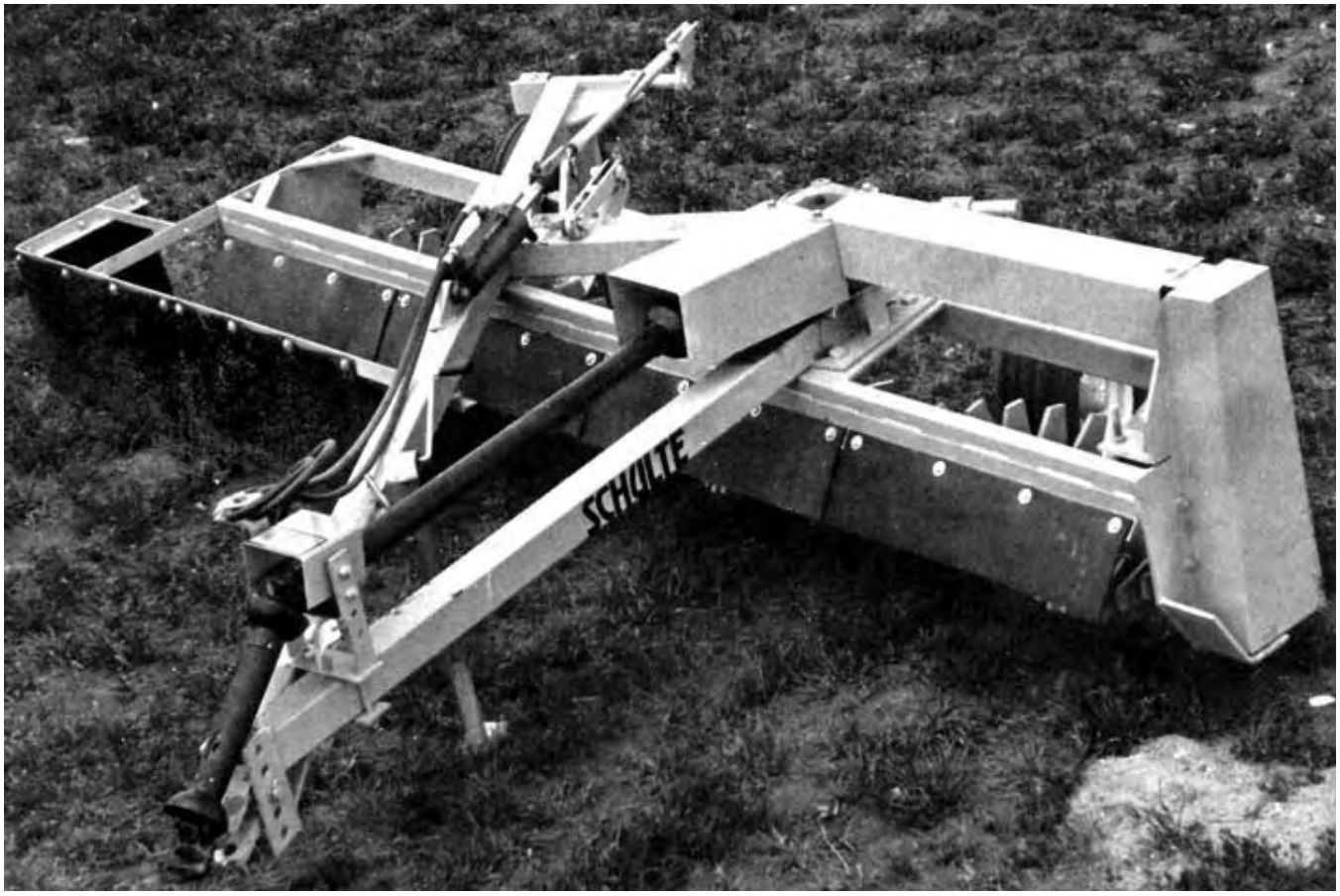
Report No. E4080A
Printed: June 1981
Tested at: Humboldt
ISSN 0383-3445

Evaluation Report 221



Schulte WR4-P Rock Rake

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

SCHULTE WR4-P ROCK WINDROWER

MANUFACTURER AND DISTRIBUTOR:

Schulte Industries Ltd.
Box 70
Englefeld, Saskatchewan
S0K 2A0

RETAIL PRICE:

$4120.00 (December, 1980, f.o.b. Humboldt, complete with 540 rpm power take-off drive).

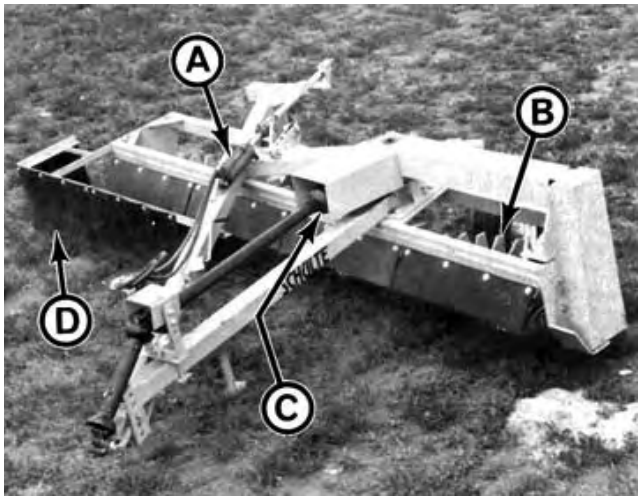


FIGURE 1. Schulte WR4-P: A) Depth Control, B) Rake Drum, C) Slip Clutch D) Rock Deflectors.

SUMMARY AND CONCLUSIONS

Overall functional performance of the Schulte WR4-P rock rake was good. Ease of operation was very good, while ease of adjustment and servicing was fair.

Typical field speeds were from 3 to 7 km/h (2 to 4.5 mph) while the average workrates varied from 1.0 to 2.5 ha/h (2.5 to 6.3 ac/h). The Schulte WR4-P worked well in rocks ranging in size from 40 to 400 mm (1.6 to 16 in). Performance was best in fields with average rock size less than 300 mm (12 in).

A tractor with 35 kW (47 hp) maximum power take-off rating had sufficient power reserve to operate the Schulte WR4-P in most field conditions.

The Schulte WR4-P transported well at speeds up to 30 km/h (20 mph). It was safe to operate as long as common sense was used and manufacturer's safety recommendations were followed.

A number of weld failures occurred during the test.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Expanding the operator's manual to include detailed information on windrower operation and adjustment.
2. Modifications to the transport lock so that inadvertent movement of the depth control cylinder will not damage the transport lock or depth control mechanisms, when the lock is in place.
3. Modifying the hitch clevis to make it sit horizontally for easier one man hook-up.
4. Improving weld quality to reduce failures resulting from machine vibration.
5. Modifications to improve the durability of the rock deflector material and support frame.
6. Modifying the shields to permit easier servicing access.
7. Providing a slow moving vehicle sign as standard equipment.
8. Providing an optional rock deflector attachment to reduce the jamming or carryover of small rocks.

Chief Engineer - E.O. Nyborg
Senior Engineer - J.D. MacAulay
Project Engineer - D.K. Garman

THE MANUFACTURER STATES THAT

The Schulte WR4-P rock windrower has been replaced as of April, 1981 with the new WR5 model. The following responses to the recommendations refer to the WR5 model rock windrower:

1. The WR5 owner's manual has been greatly expanded to include detailed information on operation, service and maintenance.
2. The transport lock on the new WR5 windrower will maintain the drum in a raised position without damaging the machine when the depth control cylinder is operated with the transport lock in place. Also, a storage hole is provided for the transport pin on the main frame.
3. Addition of a spacer strip between the back of the hitch casting and the hitch clevis is being considered.
4. Weld quality is continually monitored and improved wherever possible.
5. The rock deflector material has been replaced with a new material with an embedded cord pattern that greatly improves tear resistance.
6. Generally speaking, we feel the primary purpose of shielding is to protect the operator; service access with the shields in place is not always possible or advisable. However, the new WR5 windrower has improved access to the slip clutch adjustment nut and the shield mounting bolts so that shields can be more easily removed if necessary.
7. A slow moving vehicle sign has been provided as standard equipment.
8. Clearance between the drum and the frame on the WR5 windrower has been increased from 100 to 460 mm (4 to 18 in) to reduce jamming. Drum speed has been reduced from 270 rpm to 150 rpm at 540 rpm PTO speed. The tooth angle has been cut back 5° to reduce carryover of small rocks.

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

GENERAL DESCRIPTION

The Schulte WR4-P is a power take-off driven, pull-type rock windrower with a 3.7 m (12 ft) raking width. It is designed for use in conjunction with a rock picker.

The rake drum, which is rigidly attached to the frame at a 22° raking angle, delivers rocks to the right. It consists of a cylinder with two rows of teeth, arranged in spirals and welded to the drum surface. Penetration is controlled with a single hydraulic cylinder.

The windrower is designed for operation with a 540 rpm tractor power take-off. The drum is chain driven from a gearbox with a slip clutch on the power input shaft. An optional hydraulic drive is available. The test machine was equipped with a 540 rpm power take-off drive.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Schulte WR4-P was operated in the conditions shown in TABLE 1 for 116 hours while raking about 190 ha (470 ac). It was evaluated for rate of work, quality of work, ease of operation and adjustment, power requirements, safety and suitability of the operator's manual.

TABLE 1. Operating Conditions

Rock Size	Hours
Less than 200 mm (8 in)	66
200 to 300 mm (8 to 12 in)	37
Greater than 300 mm (12 in)	11
Total	116
Rock Concentration	**Hours**
Light	30
Medium	54
Heavy	32
Total	116

RESULTS AND DISCUSSIONS

RATE OF WORK

Suitable field speeds ranged from 3 to 7 km/h (2 to 4.5 mph). Average workrates varied from 1 to 2.5 ha/h (2.5 to 6.3 ac/h). Appropriate ground speeds depended on both the size and concentration of rocks in the field. In heavy concentrations, speeds had to be below 4 km/h (2.5 mph) to reduce misses; at higher speeds, some small rocks were missed. Low ground speeds also had to be used in large rocks of over 300 mm (12 in) in size, to minimize possible damage to the rake. Dense, uniform windrows were produced at speeds below 5 km/h (3 mph) while scattered windrows were formed at higher speeds.

QUALITY OF WORK

Raking Characteristics: The rake drum was rigidly fixed to the frame at a 22° raking angle. The drum operated at 270 rpm with a tractor power take-off speed of 540 rpm. This arrangement gave adequate raking action and rock movement in most field conditions.

In fields with a heavy concentration of small rocks, a number of rocks were missed by being thrown over the drum. If larger rocks were caught and lifted by the drum, they occasionally jammed between the frame and the drum. It is recommended that the manufacturer consider providing an optional rock deflector attachment to reduce jamming and carryover of small rocks.

To effectively windrow surface rocks and to minimize soil retention in the windrow, forward speed had to be selected to suit field conditions. With a 22° rake angle, best performance was achieved with a tooth index[1] of about 2.5 in fields with light rock concentrations, about 3 in fields with medium rock concentration and about 5 in fields with heavy rock concentrations. Since the rake drum speed was fixed at 270 rpm, corresponding ground speeds were about 8, 5 and 4 km/h (5, 3 and 2.5 mph) in light, medium and heavy concentration, respectively. FIGURE 2 shows the effect of ground speed on raking effectiveness in a field with medium rock concentration.

Windrow Formation: As is shown in FIGURE 2, windrow formation depended on ground speed. At speeds below 5 km/h (3 mph) dense, uniform windrows were formed in most conditions. High speeds resulted in scattered windrows.

Operating Depth: Performance was best with the rake teeth operating about 25 mm (1 in) below the soil surface. Deeper operation caused considerable soil to be windrowed with the rocks. In fields with subsurface rocks, deeper or faster operation also resulted in the rake bouncing, causing some surface rocks to be missed. If tooth penetration was less than 25 mm (1 in), small surface rocks were missed.

It was important to select the proper soil condition for optimum performance. For example, penetration usually was inadequate in fields with a hard surface crust. If the surface soil was very loose, operating depth had to be greater than 25 mm (1 in) to prevent misses. This produced windrows containing excessive soil.

Trashy Conditions: Surface trash caused few problems. The use of a rod weeder prior to raking was desirable since this placed small rocks on the surface, and gave a relatively firm working base.

Soil Pulverization: The windrower caused considerable soil pulverization, especially at low ground speeds. Pulverization decreased with increased ground speeds. Raking levelled the field surface and broke most surface lumps, creating a condition susceptible to wind erosion. In dry fields, operation was very dusty (FIGURE 3), often causing the windrower to be completely obscured. At times the operator was unable to see where the rake had passed on the previous round. Because of the dust problem, a tractor equipped with a cab was desirable.

Stability: The Schulte WR4-P was stable in most conditions. When large subsurface rocks were encountered, the rake skewed to bypass the rocks. Ground speed had to be selected to suit field conditions. In fields with heavy subsurface rock concentrations, ground speed usually had to be below 6 km/h (3.7 mph). At higher speeds, the rake sometimes began to bounce, missing a large number of rocks.

The windrower was relatively stable on hillsides. Skewing was never severe enough to affect operation.

[1]The tooth index is the ratio of the tangential tooth tip speed to the forward speed. A high tooth index gives aggressive raking action.

A

B

C

FIGURE 2. Typical Performance in a Field with Medium Rock Concentration: (A) Before Windrowing, (B) Windrowed at 5 km/h, (C) Windrowed at 7 km/h.

FIGURE 3. Typical Dust Conditions.

Rock Size: The Schulte WR4-P could effectively windrow rocks ranging in size from 40 to 400 mm (1.6 to 16 in). Although it could also handle rocks ranging from 400 to 500 mm (16 to 20 in) such rocks had to be windrowed with caution due to severe shock loads on the rake drum.

Performance was best in fields having a maximum rock size less than 300 mm (12 in). In fields with a large number of rocks ranging from 300 to 400 mm (12 to 16 in) lower ground speed usually had to be used to reduce shock loading. Rocks greater than 500 mm (20 in) in diameter should be removed from the field before windrowing.

EASE OF OPERATION AND ADJUSTMENT

Transporting: The Schulte WR4-P transported well at speeds up to 30 km/h (20 mph). The 150 mm (6 in) transport clearance was adequate. The transport lock was inconvenient to use. The depth control cylinder had to be positioned to enable insertion of the transport pin. This position did not correspond to the full cylinder extension. The lock bracket was damaged (FIGURE 4) by inadvertently operating the depth control cylinder when the transport lock was in place. It is recommended that the transport lock be modified so that inadvertent movement of the depth control cylinder will not damage the lock or depth control mechanisms, when the lock is in place.

FIGURE 4. Damaged Transport Lock Bracket Caused by Inadvertent Movement of Depth Control Cylinder with the Lock in Place.

Slip Clutch: The slip clutch on the power input shaft performed well when properly adjusted. Clutch adjustment had to be checked regularly. Proper clutch adjustment was about one turn of the adjustment nut, past snug, on a new clutch. This increased to one and one-half turns on a worn clutch. If clutch slippage is noticed during normal operation, the clutch should be tightened only one-quarter turn at a time until slippage stops. This allows the clutch to be loose enough to protect drive components from overload.

Hitching: The Schulte WR4-P was easily hitched to a tractor. The hitch jack was convenient. The hitch clevis was free to hang down at an angle, making one man hitching difficult. The clevis was adjustable for various drawbar heights. It is recommended that the hitch clevis be modified to sit horizontally for easy one man hitching.

Ease of Servicing: Serviceability of the Schulte WR4-P was fair. Shields had to be removed for access to the grease fittings on the rake drum drive, which required servicing every 5 hours. The shields were difficult to remove since they were bolted to the frame, and not designed for quick detachment. Similarly, shields had to be removed to adjust the slip clutch or to check the drive chain tension. It is recommended, that to improve the ease of servicing and adjustment, shields be modified to allow easy access to service points.

Maneuverability: The Schulte WR4-P was quite maneuverable. Its turning radius was short enough for easy operation, however, normal care had to be taken to prevent interference between the tractor tire and frame on sharp turns. As with most power take-off driven machinery, short turns caused high stresses in the driveline universal joints. Since many sharp turns are needed in normal rock windrowing operation, the condition cannot be avoided.

POWER REQUIREMENTS

A tractor with 35 kW (47 hp) maximum power take-off rating had sufficient power reserve to operate the Schulte WR4-P in most conditions. Average power take-off demands were about 15 kW (20 hp), however, this fluctuated widely. Power fluctuations were caused by impact loading of the rake teeth.

SAFETY

The Schulte WR4-P was safe to operate as long as normal safety practices were observed. Shielding provided adequate protection from driveline components. The windrower was equipped with a transport safety lock for the depth control cylinder. A slow moving vehicle sign was not supplied. It is recommended that a slow moving vehicle sign be provided as standard equipment.

OPERATOR'S MANUAL

The operator's manual contained a parts list, detailed assembly instructions, a list of safety precautions and some information on machine adjustments. It is recommended that the operator's manual be expanded to include detailed information on windrower operation and adjustment.

DURABILITY RESULTS

TABLE 2 outlines the Mechanical History of the Schulte WR4-P during 116 hours of field operation. The intent of the test was a functional evaluation. The following mechanical problems are those, which occurred during the functional testing. An extended durability test was not conducted.

TABLE 2. Mechanical History

Item	Hours
-The fabric rock deflectors tore off and were replaced at (After the third failure, the deflectors were not replaced until 105 hr).	3, 16 and 105
-The power take-off shield was damaged during a sharp turn and repaired at	14
-The long stabilizer arm bent, while inadvertently moving the depth control cylinder with the transport lock in place, and was replaced at	0, 18 and 42
-The rake drum bearing bolts loosened and were retightened seven times	during the test
-A rake drum pillow block bearing broke and was replaced at	30
-The rake drum slid sideways on its bearings and was repositioned five times	during the test
-The weld on the long stabilizer arm broke and was repaired at	80
-The weld on the short stabilizer arm broke and was repaired at	37
-The rake drum shaft broke and was repaired at	54
-The rock deflector shield frame broke and was repaired at	20, 45 and 116
-Weld failures on shield brackets were repaired ten times	during the test
-The fibre discs on the slip clutch wore and were repaired at	5 and 30

DISCUSSION OF MECHANICAL PROBLEMS

Stabilizer Arm: The long stabilizer arm was bent three times during the test because the operator failed to remove the transport lock before moving the depth control cylinder.

Welds: Many weld failures occurred during the test on the long and short stabilizer arms (FIGURE 5) and on the shields. It is recommended that weld quality be improved to reduce failure resulting from machine vibration.

Rock Deflectors: The rock deflectors tore at the support brackets three times during the test. It is recommended that modifications be considered to improve the durability of the rock deflectors. The rock deflector shield frame broke three times during the test. It is recommended that modifications be considered to reduce shield frame failures.

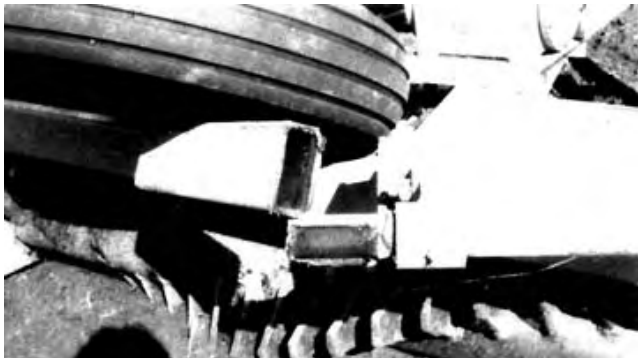


FIGURE 5. Weld Failures on Long Stabilizer Arm.

APPENDIX I
SPECIFICATIONS

MAKE:	Schulte Rock Rake
MODEL:	WR4-P
SERIAL NUMBER:	078059501
WEIGHT:	
-- left rear wheel	390 kg
-- right rear wheel	306 kg
-- hitch	262 kg
Total	958 kg
TIRES:	2, 7.60 x 15
OVERALL DIMENSIONS:	
-- width	4340 mm
-- height	1120 mm
-- length	4250 mm
-- ground clearance	135 mm
RAKE DRUM:	
-- width	3650 mm
-- diameter	220 mm
-- tooth length	115 mm
-- lateral tooth spacing	90 mm
-- operating speed	270 rpm
NUMBER OF GEARBOXES:	1
NUMBER OF CHAIN DRIVES:	1
NUMBER OF LUBRICATION POINTS:	12

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

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

APPENDIX III
CONVERSION TABLE

1 hectare (ha)	= 2.5 acres (ac)
1 kilometre/hour (km/h)	= 0.6 miles/hour (mph)
1 metre (m)	= 3.3 feet (ft)
1 millimetre (mm)	= 0.04 inches (in)
1 kilowatt (kW)	= 1.3 horsepower (hp)
1 kilogram (kg)	= 2.2 pounds mass (lb)

ALBERTA FARM MACHINERY RESEARCH CENTRE

3000 College Drive South
Lethbridge, Alberta, Canada T1K 1L6
Telephone: (403) 329-1212
FAX: (403) 329-5562
http://www.agric.gov.ab.ca/navigation/engineering/afmrc/index.html

Prairie Agricultural Machinery Institute
Head Office: P.O. Box 1900, Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-2555

Test Stations:

P.O. Box 1060
Portage la Prairie, Manitoba, Canada R1N 3C5
Telephone: (204) 239-5445
Fax: (204) 239-7124

P.O. Box 1150
Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-5033
Fax: (306) 682-5080