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The Chisel-Planter

A Minimum Tillage System for Winter Wheat

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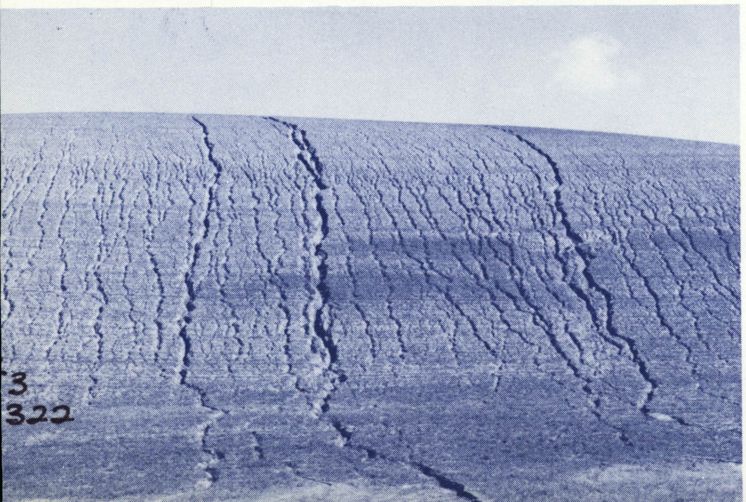
Fig. 1. The 1977 prototype Chisel-Planter from the rear showing the grain box, double disk openers and press wheels.

The predominant cause of soil erosion in the Palouse area of northern Idaho and eastern Washington is seeding fall wheat into a well-prepared seedbed. The wheat does not grow enough to anchor the soil during the wet winter and early spring. When a warm wind accompanied by low-intensity rain occurs, the snow melts rapidly on frozen soil and produces many scenes such as Fig. 2.

New tillage and crop management practices have great potential for reducing erosion. The so-called "no-till" farming concepts have generated considerable interest. Various experimental drills have been constructed but none have been totally successful partially because of the toxicity of straw on new plants when wheat is seeded directly into stubble.



The Chisel-Planter[1] described in this publication was developed to reduce erosion. It makes use of these successful practices:

1. Conservation tillage has resulted in an increased use of the chisel plow.
2. Fall-applied fertilizer is a cost-effective practice.
3. The use of fluted-feed, end-wheel drills is almost universal in the Palouse area.

The till-plant mechanism of the Chisel-Planter seeds fall wheat in a single pass over stubble. It is not a "no-till" machine because it has chisel points and packer wheels which break up the soil and clear a path ahead of the planting mechanism.

The College of Agriculture has an active research program comparing conventional, no-till and minimum tillage management. Minimum tillage in the project consists of chisel plowing followed by seeding with a conventional end-wheel drill in two separate operations. The resulting seedbed is similar to that of the Chisel-Planter and yield data should be comparable. Minimum tillage has yielded more than no-till and, averaged over three years, essentially the same as conventional tillage (Table 1). Yields were lower than normal for the area during 1977 because of drought.

[1]Patent applied for.

Fig. 2. Typical Palouse erosion scene for fall planted wheat on steep slopes.

Table 1. Average wheat yields with three tillage practices, 1976, 1977 and 1978.

Tillage practice	Average yields 1976	1977	1978	3-year average
	(bu/acre)			
Conventional	87	42	109	79
Minimum*	86	52	92	77
No-till	74	45	76	65

*Minimum tillage is chisel-plow followed by conventional double disk opener drill. Data represents three rotations on 144 plots per year and 4 varieties per plot.

Features of the Chisel-Planter

The UI Chisel-Planter is based on an International Harvester Model 645 Vibra-Chisel[2] and an International Harvester Model 510 end-wheel drill. Both machines were completely disassembled and only those parts needed were used in the final drill (Fig. 1). The drill weighs 4,720 pounds empty and 8,760 pounds fully loaded with seed and fertilizer. The drill has a planting width of 11 feet, using 11 openers on a 12-inch spacing, and an overall width of 13 feet 2 inches. Liquid fertilizer is metered into the furrow at the bottom of the chisel points about 1- to 1½-inch below the seed. The chisels run 3½ to 4 inches below the soil surface. The purpose of the chisel points is not for deep chiseling but to clear the residue and help to provide a seedbed.

Basic Frame

The vibra-chisel frame was cut down to match the end-wheel drill grain box, and the tires and wheels were located to permit the minimum possible width: 13 feet 2 inches from outside to outside of tires. The drill is built on a 3- x 4-inch tool bar frame and has 10,000-pound capacity hubs and spindles with 12.5L-16, 12-ply implement tires on W10L-16 wheels.

[2]Use of trade or firm names is for the convenience of the reader and for simplifying the description. It does not constitute an endorsement by the University of Idaho nor exclusion of other products which may be suitable.

Draft-Sensing Hitch

The drill hitch (Fig. 3) includes a strain gage draft-sensing element that allows continuous recording of the force required to pull the drill while it is operating. The unit eliminates all but the pull parallel to the frame so only the draft is sensed when the frame is level. The hitch uses quick pins at all attachment points so it is easily removable.

Lift Mechanism

The drill is raised and lowered as a unit by use of two 4-inch bore hydraulic cylinders which rotate the wheel carriers with respect to the main frame. Tillage depth is controlled by use of stops on the hydraulic cylinders. The drill has a total lift of about 18 inches.

Chisels and Packer Wheels

The connection of the packer wheels to the chisels at the mid-point of the chisel points is a unique feature. The chisels are standard International Harvester 22-inch Vibra-Chisels. The packer wheels are 6 inches wide and have ⅜- x 2-inch fins extending radially from a center hub (Fig. 4). They provide soil cover between the fertilizer and seed and also break up large clods, thus improving the seedbed directly in the row.

Liquid fertilizer tubes (⅜-inch outside diameter steel tubing) are bolted to the chisel points. The fertilizer flows into the soil through holes drilled through the sides of the tubes at the bottom of the chisel point. Hard-faced wear blocks at the bottom of the chisel points support the tubes and help prevent plugging. An experimental sensor is under development to signal the operator if the tubes become plugged.

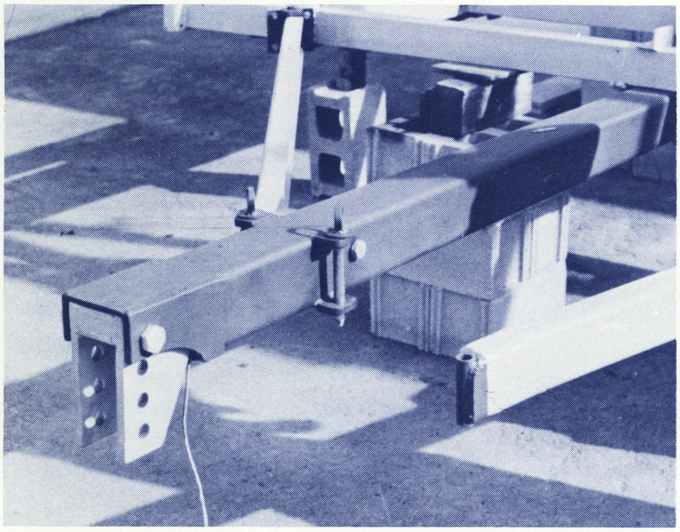


Fig. 3. Removable draft sensing hitch for the Chisel-Planter.

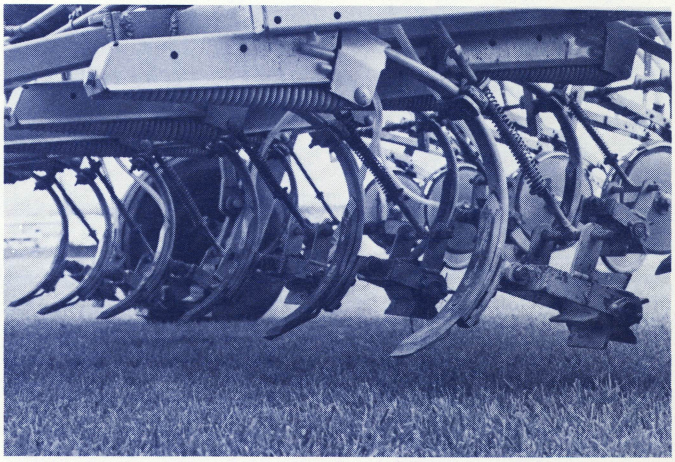


Fig. 4. Vibra-Chisels, packer wheels and fertilizer delivery tubes are shown. Note the unique attachment of the packer wheels to the chisels which gives a vibrating action to the packer wheels and aids in breaking up clods.

Liquid Fertilizer System

Liquid fertilizer is carried in two Mitchell Model 10, 115-gallon fiberglass tanks. The fertilizer is metered with two John Blue Model L-6-B squeeze pumps, one serving each side of the drill. The tanks are interconnected so each tank can contain separate concentrations of fertilizer. One or both pumps can be fed from each tank.

Using the tanks singly and then together provides three separate fertilizer rates with one filling of the tanks. While not useful for normal planting, this feature is valuable for research plots.

The pumps can apply approximately 26 pounds pressure per square inch when the tubes are blocked off, and essentially zero pressure when fertilizer is flowing properly. This pressure differential is being used to provide an alarm for detecting plugged fertilizer tubes.

Seed Box, Openers and Delivery System

The seed box is a standard International Harvester 2.4 bushel/foot grain box with a ground-driven, fluted-feed metering system. The furrow openers are also made by International Harvester and include a narrow press wheel option. The length of the attachment shank and mounting has been modified and could accommodate more furrow openers if growers want to reduce the 12-inch row spacing. Adding more chisels would not be advisable, however, because of trash problems. If openers were added without adding chisels, obviously the openers would not follow directly in a chisel furrow.

Since a gravity seed-handling system would require an exceedingly high seed box, an air delivery system was developed using venturis made from ¾-inch plastic tees. The venturis are connected directly to the fluted feed delivery spouts on the drill. The air system places a suction on the seed, drawing it into the air stream (Fig. 5) where it is carried through 1-inch tubing into the standard double disk opener. Each venturi requires approximately 4 cubic feet per minute of air at a pressure of 3 to 5 pounds per square inch. They take their air supply from a manifold of 4-inch thin wall pipe running the full width of the drill. A GAST Model 3040 air pump driven by a gasoline engine delivers air into the manifold.

The air system works well. However, a production-model machine of this width with a properly designed seedbox probably would not need an air delivery system for handling seed. The air delivery system would be useful on a wider drill to reach openers on fold-up wings.

Field Trials

The drill has performed well during field trials. Three half-acre sites with 12 plots each on pea ground, barley stubble and wheat stubble were planted with the drill in the fall of 1977 to determine if nitrogen placed beneath the seed would affect germination and early growth of the wheat plant. Another 8 acres of wheat were planted in barley straw to judge the drill's operation on a larger scale. Performance was satisfactory. Wheat yield on the 8-acre plot was 80 bushels per acre. Yield data in smaller plots are shown in Table 2.

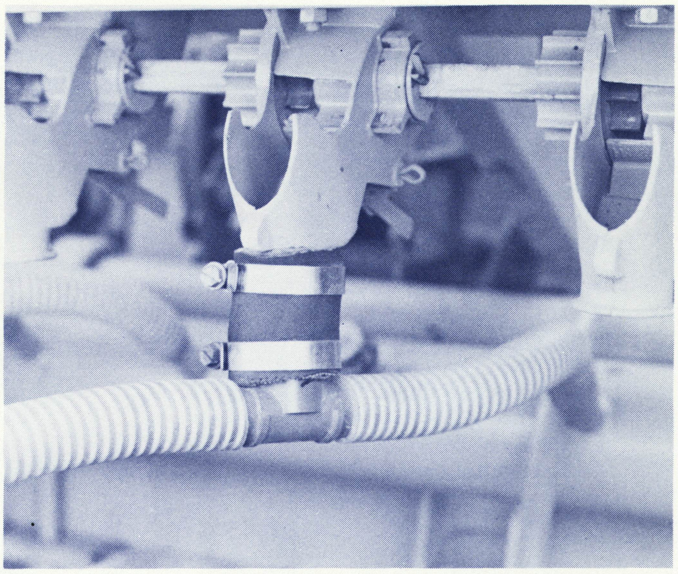


Fig. 5. Fluted feed delivery spout, venturi and distribution tubing are shown.

Table 2. 1978 Chisel-Planter fertilizer rate plots.

N Fall (lb/acre)	N Spring** (lb/acre)	Total N (lb/acre)	Yield (bu/acre)	Test weight (lb/acre)
Wheat following wheat (level field)*				
40	80	120	81	61.2
40	93	133	84	61.0
80	40	120	83	60.9
80	75	155	76	60.8
120	0	120	60	61.2
120	26	146	63	60.1
		Average	75	60.9
Wheat following peas (north slope)				
40	80	120	56	61.0
40	75	115	57	61.1
80	40	120	54	60.9
80	50	130	56	60.8
120	0	120	63	60.7
120	0	120	62	60.7
		Average	58	60.9
Wheat following barley (north slope)				
40	80	120	48	61.2
40	50	90	47	61.0
80	40	120	45	61.0
80	50	130	50	60.8
120	0	120	46	61.2
120	26	146	51	61.5
		Average	48	61.1
		Over-all average	60	61.0

*Nugaines wheat was planted in all plots at a rate of 80 pounds per acre.

**Spring nitrogen was surface applied at two rates; the amount required to bring the total to 120-pounds per acre and the amount determined by soil testing.

Fig. 6. A good stand of winter wheat after spring barley. Note the vigorous growth and mini-terrace effect of the drill furrows. The mini-terracing was effective in preventing erosion from starting in the wheel track visible in the foreground. This 8-acre field was planted to Nugaines wheat Sept. 26, 1977. Fertilizer rates were 80 pounds N, 20 pounds P_2O_5 and 15 pounds sulfur per acre.

Draft measurements indicate that the pull for the planter ranges from 3,000 to 3,500 pounds on level ground and increases to as much as 5,000 pounds on steep slopes. The drill operates adequately on the steep slopes because the chisels tend to hold it on the slope.

The Chisel-Planter leaves ridges which might be categorized as mini-terraces. This mini-terracing effect appears to give good control of erosion when seeding is done on the contour (Fig. 6). Inspection of steep slopes following the 1977-78 erosion season indicated that occasional breakthroughs of the mini-terraces did occur, but the water fanned out in the next terrace instead of concentrating in a channel. At one site, the owner of the land pulled a harrow across the north edge of the test plot field following seeding with the Chisel-Planter. Erosion started at several spots in the harrowed area but the water quickly fanned out and disappeared as it entered the area which had been worked only by the Chisel-Planter.

Controlling volunteer barley in winter wheat seeded into barley stubble appeared to be a problem. The extent of this problem will depend on fall and winter weather. Ordinarily, the barley would winterkill, but the mild winter of 1977-78 was not sufficiently cold.

Wheat in the test plots appeared to come through the winter season in above-average condition. Normal weed control and fertilization practices were required during the spring season.

Additional testing will be required before an adequate understanding of the effect of the Chisel-Planter on erosion will be known.

Conclusions

The Chisel-Planter appears to offer an alternate planting method for fall wheat following barley and peas in the Palouse. Additional testing will be required before it can be recommended for use in heavy wheat stubble. However, plots of wheat following wheat showed no evidence of toxicity except where the combine had stopped and large amounts of straw and chaff were left. Clearance of trash by the drill is a potential problem in heavy straw.

The Chisel-Planter method of seeding fall wheat appears to be effective in reducing runoff erosion while reducing the tillage energy requirement for crop production. Additional testing will be required before definite recommendations can be made.

A manufacturer-cooperator is needed to make the drill available to local farmers.

Acknowledgments

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