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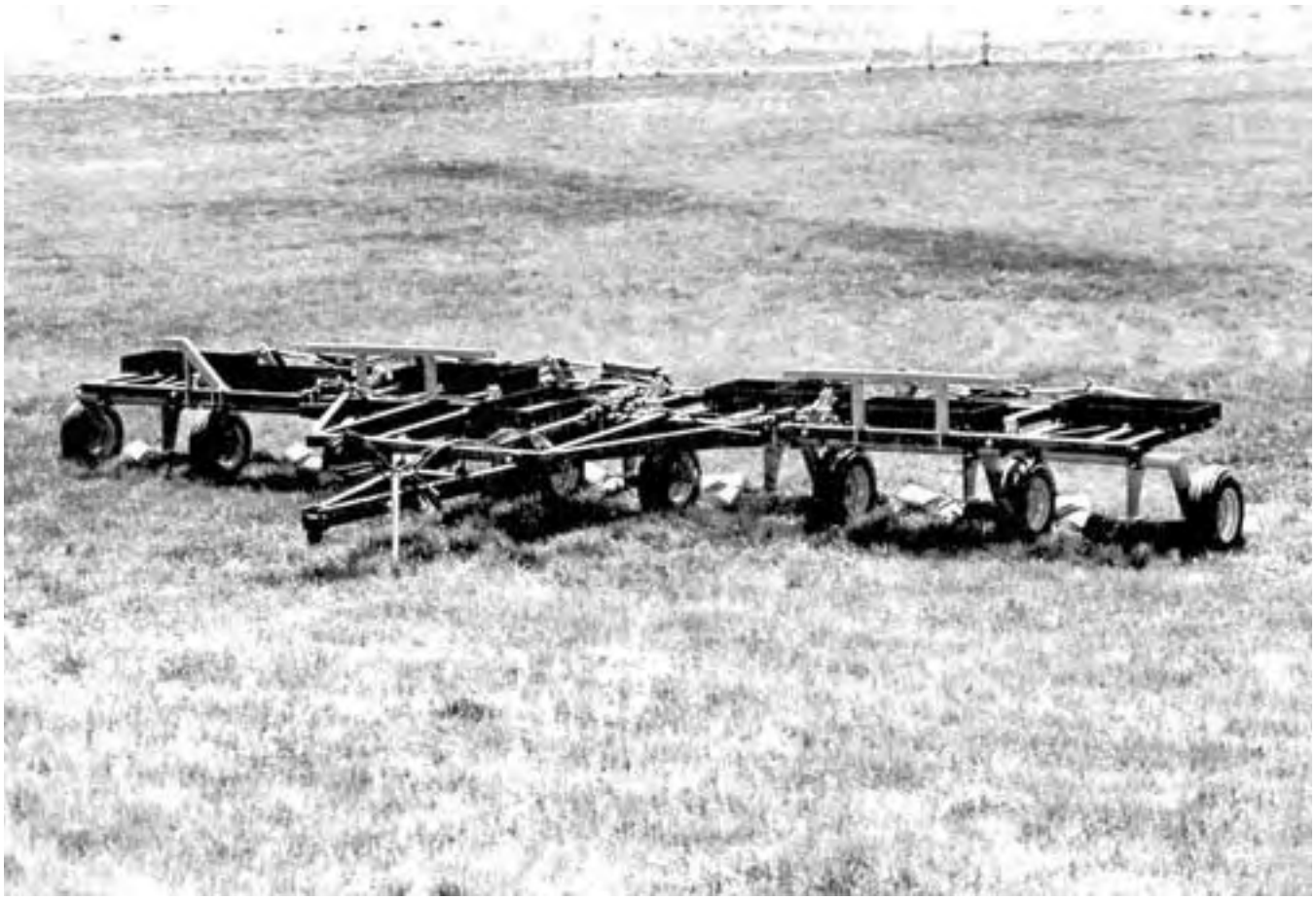
Evaluation Report 179



Noble Model NBB7623 (11.9 m) Blade Cultivator

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

NOBLE MODEL NBB7623 BLADE CULTIVATOR

MANUFACTURER AND DISTRIBUTOR:

Noble Cultivators Ltd.
P.O. Box 60
Nobleford, Alberta
T0L 1S0

RETAIL PRICE:

$14,020.20 (April, 1980, f.o.b. Lethbridge, 11.9 m width, with marker, weight boxes and shear bolt trip shanks).

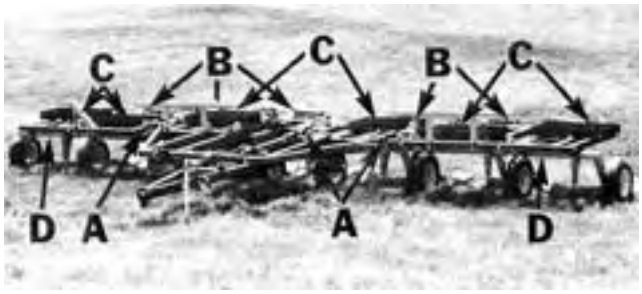


FIGURE 1. Noble Blade Cultivator: (A) Master Cylinders, (B) Wing Lift Cylinders, (C) Weight Boxes, (D) Rockshaft.

SUMMARY AND CONCLUSIONS

Overall functional performance of the Noble Model NBB7623 blade cultivator was good. Performance was reduced in loose heavy trash due to plugging at the centre shank.

The shear bolt trip shanks could lift 405 mm (16 in) to clear stones. Performance of the shank trip assemblies was fair. Shank and rockshaft damage occurred three times during testing.

Penetration was good in most conditions. In dry, hard soil additional weight was needed to obtain sufficient penetration and to maintain a uniform tillage depth. The Noble NBB7623 was very stable and did not skew appreciably. Skewing was never serious enough to affect weed kill. The Noble NBB7623 followed the contour of rolling land very well and left an excellent trash cover. Weed kill was good except in very moist soil conditions. The Noble NBB7623 was capable of clearing most trash but in loose, heavy trash, plugging occurred between the dual centre wheels and the centre shank.

The Noble NBB7623 could be conveniently placed in transport position in less than ten minutes. The 140 mm (5.5 in) sweep to ground clearance, in transport position, was usually adequate. The Noble NBB7623 towed well at speeds up to 32 km/h (20 mph). Caution had to be observed when towing on public roads due to the large transport width. The 11.9 m (39 ft) wide test machine had a transport height of 3.9 m (12.9 ft), permitting safe transport under power lines in the three prairie provinces.

Adequate adjustment was provided for both lateral and fore-and-aft levelling. The hitch jack provided for convenient hitching. Tillage depth was uniform across the width of the cultivator as long as the depth stop collars were properly adjusted.

Average draft for the 11.9 m (39 ft) wide test machine in primary tillage at 8 km/h (5 mph) varied from 34.5 kN (7590 lbs) at 50 mm (2 in) depth to 59.5 kN (13,090 lbs) at 125 mm (5 in) depth. In secondary tillage at 8 km/h (5 mph), average draft varied from 22.6 kN (4970 lbs) at 50 mm (2 in) to 55.9 kN (12,300 lbs) at 125 mm (5 in) depth.

In primary tillage at 8 km/h (5 mph) and 75 mm (3 in) depth, a tractor with 141 kW (189 hp) maximum power take-off rating will have sufficient power reserve to operate the 11.9 m (39 ft) wide Noble NBB7623. In secondary tillage, at the same depth and speed a 129 kW (173 hp) tractor is needed.

The Noble NBB7623 was equipped with transport lock pins for safe towing. No sl0w moving vehicle sign was provided. The operator's manual was clear, concise and well illustrated.

The mechanical problems occurred during the 217 hours of field operation. A blade and a turnbuckle pin broke. One shank cracked and one shank bent.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to reduce shank damage in stony conditions.
2. Relocating the centre weight box to aid in penetration.
3. Modifying the walking beam axle assembly to prevent rotation.
4. Modifications to improve trash clearance at the centre shank.
5. Modifying the over-centre transport locks on the depth control cylinders to eliminate interference with the depth control stops.
6. Providing a slow moving vehicle sign as standard equipment.
7. Working with the agricultural equipment industry to standardize hydraulic quick couplers and hydraulic hose fitting threads.

Chief Engineer: E. O. Nyborg
Senior Engineer: E. H. Wiens
Project Engineer: M. V. Eliason

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. We are presently working on a self returning trip mechanism for the shank and blade assembly, it will allow the assembly to trip to the rear (without first swinging down) and also to the side to clear obstacles encountered on the wing of the blade.
2. In most conditions we have found the weight box location to be adequate. In hard soils the center section may want to buckle up if the machine as a whole is not levelled properly.
3. We are presently making the walking beam axles with stops to prevent over-centering. We have available a bolt-on strap to upgrade older machines.
4. There is a mounting location for the center shank at the extreme rear of the frame. Mounting the center shank in this location provides an additional 6 inches of clearance, which should be enough to eliminate most plugging problems.
5. The over-center lock has been modified to allow it to drop down over the depth control stops when they are fully extended.
6. We will provide a slow moving vehicle sign as standard equipment on upcoming runs. We also intend to have reflectors on the front and rear comers of the machine for safer night transporting.
7. We do not supply hydraulic quick couplers with our machinery (we would if one design becomes standard). We are willing to make the necessary changes to our hose ends to assist in standardization (our hose ends are presently 1/2" male NPTF).

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

GENERAL DESCRIPTION

T he Noble Model NBB7623 is a trailing, flexible, seven-section heavy duty blade cultivator suitable for medium and heavy primary tillage operations. The seven-section model is available in three widths ranging from 9.8 to 14.0 m (32 to 46 ft). The test machine was an 11.9 m (39 ft) model with a 1.7 m (5.6 ft) centre frame and six 1.7 m (5.6 ft) wings. It was equipped with seven shear bolt protected rigid shanks, laterally spaced at 1680 mm (66 in), arranged in two rows.

The centre section is carried on one set of dual wheels and a single wheel while the other sections are each supported by a single wheel. Tillage depth is set by three hydraulic cylinders connected in parallel, controlling rockshafts on each frame section. The rockshafts on individual frame sections are coupled by an adjustable turnbuckle linkage. Five hydraulic cylinders, connected in parallel, fold the three right sections and two of the left sections, upwards and towards the centre, for transporting. A tractor with dual remote hydraulic controls is needed to operate the Noble NBB7623.

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

SCOPE OF TEST

The Noble NBB7623 was operated in the field conditions shown in TABLE 1 for 217 hours while cultivating about 1687 ha (4167 ac). It was evaluated for quality of work, ease of operation and adjustment, power requirements, safety and suitability of the operator's manual.

TABLE 1. Operating Conditions

Field Condition	Hours	Area (ha)
Soil Type		
- sand	59	465
- loam	139	1075
- clay	19	147
Total	217	1687
Stony Phase		
- stone free	141	1090
- occassional stones	61	481
- moderately stony	12	93
- very stony	3	23
Total	217	1687

RESULTS AND DISCUSSION

QUALITY OF WORK

Shank and Blade Characteristics: The Noble NBB7623 was equipped with 1.86 m (6.1 ft) wide blades with a 100° nose angle and a lift of 90 mm (3.5 in) (FIGURE 2). Blades with 75° nose angles were also available. A shear bolt near the top of each shank was provided for blade protection.

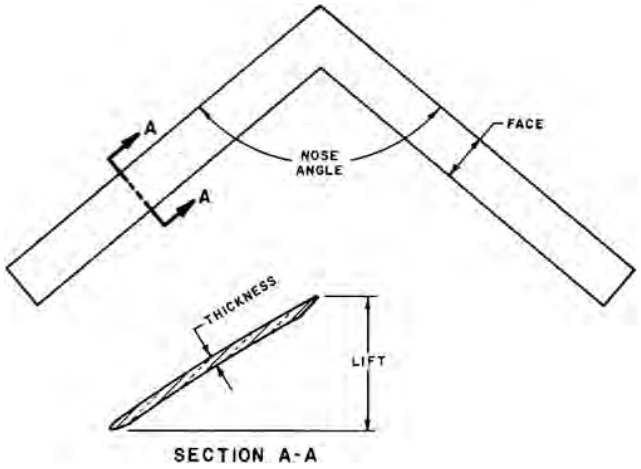


FIGURE 2. Blade Terminology.

FIGURE 3 shows the lifting pattern when a shank encounters a stone or field obstruction large enough to cause the shear bolt to fail. Maximum lift height was 405 mm (16 in). From FIGURE 3 it can be seen that as the shank and blade assembly pivoted rearward, the blade nose had to move 250 mm (10 in) downward. This forced the frame to be lifted in hard soil conditions. Performance of the shank assemblies was fair. Two shanks and a rockshaft linkage failed when the shear bolt did not shear when a solid obstruction was encountered. Modifications to reduce shank damage are recommended.

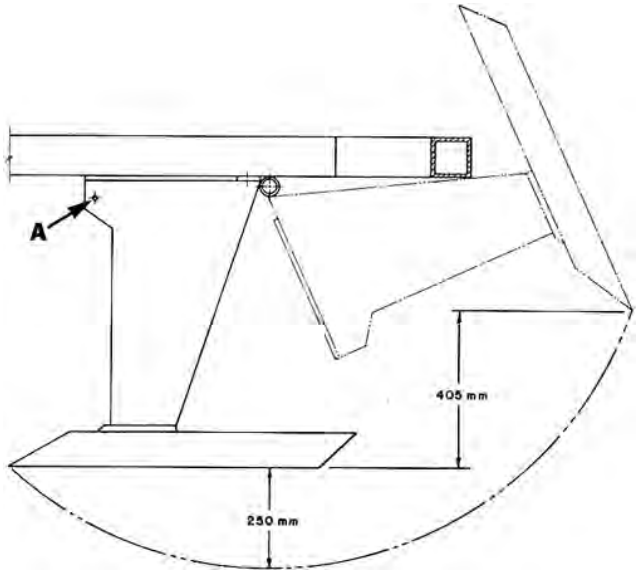


FIGURE 3. Blade Lifting Pattern: (A) Shear Bolt.

Penetration: Penetration was good in most soil conditions. In dry, hard soil, weight had to be added to the weight boxes to obtain acceptable penetration. In primary tillage up to 1000 kg (2200 lb) was added. In secondary tillage little or no additional weight was needed.

Penetration was uniform across the cultivator width, provided all the depth control linkages were properly set. Non-uniform penetration occurred in hard soils when sufficient weight could not be added to the centre weight box. The centre weight box was positioned ahead of the Centre shank, making the addition of weight less effective. All other weight boxes were located above the shanks. It is recommended that the manufacturer relocate the centre weight box to aid in uniform penetration.

When insufficient penetration occurred at the centre section, the dual wheels lifted off the ground and allowed the walking beam axle assembly to rotate and lock over centre. Uniform penetration and tillage depth could not be obtained with the axle in the over-centre position. Repositioning the assembly was accomplished by completely raising the cultivator wheels and manually reversing the walking beam. It is recommended that the manufacturer modify the walking beam axle assembly to prevent over-centre rotation.

Tires were adequately sized to provide good flotation in all soil conditions. The wheels were positioned (FIGURE 4) so that each of the three centre section wheels supported about 12% of the cultivator

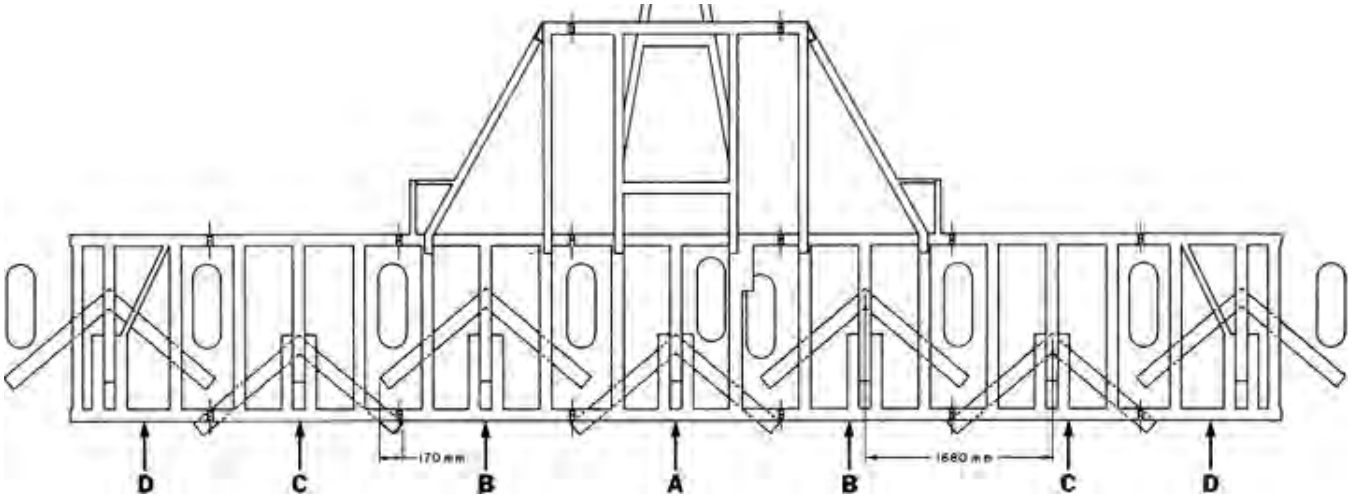


FIGURE 4. Blade Pattern Showing Wheel Location, Shank Spacing and Blade Overlap: (A) Centre Section, (B) Centre Wing Sections, (C) Extension Wing Sections, (D) Outer Wing Sections.

weight, the right centre wing wheel about 16%, the left centre wing wheel 8%, each extension wing wheel 15% and each outer wing wheel 5%. In addition, the centre section wheels supported about 14% of the total tillage suction force, the two outer wing wheels 8% and all the other wing wheels 14%. For good flotation and uniform tillage depth across the width, it is desirable to have wheels sized and positioned so that each supports equivalent weight and a similar tillage suction force.

Depth differences between front and rear blades were slight once the frame had been properly levelled. In all conditions the frame remained relatively level with very little twisting of the wing frames. The Noble NBB7623 followed gently rolling field contours very well, maintaining a uniform depth across its width. All sections were narrow enough to result in even penetration.

Plugging: Trash clearance was good. The Noble NBB7623 was capable of clearing medium to heavy trash. Plugging occurred in loose, heavy trash, between the dual centre wheels and the centre shank (FIGURE 5), which were only 205 mm (8 in) apart. Initial plugging at the centre shank was not always noticed as operator visibility of the centre shank was reduced by the centre weight box. Modifications to provide more clearance are recommended.

FIGURE 5. Plugging at the Centre Shank.

Trash Burial and Field Surface: The Noble NBB7623 buried very little trash. The majority of stubble was left standing and anchored to the soil, resulting in very little difference in field appearance before and after tillage (FIGURE 6). Some trash was buried in the small furrows left by the shanks. The amount of trash buried in the furrows depended on the depth and speed of tillage and the soil conditions.

FIGURE 6. Trash Cover Before (left) and After (right) Tillage at 75 mm Depth and 8 km/h.

Ridging: Surface ridging usually was slight and depended on the size of the furrows left by the shanks. Furrow size increased with soil moisture content and occasionally was quite large when the soil was moist and damp trash was present. Damp trash, particularly wild buckwheat, collected on the shanks and increased the size of the furrows behind each shank. The furrow bottom was always smooth and level.

Skewing and Stability: The Noble NBB7623 was very stable and did not skew sideways in normal field conditions. Momentary skewing occurred in stony fields when the shanks sometimes skewed sideways to bypass stones. Askewness did not cause weeds to be missed.

Weed Kill: Weed kill was good. The shank spacing of 1680 mm (66 in) resulted in a 170 mm (17 in) sweep overlap (FIGURE 4). Sweep wear did not cause weeds to be missed. Weed kill was occasionally inadequate when the soil moisture was high following tillage. When the top layer of soil remained moist, small lateral roots continued to grow. In moist soil, shallow tillage depth increased soil disturbance and produced a better weed kill.

EASE OF OPERATION AND ADJUSTMENT

Transporting: The Noble NBB7623 was easily placed in transport position (FIGURE 7) using the hydraulic wing lift system supplied as standard equipment. Eleven pins, which had to be inserted by hand, were provided to fold and lock the wings for transport. Mechanical over-centre transport locks were also supplied for each depth control cylinder. Interference between the locks and fully extended depth control stops (FIGURE 8) prevented complete over-centre locking. It is recommended that the manufacturer consider modifications to eliminate this interference. Raising or lowering, depending on the tractor hydraulics, took one man less than ten minutes, providing there were no weights in the weight boxes. Weights had to be removed before raising the wings.

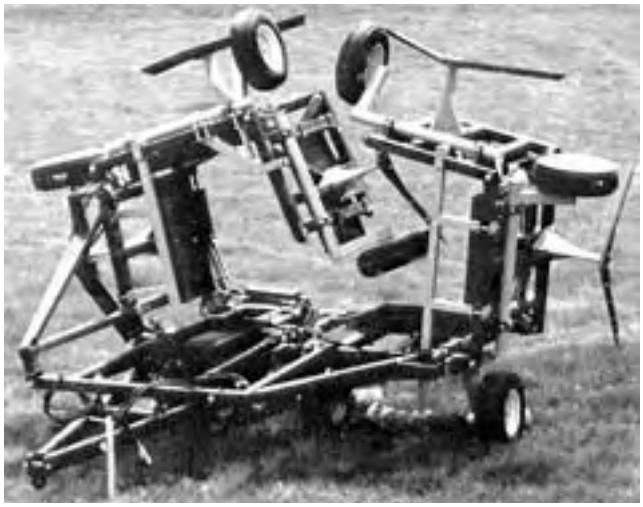


FIGURE 7. Transport Position.

FIGURE 8. Interference Between Transport Locks and Depth Control Stop Collars.

Transport width was 5.8 m (19 ft) while transport height was 3.9 m (12.9 ft). The hitch weight, in transport position, was 50 kg (110 lb), making the Noble stable while towing. It towed well at transport speeds up to 32 km/h (20 mph). Sweep to ground clearance during transport was 140 mm (5.5 in), while transport wheel tread was 3.1 m (10 ft). This usually provided ample ground clearance.

Hitching: The Noble NBB7623 was equipped with a suitable hitch jack, which permitted easy hitching. The standard hitch link swivelled downward when not hitched to a tractor. One man hitching could have been greatly facilitated if the link remained horizontal. A spring cushioned hitch link, eliminating this problem, was available

as an option.

The hitch height could be adjusted 108 mm (4.3 in) in three increments by removing one pin. This range was adequate to allow fore-and-aft cultivator frame levelling with all tractors used during testing.

Frame Levelling: Adequate lateral levelling adjustments were provided. The centre sections were levelled with a threaded adjustment at each cylinder anchor end. Wing sections were levelled with threaded linkages connecting the rockshafts on each frame.

Depth of Tillage: Tillage depth was controlled with three hydraulic cylinders, connected in parallel, controlling rockshafts on each frame section. Depth adjustment required positioning depth stop collars on each cylinder. The stop collars had to be adjusted equally as uniform tillage depth across the cultivator could not be obtained with the tractor hydraulics.

Blade Installation: It took one man about 2.5 hours to remove and replace the seven blades on the Noble NBB7623. The blade bolts were short enough to have their ends protected by the nuts, preventing thread damage during tillage, when blades were new. However, if the blade face wore to less than 115 mm (4.5 in), considerable wear to both the retaining nuts and bolts occurred, making removal difficult. High frame clearance permitted easy movement underneath the cultivator.

Shank Installation: Individual shanks could be replaced in about 20 minutes by removing three bolts.

POWER REQUIREMENTS

Draft Characteristics: FIGURE 9 shows draft requirements for blade cultivators in typical primary and secondary tillage at a speed of 8 km/h (5 mph). This figure gives average requirements based on tests in 10 different field conditions. Attempting to compare draft requirements of different makes of blade cultivators usually is unrealistic. Draft requirements for the same cultivator, in the same field, may vary significantly 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 blade cultivators.

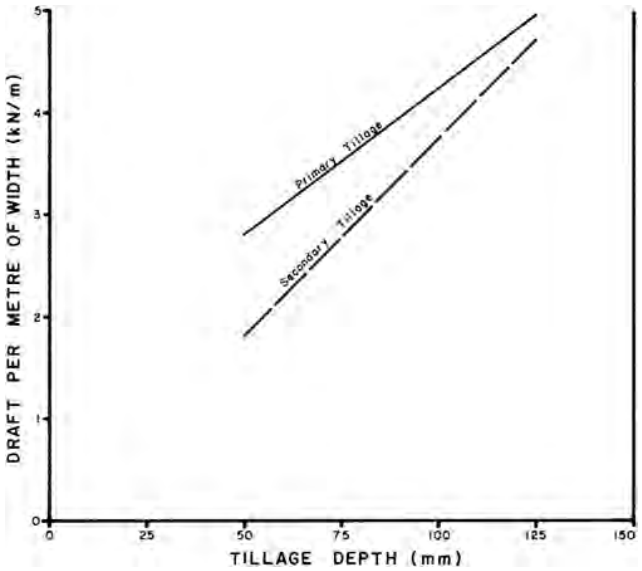


FIGURE 9. Average Draft Requirements for Blade Cultivators at 8 km/h.

In primary tillage average draft per metre width, at 8 km/h (5 mph), varied from 2.9 kN (604 lb) at 50 mm (2 in) depth to 5.0 kN (1100 lb) at 1.25 mm (5 in) depth corresponding to a total draft from 34.5 to 59.5 kN (7590 to 13,090 lb) for the 11.9 m (39 ft) test machine.

In secondary tillage, average draft per metre of width at 8 km/h (5 mph) varied from 1.9 kN (420 lb) at 50 mm (2 in) depth to 4.7 kN (1030 lb) at 125 mm (5 in) depth. This corresponds to a total draft ranging from 22.6 to 55.9 kN (4970 to 12,300 lb) for the 11.9 m (39 ft) test machine.

Increasing speed by 1 km/h (0.6 mph) increased draft by about 90 N (20 lb) per metre of width. For the 11.9 m (39 ft) wide test machine, this represents a draft increase of about 1.1 kN (240 lb) for a 1 km/h (0.6 mph) Speed increase.

Tractor Size: TABLE 2 and 3 show tractor sizes needed to operate the 11.9 m (39 ft) wide Noble NBB7623 in primary and secondary 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 Noble NBB7623 in the stated conditions.

Tractor size may be determined by selecting the desired tillage depth and speed from the appropriate table. For example, in primary tillage at 75 mm (3 in) depth and 8 km/h (5 mph), a 141 kW (189 hp) tractor is needed to operate the Noble NBB7623. In secondary tillage, at the same depth and speed a 129 kW (173 hp) tractor is needed.

TABLE 2. Tractor Size (Maximum Power Take-off Rating, kW) to Operate the 11.9 m Wide Noble NBB7623 in Primary Tillage

Depth (mm)	Speed (km/h)					
	7	8	9	10	11	12
50	97	114	132	151	171	192
75	120	141	162	185	208	232
100	144	168	193	219	245	273
125	168	195	223	252	282	313

TABLE 3. Tractor Size (Maximum Power Take-off Rating, kW) to Operate the 11.9 m Wide Noble NBB7623 in Secondary Tillage.

Depth (mm)	Speed (km/h)					
	7	8	9	10	11	12
50	72	87	102	119	136	155
75	109	129	150	172	195	219
100	147	172	198	225	254	283
125	184	214	246	278	312	347

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 (17 ft) over farm land or over secondary roads, in Alberta and Manitoba, the neutral ground wire may be as low as 4.8 m (15.8 ft) over farm land. In all three provinces, lines in farmyards maybe as low as 4.6 m (15 ft). Transport height of the 11.9 m (39 ft) wide test machine was 3.9 m (12.9 ft), permitting safe transport under prairie power lines.

The Noble NBB7623 was 5.8 m (19 ft) wide in transport position. This necessitated caution when towing on public roads, over bridges and through gates.

No slow moving vehicle sign or mounting bracket were provided. It is recommended that a slow moving vehicle sign be supplied as standard equipment.

Mechanical over-centre locks were provided to lock the depth control cylinders in transport position. Pins were also provided to lock the wings in transport position.

The four tires supporting the centre sections were adequately sized for transporting the cultivator. Individual tire loads did not exceed the Tire and Rim Association's maximum rating for 11L x 15, 8-ply tires.

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.

OPERATOR'S MANUAL

The operator's manual was good, containing useful information on safety, operation, maintenance and assembly.

DURABILITY RESULTS

TABLE 4 outlines the mechanical history of the Noble NBB7623 blade cultivator during 217 hours of field operation while tilling about 1687 ha (4167 ac). 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 4. Mechanical History

Item	Hours	Field Area (ha)
Blades and Shanks		
-Many of the blade mounting bolts had loosened and were tightened at	27, 49	209, 379
-A blade broke when working in stones and was replaced at	27	209
-Several shank to frame bolts loosened and were tightened at	27	209
-One shank bent and was replaced at	52	402
-One shank cracked and was replaced at	113	874
-a complete set of worn blades was replaced at	160	1239
Frame		
-The turnbuckle pin on the centre section rockshaft broke and was repaired at	27	209
-The centre frame wheel bearing required tightening at	49	379
-A weld on a turnbuckle cracked and was rewelded at	204	1577
Hydraulics		
-Several hydraulic fittings were leaking, necessitating tightening at	49	379
-One hydraulic hose end was pulled off due to turning too sharply and was replaced at	169	1306

DISCUSSION OF MECHANICAL PROBLEMS

BLADES AND SHANKS

Blade Wear: As is common with most cultivators, rapid non-uniform wear occurred on blades following the tractor wheel tracks. All blades were replaced when the blade face was worn to 115 m (4.5 in). A complete set of blades was replaced after 160 hours. Blade wear rate depends on the type and abrasiveness of the soil. Great variation can be expected.

Shanks: One shank cracked and another was bent when the shear bolts failed to shear upon encountering field obstructions. This also caused failure of a turnbuckle rockshaft pin (FIGURE 10).

FIGURE 10. Turnbuckle Pin Failure.

APPENDIX I
SPECIFICATIONS

MAKE:	Noble Blade Cultivator	
MODEL:	NBB7623	
SERIAL NUMBER:	1811	
MANUFACTURER:	Noble Cultivators Ltd. Box 60 Nobleford, Alberta T0L 1S0	
DIMENSIONS:	**Field Position**	**Transport Position**
-- width	11,940 mm	5770 mm
-- length	5180 mm	5180 mm
-- height	1450 mm	3940 mm
-- maximum ground clearance	140 mm	140 mm
-- wheel tread	11,680 mm	3050 mm

SHANKS:	
-- number	7
-- lateral spacing	1680 mm
-- trash clearance (flame to sweep tip)	750 mm
-- number of standard rows	2
-- distance between rows	410 mm
-- shank cross section	28 x 265 mm
BLADE	
-- number of mounting bolts	12
-- belt size	13 mm
-- blade wing width	1850 mm
-- blade nose angle	100°
-- blade face width	165 mm
HITCH: vertical adjustment range	108 mm
DEPTH CONTROL	hydraulic
FRAME: cross section	100 mm square tubing
TIRES:	
-- centre sections	7, 11 L x 15, 6-ply
-- outer wing sections	2, 9.5L x 15, 6-ply
NUMBER OF LUBRICATION POINTS:	
-- 28 grease fittings	10 hour service
-- 12 grease fittings	annual service
-- 9 wheel bearings	annual service
HYDRAULIC CYLINDERS:	
-- depth control	3, 89 x 203 mm
-- wing lift	2, 89 x 408 mm 2, 100 x 406 mm 1, 127 x 406mm

WEIGHTS:	**Field Position**	**Transport Position**
-- right outer wing wheel	223 kg	
-- right extension wing wheel	627 kg	
-- right centre wing wheel	682 kg	
-- right centre tandem wheels	1095 kg	2323 kg
-- left centre wheel	427 kg	573 kg
-- left centre wing wheel	373 kg	1368 kg
-- left extension wing wheel	623 kg	
-- left outer wing wheel	209 kg	
--hitch	55 kg	50 kg
TOTAL	4314 kg	4314 kg

OPTIONAL EQUIPMENT:
-- 3 width options in the seven section model varying from 9.8 to 14.0 m
-- weight boxes*
-- spring hitch
-- coulters
-- marker*
-- shear bolt trip shanks*
*supplied on test machine

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 mile/hour (mph)
1 kilowatt (kW)	= 1.3 horsepower (hp)
1 kilogram (kg)	= 2.2 pounds mass (lb)
1 newton (N)	= 0.2 pounds force (lb)
1 kilonewton (kN)	= 220 pounds force (lb)
1 kilonewton/metre (kN/m)	= 70 pounds force/foot (lb/ft)
1 metre (m)	= 3.3 feet (ft)
1 millimetre (mm)	= 0.04 inches (in)

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