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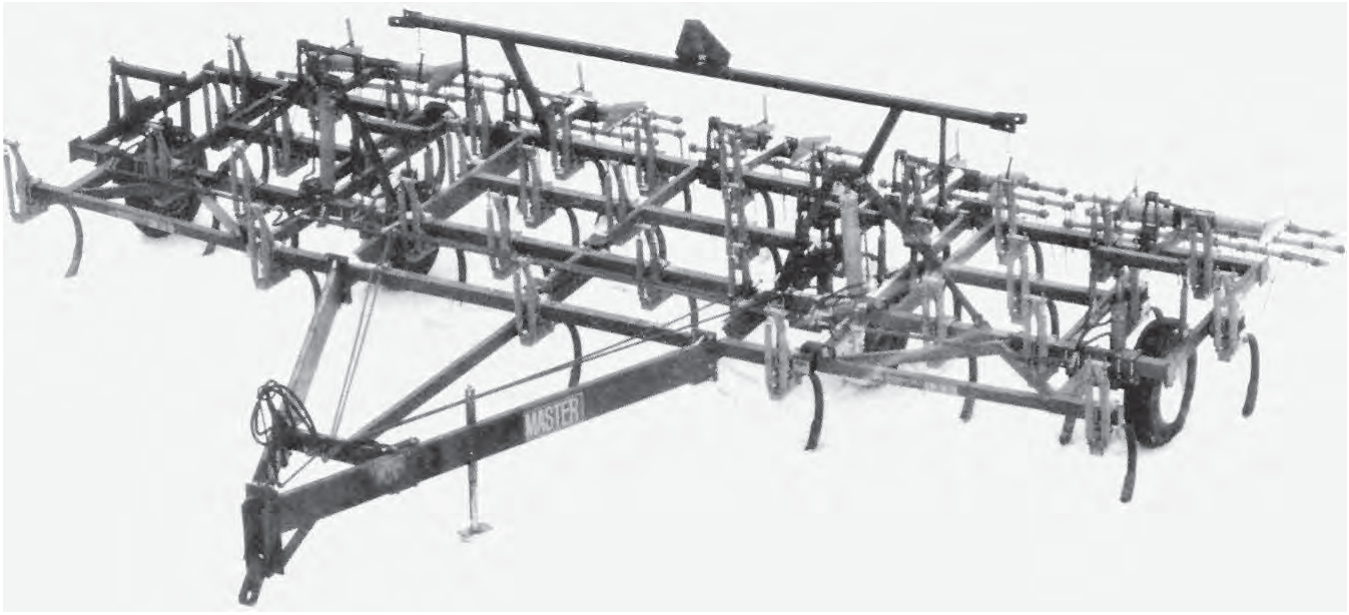
Evaluation Report 57



Bourgault (7.8m) Vibra-Master VM 24-28

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

BOURGAULT VIBRA-MASTER VM 24-28

MANUFACTURER AND DISTRIBUTOR:
Bourgault Industries Ltd.
Box 130
St. Brieux, Saskatchewan
S0K 3V0

RETAIL PRICE:
$7,340.00 (May, 1979, f.o.b. Humboldt, 7.8 m width, with optional finishing harrows).

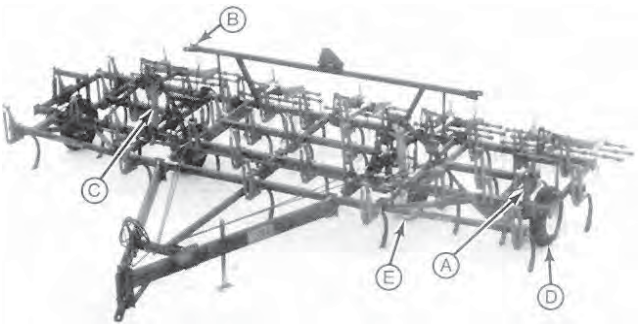


FIGURE 1. Bourgault Vlbra-Master: (A) Depth Control Cylinder, (B) Wing Safety Stops, (C) Wing Lift Cylinder, (D) Wing Wheels, (E) Centre Wheels.

SUMMARY AND CONCLUSIONS

Overall functional performance of the Bourgault VibraMaster was very good for light secondary tillage such as seedbed preparation and herbicide incorporation, providing mounted finishing harrows were used. Its performance in heavy secondary tillage and light to intermediate primary tillage was very good. Weed kill was very good if 254 mm (10 in), or larger, sweeps were used. It was unsuitable for heavy primary tillage, very hard soil or very heavy trash.

The spring cushioned shanks could lift 253 mm (10 in) to clear stones. Shanks were sufficiently rigid to be suitable for all secondary tillage as well as light to intermediate primary tillage. When equipped with sweeps having a 46 degree stem angle, sweep pitch varied from 0 to 2 degrees over the range of normal secondary tillage draft. Shank cushioning spring preload was exceeded at drafts greater than 4.6 kN/m (330 lb/ft), occurring well within the primary tillage draft range. Furrow bottom ridging occurred only in hard soils. Penetration was very good in all soils. Plugging occurred in very heavy or damp trash. The Bourgault Vibra-Master buried less trash than most heavy duty cultivators, but buried slightly more than most light field cultivators. The sweep pattern was symmetrical and sideways skewing was evident only in very hilly conditions and was never severe enough to affect weed kill. Weed kill was good as long as sweeps with adequate overlap were used.

The Bourgault Vibra-Master could be conveniently placed in transport position in less than five minutes. The 152 mm (6 in) sweep-to-ground clearance, in transport position, was occasionally inadequate. Due to its large transport width, transporting on public roads had to be with extreme caution and high transport speeds should not be used as the tires were overloaded in transport position. The 7.8 m (25.7 ft) wide test machine had a transport height of 2.9 m (9.5 ft), permitting safe transport under power lines in the three prairie provinces. Transport height of the 11.0 m (36 ft) wide model of the Bourgault Vibra-Master is 4.6 m (15.1 ft) which is high enough to contact some farmyard service lines.

When equipped with optional finishing harrows, hitch weight was negative, but did not make hitching inconvenient. Adequate adjustment was provided for both lateral and fore-and-aft leveling. Tillage depth was uniform across the width of the cultivator as long as the centre frame and wing section hydraulic cylinders were kept synchronized and cylinder adjuster nuts were set for field conditions. In soft, loose fields, excessive sinkage of centre section wheels resulted in non-uniform tillage depth.

Average draft for the 7.6 m (25.7 ft) wide test machine, in light secondary tillage, at 6 km/h (5 mph), varied from 6 kN (1350 lb) at 40 mm (1.5 in) depth to 16 kN (3600 lb) at 100 mm (4 in) depth. In heavy secondary and light primary tillage, at 6 km/h (5 mph), average draft varied from 11 kN (2470 lb) at 40 mm (1.5 in) to 29 kN (6520 lb) at 125 mm (5 in). In heavy primary tillage, at 6 km/h (5 mph), average draft varied from 14 kN (3150 lb) at 50 mm (2 in) to 36 kN (6450 lb) at 100 mm (4 in).

In light secondary tillage, at 10 km/h (6.2 mph) and 75 mm (3 in) depth, a tractor with 65 kW (67 hp) maximum power takeoff rating will have sufficient power reserve to operate a 7.8 m (25.7 ft) wide Bourgault Vibra-Master. In heavy secondary or light primary tillage at the same depth and speed, a 94 kW (126 hp) tractor is needed while in heavy primary tillage a 141 kW (153 hp) tractor is required.

The Bourgault Vibra-Master was equipped with wing transport locks and a slow moving vehicle sign to aid in transport safety. No mechanical transport locks were provided for the master depth control cylinders. The operator's manual was clear, concise and well illustrated.

Only minor mechanical problems occurred during the 313 hours of field operation, none of which seriously affected cultivator operation.

RECOMMENDATIONS

It is recommended that the manufacturer consider:
1. Supplying a mechanical transport lock for the centre frame depth control cylinders to aid in transport safety.
2. Increasing the size of centre section tires or providing dual wheels to improve flotation and eliminate tire over-loading in transport position.
3. Working with the agricultural equipment industry to standardize hydraulic quick couplers and hydraulic hose fitting threads.
4. Working with the agricultural equipment industry to standardize shank and sweep stem angles, and sweep fastener spacing and sizes.

Chief Engineer -- E. O. Nyborg
Senior Engineer -- L. G. Smith

THE MANUFACTURER STATES THAT

With regard to recommendation number:
1. Our engineering department has been actively considering this recommendation for some time but as of yet has not developed what they consider a convenient and reliable mechanism. Further work will be done in an effort to develop a suitable locking system.
2. We currently have a production model, the Commander 26-30, which has walking axles (dual wheels) on the centre section.
3. Our company would work with the agricultural equipment industry to standardize these components.
4. Our company would work with the agricultural equipment industry to standardize these components.

GENERAL DESCRIPTION

The Bourgault Vibra-Master is a trailing, flexible, three-section intermediate cultivator suitable for light or medium tillage such as seedbed preparation, herbicide incorporation, heavy secondary summerfallow and light primary summerfallow. It is available in 16 widths ranging from 3.7 to 11.0 m. The test machine was a 7.8 m model, with a 3.8 m centre frame and two 2.0 m wings. It was equipped with 38 spring cushioned shanks, laterally spaced at

203 mm, arranged in four rows.

The centre frame is carried on two wheels, while each wing is supported by a single wheel. Four hydraulic cylinders, connected in series, control the tillage depth. Two cylinders are located on the centre section, while one is located on each wing wheel. The wings fold into upright transport position with two hydraulic cylinders connected in parallel. A tractor with dual remote hydraulic controls is needed to operate the Bourgault Vibre-Master.

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

SCOPE OF TEST

The Bourgault Vibra-Master was operated in the field conditions shown in TABLE 1, for 313 hours while cultivating about 1722 ha. It was evaluated for quality of work, ease of operation and adjustment, power requirements, safety and suitability of the operator's manual. Optional attached finishing harrows were used during most of the test.

TABLE 1. Operating Conditions

FIELD CONDITION	HOURS	FIELD AREA (ha)
Soil Type		
--loam	184	1052
--clay loam	96	488
--clay	33	102
TOTAL	313	1722
Stony Phase		
--stone free	47	282
--occasional stones	110	661
--moderately stony	59	277
--very stony	97	502
TOTAL	313	1722

RESULTS AND DISCUSSION

QUALITY OF WORK

Shank Characteristics: There is a large variation in shank and sweep stem angles (FIGURE 2) on cultivators from different manufacturers. Sweeps and shanks must be matched to obtain sufficient sweep pitch to achieve and maintain penetration. Usually manufacturers recommend sweeps with a stem angle from 0 to 5 degrees less than the shank stem angle to result in a slightly positive no-load sweep pitch.

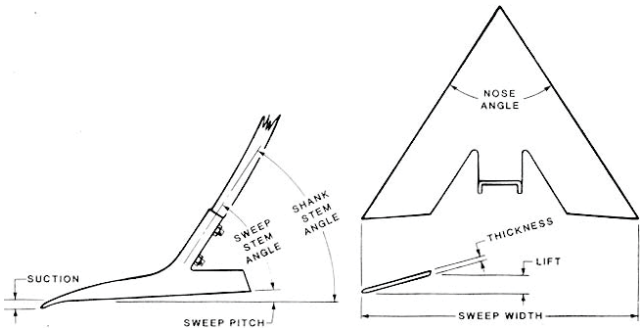


FIGURE 2. Shank and Sweep Terminology.

Sweep pitch increases in proportion to draft due to shank flexing and, depending on shank stiffness and cushioning spring preload, may become excessive in normal tillage, on some cultivators. A slightly positive sweep pitch results in uniform tillage depth and a smooth furrow bottom while excessive sweep pitch causes furrow bottom ridging and rapid sweep tip wear. Shanks which maintain a relatively constant sweep pitch, over the normal range of tillage forces, are desirable.

The Bourgault Vibra-Master was equipped with spring cushioned shank holders. Cushioning spring preload had a narrow range of adjustment. During the test, the Bourgault Vibra-Master was used with 254 mm wide sweeps with 46 degree stem angle, giving a no-load sweep pitch of 1 degree.

FIGURE 3 shows pitch characteristics of the Bourgault Vibra-Master shank assembly. The low end of the pitch curve results from shank flexing, while the steeper upper part of the curve occurs when draft is large enough to overcome cushioning spring preload. Sweep pitch varied 2 degrees over the full range of draft normally occurring in secondary tillage. When equipped with 47 degree sweeps, as used during the test, sweep pitch varied from 0 to 2 degrees over this draft range. Cushioning spring preload was exceeded at drafts greater than 4.9 kN/m, occurring well within the range of normal primary tillage drafts. This shows that the Bourgault Vibra-Master is suitable both for secondary and light to intermediate primary tillage, but is not intended for heavy primary tillage.

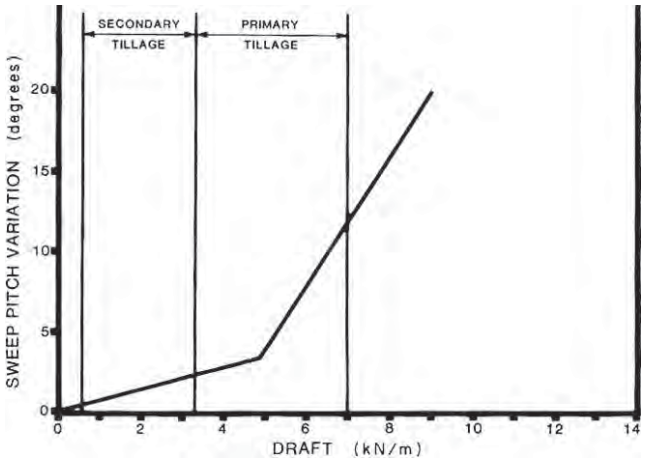


FIGURE 3. Sweep Pitch Variation over a Normal Range of Draft (203 mm Shank Spacing).

FIGURE 4 shows the lifting pattern when shanks encounter stones or field obstructions. Maximum lift height was 253 mm. The shank cushioning assembly performed well throughout the test. Two shanks bent during the test, when they became hooked under large flat rocks.

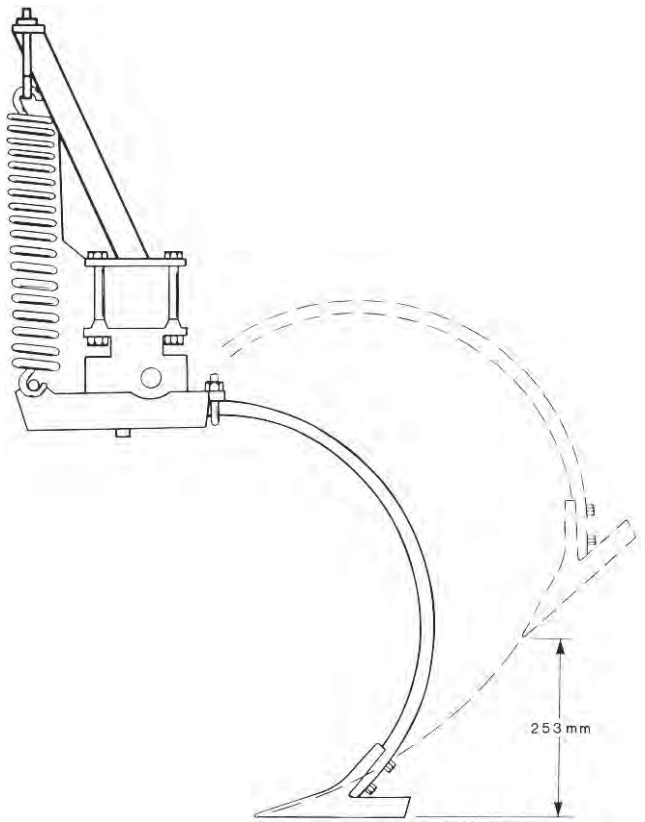


FIGURE 4. Shank Lifting Pattern.

Penetration: Penetration was very good in all secondary tillage and in light to intermediate primary tillage, provided the sweeps were not excessively worn. Penetration was inadequate in very hard

soils such as encountered in heavy primary tillage.

Penetration was uniform across the cultivator width, in normal field conditions, provided that the frame was properly leveled and the hydraulic cylinders were kept synchronized. In soft, wet soil, excessive sinkage of the centre section wheels caused large depth differences. Tires on the centre section were inadequately sized for good flotation in soft soil. The wheels were positioned so that each centre section wheel supported about 36% of the cultivator weight while each wing wheel supported about 14%. In addition, each centre section wheel supported about 32% of the total tillage suction force while each wing wheel supported about 18%. For good flotation and uniform tillage depth across the cultivator width, it is desirable to have wheels sized and positioned s o that each supports equivalent weight and similar tillage suction force. It is recommended that size of the centre section tires be increased or dual wheels be installed to improve flotation.

Depth differences between the front and rear rows of shanks were slight, once the frame had been properly leveled. In secondary and light to intermediate primary tillage, the frame remained relatively level with little twisting of the wing frames.

The Bourgault Vibra-Master followed gently rolling field contours very well, maintaining quite uniform depth across its width. As with most wing cultivators, large variations in tillage depth occurred in fields with abrupt contour changes.

Plugging: No plugging occurred in moderate trash and weeds. In dry conditions the Bourgault Vibra-Master cleared large amounts of trash. In very heavy or damp trash, plugging usually occurred behind or beside the wheels (FIGURE 5). In very heavy trash, the harrows occasionally plugged. Harrow plugging could usually be alleviated by adjusting the vertical harrow position or the tine angle.

FIGURE 5. Plugging Beside the Wing Wheel in Long Wheat Stubble.

Trash Burial and Field Surface: The Bourgault Vibra-Master buried less trash than most heavy duty cultivators and slightly more than most light field cultivators. With the optional finishing harrows, fields were left with a smooth, unridged surface (FIGURE 6). Without mounted harrows, the surface was left with 30 to 45 mm deep ridges. Furrow Bottom Ridging: In all secondary tillage operations and light to intermediate primary tillage, furrow bottom ridging was negligible. In hard soils, furrow bottom ridging increased sharply due to increased sweep pitch at high draft (FIGURE 3).

Skewing and Stability: The Bourgault Vibra-Master was very stable and sideways skewing occurred only in very hilly conditions. The shank pattern (FIGURE 7) was symmetrical and did not impose any side forces on the cultivator during normal tillage. When equipped with 254 mm sweeps, weeds would be missed if the cultivator skewed more than 1.3 degrees (FIGURE 7). In hilly conditions where skewing is excessive, wider sweeps should be used.

Weed Kill: Weed kill was good with 254 mm sweeps. Normal shank spacing was 203 mm, resulting in 51 mm overlap. When sweeps had worn to less than 210 mm width, some heavy stalked weeds remained rooted. Sweeps should be replaced before they wear to less than 210 mm.

FIGURE 6. Smooth, Unridged Surface Created by Mounted Harrows.

EASE OF OPERATION AND ADJUSTMENT

Transportation: The Bourgault Vibra-Master was easily placed in transport position (FIGURE 8) using the hydraulic wing lift system supplied as standard equipment. Two pins, which had to be inserted by hand, were provided to lock the wings during transport. It usually took one man less than five minutes to place the Bourgault Vibra-Master in transport position. No transport lock was provided for the centre section depth control cylinders to prevent machine drop in the event of hydraulic hose failure. It is recommended that a mechanical cylinder lock-up be provided to ensure transport safety.

Transport width was 6.0 m while transport height was 2.9 m. Extreme care was needed when transporting on public roads, through gates and over bridges.

Hitch weight, with finishing harrows, was minus 14 kg. Negative hitch weight caused cultivator sway at transport speeds above 30 km/h. If a farm truck is used to transport the cultivator, sufficient weight should be added to the truck to ensure stability. Swaying did not occur at normal tractor speeds.

Sweep-to-ground clearance during transport was 152 mm while transport wheel tread was 3.3 m. ground clearance was sometimes too low for convenient transport on uneven ground.

Hitching: The hitch weight, with mounted harrows, was minus 14 kg. This allowed the operator to push the hitch down without the use of hydraulics. A hitch jack was provided for use when mounted harrows were not installed.

Hitch height could be adjusted 343 mm in nine increments by removing one bolt. This range was adequate to allow fore-and-aft cultivator frame leveling with all tractors used during testing.

Frame Leveling: Adequate lateral leveling adjustments were provided for both the centre and wing sections. Frame leveling was accomplished with adjuster nuts on each cylinder mount. All cylinders were directly connected to the wheel mount assemblies.

Depth of Tillage: The tillage depth was controlled with four hydraulic cylinders connected in series; two on the centre section and one on each wing section. Depth was set with an adjustable stop valve located on the left wing cylinder.

Depth of tillage was uniform once the frame had been leveled and the field was firm. In soft fields, poor tire flotation on the centre section resulted in increased tillage depth in the centre.

As is common with series hydraulic systems, periodic synchronization of the cylinders, by completely extending them to the fully raised position was necessary.

Sweep Installation: It took one man about two hours to remove and replace the 38 sweeps on the Bourgault. The sweep bolts were short enough to have their ends completely covered by the retaining nuts, preventing thread damage to the sweep bolts during tillage. Sweep-to-ground clearance of 152 mm was adequate for easy sweep removal.

Shank Installation: It took about 5 minutes to replace a shank. Shank replacement required removing one bolt and loosening one U-bolt.

POWER REQUIREMENTS

Draft Characteristics: FIGURE 9 shows draft requirements for intermediate cultivators in typical secondary and primary tillage, at

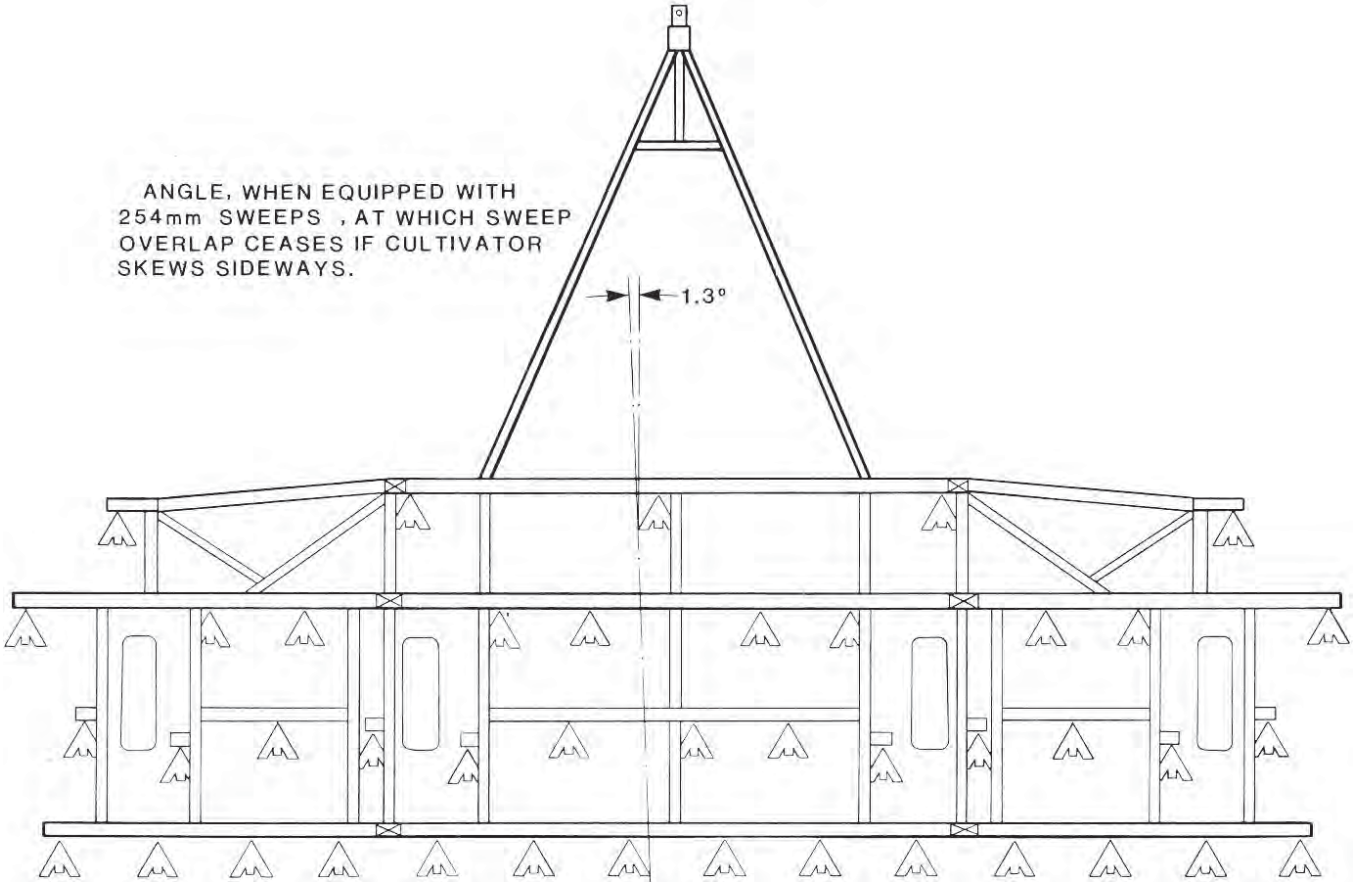


FIGURE 7. Sweep Pattern (203 mm Shank Spacing).

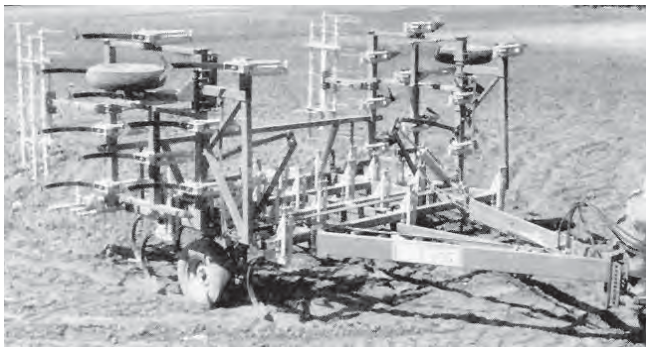


FIGURE 8. Transport Position.

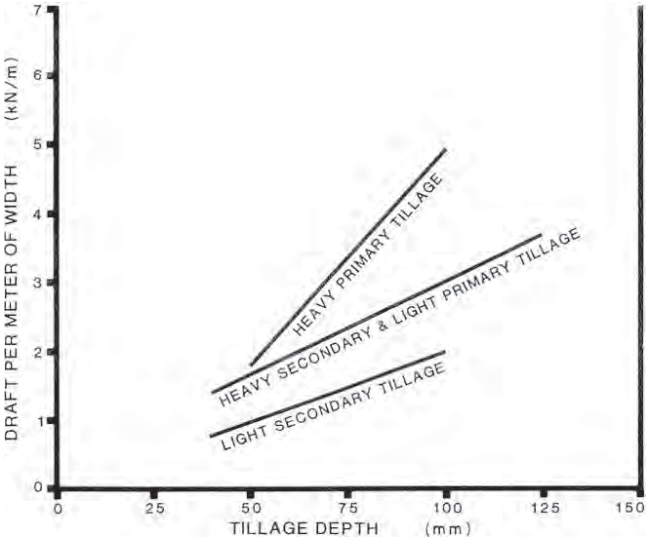


FIGURE 9. Average Dreff Requirements for Intermediate Cultivators at 8 km/h.

a speed of 8 km/h. This figure gives average requirements based on tests of 16 makes of cultivators in 52 different field conditions. Attempting to compare draft requirements of different makes of cultivators usually is unrealistic. Draft requirements for the same cultivator, in the same field, may vary by as much as 30% in two different years, due to changes in soil conditions. Variation in soil conditions affect draft much more than variation in machine make, usually making it impossible to measure any significant draft differences between different makes of cultivators.

In light secondary tillage, such as herbicide incorporation or seedbed preparation, average draft per metre of width, at 8 km/h, varied from 0.8 kN at 40 mm depth to 2 kN at 100 mm depth. For the 7.8 m wide test machine, this corresponds to a total draft ranging from about 6 to 16 kN.

In heavy secondary and light primary tillage, average draft per metre of width, at 8 km/h, varied from 1.4 kN at 40 mm depth to 3.7 kN at 125 mm depth, corresponding to a total variation from about 11 to 29 kN for the 7.8 m test machine.

In heavy primary tillage, average draft per metre of width, at 8 km/h, varied from 1.8 kN at 50 mm depth to 4.9 kN at 100 mm depth, corresponding to a total draft from about 14 to 38 kN for the 7.8 m test machine.

Increasing speed by 1 km/h, increased draft by about 90 N per metre of width. For the 7.8. m wide test machine, this represents a draft increase of 0.7 kN for a 1 km/h speed increase.

Tractor Size: TABLES 2 to 4 show tractor sizes needed to operate the 7.8 m wide Bourgault Vibra-Master in light and heavy secondary tillage as well as in primary tillage. Tractor sizes have been adjusted to include tractive efficiency and represent a tractor operating at 80% of maximum power on a level field. The sizes presented in the tables are the maximum power take-off rating, as determined by Nebraska tests or as presented by the tractor manufacturer. Selected tractor sizes will have ample power reserve to operate the Bourgault Vibra-Master in the stated conditions.

Tractor size may be determined by selecting the desired tillage depth and speed from the appropriate table. For example, in light secondary tillage at 75 mm depth and 10 km/h, a 65 kW tractor is

needed to operate the Bourgault Vibra-Master. In heavy secondary or light primary tillage at the same depth and speed, a 94 kW tractor is needed, while in heavy primary tillage a 141 kW tractor is required.

TABLE 2. Tractor Size (Maximum Power Take-off Rating, kW) to Operate the 7.8 m Wide Bourgault Vibra-Master in Light Secondary Tillage.

DEPTH (mm)	SPEED (km/h)					
	7	8	9	10	11	12
40	18	24	29	36	43	50
50	24	30	37	44	52	60
75	39	47	55	65	75	85
100	53	63	74	85	97	110

TABLE 3. Tractor Size (Maximum Power Take-off Rating, kW) to Operate the 7.8 m Wide Bourgault Vibra-Master in Heavy Secondary or Light Primary Tillage.

DEPTH (mm)	SPEED (km/h)					
	7	8	9	10	11	12
40	34	41	49	58	68	79
50	41	49	59	69	79	91
75	58	69	81	94	107	121
100	76	90	104	119	135	151
125	93	109	126	144	162	181

TABLE 4. Tractor Size (Maximum Power Take-off Rating, kW) to Operate the 7.8 m Wide

DEPTH (mm)	SPEED (km/h)					
	7	8	9	10	11	12
50	50	60	71	83	96	110
75	96	113	131	141	169	189
100	142	166	190	216	242	268

OPERATOR SAFETY

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

Transport height of the 7.8 m wide test machine was 2.9 m permitting safe transport under prairie power lines. On the other hand, transport height of the 11.0 m wide model of the Bourgault Vibra-Master is 4.6 m, which is high enough for contact with many farmyard lines.

The Bourgault Vibra-Master was 6.0 m wide in transport position. This necessitated caution when towing on public roads, over bridges and through gates. The Bourgault Vibra-Master was equipped with a slow moving vehicle sign and pins were provided to lock the wings in transport position. A mechanical transport lock was not provided for the centre frame lift cylinders. It is recommended the mechanical lift cylinder lock be supplied as standard equipment to provide for safer transport.

Centre section tire loads, in transport position, exceeded the Tire and Rim Association maximum rating for 9.5L x 15, 6 ply tires by 26%. This tire load was considered unsafe, especially at high transport speeds. It is recommended that the cultivator be equipped with tires having suitable load ratings.

The operator's manual clearly outlined safety precautions.

STANDARDIZATION

Hydraulics: During the test, considerable difficulty was encountered due to differences in hydraulic couplers on various tractors. The difficulty was in the lack of standardization both in couplers and in hose threads. More standardization is needed in this area.

Sweep Bolt Holes: The bolt hole size and spacing on cultivator sweeps and shanks, as well as stem angles, should similarly be standardized to provide some degree of interchangeability of sweeps.

OPERATOR'S MANUAL

The operator's manual contained useful information on safety, operation, maintenance and assembly. It was clear, concise and well illustrated.

DURABILITY RESULTS

TABLE 5 outlines the mechanical history of the Bourgault Vibra-Master during 313 hours of field operation while tilling about 1722 ha. The intent of the test was evaluation of functional performance. The following mechanical problems represent those which occurred during the functional testing. An extended durability evaluation was not conducted.

TABLE 5. Mechanical History

ITEMS	OPERATING HOURS	EQUIVALENT FIELD AREA (ha)
Sweeps and Shanks		
-- A shank was bent and replaced at	244, 269	1342, 1480
-- Complete sets of worn sweeps were replaced at	72, 124, 176, 204	396, 682, 968, 1122
-- Reversible chisel points were installed at	243	1337
Hydraulics		
-- The hydraulic depth control stop valve was replaced at	68, 253	374, 1392
-- The O-ring in the hydraulic depth control stop valve was replaced at	95	523
Miscellaneous		
-- The hitch clevis was worn requiring replacement at	121	666

DISCUSSION OF MECHANICAL PROBLEMS

Shanks: The two shanks were damaged by hooking under large flat rocks in hard soil conditions. Failure was not due to faulty design or workmanship.

Sweep Wear: As is common with most cultivators, rapid, non-uniform wear occurred on sweeps following the cultivator and tractor wheel tracks. The front row of sweeps also wore faster than the rear rows. Sweep wear rates depend on the type and abrasiveness of the soil. Great variation can be expected.

APPENDIX I

SPECIFICATIONS

MAKE:	Bourgault Vibra-Master
MODEL:	VM 24-28 (7.8 m size)
MANUFACTURER:	Bourgault Industries Ltd. Box 130 St. Brieux, Saskatchewan S0K 3V0

FIELD TRANSPORT DIMENSIONS:	**POSITION**	**POSITION**
-- width	1820 mm	5970 mm
-- length	5640 mm	5640 mm
-- height	1740 mm	2900 mm
-- max ground clearance	152 mm	152 mm
-- wheel tread	6810 mm	3250 mm

SHANKS:	
-- number	38
-- lateral spacing	203 mm
-- trash clearance (frame to sweep tip)	584 mm
-- number of shank rows:	
-- centre section	4
-- wings	4
-- distance between rows	737 mm
-- shank cross section	19 x 51 mm
-- shank stem angle	46°
-- sweep hole spacing	38 mm
-- sweep bolt size	11 mm

HITCH:	
-- vertical adjustment range	343 mm

DEPTH CONTROL:	hydraulic

FRAME:	
-- cross section	89 mm square tubing

TIRES:	
-- centre section	2, 9.5 L x 15, 6 ply
-- wings	2, 7.60 L x 15, 4 ply

HYDRAULIC CYLINDERS:	
-- depth control	
-- centre section	1, 89 x 203 mm 1, 76 x 203 mm
-- wings	1, 64 x 203 mm 1, 51 x 203 mm
-- wing lift	2, 76 x 457 mm

WEIGHTS: (With Mounted Harrows)	**FIELD POSITION**	**TRANSPORT POSITION**
-- right wing wheel	370 kg	
-- right centre wheel	955 kg	1325 kg
-- left centre wheel	955 kg	1325 kg
-- left wing wheel	370 kg	
-- hitch	-14 kg	-14 kg
TOTAL	2636 kg	2636 kg

OPTIONAL EQUIPMENT:
-- sixteen width options from 3.7 to 11.0 m
-- mounted finishing harrows

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
METRIC UNITS

In keeping with 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 acres (ac)
1 kilometre/hour (km/h)	= 0.62 mile/hour (mph)
1000 millimetres (mm) = 1 metre (m)	= 39.37 inches (in)
1 kilowatt (kW)	= 1.34 horsepower (hp)
1 kilogram (kg)	= 2.20 pounds mass (lb)
1 newton (N)	= 0.22 pounds force (lb)
1 kilonewton (kN)	= 220 pounds force (lb)
1 kilonewton/metre (kN/m)	= 70 pounds force/foot (lb/ft)

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