Evaluation Report 139

Frigstad C5-43 (13.1 m) Heavy Duty Cultivator
**FRIGGSTAD C5-43 HEAVY DUTY CULTIVATOR**

**MANUFACTURER AND DISTRIBUTOR:**
Frigstad Manufacturing Ltd.
Frontier, Saskatchewan
SON 0W0

**RETAIL PRICE:**
$16,140.00 (May, 1979, f.o.b. Lethbridge, 13.1 metre width).

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**SUMMARY AND CONCLUSIONS**

Overall functional performance of the Friggstad C5-43 heavy duty cultivator was very good in all working conditions.

The spring cushioned shanks could lift 254 mm (10 in) to clear stones. When equipped with sweeps having a 50 degree stem angle, sweep pitch varied from 2 to 4 degrees over the range of normal primary tillage draft. With 305 mm (12 in) spacing, shank cushioning spring preload was exceeded at drafts greater than 9.8 kN/m (762 lb/ft), occurring well beyond the range of normal primary tillage drafts.

Penetration was very good in all conditions. The Friggstad C5-43 was very stable and did not skew appreciably. Sweeping was never serious enough to affect weed kill. The Friggstad C5-43 followed the contour of rolling land better than most heavy duty cultivators. Weed kill was very good, providing sweeps with sufficient overlap were used. Furrow bottom ridging was only slight with 50 degree sweeps. The Friggstad C5-43 was capable of clearing heavy trash and plugging seldom occurred.

The Friggstad C5-43 could be conveniently placed into transport position in less than five minutes. The 115 m (4.5 in) sweep-to-ground clearance in transport position was usually adequate. The Friggstad towed well at transport speeds up to 32 km/h (20 mph). However, this was unsafe, as the tire loads in transport position exceeded the Tire and Rim Association maximum rating by 30%. Caution had to be observed when towing on public roads due to large transport width and height. The 13.1 m (43 ft) wide test machine had a transport height of 4.5 m (14.75 ft), permitting safe transport under power lines in the three prairie provinces. Some larger models of the Friggstad have transport heights greater than minimum power line heights.

A hitch jack was provided for convenient hitching. Adequate adjustment was provided for both lateral and fore-and-aft levelling. Tillage depth was uniform across the width of the cultivator when the depth control linkages and stabilizer caster wheels were properly adjusted.

Average draft for the 13.1 m (43 ft) wide test machine, in light primary tillage, at 8 km/h (5 mph) varied from 22.3 kN (4910 lb) at 50 mm (2 in) depth to 48.5 kN (10,670 lb) at 125 mm (5 in) depth. In heavy primary tillage at 8 km/h (5 mph), average draft varied from 23.6 kN (5190 lb) at 50 mm (2 in) depth to 85.2 kN (18,740 lb) at 125 mm (5 in) depth.

In light primary tillage, at 10 km/h (6.2 mph) and 75 mm (3 in) depth, a tractor with 158 kW (212 hp) maximum power take-off rating will have sufficient power reserve to operate the 13.1 m (43 ft) wide Friggstad C5-43. In heavy primary tillage, at the same depth and speed a 193 kW (259 hp) tractor is needed.

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**RECOMMENDATIONS**

It is recommended that the manufacturer consider:

1. Equipping the cultivator with tires that comply with the Tire and Rim Association load rating.
2. Modifying the depth control assembly to reduce chain stretching and breakage.
3. Providing a slow moving vehicle sign as standard equipment.
5. Working with the agricultural equipment industry to standardize hydraulic quick couplers and hydraulic hose fitting threads.
6. Working with the agricultural equipment industry to standardize shank and sweep stem angles and sweep fastener spacings and sizes.

**MANUFACTURER’S ADDITIONAL COMMENTS**

The following problems mentioned in the mechanical history have now been corrected:

1. The hitch pin now has a head welded on it and is threaded so it is locked in place with a nut and lock washer.
2. The pin joining the wing section and the main frame now has a head welded on it and is locked with a 1/2 inch, grade 8, fine threaded bolt, instead of a 3/8 inch roll pin.
3. The depth stop has now been redesigned to decrease the force on the front support. All welding on the frame is now done with MIG welders, resulting in much stronger joints.
4. The solid shaft used as main frame bumper pins have now been replaced with rollers equipped with bronze bushings.

**GENERAL DESCRIPTION**

The Friggstad C5-43 is a trailing, flexible, five-section heavy duty cultivator suitable for medium and heavy primary tillage operations. The five-section model is available in nine widths ranging from 13.1 to 18 m. The test machine was a 13.1 m model with a 4.6 m centre frame, two 2.75 m inner wings and two 1.5 m outer wings. It was equipped with 43 spring cushioned shanks, laterally spaced at 305 mm, arranged in three rows.

The cultivator is carried on 14 wheels. Two sets of tandem wheels support the centre frame while single tandem wheel sets support each wing section. In addition, two caster wheels, placed in front of the wing sections, act as wing stabilizers. Tillage depth is controlled by a master cylinder, through chains and connector linkages to each tandem wheel set. Four hydraulic cylinders connected in series, fold the inner wings into an upright position and the outer wings in towards the centre, for transporting. A tractor with dual remote hydraulic controls is needed to operate the Friggstad C5-43.
Detailed specifications are given in APPENDIX I while FIGURE 1 shows the location of major components.

**SCOPE OF TEST**

The Friggstad C5-43 was operated in the field conditions shown in TABLE 1 for 210 hours while cultivating about 1785 ha. 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**

<table>
<thead>
<tr>
<th>FIELD CONDITIONS</th>
<th>HOURS</th>
<th>FIELD AREA (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- sand</td>
<td>53</td>
<td>450</td>
</tr>
<tr>
<td>- loam</td>
<td>81</td>
<td>688</td>
</tr>
<tr>
<td>- clay</td>
<td>48</td>
<td>408</td>
</tr>
<tr>
<td>- clay loam</td>
<td>28</td>
<td>239</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>210</strong></td>
<td><strong>1785</strong></td>
</tr>
<tr>
<td>Stony Phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- stone free</td>
<td>32</td>
<td>272</td>
</tr>
<tr>
<td>- occasional stones</td>
<td>135</td>
<td>1147</td>
</tr>
<tr>
<td>- moderately stony</td>
<td>29</td>
<td>247</td>
</tr>
<tr>
<td>- very stony</td>
<td>14</td>
<td>119</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>210</strong></td>
<td><strong>1705</strong></td>
</tr>
</tbody>
</table>

**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. 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 Friggstad C5-43 was equipped with adjustable, spring cushioned shank holders. During the test, the Friggstad C5-43 was used with 405 mm wide Edwards sweeps with a 50 degree stem angle, giving a no-load sweep pitch of 2 degrees and with 406 mm wide Edwards sweeps having a 47 degree stem angle, giving a no-load sweep pitch of 5 degrees.

FIGURE 3 shows pitch characteristics of the Friggstad 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 primary tillage. When equipped with 50 degree sweeps, as used during the test, sweep pitch varied from 2 to 4 degrees over this draft range, while with 47 degree sweeps, sweep pitch varied from 5 to 7 degrees over this draft range. Cushioning spring preload was exceeded at drafts greater than 9.8 kN/m, occurring well beyond the normal draft range, indicating that the Friggstad C5-43 was well suited for heavy primary tillage.

Sweeps wore very evenly when the cultivator was equipped with 50 degree sweeps. With 47 degree sweeps the sweep nose wore much more rapidly than the wings due to increased sweep pitch.

**Penetration:** Penetration was very good in all soil conditions when equipped with either 50 or 47 degree sweeps.

Penetration was uniform across the cultivator width provided all depth control linkages were properly set. Tires were adequately sized to provide good flotation in all soil conditions. The wheels were positioned so that each centre section wheel supported about 13% of the total cultivator weight, each inside wing wheel 7%, each outer wing wheel 4% and each stabilizer wheel 2%. In addition, each centre section wheel supported about 11% of the total tillage suction force while each inside wing wheel supported about 8.5% and each outer wing wheel about 5.5%. For good flotation and uniform tillage depth across the cultivator 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 the front and rear rows of shanks.
were slight, once the hitch and stabilizer caster wheels had been properly adjusted to level the frame. In all conditions, the frame remained relatively level with very little twisting of the wing frames. The wing sections were attached to the centre frame at one point and were supported by the stabilizer caster wheels, allowing the wing sections to pivot relative to the centre frame. This design allowed the Friggstad to follow rolling field contours extremely well, maintaining very uniform depth across its entire width.

Plugging: Trash clearance was excellent. The Friggstad C5-43 was capable of clearing large amounts of trash. Minimum plugging occurred at the shanks next to the wheels in heavy, damp trash and in heavily buckwheat infested areas.

Trash Burial and Field Surface: With 50 degree sweeps at 75 mm tillage depth, the Friggstad C5-43 left most stubble standing upright, at speeds below 6 km/h (FIGURE 5) The amount of trash buried increased at speeds above 6 km/h and at depths greater than 75 mm. Slightly more trash was buried with the 47 degree sweeps than with 50 degree sweeps.

Surface ridging with 50 degree sweeps was from 25 to 50 mm (FIGURE 6). With 47 degree sweeps, ridging increased slightly.

Furrow Bottom Ridging: The Friggstad C5-43 left a very smooth, even furrow bottom. Furrow bottom ridging with 50 degree sweeps was always less than 10 mm. With 47 degree sweeps, ridging was

Skewing and Stability: The Friggstad C5-43 was very stable and sideways skewing occurred only in very hilly conditions. The shank forces on the cultivator during normal tillage. When equipped with 406 mm sweeps, the Friggstad had to skew more than 3 degrees to miss weeds. Skewing never was serious enough to cause weeds to be missed.

Weed Kill: Weed kill was very good when equipped with 406 mm sweeps. The standard sweep spacing of 305 mm resulted in 101 mm sweep overlap. Considerable sweep wear could occur before weeds were missed. When sweeps wore to 330 mm, larger weeds could work their way between the sweeps and be missed.

EASE OF OPERATION AND ADJUSTMENT

Transporting: The Friggstad C5-43 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. A mechanical transport lock was also supplied for the depth control cylinder. Raising or lowering, depending on the tractor hydraulics, took one man less than five minutes. Transport width was 8 m while transport height was 4.5 m. Extreme care was needed when transporting on public roads, through gates, over bridges and beneath power and telephone lines. The hitch weight, in transport position, was 630 kg making the Friggstad very stable while towing.
It towed well at transport speeds up to 32 km/h. Sweep-to-ground clearance during transport was 115 mm, while transport wheel tread was 3.4 m. This usually provided ample ground clearance.

**FIGURE 8. Transport Position.**

Hitching: The Friggstad C5-43 was equipped with a suitable hitch jack, which permitted easy hitching.

The hitch link swivelled slightly downward when not hitched to a tractor (FIGURE 9). One man hitching would have been greatly facilitated if the hitch link remained horizontal.

The hitch height could be adjusted 356 mm in six increments by removing one pin. This range was adequate to allow fore-and-aft cultivator frame levelling with all tractors used during testing.

**FIGURE 9. Hitch Link Swivelled Downward.**

Frame Levelling: Adequate lateral levelling adjustments were provided for the centre and all wing sections. All frame sections were levelled by means of threaded connectors. Adjustments were easily made by lowering the machine, removing the pin and adjusting the clevis as required.

The chains linking the threaded connectors to the master depth control cylinder stretched twice, necessitating frame levelling.

Depth of Tillage: Tillage depth is controlled by one hydraulic cylinder linked to each tandem wheel set by chains and connector links. A depth stop, consisting of an eccentric block positioned in an appropriate hole between the depth control bars, (FIGURE 11) provided depth adjustment. This adjustment required the use of wrenches. Uniform tillage depth across the cultivator width could usually be obtained with the tractor hydraulics, without using the depth control stop.

Sweep Installation: It took one man about 2 hours to remove and replace the 43 sweeps on the Friggstad C5-43. The sweep bolts were short enough to have their ends protected by the nuts, thereby preventing thread damage during tillage. High frame clearance permitted easy movement underneath the cultivator.

Shank Installation: A shank could be replaced, without having to remove the complete shank holder assembly from the frame, in less than 10 minutes.

**FIGURE 10. Average Draft Requirements for Heavy Duty Cultivators at 8 km/h.**

**TABLE 2. Tractor Size (Maximum Power Take-off Rating, kW) to Operate the 13.1 m Wide Friggstad C5-43 in Light Primary Tillage.**

<table>
<thead>
<tr>
<th>DEPTH (mm)</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>68</td>
<td>83</td>
<td>98</td>
<td>115</td>
<td>133</td>
<td>152</td>
</tr>
<tr>
<td>75</td>
<td>98</td>
<td>117</td>
<td>136</td>
<td>158</td>
<td>180</td>
<td>203</td>
</tr>
<tr>
<td>100</td>
<td>128</td>
<td>151</td>
<td>175</td>
<td>200</td>
<td>227</td>
<td>254</td>
</tr>
<tr>
<td>125</td>
<td>157</td>
<td>185</td>
<td>213</td>
<td>243</td>
<td>273</td>
<td>305</td>
</tr>
</tbody>
</table>

**TABLE 3. Tractor Size (Maximum Power Take-off Rating, kW) to Operate the 13.1 m Wide Friggstad C5-43 in Heavy Primary Tillage.**

<table>
<thead>
<tr>
<th>DEPTH (mm)</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>64</td>
<td>78</td>
<td>92</td>
<td>107</td>
<td>124</td>
<td>142</td>
</tr>
<tr>
<td>75</td>
<td>124</td>
<td>146</td>
<td>169</td>
<td>193</td>
<td>218</td>
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<td>100</td>
<td>184</td>
<td>214</td>
<td>246</td>
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<td>346</td>
</tr>
<tr>
<td>125</td>
<td>243</td>
<td>282</td>
<td>322</td>
<td>363</td>
<td>406</td>
<td>449</td>
</tr>
</tbody>
</table>
Tractor size may be determined by selecting the desired tillage depth and speed from the appropriate table. For example, in light primary tillage at 75 mm depth and 10 km/h, a 158 kW tractor is needed to operate the Friggstad C5-43. In heavy tillage, at the same depth and speed, a 193 kW tractor is needed.

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 farmland or over secondary roads. In Alberta and Manitoba, the neutral ground wire may be as low as 4.8 m over farmland. In all three provinces, lines in farmyards may be as low as 4.6 m.

Transport height of the 13.1 m wide test machine was 4.6 m, permitting transport under prairie power lines. On the other hand, transport height of the 18 m wide model of the Friggstad cultivator is 5.7 m, which is high enough for contact with many prairie power lines. The legal responsibility for safe passage under utility lines rests with the machinery operator and not with the power utility or the machinery manufacturer. All provinces have regulations governing maximum permissible equipment heights on various types of public roads. If height limits are exceeded, the operator must contact power and telephone utilities before moving.

The Friggstad C5-43 was 8 m 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.

Pins were provided to lock both the centre frame lift cylinder and the wings in transport position.

The Friggstad C5-43 towed well at speeds up to 32 km/h. Centre section tire loads, in transport position, exceeded the Tire and Rim Association maximum rating for 9.5 L x 15, 8 ply tires by 30%. This tire overload was considered unsafe and hazardous, especially at high transport speeds. It is recommended that the cultivator be equipped with tires having suitable load ratings.

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 interchangability of sweeps.

OPERATOR’S MANUAL

Set-up and assembly instructions were supplied but no operator’s manual was available. It is recommended that a suitable operator’s manual be provided.

DURABILITY RESULTS

TABLE 4 outlines the mechanical history of the Friggstad C5-43 during 210 hours of field operation while tilling about 1785 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.

DISCUSSION OF MECHANICAL PROBLEMS

SWEEPS AND SHANKS

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 wore faster than the rear rows. Sweep wear was more rapid with 47 degree than 50 degree sweeps. All sweeps were replaced when worn down to a 330 mm width. Complete sweep sets needed replacement twice in 210 hours. Sweep wear rate depends on the type and abrasiveness of the soil. Great variation can be expected.

FRAME

Frame Levelling: The frame required releveiling four times during the test; twice due to the depth control chain breaking and twice due to the chain stretching. It is recommended that the manufacturer modify the depth control chain to reduce this problem.

Depth Control Stop: The weld on the front upright of the depth control stop bracket (FIGURE 11) cracked and had to be rewelded. Since the entire weight of the cultivator in transport position is supported by this bracket, adequate welding should be provided.

Bumper Pins: At the end of tests there was considerable wear on the bumper pins located between the main frame and first wing sections (FIGURE 12). The rockshaft arms pivot and slide on the pins when raising the wings for transport, causing pin wear.

FIGURE 11. Weld Failure on Depth Control Upright: (A) Weld Failure, (B) Depth Control Bars.
FIGURE 12. Worn Bumper Pin: (A) Bumper Pin, (B) Rockshaft Arm.

APPENDIX I

SPECIFICATIONS

MAKE: Friggstad Heavy Duty Cultivator
MODEL: C-78-75
MANUFACTURER: Friggstad Manufacturing Ltd.
         Frontier, Saskatchewan
         S0N 0W0

FIELD TRANSPORT

DIMENSIONS:

- width 13,300 mm  8050 mm
- length  7190 mm  7190 mm
- height  2100 mm  4500 mm
- maximum ground clearance 115 mm  115 mm
- wheel tread 12,560 mm  3390 mm

SHANKS:

- number  43
- lateral spacing 305 mm
- trash clearance (frame to sweep tip)  730 mm
- number of shank rows  3
- distance between rows 1016 and 914 mm
- shank cross section 32 x 51 mm
- shank stem angle  52°
- sweep hole spacing  57 mm
- sweep bolt size  1 mm

HITCH:

- vertical adjustment range  356 mm

DEPTH CONTROL:

hydraulic

FRAME:

- cross section  100 mm square tubing, 6.4 mm thick

TIRES:

- centre section  4, 95L x 15, 8ply
- wings  8, 95L x 15, 6ply
- wing stabilizers  2, 9.5L x 15, 6 ply

NUMBER OF LUBRICATION POINTS:

- 4 grease fittings, 10 hour service
- 12 wheel bearings, annual service

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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