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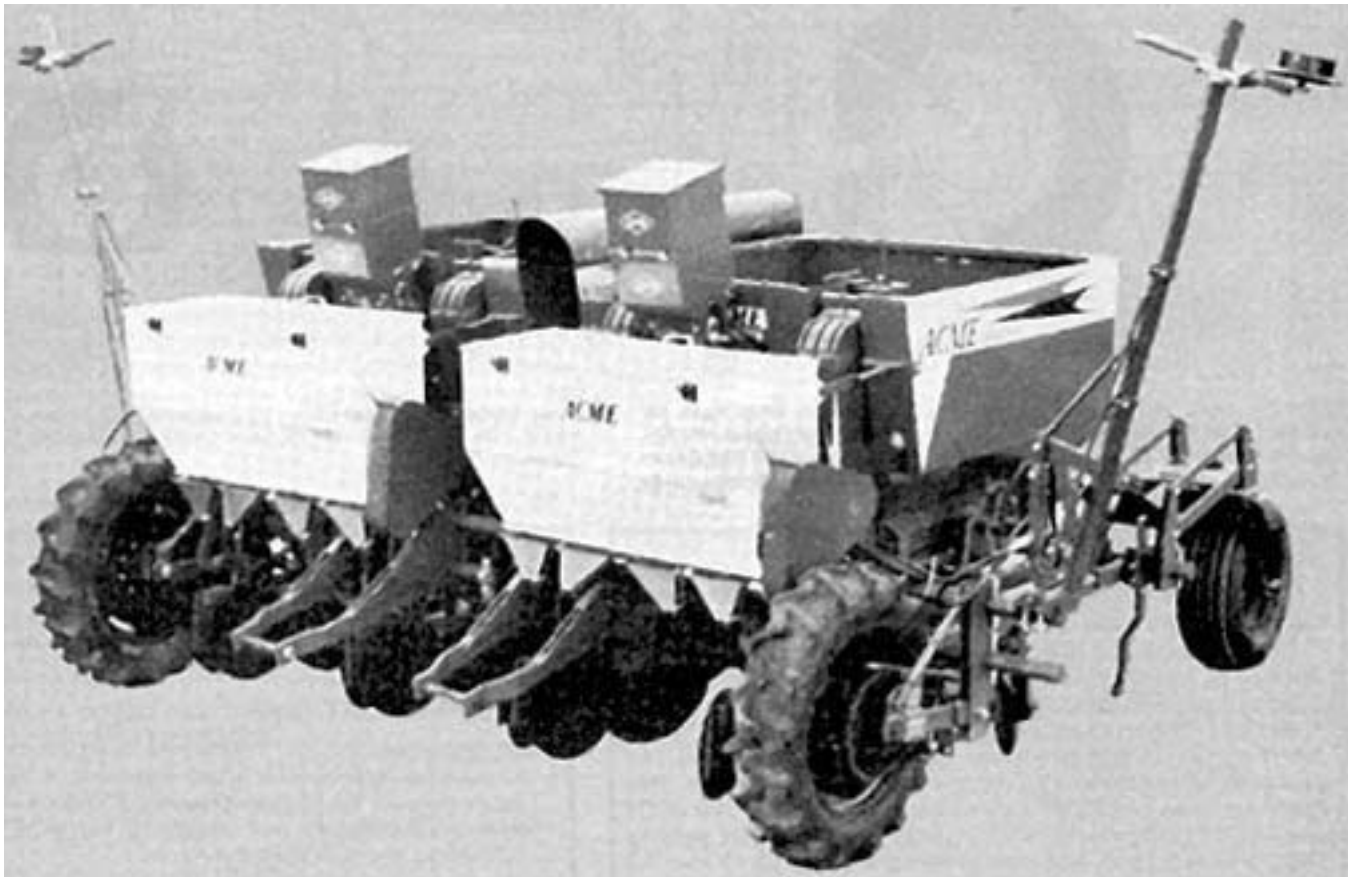
Evaluation Report 163



Acme 400 ST Potato Planter

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

ACME 400 ST POTATO PLANTER

MANUFACTURER:

Acme Manufacturing Company, Inc.
500 Main Street
Filer, Idaho
U.S.A. 88328

DISTRIBUTOR:

A.M. Briggs, Ltd.
Box 273
Portage la Prairie, Manitoba
R1N 3B5

RETAIL PRICE:

$22,040.00 (November 1979, f.o.b. Portage la Prairie, Manitoba, with extended lift arms, 355 mm covering discs, three rear castor wheels, furrowing-out shanks, hydraulic row markers, dry fertilizer unit and coulter fertilizer injectors.

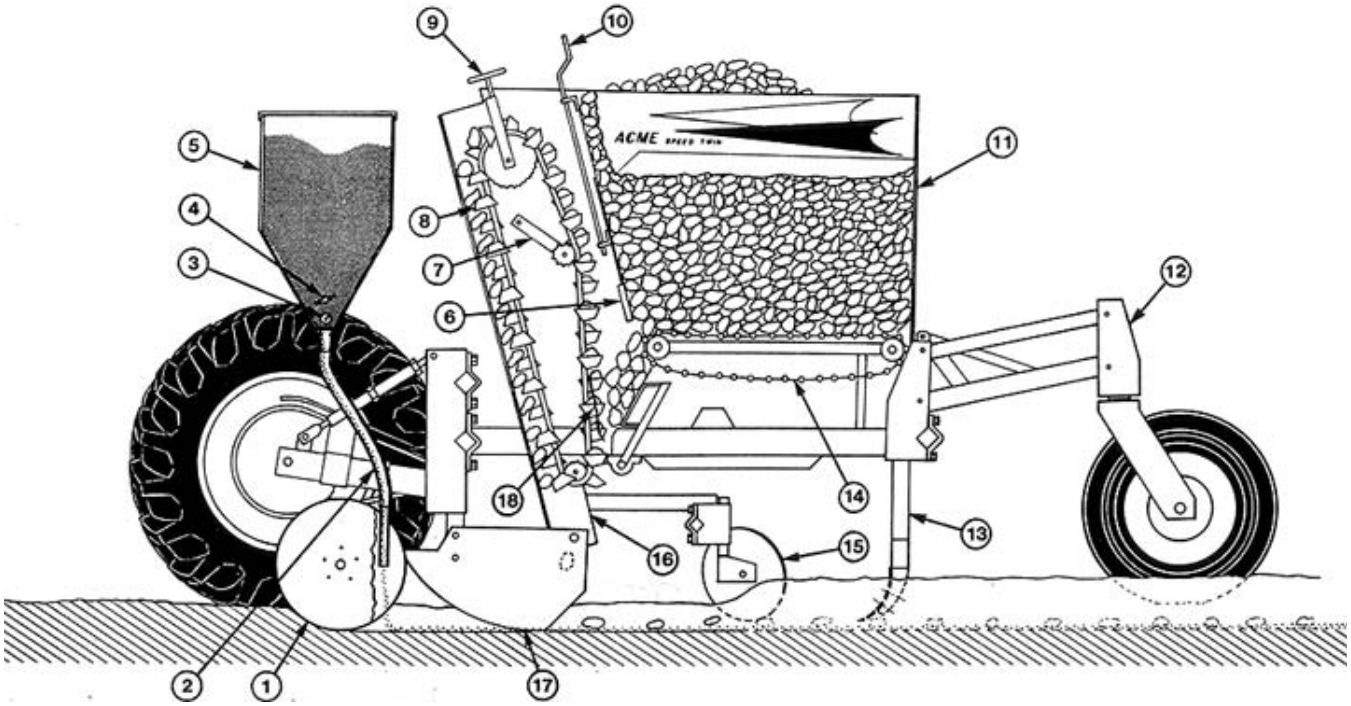


FIGURE 1. Acme 400 ST: (1) Opening Disc, (2) Fertilizer Drop Hose, (3) Fertilizer Feed Screw, (4) Fertilizer Agitator, (5) Fertilizer Hopper, (6) Adjustable Seed Gate, (7) Cup Chain Agitator, (8) Cup Chain, (9) Cup Chain Tension Adjustment, (10) Seed Gate Adjustment, (11) Seed Hopper, (12) Rear Castor Wheel Assembly, (13) Furrowing Out Shank, (14) Seed Conveyor, (15) Covering Disc, (16) Seed Chute, (17) Planting Shoe, (18) Cup Bowl.

SUMMARY AND CONCLUSIONS

Overall functional performance of the Acme 400 ST Potato Planter was very good.

The seed metering and feeding system was excellent, which resulted in trouble free seed flow and few misses or doubles. Seed spacing was good. When set at a nominal spacing of 460 mm (18 in), 72% of the cut seed was spaced between 220 and 860 mm (9 and 34 in), with an average spacing of 450 mm (18 in). The coefficient of variation (CV) of single seed spacing was 36%. This coefficient was constant for all planting speeds. The overall CV was 64% for Cut seed and 66% for whole seed. Control of seeding depth was very good, with seed pieces placed within 12 mm (0.5 in) of the desired depth. The covering discs could be adjusted to produce excellent hills with uniform cover in all soil conditions.

Performance of the fertilizer metering system was good. Performance was reduced by occasional plugging of the flexible drop hoses and exposure of the feed screws to rain. The application rate was not affected by field roughness, field slope, ground speed or fertilizer level in the hoppers. Fertilizer placement was good, with bands placed 130 mm (5 in) to each side of the seed. Opener adjustment was adequate to permit the fertilizer to be placed below seed level in all soil conditions. The manufacturer's fertilizer charts were incomplete, making it necessary to recalibrate, to suit prairie application rates.

Both the fertilizer and seed systems were convenient to adjust, service and operate. No walkways were provided for filling of the seed or fertilizer hoppers.

A 100 kW (135 hp) tractor had adequate power to operate the Acme 400 ST in most soils, at speeds up to 10 km/h (6 mph).

The operator's manual was good, containing instructions on operation, adjustment, maintenance and safety. The Acme was safe to operate if normal safety procedures were followed.

Durability problems occurred with one castor wheel and one cup chain jammed in the seed tube after jumping off a sprocket.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Moving the fertilizer placement assembly further forward, directly beneath the fertilizer hoppers, to reduce plugging in the flexible drop hoses, and modifying the fertilizer collection funnels to improve their durability.
2. Supplying convenient access to the fertilizer hoppers for filling.
3. Supplying fertilizer calibration charts for fertilizers and application rates common to the prairie provinces.
4. Supplying a suitable planting monitor as optional equipment for machines equipped with fertilizer attachments, due to restricted operator visibility of the planting mechanism.
5. Modifying the rear castor wheels to reduce shimmying during road transport.
6. Supplying a slow moving vehicle sign as standard equipment.

Chief Engineer -- E.O. Nyborg
Senior Engineer -- J.C. Thauberger
Project Engineer -- Gregory R. Pool

THE MANUFACTURER STATES THAT:

With regard to recommendation number:

1, 2. & 3. At present, a very small percentage of the planters are sold with fertilizer units. If and when the demand for fertilizer units is increasing, a custom built unit will be used which should satisfy #1, 2 and 3 recommendations.

4. Monitors, used in the past, were interfering with the proper function of the planter. We will endorse units, to be installed by our dealers, as soon as all problems are solved.
5. In the past we had tie-rods available to tie the rear assist wheels together and run them with a small amount of toe-in. If the demand warrants it, we could make them available again.
6. This will be done.

Note: This report has been prepared using SI units of measurement. A conversion table is given in APPENDIX III.

GENERAL DESCRIPTION

The Acme 400 ST (FIGURE 1) is a four-row, semi-mounted, twin cup, potato planter. The main frame is fabricated in two sections. It is supported, at the front, by the two lifting links of a Category II three-point hitch and by three castor wheels at the rear. The planter is designed for use without a riding operator.

The Acme is equipped with two seed hoppers of 1435 L capacity each. The hoppers are placed above four draper chain conveyors, which deliver the seed into four cup bowls. Adjustable gates control the seed level in the cup bowls. Twin cup chain assemblies, each with 44 cups, pass through each cup bowl. Metal cups, on each side of the cup chains, carry seed pieces out of the bowls, into seed tubes. As the cups rise, the chains are agitated to remove excess seed pieces from the cups. As the cups descend, seed is dropped through seed chutes into furrows formed by the planting shoes. Seed spacing can be varied by changing drive sprockets, while seeding depth is controlled by the three-point hitch and the hydraulic cylinders on the rear castor wheels. Two covering discs cover each row with soil hills.

One fertilizer hopper is provided for each set of two rows. Fertilizer is metered from the hoppers with feed screws. The application rate can be varied by changing the feed screw drive sprockets. Flexible hoses deliver the fertilizer to the opening discs on each side of each seed row. Fertilizer depth is adjusted by means of a threaded support rod.

The test machine was equipped with hydraulically controlled row markers.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Acme was operated in the conditions shown in TABLE 1 for 79 hours while seeding about 177 ha. It was evaluated for rate of work, quality of work, ease of operation, ease of adjustment, power requirements, operator safety and suitability of the operator's manual. In addition, the fertilizer system was calibrated in the laboratory.

Seed placement trials[1] were performed with both cut and whole Netted Gem seed, with an average seed size of about 60 g. The machine was set for a nominal 460 mm seed spacing within the rows.

TABLE 1. Operating Conditions

Soil Texture	Field Area	Hours
	ha	
Loam	32	15
Loamy sand	107	45
Silty Clay	38	19
Total	177	79

RESULTS AND DISCUSSION

RATE OF WORK

Average planting rates in loamy sand were about 2.4 ha/h, while maximum planting rates were as high as 4.0 ha/h at a speed of 11 km/h. Maximum planting rates did not include the time required to fill the fertilizer and seed hoppers.

QUALITY OF WORK

Seed Placement: Seeding depth uniformity was very good. Deviations of less than 12 mm from the desired depth were maintained for planting speeds from 6 to 12 km/h.

Seed spacing in the rows was good. TABLE 2 shows seed placement uniformity when using both cut seed and whole seed. When planting at 8.6 km/h in level loamy sand, with the planter at a nominal 460 mm setting, 72% of the cut seed was singly spaced between 220 and 860 mm. Average spacing of single cut seeds was 450 mm, with a coefficient of variation[2] (CV) of 36%. Seed spacing uniformity was not affected by planting speed over a range from 6.5 to 12 km/h. When planting whole seed of about the same size, at 10.6 km/h, 70% of the whole seed was singly spaced between 220 and 860 mm. Average spacing of single whole seeds was 500 mm, with a CV of 35%. Overall CV's for all seed were 64% for cut and 66% for whole seed.

TABLE 2. Seed Placement

Uniformity of Placement	Percent of Total Seed	
	Cut Seed	Whole Seed
Single seed	72	70
Double seed	23	9
Missed seed	4	11
Double missed seed	1	10

Seed spacing increased with an increase in ground speed. Average cut seed spacing increased from 380 to 455 mm when the planting speed was increased from 6.7 to 17.1 km/h. Average whole seed spacing increased from 520 to 750 mm when planting speed was increased from 6.7 to 15.0 km/h.

Fertilizer Placement: Fertilizer placement was good for planting speeds from 6 to 12 km/h. The fertilizer was placed in bands on either side of and slightly below the seed. At slow speeds, the bands were compact and well defined. As speed increased, the fertilizer bands were less clearly defined.

Fertilizer Metering System: The manufacturer's fertilizer rate charts were not suitable for application rates and seed spacings typically used in the prairie provinces. By extrapolating the data in the rate charts, suitable sprocket ratios could be derived for the 460 mm seed spacing and 915 mm row spacing typically used in the prairies. The manufacturer's charts also did not mention the types of fertilizers for which the charts applied. A PAMI calibration with 16-20-0 fertilizer, with a density of 1010 kg/m^3, agreed well with the manufacturer's rate charts. It is recommended that the manufacturer supply fertilizer rate charts compatible with seed spacings, fertilizer types and application rates commonly used in the prairie provinces. Application rates down to 50 kg/ha should be included in the charts.

The flexible drop hoses connecting the fertilizer hoppers and the opening discs were too long (FIGURE 2), resulting in plugging. The hoses had to be shortened to one-half their original length, to assure the free flow of fertilizer to the opening discs.

The fertilizer application rate was not significantly affected by the fertilizer level in the hoppers, ground speed, sloping terrain or field roughness.

Hill Formation: Excellent hills were formed over the seed. Hills were uniform in size for planting speeds from 6 to 15 km/h. Due to the placement and design of the covering discs, plugging never occurred, even in wet fields or in fields with a heavy trash cover.

Floatation: The Acme was equipped with two drive wheels and three rear castor wheels which provided good floatation in soft soil. All wheels operated between the rows without causing undue soil compaction of the hills.

Rear Mounted Tools: Cultivator shovels on the rear tool bar provided good loosening of compacted soil behind the tractor wheels. The resulting deep furrows also helped to steer the tractor used for row crop cultivating.

[1] *PAMI T7714-R78, Detailed Test Procedure for Potato Planters.*

[2] *The coefficient of variation is the standard deviation of seed spacing, expressed as a percent of the mean seed spacing. It is a measure of seed spacing uniformity. The lower the CV, the more uniform is the seed spacing. It is commonly accepted, that for acceptable seeding, the CV of single seed placement should be less than 40%.*

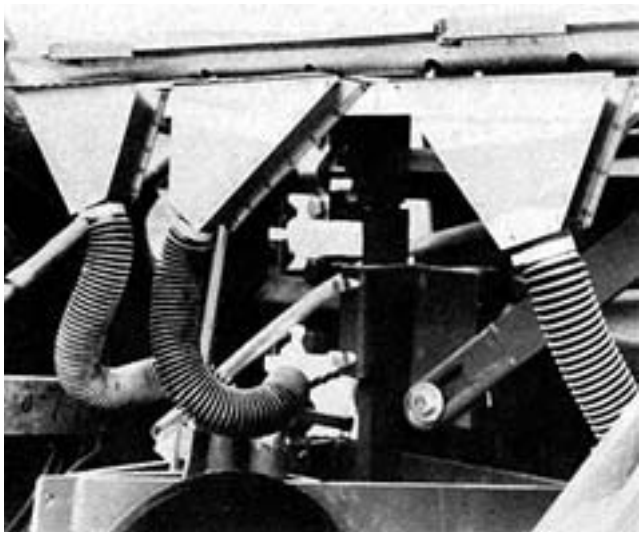


FIGURE 2. Flexible Drop Hoses.

EASE OF OPERATION

Row Markers: The hydraulically controlled row marker attachment was effective and easy to use. The marker discs could be adjusted to create a clear mark, and marker length was adjustable to suit the row spacing. The complete assembly was rugged and maintained adjustment after being set.

Hopper Filling: Filling of the seed hoppers was safe and convenient, although there were no walkways supplied at the rear or front of the machine. However, filling the fertilizer hoppers was inconvenient and unsafe, especially when using bagged fertilizer. It is recommended that the manufacturer provide suitable walkways to allow safe and convenient filling of the fertilizer hoppers. Separate lids were supplied for each of the fertilizer hoppers, but these were inconvenient since they were hinged at the front of the planter (FIGURE 3).

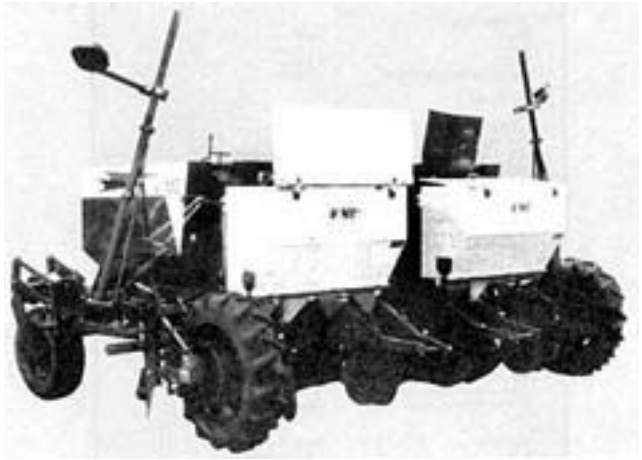


FIGURE 3. Fertilizer Hopper Lids.

Moisture: the hop The fertilizer hoppers were adequately sealed to prevent leakage into hoppers during rain. However, rain entered the feed hoses by way of the open, exposed collection funnels under the hopper feed screws (FIGURE 4). Moisture was also able to enter the hoppers through the ends of the feed screws. If the planter was left to stand in the rain with full fertilizer hoppers, the feed screws and feed hoses had to be checked for free operation.

Cleaning: As with most potato planters, a pressure washer was needed for thorough machine cleaning and disinfecting. Access to the seed cup chains was difficult, with only two small access holes near the bottom of each seed chute and a small cover at the top. The fertilizer hoppers and seed bins were permanently attached to the frame and could not be removed for cleaning.

Hitching: The Acme was relatively easy to hitch to the tractor if the tractor was equipped with extendible lift arms.

Planting: It was easy for the tractor operator to monitor the flow of fertilizer, but it was impossible to view the four seed cup chains, due to the obstruction caused by the fertilizer hoppers. Since the machine is intended for use without a planter operator, it is recommended that the manufacturer supply a suitable planting monitor as optional equipment for machines equipped with granular fertilizer applicators.

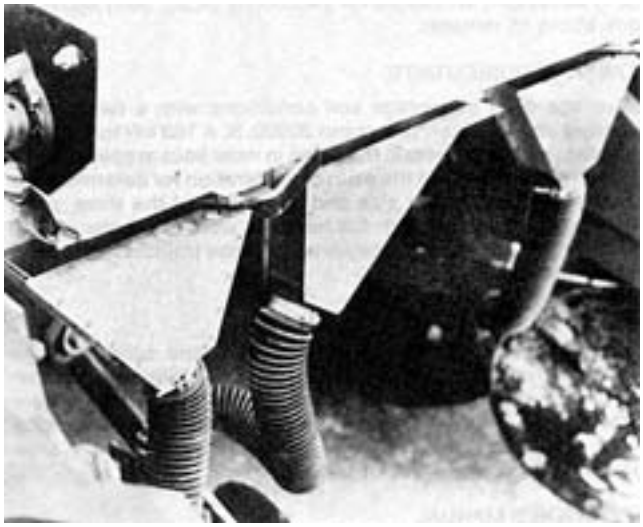


FIGURE 4. Fertilizer Collection Funnels.

The draper chain conveyors delivered seed effectively to the cup bowls, without bridging. Cut Netted Gem seed resulted in fewer misses than with whole seed (TABLE 2). Cut seed pieces were of more uniform size, fitting better into the seed cups than the elongated Netted Gem whole seed.

Transportation: The Acme transported well at speeds up to 10 km/h. Speeds in excess of 10 km/h caused excessive shimmy of the rear castor wheels. It is recommended that the castor wheels be modified to reduce shimmying during road transport. Ground clearance of 250 mm was excellent for all conditions. It was advisable to unhook the row marker lift cylinders to reduce width when transporting on public roads.

EASE OF ADJUSTMENT

Seed Spacing: Seed spacing was adjusted by varying the lower cup chain and jackshaft sprockets. Sprockets were accessible and easy to change. Twelve nominal seed spacings between 100 and 460 mm were possible with the standard sprockets.

Seed Depth: Adjustment of planting depth was easy. Field depth control was provided through the tractor hydraulics to a cylinder on each of the three rear castor wheels, and through the two lifting links on the tractor three point hitch. With all three castor wheel cylinders on the same hydraulic circuit, any attempt to adjust them between the full up or down position resulted in poor levelling of the planter. Planting depth was easier to adjust by changing the height of the three point hitch lift arms. Two other methods of changing planting depth included adjusting the covering discs for more or less cover, or positioning the planting shoes. The latter adjustment was not attempted due to the time and labour involved.

Fertilizer Placement: The level of the fertilizer in relation to the seed depth was easily adjusted with individual controls for each row. Two bands of fertilizer were applied slightly below the seed level and about 130 mm to each side of the seed.

Hill Formation: A wide range of adjustments were provided for the covering discs. At normal operating speeds, uniform hills could be produced over the seed, without disturbing the fertilizer.

Fertilizer Application Rate: The fertilizer feed screw drive sprockets had to be changed to adjust the fertilizer application rate. Changing sprockets was easy, and took about ten minutes to complete.

Cup Chain Tension: The cup chain tension was easily adjusted with a T-handle adjusting screw on top of each seed chute. A spring loaded vibrator also maintained cup chain tension as well as dislodging some potential double seed pieces from the cups.

Seed Hopper Gates: The flow of seed from the main seed hopper to the cup bowls was controlled by adjustable gates. A rough adjustment could be made by changing the length of stroke of the

activator arm on the ratchet and pawl feed sprocket.

Lubrication: The Acme was equipped with 25 pressure grease fittings. All grease fittings, drive chains, idlers and other components were easily accessible for greasing or oiling. Daily servicing took about 15 minutes.

POWER REQUIREMENTS

Average draft in average soil conditions with a full load of potatoes and fertilizer, was about 20,000 N. A 100 kW tractor had adequate power to operate the Acme in most soils at speeds up to 10 km/h. Power was not the main consideration for determining a suitable tractor. Tractor size and the ability of the three-point hitch to lift the planter with full hoppers, were of greater importance. Front ballast may be required for some tractors to properly handle the Acme.

OPERATOR SAFETY

The Acme 400 ST was safe to operate and service, if the manufacturer's safety recommendations were followed. All moving parts were adequately shielded. Two safety problems were evident. The Acme did not have a front platform, which made filling of the fertilizer hoppers unsafe and inconvenient. A slow moving vehicle sign was not supplied.

OPERATOR'S MANUAL

The operator's manual was simple to understand, well illustrated and presented much useful information on adjustments, maintenance and safety. A comprehensive parts list was provided in the operator's manual. The effectiveness of the manual was reduced because the fertilizer application rate charts were not suitable for prairie conditions.

DURABILITY RESULTS

TABLE 3 outlines the mechanical history of the Acme 400 ST during 79 hours of field operation while planting about 177 ha.

The intent of the test was evaluation of functional performance.

The following failures represent those, which occurred during functional testing. An extended durability evaluation was not conducted.

TABLE 3. Mechanical History

Item	Operating Hours	Field Area ha
-The double pitch fertilizer drive chain was replaced with a single pitch chain at	start of test	
-The flexible fertilizer drop hoses were shortened to prevent plugging at	start of test	
-Two tool bar clamps broke and were repaired at	38	82
-A castor wheel bearing failed and was replaced at	50	110
-A castor wheel assembly broke and was replaced at	55	120
-A frame hinge assembly broke and was repaired at	59	132
-A cup chain jumped a sprocket, breaking a seed cup at	59	132
-Loose bolts were retightened many times	during test	

DISCUSSION OF MECHANICAL PROBLEMS

Castor Wheel and Frame Hinge Assembly: Both of these failures were attributed to excessive shimmy during transport. At speeds above 10 km/h, the castor wheels experienced severe shimmy and shaking.

Fertilizer Attachment: The fertilizer collection funnels under the hopper feed screws were poorly designed, and constructed of sheet metal of inadequate strength. These funnels were badly damaged by the end of the test (FIGURE 5). The fertilizer placement assembly was not located directly under the fertilizer hoppers, which caused some feeding problems with the flexible drop hoses. It is recommended that the fertilizer placement assembly be moved further forward and the fertilizer collection funnels be modified to increase their durability.

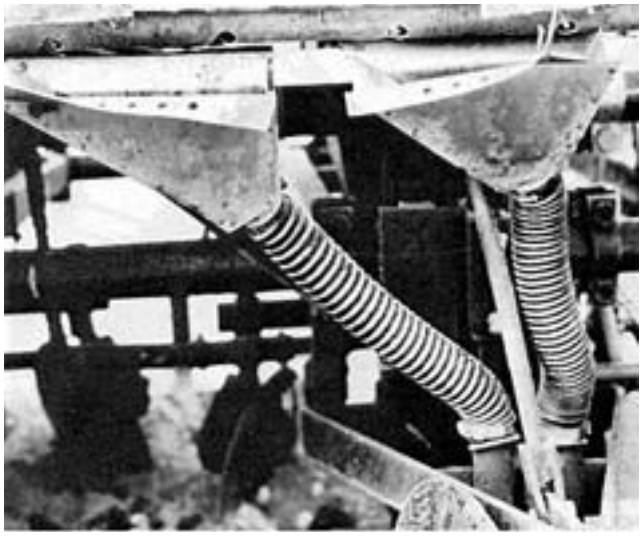


FIGURE 5. Damaged Fertilizer Collection Funnels.

APPENDIX I
SPECIFICATIONS

Make:	ACME
Model:	400 ST
Serial No.:	7738
Weight: (All Empty Hoppers)	
-- right castor wheel	650 kg
-- centre castor wheel	280 kg
-- left castor wheel	688 kg
-- hitch point	2056 kg
Total	3674 kg
Overall Dimensions:	
-- length	4200 mm
-- width	4940 mm
-- height	2900 mm
-- transport ground clearance	250 mm
Seeding System:	
-- type	twin cup
-- number of rows	4
-- cups per row	44
-- type of drive	chain and sprockets from ground wheel
-- type of adjustment	interchangeable sprockets
-- range of seed spacing	100 to 460 mm
-- range of row spacing	810 to 960 mm in 50 mm increments
-- seed hopper capacity	2870 L
-- covering disc diameter	355 mm
-- space between covering discs	adjustable
-- angle of covering discs	adjustable
Fertilizer System:	
-- typo of drive	chain and sprockets from ground wheel
-- type of adjustment	interchangeable sprockets
-- application rate	70 to 1425 kg/ha
-- type of feed	positive displacement screw auger
-- number of hoppers	2
-- hopper size	325 kg each
-- opening disc diameter	400 mm
-- space between opening discs	100 mm at front
-- angle of opening discs	14° toe-in
-- fertilizer agitator type	finger
Tires:	
-- rear castor	3, 11L x 15, 6-ply
-- drive	2, 9.50 x 24.4 ply
Number of Chain Drives:	14
Number of Lubrication Points:	25

Other Optional Equipment:
- -- Dry Fertilizer Attachment
- -- Coulter Fertilizer Injectors
- -- Furrowing-out Shanks
- -- Extended Lift Arms
- -- Centre Rear Castor Wheel
- -- Hydraulic Row Markers

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports

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

APPENDIX III
CONVERSION TABLE

1 hectare (ha)	= 2.5 acres (ac)
1 kilometre/hour (km/h)	= 0.6 miles/hour (mph)
1 kilogram (kg) = 1000 grams (g)	= 2.2 pounds (lb)
1 newton (N)	= 0.2 pounds force (lb)
1 litre (L)	= 0.035 cubic feet (ft^3)
1 kilogram/hectare (kg/ha)	= 0.9 pounds/acre (lb/ac)
1 kilowatt (kW)	= 1.3 horsepower (hp)

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