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Power tiller operated relay seeder as a possible solution for the late sowing of wheat crop

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Abstract
This research describes the development and performance evaluation of the relay seeder. The major objective of the research is to overcome the problem of late sowing of the wheat crop due to the late harvesting of the cotton crop. It ultimately leads to yield loss of wheat crop. The study proposed the relay seeder and was tested in the standing cotton crop. The various measurement of crop growth parameters were observed such as seed germination percentage, plant population per square meter area, ear head length, number of ear heads per square meter area and number of seeds in one ear head. The following performance parameters of the machine were also determined such as seed germination, depth of sowing, fuel consumption rate and field efficiency. This research confirmed potential of the relay seeder to minimize the problem of late sowing of the wheat crop with seed germination (85%), sowing depth (7 cm) and fuel consumption rate (0.3 l/hr). The research also reported the labor intensive problem associated with operation of the machine in the cotton standing crop.

Keywords: Power tiller, relay seeder, seed drill, wheat crop, cotton crop, farm mechanization

Introduction
India holds second place in the world in terms of population after China. It is also believed that in India, populations will cross that of china till 2050. However, India has limited agricultural area with scanty irrigation facilities. Therefore, it is very difficult to fulfill the demand of food for the population. Hence, farm mechanization using various technologies is one of the best way by which demand of the food can be met. As per the agronomists, farmers lose considerable quantity of wheat per day due to delay in sowing of the wheat crop. Various studies had been conducted to determine the effect of date of sowing on the yield of the wheat crop and reported considerable loss (French *et al*. 1979; McDonald *et al*. 1983; Dabre *et al*. 1993; Singh and Uttam, 1999; Rajput *et al*. 1994; Wajid *et al*. 2004; Akhtar *et al*. 2006; Shah *et al*. 2006; Qasim *et al*. 2008; Akmal *et al*. 2011; Baloch *et al*. 2012) [5, 6, 4, 9, 10, 3, 8, 7, 1, 2]. Therefore, timely sowing of the wheat crop is required for reducing the loss. In this study, we present a famous technique: relay cropping, in which power tiller assisted seed drill (relay seeder) was employed and tested in the field to determine the potential of the machine to minimize the yield loss of the wheat crop.

Materials and Methods
In this study, a relay seeder was proposed which consists of seed drill unit attached with the power tiller. It allows the farmers for the direct sowing of wheat in the standing cotton field. The four rowed seed drill was attached behind the power tiller. The rotary unit of the seeder was mounted in front of the seed drill and received the power from the power tiller engine. However, the shaft of fluted roller metering mechanism of the seed drill was connected to the shaft of the power tiller wheel through the chain and sprocket system (Figure 1b). The detailed specification of the machine is shown in Table 1. The experiments were performed at the Wheat Section Farm at Chaudhary Charan Singh Haryana Agricultural University, Hissar (Haryana), India using developed relay seeder (Figure 1a). For the experimentation purpose, the wheat variety (WH1105) was selected and sown in the field (Figure 1c & 1d). In this research, the working speed of operation was maintained at 1.08 km/hr, low speed of operation was selected because of the high and bushy growth of the cotton crop. During the sowing operation of the wheat crop, the operator trailed the machine and engine delivered the power to the rotary unit of the machine. It pulverized the moist soil in the field in front of the seed drill.

Two to three labours were required for the smooth working of the machine. The labours created free and open space in the bushy cotton crop in front of the machine to ensure smooth conduct of the seeder. The net area sown was about 756 m^2 with the help of the relay seeder by maintaining the row to row spacing as 1 meter. The seed rate was maintained at about 50 kg per acre. However, after the harvesting season of the cotton, the cotton stems were uprooted (Figure 1e) from the wheat sown field. The wheat crop is shown (Figure 1f) at the harvesting season obtained through the relay seeder.

Table 1: Machine specifications

Sr. No.	Particulars	Values
1.	Seed box Dimensions (L×W×H)	49 cm×20 cm×16 cm
2.	Seed box capacity	15 kg
3.	Metering mechanism	Fluted roller
4.	Transmission system	Chain and sprocket
5.	Number of furrow openers	4
6.	Power source	Power tiller
7.	Seed box design	Trapezoidal section
8.	Diameter of fluted rollers	5 cm
9.	No of fluted rollers	4
10.	Wheat crop: row to row spacing	20 cm
11.	Height of machine from ground	80 cm
12.	Ground wheel diameter	17 cm
13.	Width of ground wheel	7 cm
14.	Width of the machine	64 cm

Fig 1: (a) Relay seeder, (b) chain sprocket mechanism of the relay seeder, (c) & (d) sowing of the wheat crop using the seeder, (e) uprooting of cotton crop and (f) wheat crop

Results and Discussion

The various crop growth parameters were measured such as seed germination percentage, plant population per square meter area, ear head length, number of ear heads per square meter area and number of seeds in one ear head as shown in table 2.

Table 2: Plant growth parameters achieved by the machine

Sr. No.	Particulars	Values
1.	Seed germination, %	85
2.	Plant population per, m^2	173
3.	Ear head length, cm	10.4
4.	No. of ear heads per m^2	317
5.	No. of seeds in one ear head	56

In this research, WH1105 variety of wheat crop was sown in the cotton raised field using the relay seeder. The performance evaluation of the machine was estimated for determination of its potential to overcome the yield loss due to the delayed sowing in the relay cropping system. The developed system showed good potential to sort out the problems of late sowing and provided good seed germination percentage (table 3). However, it required two to three labours during the operation in the cotton field for the free movement of the machine. It is a reasonable and noticeable problem associated with the proposed relay seeder, but on the other hand, provided good performance in the field.

Table 3: Machine performance parameters

Sr. No.	Particulars	Values
1.	Seed germination, %	85
2.	Theoretical field capacity, ha/h	0.090
3.	Actual field capacity, ha/h	0.069
4.	Field efficiency, %	76.67
5.	Dropped seeds in 1 m^2	202
6.	Rate of fuel consumption, l/h	0.3
7.	Depth of sowing, cm	7

Conclusions

This research confirmed the potential of the relay seeder to rectify the problem of late sowing of the wheat crop by exhibiting good seed germination percentage, appropriate depth of sowing and acceptable fuel consumption rate (l/hr). It provides an alternative way for the farmers to deal with the late sowing problem. It could have higher potential ability to perform satisfactorily in a better way in any standing crop except for the bushy crops like cotton, because for the working with the bushy crops, there is an increase in the labour requirement, to clear the pathway for the machine to work smoothly. However, it further increases the worries of the farmers for labour arrangement during the critical harvest season of cotton. Therefore, considering the pros and cons of the machine developed, it can be helpful for the timely sowing of next crop in the previously standing crop conditions.

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