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Group 9(a)

Evaluation Report 502

Morris M H-310 Hoe Press Drill

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

MORRIS MH-310 HOE PRESS DRILL

MANUFACTURER AND DISTRIBUTOR:
Morris Rod Weeder Co. Ltd.
85 York Road
Yorkton, Saskatchewan
S3N 2X2

RETAIL PRICE:
$14,765.00 (August, 1986, f.o.b. Lethbridge, Alberta – one unit with dual front castor, single hitch, hydraulic transport, transport hitch and acremeter).

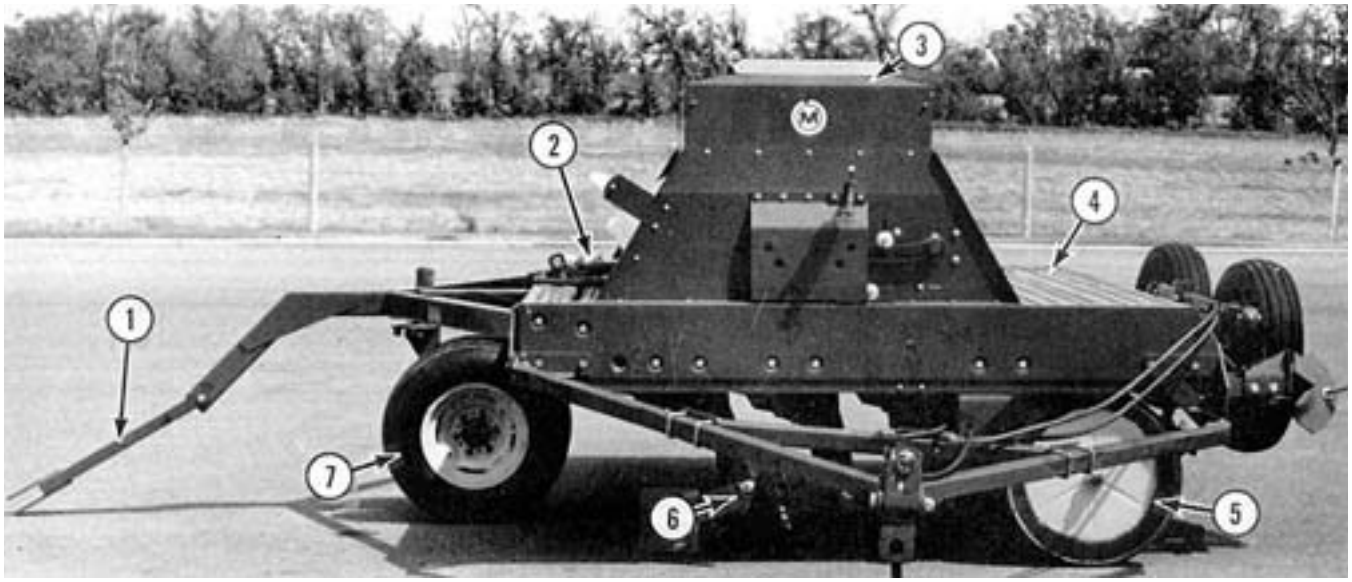

FIGURE 1. Schematic of Morris MH-310 Hoe Press Drill: (1) Hitch, (2) Hydraulic Lift Cylinder, (3) Grain and Fertilizer Boxes, (4) Rear Walkway, (5) Press Wheels, (6) Hoe Openers, (7) Castor Wheel.

SUMMARY

Quality of Work: Penetration was good in tilled field conditions and in stubble conditions provided the stubble soil contained adequate moisture.

Seed and fertilizer were normally placed in a 1.5 in (38 mm) wide band with most seeds within 0.5 in (13 mm) of the average seed depth in uniform soil conditions. Each press wheel exerted a packing force of at least 208 lb (926 N), which effectively packed the soil around the seed and fertilizer.

Trash clearance was adequate in all test conditions except long wheat straw on summerfallow in which case occasional plugging occurred.

The trip system in conjunction with the compression spring provided adequate protection in stony conditions. Maximum lift height of the shank was 9.25 in (235 mm).

Grain Metering System: Metering calibrations in wheat, barley and canola were accurate. Differences between the manufacturer's and PAMI's metering calibrations were attributed to the difference in seed size and density.

Variation in seeding rates among seed runs across the width of the machine was insignificant when seeding wheat, barley and canola. The seeding rates in all crops were unaffected by level of seed in the box, variations in ground speed and field roughness. Travelling up a 15° slope caused a 11% decrease, while travelling down a 15° slope caused a 5% increase in seeding rate. Seeding on a side slope did not affect seeding rate.

Fertilizer Metering System: The fertilizer metering calibration was accurate when density and particle size differences were considered. Variation in application rate among runs across the width of the machine was low. The application rate was unaffected by level of fertilizer in the box, ground speed or by field vibrations. Travelling up a 15° slope caused a 7% increase while travelling down a 15° slope caused a 10% decrease in fertilizer application rate. Seeding on a side slope did not affect the fertilizer application rate.

Ease of Operation and Adjustment: Hitching in transport position was convenient and the optional transport package enabled the drill to be placed in transport position in a couple of minutes. Dual wheel tractors interfered with the transport hitch when turning corners.

The seed and fertilizer rates were easy to adjust. Seeding depth was adjusted with the hydraulic lift cylinder and the spring length of the individual openers. The large metal walkway made filling with grain and fertilizer safe and convenient. A partition between the grain and fertilizer compartments could be easily opened to permit filling both compartments with seed. The seed and fertilizer box openings permitted cleaning with a small pail only. The feed gates could be easily opened to allow grain and fertilizer to fall through the cups.

The area counter was very accurate. Lubrication was easy with good access to all grease fittings.

Power Requirements: Tractor size depended on field conditions, soil type, seeding depth, ground speed and drill width. In silt loam soil, seeding at a normal seeding depth at 5 mph (8 km/h), a 45 hp (34 kW) tractor was needed to operate one 10 ft (3 m) section of the Morris MH-310.

Operator Safety: The Morris MH-310 seed drill was safe to operate provided normal safety precautions were observed.

Operator's Manual: The operator's manual contained useful information on adjustments, maintenance, and operation as well as a complete parts list.

Mechanical History: One shank bent and another broke while turning a corner in hard soil. Each hoe point was still useable after seeding 28 ac (11 ha).

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifying the seed box so emptying is more uniform.
2. Explaining the operation of the depth control lockup pin in greater detail in the operator's manual or on the machine itself to prevent damage to the lockup system.
3. Modifying the transport hitch so dual wheel tractors do not interfere when turning corners.
4. Supplying a slow moving vehicle sign as standard equipment.

Project Manager: R. P. Atkins

Project Engineer: L. W. Papworth

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. We will consider making box panels that are not interchangeable with our M-10 Disc Press Drill. This would allow

even spaced seed and fertilizer metering openings.
2. We will ensure a more detailed decal is installed on all new units and also supplemented with greater detail in our operator's manual.
3. We will look at modifying the transport hitch so dual wheel tractors will not interfere when turning corners.
4. A slow moving vehicle bracket and socket are provided and a slow moving vehicle sign is available from the dealer.

GENERAL DESCRIPTION

The Morris MH-310 is a basic 10 ft (3 m) three-row hoe drill with either 7.5, 10 or 12 inch (191, 254 or 305 mm) spacing. Hitches are available for hitching up to six basic drill units together. Seeding depth is controlled with adjustable springs on each opener and a hydraulic cylinder equipped with an adjustable stop. The divider in the combination grain and fertilizer box may be opened to allow filling the entire box with grain. The box is capable of holding 18.5 bu (673 L) of grain with 900 lb (408 kg) of fertilizer or 29.4 bu (1070 L) of grain only.

Grain is metered by externally cogged, fine and coarse metering wheels through plastic feed cups, equipped with adjustable flaps and shutoff slides. Fertilizer is metered through the feed cups by coarse metering wheels only. The metering wheels are chain driven from the press wheels through a variable speed drive box. The metering drive clutch system is protected with a shear pin. A motion indicator is provided to indicate rotation of the grain metering system.

Convoluted rubber hoses deliver the seed and fertilizer separately to the openers. Two gangs of 25 in (635 mm) diameter press wheels pack the soil directly behind each opener. Rubber capped packer wheels are available but the test unit was equipped with standard steel packer wheels.

The test machine consisted of one basic drill unit with 7.5 in (191 mm) spacing, equipped with optional equipment including transport system, dual wheel front castor and acremeter. An optional grass seed attachment is available, but was not evaluated.

FIGURE 1 shows the location of major components while detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Morris MH-310 was operated in the conditions shown in TABLE 1 for 108 hours while seeding about 452 ac (181 ha). It was evaluated for quality of work, ease of operation, ease of adjustment, power requirements, operator safety and suitability of the operator's manual. In addition, the seed and fertilizer metering systems were calibrated in the laboratory.

TABLE 1. Operating Conditions

Crop	Soil	Stone Conditions	Field Area		Hours
			ac	ha	
Oats on wheat stubble Spring	Silty loam	Occasional stones	16	7	3
wheat on summerfallow	Silty loam	Occasional stones	152	61	35
Barley on summerfallow	Silty loam	Occasional stones	26	10	6
Barley on tilled barley stubble	Silty loam	Occasional stones	26	10	6
Spring wheat on summerfallow	Silty loam	Occasional stones	54	22	12
Spring wheat on summerfallow	Silty loam	Very stony	26	10	8
Rye on summerfallow	Fine sand	Occasional stones	77	31	22
Winter Wheat on summerfallow	Sandy loam	Occasional stones	48	19	10
Winter wheat on wheat stubble	Sandy loam	Occasional stones	27	11	6
Total			452	181	108

RESULTS AND DISCUSSION

QUALITY OF WORK

Penetration: Penetration was good in a wide variety of field conditions provided the openers (FIGURE 2) were properly adjusted and adequate pre-seeding tillage had been performed. Penetration was good when seeding directly into stubble fields provided the soil contained adequate moisture.

Opener force was controlled by the spring length. Shortening the spring length increased the spring force. For normal seeding conditions the manufacturer recommends a spring length of 14 inches, and for openers in tractor tire tracks, a spring length of 13.5 inches.

Opener depth was controlled by the level adjustment bolt on the opener and the setting of the hydraulic lift cylinder.

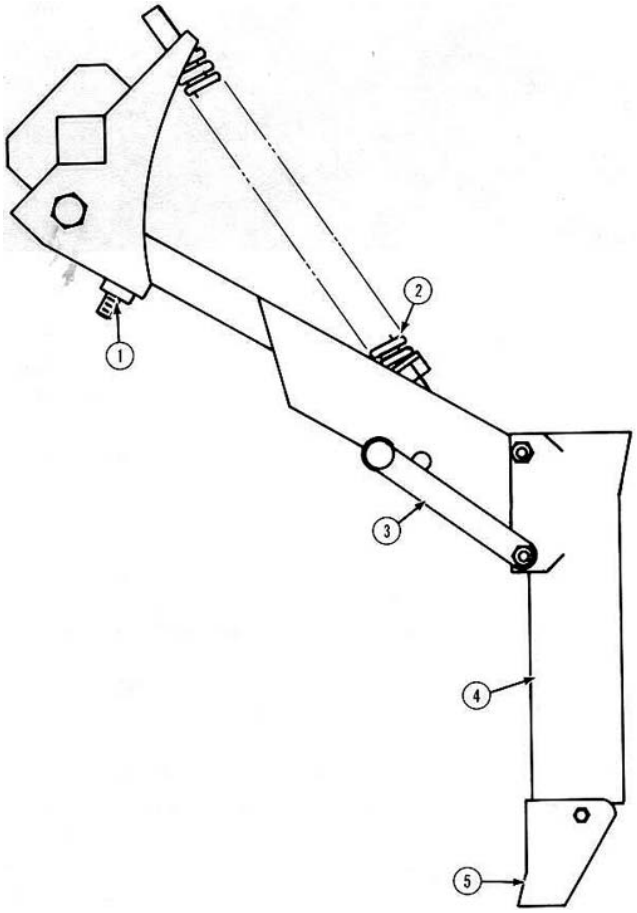

FIGURE 2. Hoe Assembly: (1) Level Adjustment Bolt, (2) Compression Spring, (3) Trip Arm, (4) Hoe Trip Boot, (5) Hoe Point.

The spring trip system was effective in providing opener protection in stony conditions. The trip system operates off the same compression spring that controls downward opener force. Consequently, the trip force increased as the downward pressure on the hoe increased.

Seed Placement: In normal prairie conditions, the grain is ideally placed when it is in moist soil on a firm seedbed from 1 to 2 in (25 to 50 mm) deep with soil packed tightly around the seed for optimum moisture contact and minimum soil drying.

The Morris MH-310 normally placed seed and fertilizer within a 1.5 (38 mm) wide band. When seeding in pre-tilled uniform soil conditions, variation in seed depth was quite uniform. For example, at an average seeding depth of 2.4 in (61 mm), although seeding depth across the width of the machine varied from 1.7 to 3.2 in (43 to 81 mm), most of the seeds were placed within 0.5 in (13 mm) of the average seed depth.

Soil Compaction: The V-shaped steel press wheels followed directly behind the openers, effectively pressing the soil about the seeds in all soils encountered. Average packing force exerted by each press wheel ranged from 208 lb (926 N) with empty seed and fertilizer boxes to 276 lb (1228 N) with full boxes. Press wheel furrow depth ranged from 1.2 to 2.0 in (30 to 50 mm) depending on soil conditions. FIGURE 3 shows the soil surface after seeding into a summerfallow field. The 1.6 in (41 mm) wide hoe point provided minimum soil disturbance, therefore giving the seed good soil coverage.

Trash Clearance: Trash clearance is dependent on field conditions and a number of drill design characteristics. Field conditions that affect trash clearance are soil type, soil and straw moisture content, straw length and type, how the soil was tilled last and how the trash was managed. The drill design characteristics that affect trash clearance are shank type, number of hoe rows, run spacing, distance between rows and the ground to frame clearance.

The Morris MH-310 was operated in four different types of trash conditions- summerfallow with long wheat straw, pre-tilled heavy barley stubble, wet wheat stubble and dry wheat stubble. The Morris

MH-310 cleared trash adequately in all conditions but performance was reduced in summerfallow with long wheat straw. The distance of 16 in (406 mm) between the rows on the Morris MH-310 resulted in the long straw building up on the shanks and eventually plugging up the machine (FIGURE 4).

FIGURE 3. Soil Surface after Seeding into Summerfallow.

FIGURE 4. Plugging in Summerfallow Field.

Operation in Stony Fields: The trip system in conjunction with the compression spring provided adequate protection in stony conditions. The trip system allowed the hoe boot to pivot back on the trip arm. This allowed the hoe boot to follow over rocks and obstructions easier. Maximum lift height, when the hoe boot was fully tripped, was 5.75 in (146 mm) and when the hoe boot did not trip at all, 9.25 in (235 mm). Maximum clearance would therefore be anywhere in between the two values depending on trip circumstances.

Plant Emergence: As with most drills, plant emergence depended primarily upon seedbed preparation and soil moisture. FIGURE 5 illustrates good emergence in a pre-tilled summerfallow field seeded to wheat.

FIGURE 5. Wheat Emergence on Summerfallow Field.

Metering Accuracy: The grain and fertilizer metering systems (FIGURE 6) were calibrated in the laboratory and compared with the manufacturer's calibrations. Since the actual application for certain settings depends on factors such as size, density and moisture content of seeds and fertilizer particles, it is not possible for a manufacturer to present charts to include all the variations of seed and fertilizer used. Field calibrations may be necessary for seed and fertilizer with properties differing from those indicated in the manufacturer's table. Research has shown, however, that small variations in seed or fertilizer application rates will not significantly affect grain crop yields.

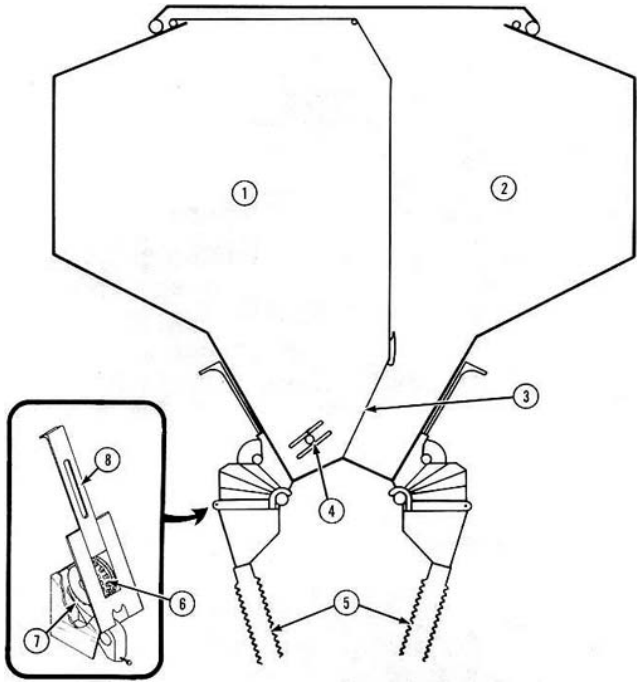

FIGURE 6. Grain and Fertilizer Metering Systems: (1) Grain Box, (2) Fertilizer Box, (3) Partition, (4) Agitator Shaft, (5) Grain and Fertilizer Tubes, (6) Externally Cogged Metering Wheels, (7) Adjustable Flap, (8) Adjustable Shut-off Slides.

The Morris MH-310 came equipped with a "Len Digney Gauge" (FIGURE 7) to check the calibration of the metering system. To operate the gauge, the cylinder was placed under a shank to collect the grain coming from one seed cup. The feed shaft was then turned a certain number of times using a hand crank or by moving the drill. The reading off the cylinder was then compared to the feed rate chart. During testing the gauge proved to be accurate.

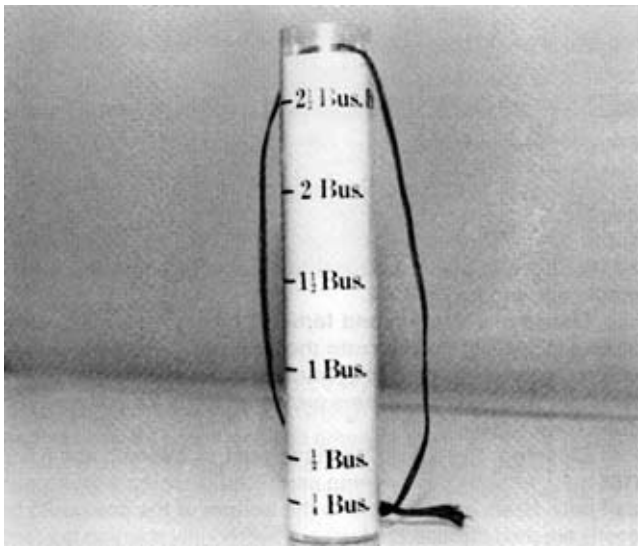

FIGURE 7. Len Digney Gauge.

Grain Metering System: FIGURES 8 to 10 show the calibration curves obtained by PAMI and the manufacturer for the Morris MH-310 in wheat, barley and canola. The barley and canola calibration curves were accurate. The wheat calibration curve was accurate within the normal seeding range but was higher than the manufacturer's curve at rates above 90 lb/ac (100 kg/ha) as shown by the curve. Any differences between the calibration curves obtained by PAMI and those given by the manufacturer are probably due to different seed size, density and moisture content. The seed densities (bushel weights) used by PAMI and the manufacturer are indicated on the graphs.

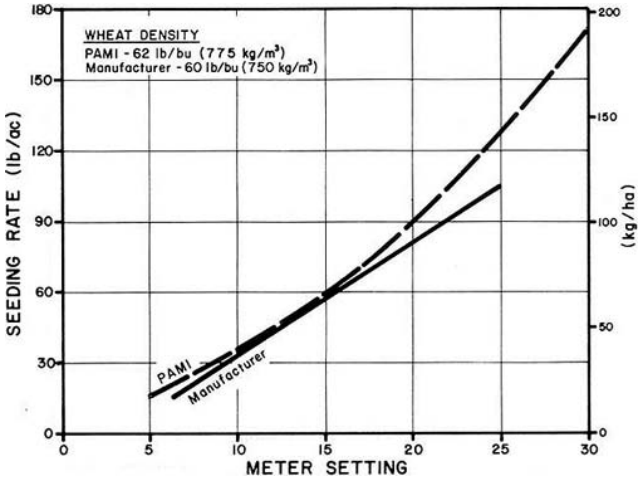

FIGURE 8. Metering Accuracy in Wheat.

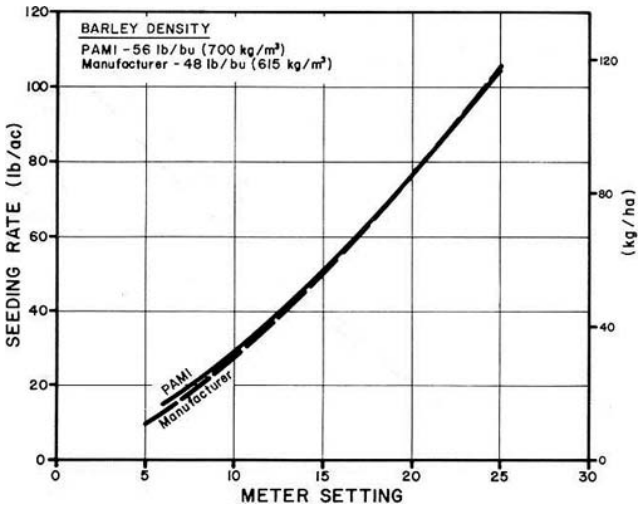

FIGURE 9. Metering Accuracy in Barley.

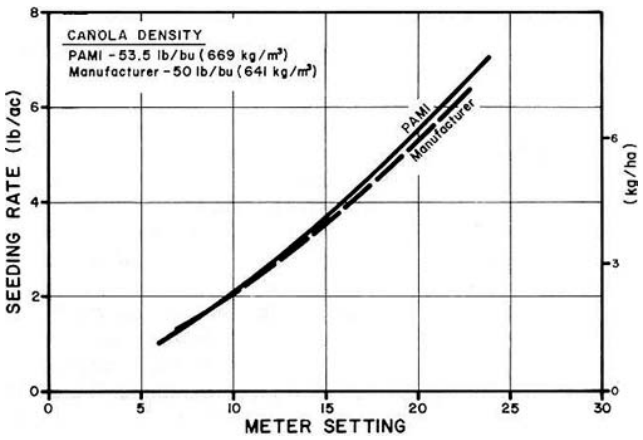

FIGURE 10. Metering Accuracy in Canola.

Level of seed in the grain box, variation in ground speed, and field roughness did not affect the seeding rate of either large or small seeds. FIGURE 11 shows the variation in seed application rates as affected by field slope. Travelling up a 15° slope caused an 11% decrease in seeding rate and travelling down a 15° slope caused a 5% increase. Seeding on a side slope did not affect seeding rate.

The coefficient of variation (CV)[1] is commonly used to describe the variation of application rate among individual seed cups across the width of the machine. An accepted variation for grain or fertilizer is a CV value not greater than 15%. If the CV is less than 15%, seeding is acceptable, whereas if the CV is much greater than 15%, the variation among individual seed cups is excessive.

[1]The coefficient of variation is the standard deviation of application rates from individual seed cups, expressed as a percent of the mean application rate.

The seeding rate, across the width of the machine for wheat, barley and canola, was very uniform with CV's of 1 to 4%. Grain crackage through the grain metering system was negligible for both small and large seeds.

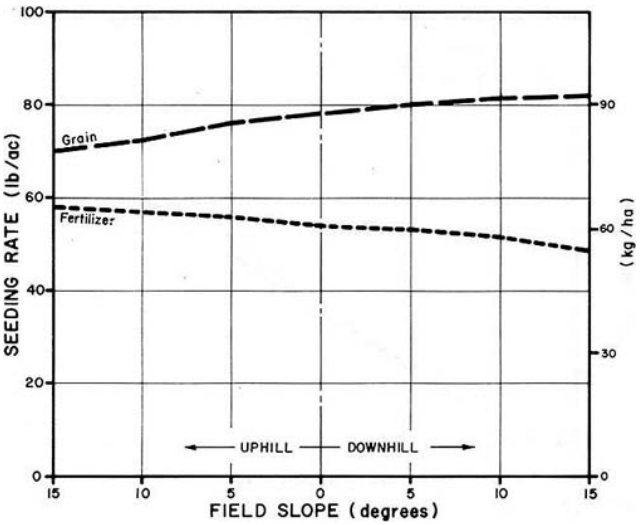

FIGURE 11. Variation in Seed and Fertilizer Application Rate with Change in Slope.

Fertilizer Metering System: FIGURE 12 shows the calibration curve for fertilizer obtained by PAMI and the manufacturer while metering 11-51-00 fertilizer. The slight difference between the two curves is probably due to the variation in the size and density of the fertilizer used in the two calibrations. The maximum fertilizer rate attainable was 320 lb/ac (360 kg/ha) at a meter setting of 50.
Fertilizer distribution across the width of the drill was quite uniform. CV's ranged from 2 to 5%.

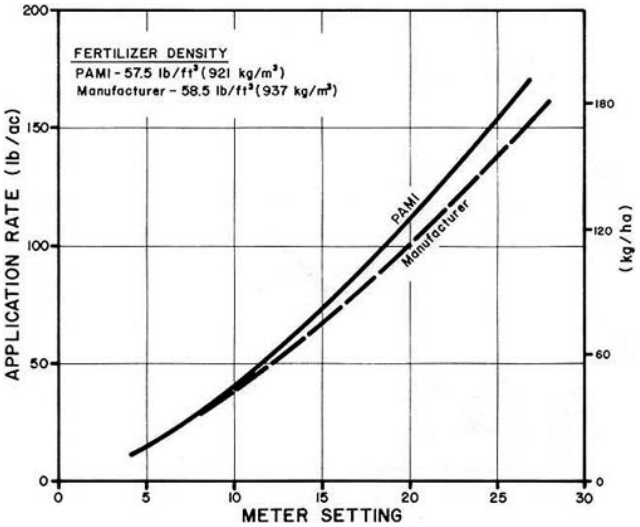

FIGURE 12. Metering Accuracy in Fertilizer.

Level of fertilizer in the box, ground speed and field vibrations did not significantly affect the application rate of fertilizer. FIGURE 11 shows the variation in fertilizer application rates as affected by field slope. For example, travelling up a 15° slope increased the fertilizing rate by about 7%. Travelling down a 15° slope decreased the fertilizing rate by about 10%.

EASE OF OPERATION

Hitching: Hitching in transport position was convenient since the hitch was supported with a hitch jack. The transport hitch came with a single and double lipped clevis making hitching to any drawbar convenient.

Feed Gate: The grain seed cups and the fertilizer cups were equipped with adjustable feed gates. The gates could be set in 8 different positions for different sized seeds and in a fully open position for cleaning the seed cups. The gates were spring loaded to allow foreign material to pass without damage to the cup.

Filling: The 35 in (890 mm) wide metal walkway on the rear of

the drill made filling with grain and fertilizer safe and convenient. The fertilizer and grain compartments were covered by one lid that could be reversed for front or rear filling. There was also an additional interior lid covering the fertilizer hopper. The lids were difficult to close requiring the operator to stretch both arms to unlock the lid supports (FIGURE 13).

FIGURE 13. Inconvenient Lid Closing.

The partition between the grain and fertilizer compartments could be opened to permit filling both compartments with seed. This permitted carrying 18.5 bu (673 L) of grain and 900 lb (408 kg) of fertilizer, or 29.4 bu (1070 L) of grain only. It took approximately one man 5 minutes to change positional the partition.

Grain and fertilizer level indicators were included on the MH-310 (FIGURE 14). They effectively showed the levels by floating on top of the grain and fertilizer as the level went down. View of the indicators from the tractor cab was good.

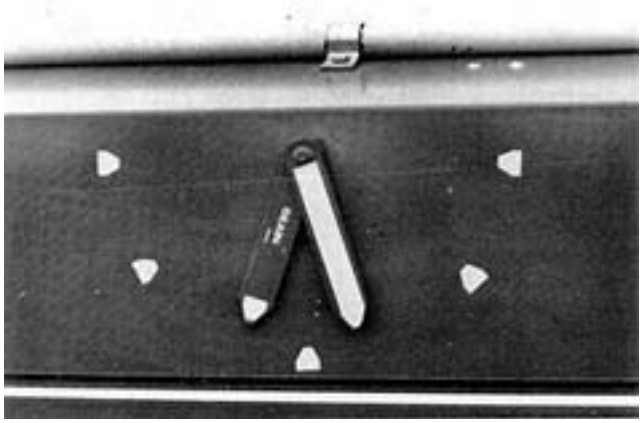

FIGURE 14. Grain and Fertilizer Level Indicators.

During testing the grain box emptied unevenly (the center emptied faster than the sides) due to the position of the box supports and the blocked off feed cup holes. It is recommended that the manufacturer consider modifying the seed box so emptying is more uniform.

Moisture: The grain and fertilizer boxes were adequately sealed to prevent leakage into the boxes in light rains. During testing, however, a tarp was used to prevent leakage during heavier rains. Vinyl weather covers protected the seed and fertilizer cups from rains.

Cleaning: The 8.5 in (216 mm) seed box opening and 6.5 in (165 mm) fertilizer box opening permitted cleaning with a small pail only. Grain and fertilizer in the bottom of the box could be easily brushed through the feed cups after fully opening the feed gates. The agitator shaft in the grain box did however hinder this procedure. A vacuum cleaner or compressed air could be used as well.

Acre Counter: The optional acre counter (FIGURE 15) was very accurate. It recorded to the nearest tenth acre up to one million acres.

Transporting: The optional drill transport package (FIGURE 16) was convenient for transporting the drill over long distances. It took less than 5 minutes to place the drill in transport position.

FIGURE 15. Acre Counter.

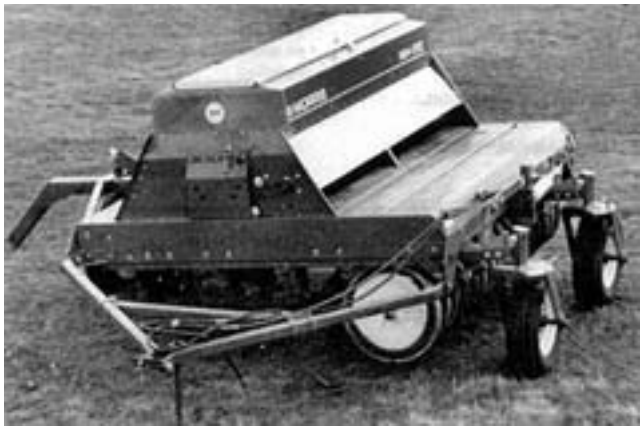

FIGURE 16. Transport Position.

The depth control lock-up pin had a working position and a transport position. This was designed as a safety feature to allow the cylinder to move freely while locked in transport position. This feature was not clearly outlined in the operator's manual or on the machine. It is recommended that the manufacturer consider explaining this feature in greater detail in the operator's manual or on the machine itself to prevent damage to the lock-up system.

The manufacturer recommended that the drill not be transported at speeds above 10 mph (16 km/h) or with the boxes more than half full. If all the wheels were locked the drill could be safely transported at speeds above 10 mph (16 km/h). The transport castor wheels had to be locked when backing up the Morris MH-310 in transport position, since the wheels could not turn 180 degrees.

When turning a corner, with the drill in transport position with a large tractor, the transport hitch tended to interfere with the tractor tires. It is recommended that the manufacturer consider modifying the transport hitch so dual wheel tractors do not interfere when turning corners.

EASE OF ADJUSTMENT

Lubrication: Lubrication was easy with good access to all grease fittings. Thirteen grease fittings required daily greasing, while five grease fittings required greasing every 50 hours. Sight glasses for the oil levels on the drive boxes made daily servicing easy. The wheel bearings required packing with grease each season.

Seeding and Fertilizing Rates: Seeding and fertilizing rates were easily changed by moving the rate adjusting lever on the drive box (FIGURE 17) to the desired setting. Shutoff slides (FIGURE 18) and the bottom flaps on each feed cup had to be adjusted for different varieties of grain and fertilizer. The bottom flaps for all seed or all fertilizer cups were adjusted by one lever (FIGURE 18).

For fine seeds such as canola, each coarse metering wheel was disengaged from the fine metering wheel, using the supplied engaging hook. This prevented the coarse metering wheel from turning, letting the fine wheel turn. A flathead screwdriver was required to tighten the brass screw on the coarse metering wheel when changing metering wheels.

Depth of Tillage: Seeding depth was adjusted by positioning the hydraulic lift cylinder. Seeding depth from front to back was equalized by adjusting turnbuckles between the rows of hoe openers. Each opener could be individually adjusted by changing

the spring length or the level adjustment bolt on the rocker-shaft pivot bracket (FIGURE 2).

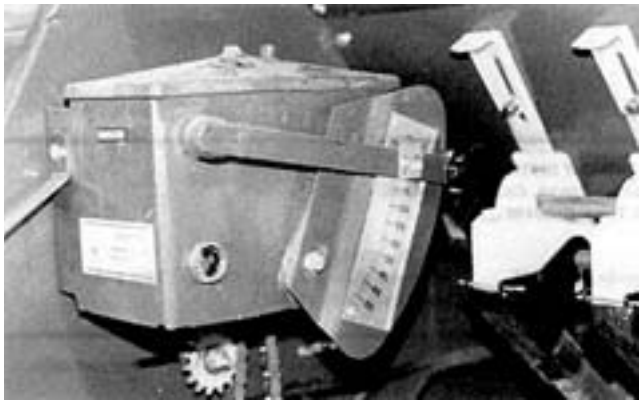

FIGURE 17. Metering Drive Box.

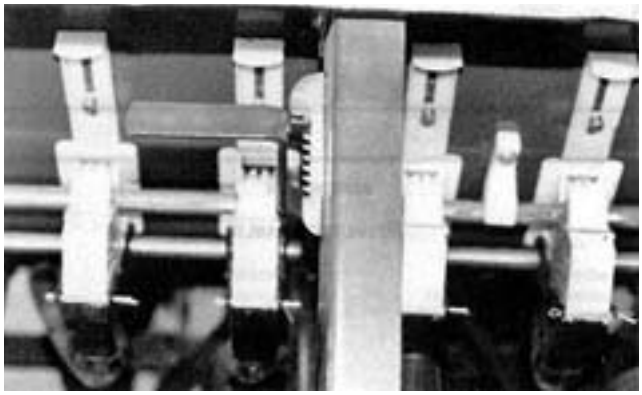

FIGURE 18. Shutoff Slide and Flap Lever Adjustment.

POWER REQUIREMENTS

Draft: Draft (drawbar pull) requirements depended on field preparation, soil type and moisture content, ground speed and amount of fertilizer and grain in the boxes.

Average draft at a normal seeding depth and at 5 mph (8 km/h), with fully loaded seed boxes, ranged from 1800 lb (8010 N) to 2000 lb (8900 N) in silt loam soil for one 10 ft (3 m) drill unit.

FIGURE 19 shows the horsepower requirements throughout the seeding depth range in the stated conditions.

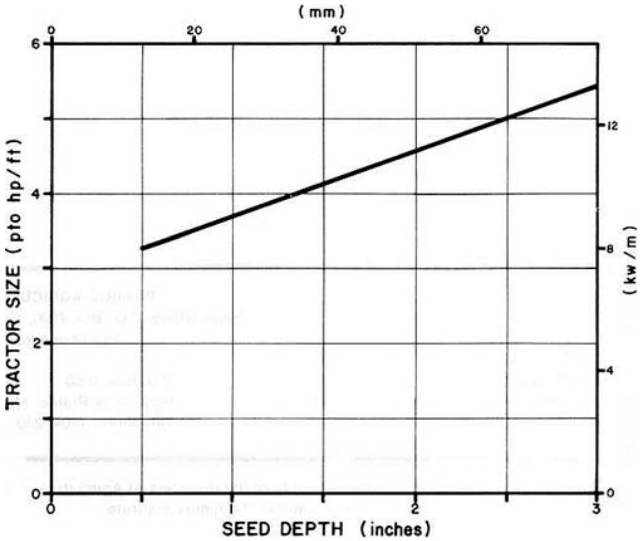

FIGURE 19. Average Horsepower Requirements at 5 mph (8 km/h).

Tractor Size: The power take-off horsepower requirements per foot of drill width for varying seed depths are given in FIGURE 19. Requirements varied from 3.25 hp/ft (7.95 kW/m) at 0.5 in (13 mm) seed depth to 5.44 hp/ft (13.31 kW/m) at 3.0 in (75 mm) seed depth. Therefore, overall tractor size needed to pull 10 ft (3 m) of Morris MH-310 drill varied from 43 hp (32 kW) to 48 hp (36 kW) in silt loam soil. These tractor sizes have been adjusted to include tractive efficiency and represent a tractor operating at 80% of maximum power take-off ratings as determined by Nebraska tests or as presented by the tractor manufacturer. The tractor sizes given will have ample power reserve to operate in the stated conditions.

OPERATOR SAFETY

The Morris MH-310 was safe to operate if normal safety precautions were observed. Lock-up pins were provided for the hoe bed and the transport system. The platform at the rear of the drill was large enough for safe and convenient filling. The rear transport wheels were locked when in field position, making them safe to step on for mounting the rear platform. A mounting bracket for a slow moving vehicle sign was provided, but no slow moving vehicle sign was supplied. It is recommended that the manufacturer consider supplying a slow moving vehicle sign as standard equipment.

Tire loads did not exceed the Tire and Rim Association maximum load rating. Slight overloading will occur if the machine is equipped with the single front castor wheel.

OPERATOR'S MANUAL

The operator's manual contained useful information on adjustments, maintenance and operation as well as a complete parts list. Calibration charts were provided in the operator's manual and on the drill box. Seeding rates were expressed in Imperial units (lb/ac) and in metric (SI) units (kg/ha). As mentioned before, detailed information on use of the hoe bed lock-up pin should be included in the operator's manual.

MECHANICAL PROBLEMS

The Morris MH-310 was operated for 108 hours while seeding about 452 ac (108 ha). The intent of the test was evaluation of functional performance and an extended durability evaluation was not conducted. TABLE 2 outlines the mechanical problems that did occur during the functional testing.

TABLE 2. Mechanical History

Item	Operating Hours	Equivalent Field Area	
		ac	(ha)
-broke off grain box hood latch	5	25	(10)
-bent depth control cylinder lock-up pin holder	9	42	(17)
-broke one hoe and bent another while turning corner in hard soil	33	146	(58)

DISCUSSION OF MECHANICAL PROBLEMS

Hoe Point Wear: FIGURE 20 shows the wear on a typical hoe point at the end of the test. Each point seeded approximately 28 ac (11 ha) in the conditions listed in TABLE 1. It should be noted that this hoe point provided adequate performance at the end of the test.

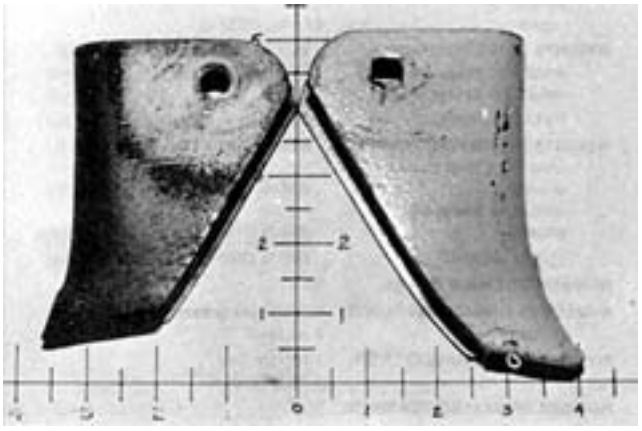

FIGURE 20. Hoe Point Wear at End of Test.

APPENDIX I
SPECIFICATIONS

MAKE:	Morris
MODEL:	MH-310 Hoe Press Drill
SERIAL NUMBER:	4191
MANUFACTURER:	Morris 85 York Road Yorkton, Saskatchewan S3N 2X2

DIMENSIONS OF SINGLE UNIT:	**Field Position**	**Transport Position**
-- height	7.2 ft (2.2 m)	5.9 ft (1.8 m)
-- length	14.6 ft (4.5 m)	15.4 ft (4.7 m)
-- width	11.0 ft (3.4 m)	14.6 ft (4.5 m)
-- effective seeding width	10.0 ft (3.0 m)	
-- transport ground clearance		5.0 in (127 m)

SEED METERING SYSTEM:	
-- type	externally cogged fine and coarse metering wheels
-- drive	chain driven through variable speed drive box from press wheels
-- adjustment	fine or coarse wheels, flaps and shutoff slides on feed cups, lever on variable speed drive
-- transfer to openers	convoluted rubber hose
FERTILIZER METERING SYSTEM:	
-- type	externally cogged coarse metering wheels
-- drive	chain driven through variable speed drive box from press wheels
-- adjustment	flaps and shutoff slides on feed cups, lever on variable speed drive
-- transfer to openers	convoluted rubber hose
OPENERS:	
-- type	hoe
-- point	1.6 in (41 mm) standard
-- number	16 per unit
-- spacing	7.5 in (190 mm)
-- number of rows	3
-- distance between rows	16 in (406 mm)
-- options	10 or 12 in (255 or 305 mm) spacing
PRESS WHEELS:	
-- type	V-shaped steel
-- diameter	25 in (635 mm)
-- width	1.75 in (45 mm)
-- number	16 per unit
-- spacing	7.5 in (190 mm)
-- number of gangs	2
CASTOR WHEELS:	
-- number	2 per unit (1 per unit standard)
-- tire size	7.60 x 15 in - 6 ply
GRAIN AND FERTILIZER BOX CAPACITIES:	
-- with box partition in position 1	
-grain	18.5 bu (673 L)
-fertilizer	900 lb (408 kg)
-- with box partition in position 2	
-grain	29.4 bu (1070 L)

WEIGHTS: (Field Position)	**Boxes Empty**	**Boxes Full**
-- weight on press wheels	3320 lb (1505 kg)	4415 lb (2000 kg)
-- weight on castor wheels	1270 lb (575 kg)	2185 lb (990 kg)
Total	4590 lb (2080 kg)	6600 lb (2990 kg)

WEIGHTS: (Transport Position)	**Boxes Empty**	**Boxes Full**
-- weight on front castor wheels	1980 lb (900 kg)	3180 lb (1440 kg)
-- weight on transport wheels	2610 lb (1180 kg)	3420 lb (1550 kg)
Total	4590 lb (2080 kg)	6600 lb (2990 kg)

NUMBER OF CHAIN DRIVES: 5

NUMBER OF LUBRICATION POINTS: 18 pressure grease fittings 2 oil level

NUMBER OF HYDRAULIC LIFTS: 1 for hoe bed 1 for transport

NUMBER OF SEALED BEARINGS: 9

OPTIONS INCLUDED ON TEST MACHINE:
-- Acre counter, dual wheel front castor, transport system

OTHER AVAILABLE OPTIONS:
-- 10 and 12 in (255 and 305 mm) spacing
-- rubber clinch type rim packers
-- marker

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

Excellent	Very Good
Good	Fair
Poor	Unsatisfactory

APPENDIX III
CONVERSION TABLE

acres (ac) x 0.40	= hectares (ha)
miles/hour (mph) x 1.61	= kilometres/hour (km/h)
inches (in) x 25.4	= millimetres (mm)
feet (ft) x 0.305	= metres (m)
horsepower (hp) x 0.75	= kilowatts (kW)
pounds (lb) x 0.45	= kilograms (kg)
pounds force (lb) x 4.45	= newtons (N)
bushels (bu) x 36.4	= litres (L)
pounds/acre (lb/ac) x 1.12	= kilograms/hectare (kg/ha)
pounds/bushel (lb/bu) x 12.5	= kilograms/cubic meter (kg/m³)

SUMMARY CHART
MORRIS MH-310 HOE PRESS DRILL

RETAIL PRICE:	$14,765.00 (August, 1986, f.o.b. Lethbridge)
QUALITY OF WORK:	
Penetration	**good;** moist stubble fields
Trash Clearance	plugged occasionally in long wheat straw on summerfallow; cleared in all other conditions
Stony Conditions	adequate protection
Metering	accurate in wheat, barley, canola and fertilizer
EASE OF OPERATION:	
Filling	convenient
Cleaning	easy with small pail and brush
Transportability	**very good,** except that dual wheels interfered with hitch when turning
EASE OF ADJUSTMENT:	
Seeding and Fertilizer Rates	easy to change
Depth	simple; openers in tire tracks could be set deeper
POWER REQUIREMENTS:	45 PTO hp (34 kW) tractor per 10 ft (3 m) drill was sufficient for all conditions
OPERATOR SAFETY:	safe, if normal precautions observed no slow moving vehicle sign supplied
OPERATOR'S MANUAL:	contained useful information; parts list provided
MECHANICAL HISTORY:	hoe points were still useable after 28 ac (11 ha) per point

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