SUCCESS STORIES

On

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8. Tractor Operated Laser Land Leveler

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3. Tractor operated Strip-till Drill

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PAU Ludhiana

Introduction

Tillage is one of the major farm operations and is an important contributor to the total cost of production. Excessive tillage is energy and time consuming and costly operation. It is considered harmful to the soil structure. It also contributes to wind and water erosion of the soil. The rising cost of hydrocarbon fuels which are bound to be exhausted sooner or later, availability of herbicides coupled with the motive of timely sowing and reducing the cost of production has provided enough incentive to the researchers all over the world to investigate tillage operations more closely.

Research has been conducted under the titles of minimum-tillage, no-tillage, optimum tillage, soil compaction, etc. Results have shown that with the development and use of appropriate herbicides, the technique of zero tillage/minimum tillage/direct drilling has shown considerable potential for some crops under certain conditions. Research conducted in the Dept. of Agronomy at Punjab Agricultural University, Ludhiana has shown that wheat crop could be grown under minimum tillage conditions without any loss in yield. However, the major handicap in the adoption of this technology was the non-availability of a suitable planting machine.

Development of Strip-till Attachment:

In Punjab, wheat is grown in an area of about 3.4 m-ha and is planted by tractor or bullock drawn seed-cum-fertilizer drills. The first approach to the development of a suitable minimum till drill was to develop an appropriate attachment to an existing drill for adoption of the technology. With this end in view, five different types of commercially available seed-cum-fertilizer drills were tried for direct drilling of wheat in manually harvested paddy fields. This was intended to assess the problems arising from the use of commercially available drills under no-tillage regime. The major problems encountered were:

- Accumulation of straw and stubble in front of the tynes.
- Formation of clods
- Poor coverage of seed and fertilizer leading to bird-damage to the seeds

- Excessive slippage and lack of contact of ground wheel due to uneven fields leading to skips in the placement of seed and fertilizer
- Higher power requirement for the operation.

To overcome the above-mentioned problems, it was decided to develop an attachment in front of furrow openers of the existing seed drill.

Coulter Attachment:

After careful review of various no-till drills available in the literature and considering the specific requirements of wheat farmers of Punjab, a disc-coulter attachment was designed and fabricated in the Development of Farm Power and Machinery, PAU, Ludhiana. Major limitation of such a machine was its poor performance in medium and heavy soils. To overcome these problems, a rotary blade attachment was designed, developed and tested. Details of the work are given below:

Strip-till Seed-cum-fertilizer Drill:

The drill is essentially a 9 row seed-cum-fertilizer drill with a rotary blade attachment for minimum soil manipulation running ahead of the normal furrow openers (Fig. 3.1). A tractor of 35 or higher horsepower (26.11 kW) operates it. The rotary attachment consists of a frame with a rotor having '9' flanges. Each flange has 6 C-type tines (blades). The spacing between the flanges is the same as the row spacing for the crop to be planted. Power to the rotor shaft is provided from the tractor PTO through a speed reduction gearbox and chain and sprocket drive. The rotor revolves at a speed of 300-rpm corresponding to the rated PTO speed of 540 rpm. The rotary attachment is provided with an MS sheet cover to protect the power transmission system. It also helps to reduce the soil cover over the seed. An 11-row machine is also available. Machine in double drive version is also available. The specifications of the strip-till-drill are given in Table 3.1.

Table 3.1: Main specifications of the Strip-Till Drill

Type	Tractor mounted
Power required (hp)	35 or above (26.11 kW)
No. of furrow openers	9
Type of furrow openers	Reversible shovel type
Row spacing (mm)	204
Provision on drive wheel to reduce slippage	Lugs
Seed metering device	External fluted feed rollers
Fertilizer metering device	Gravity type with adjustable orifices agitators
Transmission system	Chain and sprocket drive

Strip-till attachment	Detachable type
Rotor shaft	High pressure pipe
Internal diame	50
Thickne	10
Transmission shaft diameter (mm)	50.8
Flange number	9
Flange diameter (mm)	230
Flange thickness (mm)	10
No. of blades on each flange	6
Blade type	C type
Width of cut of each blade (mm)	Properly and uniformly staggered to helical cutting pattern for even load tractor
Type of gear in gear box	Bevel
No. of teeth of drive	10
No. of teeth of driven	10

Experimental Procedure for Field Evaluation:
In the first phase the drill was used for planting wheat crop in heavy texture soils under paddy-wheat crop rotation at research farm. Wheat variety WL-711 was sown. The experiments were conducted for four years continuously, i.e., 1985 through 1988-89 in the same field using randomized block design with three treatments (including control) and four replications. In each plot 18 rows of wheat crop were planted. The control treatment consisted of adopting standard field preparation as per recommendations of Punjab Agricultural University for raising wheat crop in heavy textured soils. These included two operations by a disk harrow, two operations by a field cultivator and three operations by a planker in manually harvested paddy field. Post emergence weed control was done mechanically with a manually operated wheel-hoe type weeder.

Fig. 3.1: A view of tractor operated strip-till drill in operation.

In treatment TI direct sowing of wheat with strip-till seed drill without any preparatory tillage was performed. Post emergence weed control was done chemically. However, in treatment T2 Post emergence weed control was done mechanically. Experimental data regarding soil moisture content at the time of sowing, fuel consumption, labour requirement, germination count and yield were taken. The field data was analyzed and found quite encouraging.

Based on the promising results of the experiment, it was decided to undertake multi-location field trials at different research farms of PAU, Ludhiana. The experiments were conducted during the 1991-92-wheat season. These experiments were conducted at the Drainage Farm, Dept. of Soil and Water Engg. Rice Research Station, Rauni (Patiala), Rice Research Station, Kapurthala, Seed Farm, Naraingarh and the Agronomy Farm of PAU, Ludhiana. Observations on date of sowing, germination count and yield data were recorded.

Based on the multi-location trial results, the Punjab Agricultural University, Ludhiana approved the inclusion of Tractor drawn strip-till drill in its package of practices. As a first step towards the popularization of the machine, farmer's field trials/demonstrations were conducted during 1993-94 wheat season at three villages namely Sidhwan Khurd, Rohalla (Samrala) and Katani Khurd in the district of Ludhiana.

Results and Discussion :
Results of experiments conducted at Dept. of Farm Power & Machinery farm are given in Table 3.2. The field had medium heavy soil with the soil moisture varying between 16.45 and 23.63% during different years. Average soil bulk density before sowing varied between 1.12 and 1.52 g/cc. in plots of different treatments during the four years of study. The average soil bulk density values in the control plots each year were less than T1 and T2 treatment plots. There was non-significant difference in average soil bulk density of 'T1' and 'T2' plots. The average germination count in plots of different treatments during the period varied from 49.7 to 117.3 plants/m^2. No definite correlation in germination count between different treatments was found. The average yield for various treatments varied from 3.62 to 4.10 t/ha. There was no significant difference in the yield at 5% level of significance among the different treatments.

Cone penetrometer readings were recorded for all the plots. The average cone index values in 'T1' and 'T2' plots were higher than those for the control or normal tillage plots. This is in conformity with the data on average bulk density recorded for different treatment plots. The effect of tillage as measured through cone index values was studied up to a depth of 20 cm.

The results of the multi-location research trials are given in Table 3.3. The dates of planting at different locations were between Nov. 23, 1991 and Jan. 8, 1992. The late planting at Naraingarh Farm was due to delayed picking of cotton in the cotton-wheat rotation. The yield varied between 3.24 and 5.04 t/ha except in the case of Nariangarh Farm where it was 1.96 t/ha due to fairly late planting of wheat after the last picking of cotton and uprooting of the cotton sticks. It was observed that, in general, there was no perceptible difference in the yields between the two treatments except in the case of Rice Research Station Kapurthala where yield in unprepared field using strip till drill was considerably higher than the conventional till field.

Table 3.2: Average Field Data of No-till Experiments for Wheat Crop in Heavy Soil

Crop Year	Treatment	Soil Moisture (percent)	Soil Bulk density before sowing (g/cc)	Germination count (No./m^2)	Yield (t/ha)
1985-86	C	18.78	1.36	92.7	3.83
	T1	18.93	1.47	89.0	3.76
	T2	19.36	1.52	80.8	3.72
1986-87	C	22.20	1.26	74.7	4.10
	T1	23.63	1.31	49.7	3.99
	T2	22.26	1.36	60.7	3.82
1987-88	C	16.45	1.12	103.0	3.77
	T1	17.19	1.29	110.0	3.79
	T2	17.72	1.36	88.2	3.81
1988-89	C	19.72	1.21	104.9	3.94
	T1	21.09	1.32	117.3	4.05
	T2	21.31	1.32	111.6	3.62

Note: C - conventional tillage and weed control practices as recommended by PAU, Ludhiana

T1 - Strip-till drill sowing and use post emergence chemicals for weed control

T2 - Strip-till drill sowing and post emergence weed control mechanically

Table 3.3: Salient Data on Strip-Till Drill Experiments (1991-92) for Sowing Wheat

Location	Date of sowing	Germination count (Plant/m)		Yield, t/ha	
		Conventional	Strip Till	Conventional	Strip Till
Drainage Farm Dept. of Soil & Water Engg. Ludhiana	23.11.91	217	227	3.00	3.24
Rice, Research Station, Rauni, Patiala	30.11.91	96	142	3.54	3.40
Rice Research Station Kapurthala Dept. of Agronomy Farm, PAU Ludhiana	4.12.91	-	-	3.06	3.85
Paddy-wheat	6.12.91	46/m	41/m	5.04	5.04
Cotton-wheat	12.12.91	60/m	61/m	4.71	4.61
Seed Farm Naraingarh Cotton-wheat	8.1.92	-	-	1.96	1.97

Energy input of wheat under paddy-wheat rotation in heavy soil for conventional tillage and strip-tillage was also studied from 1985-86 to 1988-89. Under the minimum tillage system, the diesel fuel consumption in planting operation only (no separate seedbed preparation required) was 18 l/ha while diesel fuel used for seedbed preparation and sowing under conventional tillage system was 60 l/ha. Thus, there was a saving of diesel to the extent of 42 l/ha. The total energy input for minimum tillage system with mechanical weed control was 17264 MJ/ha and that with chemical weed control was 17328 MJ/ha. In conventional tillage, under similar soil conditions, the energy input varied between 19659 MJ/ha and 19723 MJ/ha. Hence, under the strip tillage system, energy saving under heavy soil condition was 2395 MJ/ha.

In the experimental results, no significant difference in the yield was observed when the crop was planted on the same day for both the conventional and strip tillage systems. However, with the strip-tillage system, a time saving of 65 to 70% in comparison with the conventional tillage planting was obtained. Thus, by adopting the strip tillage planting technology for wheat, the timeliness of operation improved significantly resulting in an increase in the total yield of wheat. In the Punjab State, wheat is grown in an area of about 3.4 m-ha. The diesel saving for

every million ha brought under this system will be about 4 million litres. Thus, there is a good potential of saving the precious petroleum fuel and sowing of wheat at optimum time.

Farmers Field Demonstration Trials:

About 3.8 ha of wheat crop were sown in these villages. The date of sowing varied from 3rd Nov. to 24th Nov. 1993 (Table 3.4). The soil type varied from light to heavy. Crop rotations were paddy-wheat, moong-wheat and fodder-wheat. The yield varied from 4.0-5.58 t/ha. At one location, experimental trials to compare strip-tillage with conventional tillage under paddy-wheat rotation at farmer's field were conducted. The yield in conventional tillage field was 4.3 t/ha whereas in strip-tillage field, it was 5.1 t/ha. Thus farmers' field yield results clearly demonstrated that there was no yield loss in strip-till drill sown wheat crop. In addition it has advantages of timeliness, diesel saving, time saving and reduction in cost of production.

Table 3.4: Results of demonstration trials of Strip-Till Drill for wheat crop at farmer's field (1993-94)

S. No.	Name and Addr farmer	Date of sowi	Area Sown (ha	Yield (t/ha)	Remark
1.	Balbir Singh Vill Rohle Ludhiana	3.11.93 5.11.93	0.2 0.6	5.58 5.13	Demonstration
2.	Kulwant Singh Vill Sidhwan Khurd Ludhiana	8.11.93	0.2	5.1 4.3*	Trial
3.	Ajmer Singh Vill Katani Khurd Ludhiana	10.11.93	0.8	4.0	Demonstration
4.	Kulwant Singh Vill Sidhwan Khurd Ludhiana	24.11.93	2.0	4.85	Demonstration

- Yield of control (conventional field)

Annexure I

List of Manufacturers

1. **M/s. Dashmesh Mechanical Works**
   Amargarh
   Distt. Sangrur

2. **M/s. Amar Agricultural Implement Works**
   Amar Street, Gill Road, Janta Nagar,
   Ludhiana – 141003.

3. **M/s. A.S. Foundary Works**
   Amritsar Road, Jandiala Guru,
   Amritsar.

4. **M/s. National Agro Industries**
   Link road, Industrial Area A,
   Opp. Transport Nagar
   Ludhiana – 141 003