers prevented nozzle plugging. The nozzle strainer required the use of nozzles for which the pump did not have sufficient capacity. Closer attention must be paid to matching pump and nozzle strainer size, since nozzles must be matched to the nozzle strainer to prevent frequent plugging.

PUMP CAPACITY

Agitation Capability: The Hypro 7700 pump, supplied as standard equipment, has a delivery, when new, of 0.82 L/s (10.8 gal/min) at 275 kPa (40 psi) and 540 rpm (Figure 11). This was adequate to apply 92 L/ha (8.2 gal/ac) of emulsifiable concentrates at 8 km/h (5 mph) but there was not sufficient pump capacity to apply wettable powders and provide sufficient agitation to keep the solution in the tank properly mixed. The larger Hypro 1700 pump, available as optional equipment, should be obtained if wettable powders are to be applied. Normally recommended agitation rates for emulsifiable concentrates such as 2,4-D are 0.03 L/s per 100 L of tank capacity (1.5 gal/min per 100 gal of tank capacity). For wettable powders such as Atrazine and Sevin, recommended agitation rates are 0.05 L/s per 100 L of tank capacity (3.0 gal/min per 100 gal of tank capacity).

If a 20% pump wear allowance is assumed, a worn pump could apply and agitate 57 L/ha (5.1 gal/ac) of emulsifiable concentrates at 8 km/h (5 mph). Therefore, pump size was not adequate for the TeeJet 6502 nozzles, which applied 112 L/ha (10 gal/ac), if normally recommended agitation rates are to be attained. Therefore, it is important to match pump size and nozzle tip size to ensure chemical can be properly applied.

Operation at Reduced Speed: Figure 11 also shows that reducing pump speed from 540 rpm to 400 rpm resulted in a 30% reduction in pump output. Reduction in pump speed would occur when reducing tractor speed to turn a corner or when operating at reduced engine speed to obtain a correct ground speed to suit nozzle calibration.

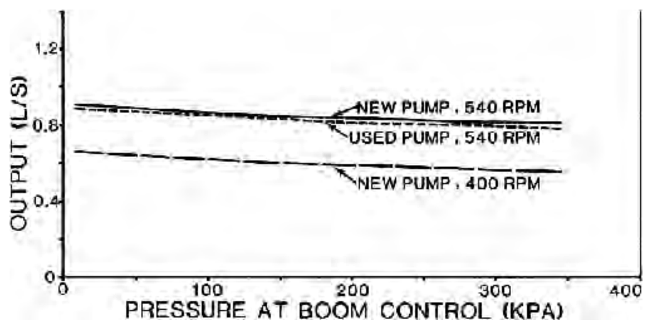

Figure 11. Pump Curves.

Pump Wear: Pump capacity decreased by 2.2% after 50 hours of field operation. Pump wear depends on the type of chemicals sprayed and abrasive materials in the water.

EASE OF OPERATION

Controls: Chemical flow to the booms was controlled with one lever. The pressure gauge could be read from the tractor seat of most tractors. However, the controls were impossible to reach from this position (Figure 12). Application rate was controlled by adjusting tractor ground speed and spraying pressure. Pressure was controlled with the pressure regulator, the agitator control valve or a combination of the two (Figure 13). The pressure regulator was sensitive to adjust since small adjustments resulted in a large change in pressure. Modifications are required to make pressure less sensitive to adjust.

Since pump capacity was low, the pressure regulator was set so that there was very little bypass flow. This created some problems when the booms were shut off since the strong spring on the bypass regulator caused the pressure to rise excessively.

The tank liquid level indicator was easy to read if the solution in the tank was opaque. With clear solutions such as Banvel, the fluid in the tube was difficult to read. The fluid level indicator was a rough indication of fluid in the tank, since operation on hills and movement of liquid in the tank caused the fluid level in the tube to fluctuate.

Transport: The 902 CE could be folded into transport or unfolded to field position by one man in five minutes, without using tools. Care had to be exercised when unfolding the 902 CE into field position to ensure that the boom hoses did not catch on the nozzle clamps (Figure 14). When the boom height was set from 420 to 520 mm (16.5 to 20.5 in) the booms were impossible to fold into transport due to interference with the centre and side booms.

The 902 CE had a turning radius of 9 640 mm (31.6 ft). This provided reasonable maneuverability. Backing the sprayer in transport position was awkward. The sprayer towed well at speeds up to 40 km/h (25 mph).

Figure 12. Awkward Location of Controls.

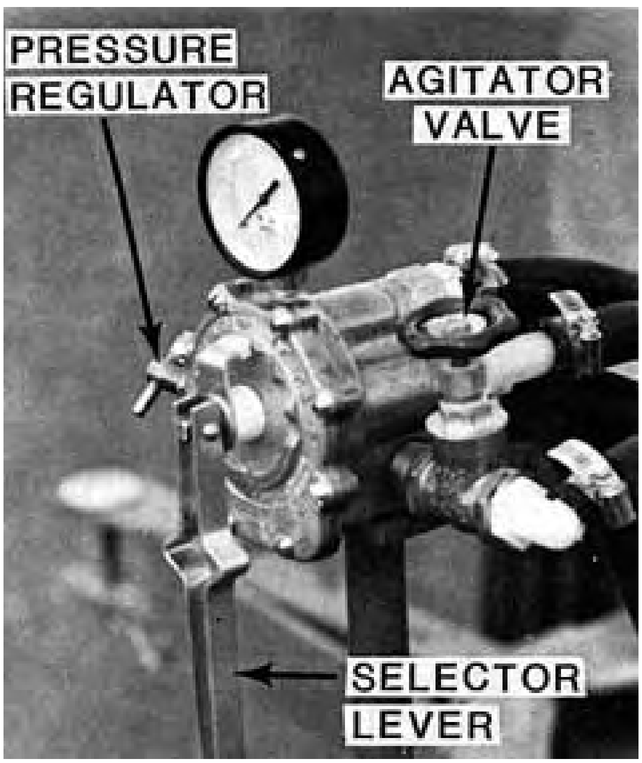

Figure 13. Controls.

Figure 14. Boom Hose Caught on Nozzle Clamp.

Tank Filling: The tank was conveniently filled by gravity from a nurse tank mounted on a farm truck. The 370 mm (14.5 in) filler opening size was adequate for adding chemicals and water. The location of the filler opening near the front corner of the tank made filling convenient.

Nozzle Adjustment: Loosening of the clamp on the boom carrier was intended to allow rotation of the boom carrier to adjust nozzle height (Figure 15). However, there was too much friction in the threads to allow rotation unless the threads were well lubricated or a large pipe wrench was used. An alternate method of adjusting boom height was to loosen the clamps on the boom struts and rotating these on the boom carrier (Figure 16).

Nozzle angle adjustment was conveniently done without the use of tools.

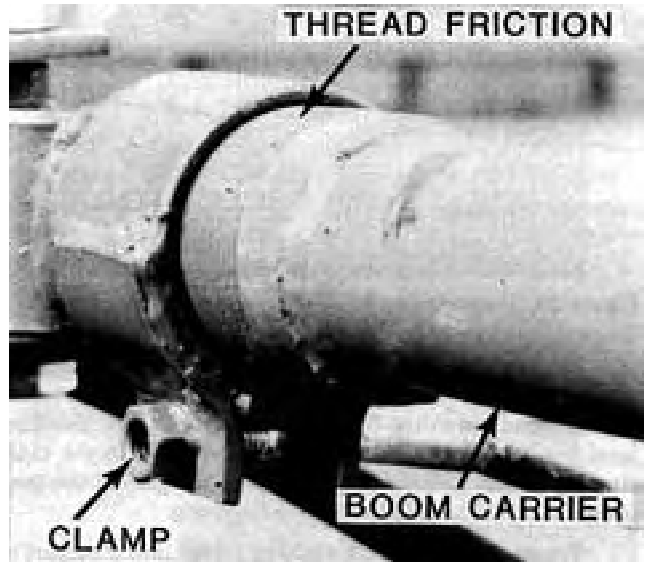

Figure 15. Boom Height Adjusting Mechanism.

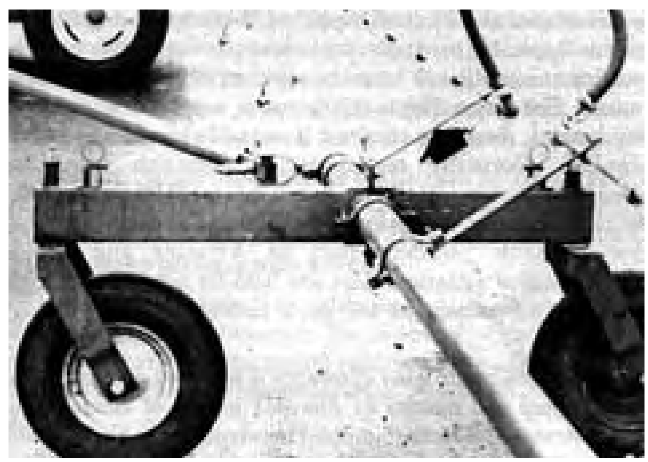

Figure 16. Boom Struts.

Nozzle Cleaning: Nozzles were conveniently removed for cleaning without the use of tools.

Hitching: The sprayer could be hitched to a tractor without the use of a jack when the tank was full or empty. The quick disconnect coupling used to attach the sprayer pump to the power take-off shaft was convenient.

Servicing and Cleaning: The 902 CE was easy to service since all grease fittings were accessible. The inside grease fitting on the trailer rocker arm did not take grease readily.

There was no clearance on the back side of the grease fitting and grease had no place to disperse.

The tank was drained by removing the bung located at the bottom of the sump. The bung was not easily removed with common tools (Figure 17). Problems were also encountered in seating the bung gasket properly.

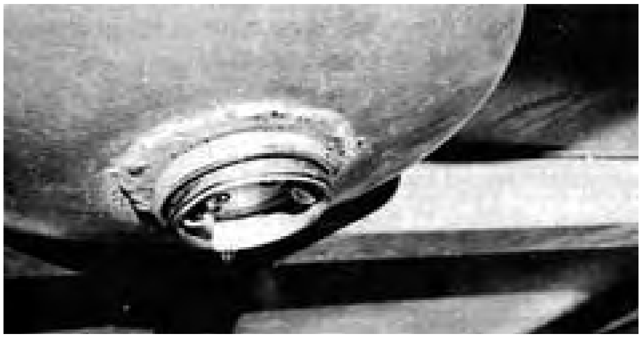

Figure 17. Tank Drain.

OPERATOR SAFETY

Hitching: When the tank was partly full, raising the hitch slightly caused all the water to rush to the rear of the tank. This caused the hitch to rise. An operator not expecting this to happen could get injured.

Slow Moving Vehicle Sign: No slow moving vehicle sign was provided with the sprayer. This item should be standard equipment for the sprayer to comply with safety regulations.

Caution: Operators of all spraying equipment are cautioned to wear suitable eye protection, respirators and clothing to minimize operator contact with chemicals. Although many commonly used agricultural chemicals appear to be relatively harmless, they may be deadly. In addition, little is known about the long term effect of human exposure to many commonly used chemicals. In some cases, the effects may be cumulative, causing harm after continued exposure over a number of years.

OPERATOR'S MANUAL

Generally, the operator's manual was excellent. It contained a parts list and explained sprayer operation and storage. It also provided information on agitation and selection of pumps and nozzle tips. It did not include lubrication instructions.

The operator's manual suggests that 1.5% of tank capacity agitation flow per minute is recommended for wettable powders. Normally recommended agitation rates are 3% for wettable powders when using normal by-pass flow. However, when using an agitator nozzle in the tank, similar to that used with the 902 CE, a smaller flow rate for agitation may be adequate.

The operator's manual was prepared in English units. It is recommended that the manual also be prepared using SI (metric) units to facilitate sprayer operation after conversion to the SI system.

Durability Results

Table 3 outlines the mechanical history of the Great Northern 902 CE sprayer during 50 hours of field operation while spraying 974 ha (2408 ac). The intent of the test was evaluation of functional performance. The following failures represent only those, which occurred during the functional testing. An extended durability evaluation was not conducted. Consider each failure separately since some are not as serious as others.

Table 3. Mechanical History

Item	Hours	Hectares	Acres
Plumbing Assembly			
-the outer fittings on the left boom extension leaked. This was repaired by tightening the fitting at		beginning of test	
-the inner fittings on the boom extensions leaked. The two leaking fittings were repaired by wrapping a piece of inner tube around them at	10	195	482
-the outer fitting on the right boom extension leaked at	19	370	915
-the four fittings were replaced with a modified assembly at	19	370	915
-six of the nozzles were leaking and repaired at	21	409	1011
-five of the nozzles were leaking and repaired at	36	702	1734
-one complete nozzle assembly was lest at	43	838	2071
-the left boom extension hose was damaged at	46	896	2215
-the fitting on the pump outlet was worn at	46	896	2215
-the tank lid handle was broken and rewelded at	end	974	2408
Trailer Frame			
-the hitch clevis bent at	35	682	1686
-the rocker axles were worn at	end	974	2408
Boom And Castor Frame			
-the front castor wheel frames were bent at	40	779	1926
-three of the boom struts were bent at	43	838	2071
-the left boom carrier was bent at	46	896	2215

Discussion of Mechanical Problems

PLUMBING ASSEMBLY

Boom Fittings: The fittings used to join the booms (Figure 18) leaked. The plastic female fittings were damaged by vibration of the boom hose. The plastic fittings were not strong enough and the threads stripped, making it impossible to tighten the fittings. The assemblies were replaced with standard 90° elbows with a male threaded plastic fitting. No problems were encountered after this modification.

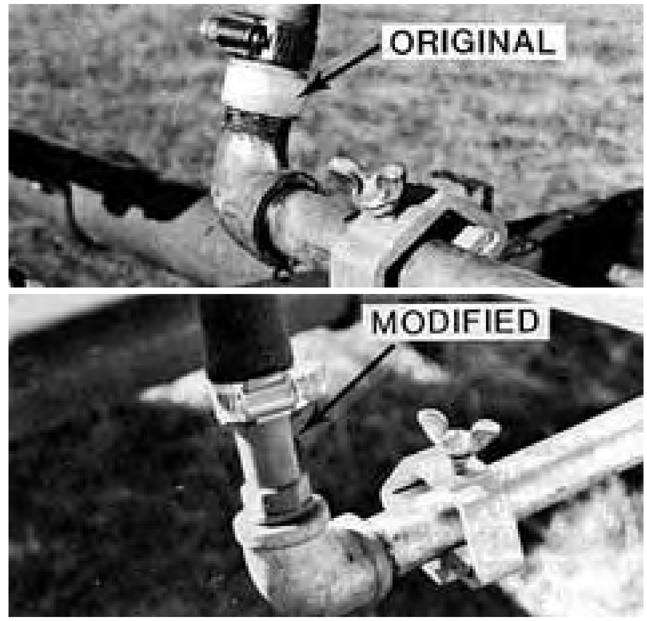

Figure 18. Boom Extension Fittings.

Nozzles: Leakage of the nozzle saddle washers (Figure 5) occurred throughout the test and was caused by deterioration of the saddle washers from reaction with 2,4-D solutions and loosening of the setscrew on the nozzle clamp. Nylon saddle washers were supplied by the manufacturer at the end of the test but these were not field tested. Laboratory tests indicated that the replacement washers did not deteriorate in 2,4-D solution (Figure 19). The replacement washers should therefore reduce the leakage problem. However, there would still be some problems due to setscrews loosening.

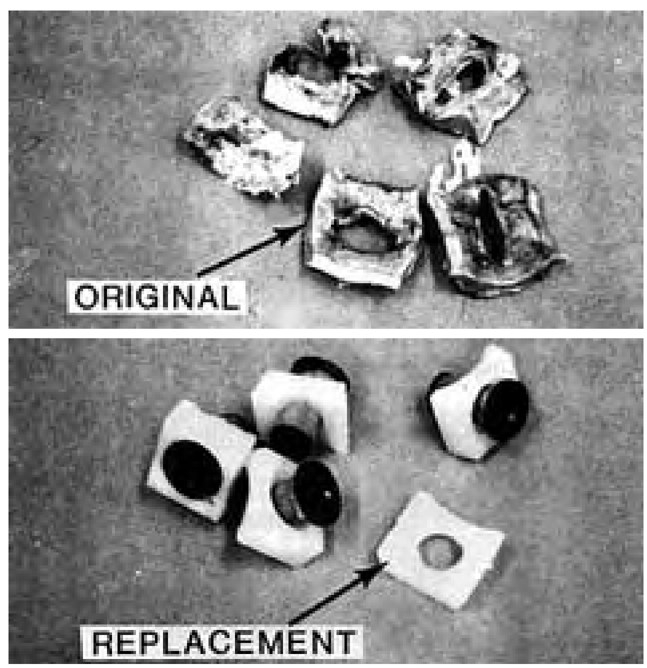

Figure 19. Comparison of Original and Replacement Saddle Washers.

TRAILER FRAME

Hitch Clevis: The hitch clevis bent in the field (Figure 20).

Although the hitch did not fail completely, modifications are required to prevent bending.

Figure 20. Bent Hitch Clevis.

Rocker Axle Assembly: The rocker arms were cambered at the end of the test (Figure 21) due to cracking of the rocker arm bushing (Figure 22), a loose .t between the axle shaft and bushing, and wear on the axle (Figure 23). The rocker axles were worn because the inside grease fitting did not accept grease.

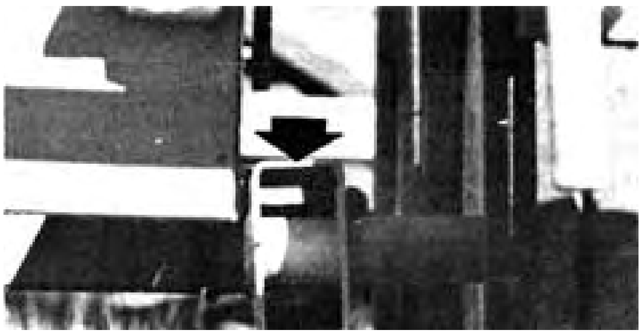

Figure 21. Rocker Arm Camber.

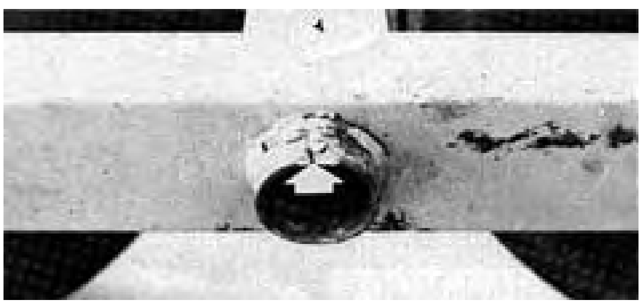

Figure 22. Cracked Rocker Arm Bushing.

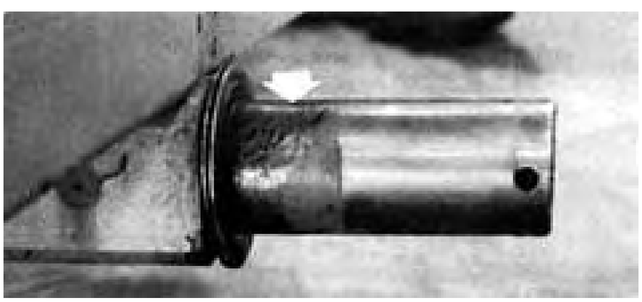

Figure 23. Worn Axle.

BOOM AND CASTOR ASSEMBLY

Castor Wheel Frames: The front castor wheel frames were bent in field operation. Twisting occurred where the castor pivot was welded to the angle iron frame (Figure 24). This caused problems on corners since the castor frame jammed against the walking beam frame and would not rotate. When the castors did not rotate they caused the walking beam assembly to flip over completely. This caused bending of the boom carriers (Figure 25) and damage to the boom extension hoses (Figure 26). Washers were installed on top of the castor pivots to allow them to rotate. However, modifications are required to prevent castor wheel frame failure.

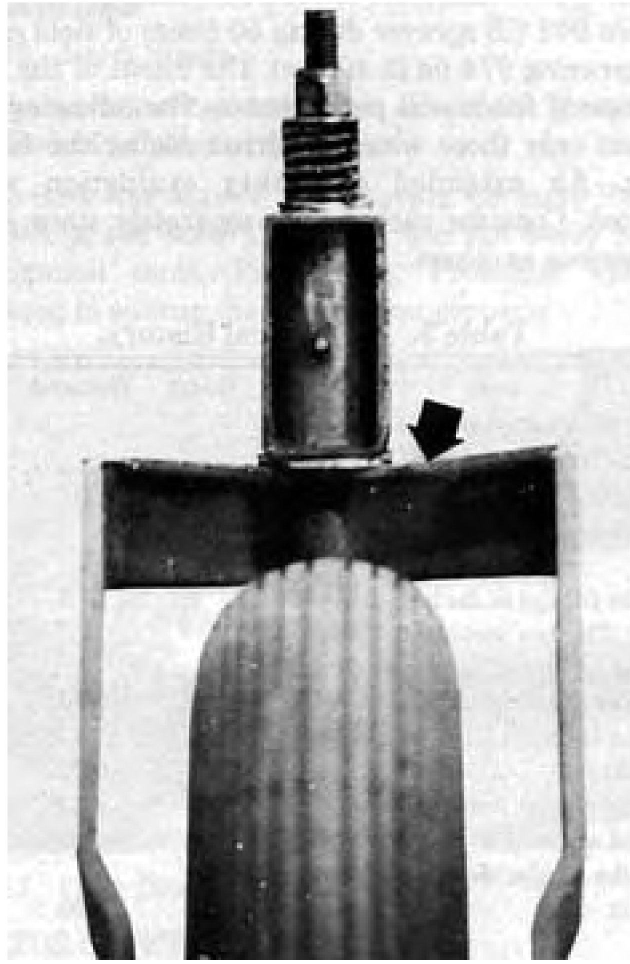

Figure 24. Twisted Castor Frame.

Figure 25. Bent Boom Carrier.

Boom Struts: The boom struts were made of flat iron and were easily bent (Figure 26).

Figure 26. Damaged Boom Extension Hose and Bent Boom Strut.

APPENDIX I
SPECIFICATIONS

Model:	902 CE	
Serial Number:	76-1063	
	<u>**Field Position**</u>	<u>**Transport Position**</u>
Overall Width:	17,800 mm (58.4 ft)	2400 mm (7.9 ft)
Overall Length:	3890 mm (12.8 ft)	11,500 mm (37.7 ft)
Overall Height:	1290 mm (4.2 ft)	1290 mm (4.2 ft)
	<u>**Trailer**</u>	<u>**Castor**</u>
Wheel Base:	800 mm (2.6 ft)	1000 mm (3.3 ft)
Wheel Tread:	1990 mm (6.5 ft)	10,000 mm (32.8 ft)
Tire Size:	4 - 6.70 x 15, 6-ply, rib implement	4 - 4.80/4.00 x 8, 2-ply, rib implement
Weights:	<u>**Tank Empty**</u>	<u>**Tank Full**</u>
-- left trailer wheels	240 kg (530 lb)	1125 kg (2480 lb)
-- right trailer wheels	240 kg (530 lb) 1	129 kg (2490 lb)
-- left castor wheels		
-front	56 kg (123 lb)	56 kg (123 lb)
-rear	46 kg (101 lb)	46 kg (101 lb)
-- right castor wheels		
-front	55 kg (121 lb)	55 kg (121 lb)
-rear	40 kg (89 lb)	40 kg (89 lb)
-- hitch	<u>11 kg (24 lb)</u>	<u>59 kg (30 lb)</u>
TOTAL	688 kg (1518 lb)	2510 kg (5534 lb)
Tank:	material - galvanized steel capacity - 1818 L (400 gal)	
Filters:	tank - nylon mesh screen [opening size 1.5 x 1.0 mm (0.06 x 0.04 in)] line strainer - 80 mesh nozzle strainers - 50 mesh	
Pump (540 rpm PTO driven):	standard - Hypro C 7700 nylon roller pump optional - Hypro 1700 nylon roller pump	
Agitation:	hydraulic	
Pressure Gauge:	Winters Thermogauges dual scale 1 to 100 psi (1 to 7 kg/cm²)	
Boom:	3/4 inch aluminum pipe	
Nozzles (not supplied):	number required - 35 spacing - 508 mm (20 in)	
Spraying Width:	17,780 mm (58.3 ft)	
Boom Adjustment:	height - maximum 810 mm (31.9 in) -minimum 100 mm (3.9 in)	
Nozzle angle:	360°	
Hitch Height Adjustment:	maximum 615 mm (24 in) minimum 325 mm (13 in)	
Lubrication Points:		
-- trailer rocker arms	4	
-- castor rocker arms	4	
-- castor pivots	4	
-- castor wheel bearings	4	

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

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

APPENDIX III
METRIC CONVERSIONS

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

1 hectare (ha)	= 2.47 acre (ac)
1 litre per hectare (L/ha)	= 0.09 Imperial gallon per acre (gal/ac)
1 kilopascal (kPa)	= 0.15 pound per square inch (psi)
1 kilometre per hour (km/h)	= 0.62 mile per hour (mph)
1 kilowatt (kW)	= 1.34 horsepower (hp)
1 litre per second (L/s)	= 13.20 Imperial gallons per minute (gal/min)
1 metre (m) = 1000 millimetres (mm)	= 39.37 inches (in)
1 litre (L)	= 0.22 Imperial gallon (gal)

ALBERTA FARM MACHINERY RESEARCH CENTRE
3000 College Drive South
Lethbridge, Alberta, Canada T1K 1L6
Telephone: (403) 329-1212
FAX: (403) 329-5562
http://www.agric.gov.ab.ca/navigation/engineering/afmrc/index.html

Prairie Agricultural Machinery Institute
Head Office: P.O. Box 1900, Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-2555

Test Stations:

P.O. Box 1060
Portage la Prairie, Manitoba, Canada R1N 3C5
Telephone: (204) 239-5445
Fax: (204) 239-7124

P.O. Box 1150
Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-5033
Fax: (306) 682-5080