

TRACTOR MOUNTED ZERO-TILL SEED CUM FERTILIZER DRILL

- A Success Story



All India Coordinated Research Project on

Farm Implements and Machinery

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Introduction

Zero-till drilling of wheat is becoming an attractive alternative to the conventional tillage and sowing of wheat after rice. In Indo-Gangetic plains of Punjab, Haryana, Uttar Pradesh and Bihar and in irrigated zones of Madhya Pradesh and Rajasthan, farmers are shifting to direct drilling of wheat after harvest of rice to maintain the timeliness in delayed wheat sowing condition. Direct zero-till drilling offers the apparent advantage of timely planting at reduced time, fuel and labour costs and therefore helps reducing the cost of production besides reducing the drudgery involved in the task. Moreover zero-till drilling carries special significance and has proved more cost-effective in situations where late harvesting of rice compels delay in sowing of wheat.

Traditional practices for sowing of wheat and necessity for development

The traditional methods of sowing wheat are manual broadcasting or seeding behind the country plough by dropping the seeds manually through a seed tube with funnel. For farmers owning tractor, the traditional practice is manual broadcasting of seeds over a ploughed field followed by one operation of cultivator to mix the seeds with soil. With all these methods the plant mortality becomes high due to uneven placement of seeds with inadequate soil coverage resulting into poor establishment of crop.

With seed cum fertilizer drill the seeds are sown along with basal placement of fertilizer over a well prepared seed bed. For this, the field after the harvest of rice is prepared by 7-8 cultivation operations which consumes enormous time, labour and energy besides causing delay in sowing of wheat with increased cost of cultivation. Due to delayed sowing of wheat the plant stand, growth and yield become poor especially in the situation when rice harvest is late or prolonged. The result is low economic return to the farmers. However, opportunity exists to increase the productivity and profitability of wheat cultivation

by direct drilling to maintain timeliness of planting at reduced cost of operation. Therefore, a tractor mounted zero till drill has been developed by the GBPUAT, Pantnagar Centre of AICRP on FIM.

Salient features of Tractor mounted zero-till seed drill

The Tractor mounted zero-till seed drill was initially developed at GB Pant University of Agriculture and Technology, Pantnagar and subsequently modified to the site needs (Fig. 1).



Fig 1 Tractor mounted zero till seed cum fertilizer drill

The machine is used to sow the crop directly into the uncultivated field just after the harvest of previous crop (rice) by eliminating the tillage operations. It is a nine/eleven-row unit consisting of fluted rollers for metering of seeds and vertical rotors over adjustable openings/variable hole-mesh type for metering of fertilizer. The ground drive wheel supply power through sprocket and chain for metering of seed and fertilizer. The furrow openers are of inverted 'T' type (Fig. 2) spaced at 200 mm row spacings. The machine is operated by tractor of 35 hp (26 kW) or above. The specification of the machine are given in the Table 1.

Table 1 Specifications of tractor mounted zero till seed cum fertilizer drill

Type	Tractor mounted
Power requirement, kW	Tractor , 26 (35 hp)
Size (L x W x H), mm	1800 x 600 x 1100
Frame	Rectangular Mild steel box section : 70 x 70 mm
Number of furrow openers,	9/11 spaced 200 mm with provision for changing the row spacing
Type of furrow openers	Inverted 'T' type
Seed metering device	External fluted feed rollers of die casted aluminum, no. of flutes = 10
Fertilizer metering device	Gravity type with adjustable hole and vertical rotor agitator / variable hole - mesh type
Transmission system	Sprocket chain drive
Ground drive wheel, mm	Front mounted - floating type with lugs on wheel periphery, size Diameter = 380 Width = 105 No. of lugs = 10 Height of lug = 30 Lug angle = 90°
Overall weight, kg	250
Unit cost, Rs	15,000/-

Evolution / Design Manufacturing Process

Since the first development in direct drilling machinery almost all work was based on the philosophy of describing the responses of direct drilled seeds to different soil micro-environments and accordingly the functional design specifications of the machine could be written. Earlier the field performance of prototypes was reported more on biological parameters than mechanical aspects. Gradually the

mechanical performance of the machine attracted significant importance in terms of structural design improvements of the machine.

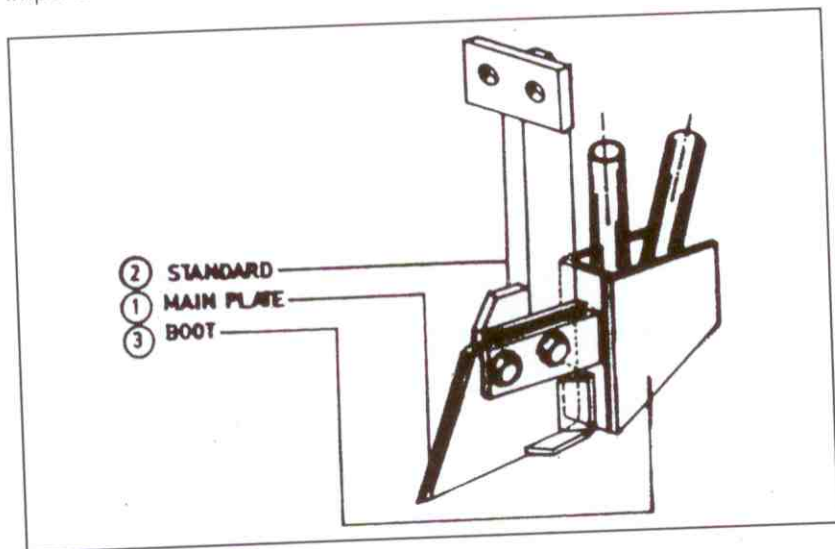


Fig 2 Schematic diagram of Inverted 'T' type furrow opener

The Tractor mounted zero-till drill is similar to that of the conventional seed cum fertilizer drill except the furrow openers of inverted 'T'-type which creates inverted 'T' type furrow groove with reduced surface exposure and thereby helps to maintain the ingroove humidity in a reasonably wet soil for better germination and emergence of seedlings. Since, the furrow openers are generally exposed to the service loading with wear and impact in a uncultivated soil those need adequate strength, toughness and hardness through standard manufacturing process. The furrow opener being the key component may be made from high grade steel : say EN 42 for main plate and standard. Carburized structural steel may be used for boot. The front leading edge of the main plate may be given hard surface coating or shot peening treatment for extension of service life with higher quality of field operation.

The manufacturing process should include fabrication of components through drilling jigs and welding fixtures to ensure uniformity and

stress-free assembly. Other processes such as hard facing, cutting, grinding, surface finish etc., may be done precisely as those influence the mechanical and field performance of the machine.

Performance of the machine

Laboratory test

The machine may be calibrated in the laboratory for metering of desired quantity of seed and fertilizer with measurements on row to row variations and mechanical damage to the seeds. The laboratory test results showed that mechanical damage to the seeds was within 0.50% and average number of seeds (test weight of wheat = 40 g) per metre length of row was 45 with per cent variation of seeds among the rows for $\pm 1.0\%$.

Field test

The machine was field tested at CIAE, Bhopal for direct drilling of wheat after harvest of rice. The crop was sown shallow (depth of sowing = 50-60 mm) at 200 mm row spacing with seed rate of 120 kg/ha and reduced basal dose of Nitrogen (25% of the recommended dose). The sowing could be done satisfactorily through the standing rice stubbles (Fig.3) at average field capacity of 0.35 hectare per hour with field efficiency of 80%.

The shape and size of furrow/slit created by the inverted 'T' type furrow openers could well accommodate the seeds and fertilizer without excessive exposure. However, under high soil moisture condition the sown seeds remained uncovered due to inadequate soil backflow to the furrow. A light weight plank was hinged behind the drill which partially covered the seeds and gently pressed the furrow wall for better seed soil contact. First irrigation was given after 10 days of sowing to support the crop at its initial stage of establishment.

The germination and emergence of the crop were found satisfactory with low plant mortality (Fig.4 and Table 2).



Fig 3 Field testing of zero-till drill for sowing of wheat after harvest of rice



Fig 4 Zero-till drilled wheat (LOK-1) at 15 days of sowing

Table 2 Performance of zero till drilled and conventionally sown wheat at initial stage of establishment (15 days after sowing)

Sl. No.	Parameters	Observed values *	
		Direct drilled	Conventionally sown
1	Seed rate, kg/ha	120	100
2	Germination, %	78-82	91-95
3	Pre-emergence plant mortality, %	4-5	1-2
4	Emergence failure, %	5-8	3-4

* Data represents means of 10 observations.

The results showed that with zero-till drill 80% of the seeds eventually germinated, this being 17.6% less than the measured in the laboratory germination test. The non-germinated seeds were found swelled, discoloured and decayed. Due to zero-till drilling there were average of 4.5% pre-emergence mortality at 6.5% emergence failure positions where the germinated seeds failed to grow and emerge as seedlings. Compared to conventionally sown wheat the germination and emergence percentage in zero till drilling were 13.0 and 3.0%, respectively less for which higher seed rate was applied to take care of the eventuality.

Comparative performance of zero till drilling Vs conventional sowing of wheat is given in Table 3 with production economics and energy use in Table 4.

Table 3 Zero till drilling Vs conventional sowing of wheat after harvest of rice in vertisol

Sl. No.	Parameters	Zero till drilling of wheat	Conventional sowing of wheat	Percentage savings through zero till drilling
1	Time of sowing, h/ha	3.5	11.5	69.6
2	Fuel consumption, l/ha	14.0	38.3	63.5
3	Operational energy, MJ/ha	810.9	2177.0	62.8
4	Cost of seeding operation, Rs/ha	665	1865	64.3

Table 4 Production economics and energy use of zero-till drilled and conventionally sown wheat after harvest of rice in vertisol

Parameters of comparison	Previous field / soil condition					
	Puddle transplanted rice / wet plastic soil			Direct-dry seeded rice / friable soil		
	Zero-till drilled wheat	Conventionally sown wheat	Percent age benefit through zero till drilling	Zero-till drilled wheat	Conventionally sown wheat	Percent age benefit through zero till drilling
Grain yield, t/ha	5.24	5.14	1.90	5.40	5.25	2.80
Cost of production, Rs/ha	9097	11689	22.20	9548	11682	18.30
Benefit cost ratio	3.34	2.55	23.65	3.28	2.61	20.43
Specific energy use, MJ/kg	1.24	1.79	30.73	1.35	1.74	22.41
Specific cost of production, Rs/kg	1.73	2.27	23.79	1.77	2.23	20.63

* Sale price of wheat (2000-2001). Rs/kg = 5.80

The results showed that zero till drilling of wheat was energy efficient and cost-effective by ensuring timeliness of planting and by avoiding repeated tillage operations. Therefore, the machine is recommended for adoption by farmers for timely planting of wheat during the brief turn around time after harvest of rice to increase the productivity and profitability of wheat.

The Prototype Feasibility Testing of tractor mounted zero-till drill was carried out on farmers' fields by PAU, Ludhiana; AADU, Allahabad; HAU, Hisar; GBPUAT, Pantnagar; NDUAT, Faizabad; and RAU, Pusa Centres. A total area of 553 ha was covered by these centres using the zero-till drill for direct sowing of wheat after rice harvest.

Tractor mounted zero till seed drill in Bihar

There is water logged area in Bihar where soil moisture is very high and it is not possible to prepare seedbed for wheat sowing in time.

RAU, Pusa centre carried out feasibility testing of tractor mounted zero till seed drill in 75 ha area during the year 2000-2001.

It was used under very high soil moisture condition (35-40% db). The yield varied from 38.45 - 51.59 q/ha. The machine was compared with power tiller operated Chinese till plant machine and broadcasting behind tractor. Zero till drill performed better over other two methods (Table 5).

Table 5 Cost of wheat production under various treatments at RAU, Pusa

Treatment	Seed-bed preparation, Rs/ha	Cost of sowing, Rs/ha	Total Cost, Rs/ha
Tractor mounted Zero till drill	-	247	247
Power tiller operated Till plant machine	-	482	482
Tractor drawn cultivator for ploughing and broadcasting	844	281	1125
Animal drawn ploughing and sowing	1044	764	1808

The field capacity of the machine varied from 0.35 to 0.50 ha/h. About 20 l/ha fuel can be saved over the conventional method of wheat sowing. Besides fuel saving, timeliness of sowing is a significant advantage. On an average, about 10 tractor-h/ha can be saved in sowing wheat by no-till drill over conventional method of sowing.

Status of the technology

The Tractor mounted zero till seed drill was tested extensively for direct drilling of wheat after harvest of rice in Indo Gangetic plains from Punjab to Bihar. The machine has been used for sowing of wheat in nearly one lakh ha (2000-01) on farmer's field in Haryana, Punjab and Western Uttar Pradesh. A large number of demonstrations and adaptive trials have been conducted in thousands since 1997. Nearly 1000 machines are in use by the farmers and by different organizations.

Under National Agricultural Technology Project (NATP) and Frontline demonstration programme of AICRP on FIM, the tractor mounted zero till seed drills are being demonstrated in (Punjab, Haryana, Uttar Pradesh, Uttaranchal, Bihar, Madhya Pradesh, Chhattisgarh, West Bengal, Rajasthan, Himachal Pradesh, Assam and Jammu and Kashmir) with target area of over 2000 hectares.

The list of few prominent manufacturers of zero-till drill is given in Annexure-I.

List of Manufacturers

1. M/s National Agro Industries
Link Road, Opposite Transport Nagar
Industrial Area-A
Ludhiana-141 003, Punjab (Fax : 0161-663299)
2. M/s The Oriental Science Apparatus Workshop (OSAW)
Jawahar Lal Nehru Marg
Ambala Catt. - 133 001, Haryana (Fax : 0171-643183)
3. M/s Kamla Engineering Works
Ismailabad
Distt.: Kurukshetra, Haryana
4. M/s Amar Agricultural Implements Works (Regd.)
Amar Street, Janta Nagar
Gill Road, Ludhiana-141 003, Punjab.
Fax : 91-161-490594, Tel.: 0161-491780, 493128
5. M/s ASS Foundry and Agril. Works
GT Road, Near Anmol Cinema
Jandiala Guru
Amritsar-143 115, Punjab (Tel.: 0183-322367, 322545)
6. M/s Sherpur Agro Industries
GT Road, Focal Point
(Near Glaspur Railway Crossing)
Ludhiana-141 010, Punjab
Fax : 0161-677239, Tel.: 0161-671887, 673839
7. The Principal Investigator
Revolving Fund Scheme
Department of Farm Machinery and Power Engineering
College of Technology
GB Pant University of Agric. And Technology
Pantnagar-263 145, Uttaranchal (Fax No. 05944-33473 & 33608)
8. The Principal Investigator
Revolving Fund Scheme
Prototype Production Centre
CIAE, Nabi Bagh, Berasia Road
Bhopal-462 038 (MP)
Fax : 0755-734016, Tel.: 0755-730980, Ext. 168

..... *A Step Towards Farm Mechanization*

Substance of a desirable level of agricultural productivity goes hand in hand with mechanization of different farm operations, which aims at achieving timeliness of operations, efficient use of inputs, improvement in quality of produce and safety and comfort of farmers, and reduction in loss of produce and drudgery of farmers.

The All India Coordinated Research Project (AICRP) on Farm Implements and Machinery (FIM) with its 28 centres in different parts of the country, has been endeavouring to develop, test and popularize need based farm implements and machinery for different regions. The research and development activity under AICRP on FIM involves design, development, testing and design refinement of farm implements and machinery. Prototype manufacturing activity is for multiplication of research prototypes for multi-location trials, development of manufacturing technology for new machines and promoting their manufacture by involving local manufacturers. Prototype feasibility testing activity of a Centre includes identification of farm mechanization needs under local agro-climatic conditions and identification and adaptation of machines to fill the identified mechanization gaps through their feasibility trials.

One-hundred-fifty-nine farm implements and machinery have been designed and developed under the AICRP on FIM. Eighty-three of these have been commercialized. This publication is one among the series of such publications being brought out by the Project on successful technologies.