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PERFORMANCE EVALUATION OF POWER TILLER OPERATED SEED CUM FERTILIZER DRILL

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ABSTRACT

In South Gujarat, where most farmers are small-scale landholders, crops like maize, rice, gram, pigeon pea, and green gram are commonly grown during the kharif and summer seasons. Traditionally, these crops are sown manually through dibbling or line sowing. However, existing planting machines often cater to only one or two crops, are inefficient, and struggle with seed placement in heavy black soils. To address these issues, a power tiller-operated seed cum fertilizer drill was developed. This machine was field-tested for sowing pigeon pea and maize crops. The results showed improved crop performance compared to manual methods. For pigeon pea, there were 14 plants per m² with an average plant height of 19.20 cm using the drill, versus 12 plants per m² and 14.95 cm with manual sowing. Similarly, maize crops sown by the machine had 11 plants per m² and an average height of 15.07 cm, compared to 8 plants per m² and 10.11 cm with manual methods. The machine's effective field capacity was 0.11 ha/h, with a field efficiency of 61.67%. The operational cost of using the drill was 1351/ha, significantly lowers than 2400/ha for manual sowing, saving 43.71% in costs and 55% in time. Plant spacing averaged 90.66 mm for pigeon pea and 93.73 mm for maize, with no missing seeds recorded. The power tiller-operated seed cum fertilizer drill proved to be a cost-effective and time-efficient solution for small farmers.

Key words: Power tiller, field capacity, field efficiency, operational cost, pigeon pea and maize

Introduction

Agriculture in India has a significant history. Today, India ranks second worldwide in farm output. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India. The comparison between the traditional sowing method and the new proposed machine which can perform a number of Agricultural sectors is changing the socio-economic environment of the population due to liberalization and globalization. About 75% people are living in the rural area and are still dependent on agriculture. About 43% of geographical area is used for agricultural activity (Singh *et al*., 2014).

The cost of cultivation is increasing every year due to increase in price of inputs and labour. Non availability of labour is utmost problem in the agriculture sector. Introduction of the farm implement such as seed cum fertilizer drill have significantly reduced labour as well as other inputs due to their judicious utilization. Thus, it is helping in reducing the cost of cultivation and increasing the crop yield significantly (Lakhani and Vagadia, 2023). Presently, most of the farmers in the adopted villages are using the power tiller. The use of power tiller is also becoming popularized among the farmers in the adjoining villages (Ghadge *et al*., 2000).

The concept of power tiller came to the world in the year 1920. The first country to use power tiller on large scale was Japan. The first successful model of power tiller was designed in the year 1947. During the year 1950 to 1965 the production of power tiller increased rapidly. Power tiller was introduced in India during 1963. Power tiller is a walking type tractor. Power tiller is mainly used for seedbed preparation in low land paddy fields. Power tiller is also used as a power source for other agricultural operations such as seed bed preparation, sowing and fertilizer application. At present, most of the power tillers are fitted with diesel engine. The makes like Kubota, Mitsubishi, and Sarachi have used diesel engine in India.

Several type of seed cum-fertilizer drills have been developed by various research organization and Agricultural Engineering institutions. But they are costly and suitable for very limited crops. Farmers cannot afford to purchase several seed drills for sowing different crop. Hence there is need to develop a machine which can be used for sowing different crops like that maize, rice, gram, green gram and other similar crops without changing the seed meeting device for the crop (Modi *et al.*, 2020).

Traditional Sowing Methods

Traditional methods include broadcasting manually, opening furrows by a country plough and dropping seeds by hand, known as 'Kera', and dropping seeds in the furrow through a bamboo/metal funnel attached to a country plough (Pora) (Vinosh *et al.*, 2021). For sowing in small areas dibbling i.e., making holes or slits by a stick or tool and dropping seeds by hand, is practiced. Multi row traditional seeding devices with manual metering of seeds are quite popular with experienced farmers.

Modern Sowing Method

Now a day, seed sowing is done with the seed sowing machines in most of the agricultural parts. As day by day the labor availability becomes the great concern for the farmers and labor cost is more, this machine reduces the efforts and total cost of sowing the seeds and fertilizer placement. Various types of seed sowing machines are available across the different parts of the world. The major difference in different designs of these is in type of seed and fertilizer metering and furrow openers. Sowing machine is a device that plants or sows the crops, it digs a furrow places the seed or seeds into the furrow and covers it. Seed sowing machine ensures uniformity in seed broadcasting and saves time and money. A multi seed sowing machine is a type of sowing machine that is used to sow seeds of different types either at a time or at different times (Ali, 2019).

Materials and Methods

The study was conducted at project field of College of Agricultural Engineering and Technology, Navsari Agriculture University, Dediapada. The field was situated at 28.38° N, 77.2° E at an altitude of 169.00 m above mean sea level. The study area is in semi-arid and sub-tropical climate with hot summers and cool winters with an average rainfall of 1050 mm.

Components of Power Tiller Operated Seed cum Fertilizer Drill

Seed hopper

The size of the seed hopper is 22×20 cm. It should be hold sufficient quantity of seed. The shape of the seed hopper should be such as it allows free picking of seed into seed metering device without bridging. It should be easily accessible and visible to the operator. Photographic view of Seed hopper presented in Fig. 1.

Fertilizer hopper

The size of the fertilizer hopper is 22×20 cm. It should be hold sufficient quantity of fertilizer. There must be an arrangement of controlling the rate of application of fertilizer. Photographic view of Seed hopper presented in Fig. 2.

Seed metering mechanism

It should be able to pick the seed comes from the seed hopper and drop into the furrow tube. There should not be any internal or external damage to the Seed. There should be continuous flow of seeds. It should be maintain the proper seed to seed distance. Photographic view of

Fig. 1: Seed hopper.

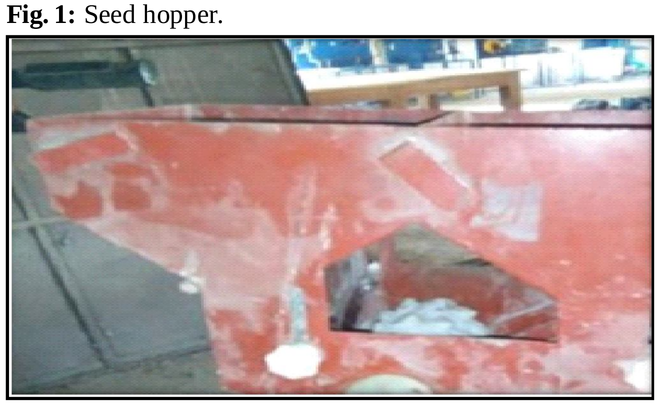

Fig. 2: Fertilizer hopper.

Seed hopper presented in Fig. 3.

Fertilizer metering mechanism

It should be meter the fertilizer at the specified rate and there should be continuous flow in the fertilizer tube. There should not be any chocking in the tube. The fertilizer should be drop below the seed. Photographic view of Fertilizer metering mechanism presented in Fig. 4.

Fig. 3: Seed metering mechanism.

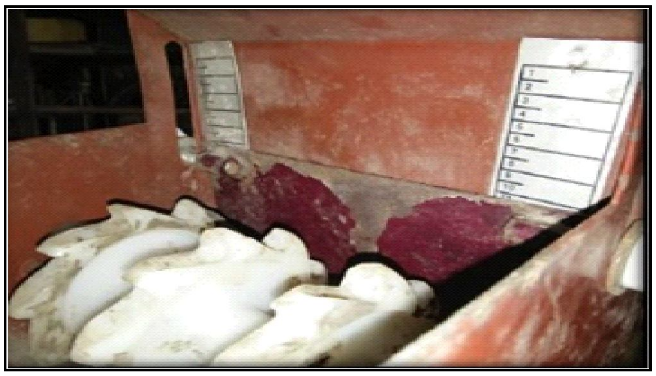

Fig. 4: Fertilizer metering mechanism.

Fig. 5: Furrow tubes.

Fig. 6: Furrow opener.

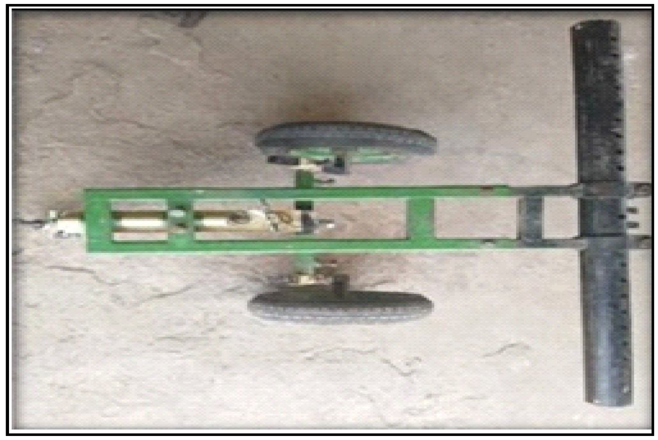

Fig. 7: Linkage frame

Furrow tubes

The working of furrow tube is to transmit the seeds and fertilizer from the metering device to the furrow opener. There are four furrow tube of seeds and four furrow tubes of fertilizer is used. Photographic view of furrow tubes presented in Fig. 5.

Furrow opener

It should maintain the required depth of seeds and fertilizer. Width of furrow should be sufficient to facilitate lateral Placement of seeds and fertilizer. Photographic view of Furrow opener presented in Fig. 6.

Linkage Frame

The overall length, width and height of linkage frame were 908 mm, 872 mm and 544 mm, respectively. Linkage frame mainly consists Manual Hydraulic, Depth Control and Balancing wheel and Tool bar. Photographic view of linkage frame presented in Fig. 7.

Ground wheel

The diameter of the Ground wheel is 0.42cm and it is made of iron also. The ground wheel is used to operate the whole seed drill. It is rotate the chain and the chain is rotate the metering mechanism then seed is throe to the ground via pipe and furrow opener. Photographic view of frame an ground wheel presented in Fig. 8.

Fig. 8: Ground wheel.

Machine and Operational Parameters

Operating time for each operation

To determine operation time, time is noted at starting and ending point of sowing by using stop watch, so that actual time required for sowing by seed drills was computed in terms of hha^{-1}. The time required for one turn of seed drill and time consumed for adjustment were also noted to compute time loss in operation.

Speed of the operation

To determine the seed of operation, mark the length of 10 m and the drill is operated in the marked run length. A stop watch was used to record the time for the drill to traverse the marked run so that the speed of travel was computed in m/s.

Effective field capacity

Effective field capacity is measured by the actual area covered by the implement, based on its total time consumed and its width. Effective field capacity is determined by the following relationship (Adamu *et al.*, 2014).

$$Fc_e = \frac{W \times L}{10000\ (t_p + t_u)} \quad (1)$$

Where,

Fc_e= Actual field capacity of tractor operated groundnut digger cum inverter, ha/h

W = Width of plot, m

L = Length of plot, m

t_p = Productive time utilized during operation, h

t_u = Unproductive time utilized during operation, h

Theoretical field capacity

Theoretical field capacity is the rate of field coverage of the implement, based on 100% of time at the rated speed and covering 100% of its rated width. The Theoretical field capacity is determined using the following relationship (Kumar *et al.*, 2017).

$$Fct = \frac{W \times V_t}{10} \quad (2)$$

Where,

Fct = Theoretical field capacity of mini tractor operated groundnut digger cum inverter, ha/h

W = Width of digger, m

V_t = Forward speed of tractor operated groundnut digger cum inverter, km/h

Field Efficiency

Field Efficiency is the ratio of effective field capacity to theoretical field capacity, it is determined by the following formula (Saha *et al.*, 2021).

$$n_f = \frac{FC_a}{FC_t} \times 100 \quad (3)$$

Where,

n_f = Field efficiency, %

FCa= Actual field capacity of the tractor operated groundnut digger cum inverter, ha/h

FCt = Theoretical field capacity of the tractor operated groundnut digger cum inverter, ha/h

Fuel consumption

The fuel consumption has direct effect on economics of the machine. The fuel consumption was measured by top fill method. The fuel tank of the tractor was filled at its full capacity. The tractor along with seed drill was run in the test plot at constant speed. After completion of the test operation, the fuel was refilled in the tank up to the top level. The quantity of refilled fuel was measured by measuring cylinder. This observation is used for computation of fuel consumption in l/hr and l/ha (Naik and Raheman, 2019).

Sowing Parameters

Seed rate

The seed rate is determined by taking the weight of seed before and after sowing operation. Then subtracted the final weight of seed from initial weight of seed so that the seed rate was obtained and the results were expressed in terms of kg/ha.

Depth of sowing

Depth of sowing of seeds was determined with the help of steel scale of 30 cm. seven random observations were taken for each plot and their mean was calculated to represent the depth of sowing.

Row to row spacing

Row to row spacing was measured by a steel scale of 30 cm length after sowing. The soil was removed carefully without disturbing the seed at minimum five random in 9 rows and the mean was determined to represent row to row spacing.

Seed sowing

Take 5 kg seed and 10 kg fertilizer and filled in the

Table 1: Agronomical recommendation.

Sr. No.	Crop	Seed rate (kg/ha)	Row spacing (mm)	Seed spacing (mm)	Depth of sowing	Climate (°C)
1	Pigeon pea	55-60	300-750	100-200	50-100	26-30
2	Maize	20-25	300-600	100-200	50-70	24-30

Fig. 9: Average plant population.

particular hopper then jack up the seed drill by tractor and go to the Field then lower down the seed drill and ground wheel also and then start sowing of gram and when turn the tractor rise up the ground wheel and after turned lower it.

Crop Parameters

Average plant population

The average plant population was determined by count by number of plants per square meter at five random places and the mean value was determine to represent the average plant population.

Average plant height

Plant height was measured form the base of stem to the tip of the top most leaf at five randomly selected areas. The plant height was recorded at different intervals in vegetative stage. The mean plant height was calculated and expressed in cm.

Missing index (Imiss)

Missing index is an indicator of how often a seed

Fig. 10: Average plant height.

skips the desired spacing. It is the percentage of spacing greater than 1.5 times the theoretical spacing (adachi *et al.*, 2013). Smaller values of missing index indicate better performance:

$$I_{miss} = \frac{n1}{N}$$

Where,

N = Total number of observations, and

n_1= Number of spacing's in the region > 1.5 times of the theoretical spacing.

Result and Discussion

Different experiments were conducted in the field to evaluate the performance of the power tiller operated seed cum fertilizer drill. Two selected crop for performance evaluation of power tiller operated seed cum fertilizer drill. Pigeon pea and maize were selected for this study. Crop was sown by power tiller operated seed cum fertilizer drill and broadcasting methods. Parameters like plant population and plant height were measured and compared with broadcasting method.

Plant Population of Pigeon Pea Crop by Seed Drill and Broadcasting

The bar graph (Fig. 11) compares the plant population of pigeon pea (plants per square meter) across five plots (P1 to P5) under two sowing methods: the seed drill method and the broadcasting method. The plant population is shown on the y-axis, while the x-axis represents the plots. In all five plots, the seed drill method consistently results in a higher plant population than the broadcasting method. The seed drill method produces populations ranging between 13 and 15 plants per square meter, showing minimal variation across the plots. On the other hand, the broadcasting method yields lower and more variable populations, ranging from approximately 8 to 12 plants per square meter. The most significant difference is observed in plot P3, where the seed drill method achieves around 13 plants per square meter, while the

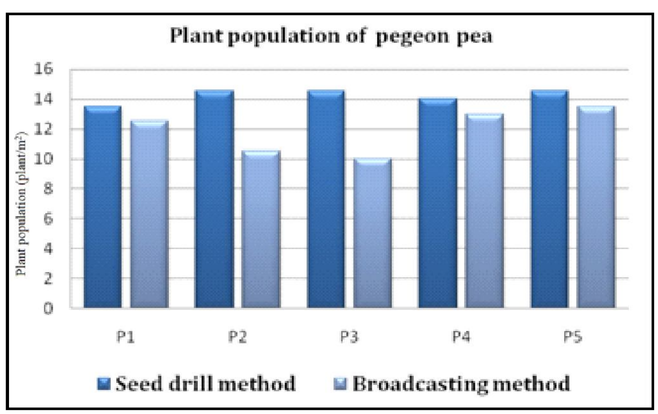

Fig. 11: Plant population of pigeon pea crop.

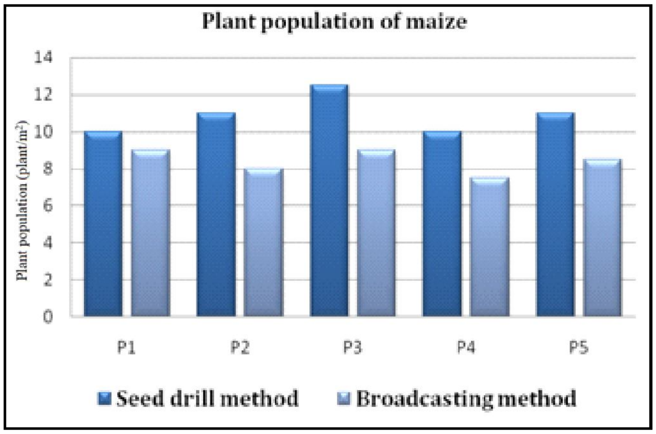

Fig. 12: Plant population of maize crop.

broadcasting method only reaches about 8 plants per square meter. In plot P2, the seed drill method shows the highest population of approximately 15 plants per square meter, compared to 12 for the broadcasting method. Overall, the data indicates that the seed drill method consistently leads to better plant establishment and higher pigeon pea populations across all plots, suggesting its effectiveness over the broadcasting method for denser crop growth.

Plant Population of Maize Crop by Seed Drill and Broadcasting

The bar graph (Fig. 12) depicts maize plant density (plants per square meter) across five experimental plots (P1 to P5) comparing two sowing techniques: seed drilling and broadcasting. The seed drill method consistently yields higher densities, ranging from 10 to 13 plants per square meter, with plot P3 exhibiting a maximum density of approximately 13 plants. In contrast, broadcasting results in lower and more variable densities, ranging from 6 to 10 plants per square meter. The most significant difference occurs in plot P3, where seed drilling surpasses broadcasting. Overall, seed drilling is more effective in enhancing maize plant density across all experimental plots compared to broadcasting.

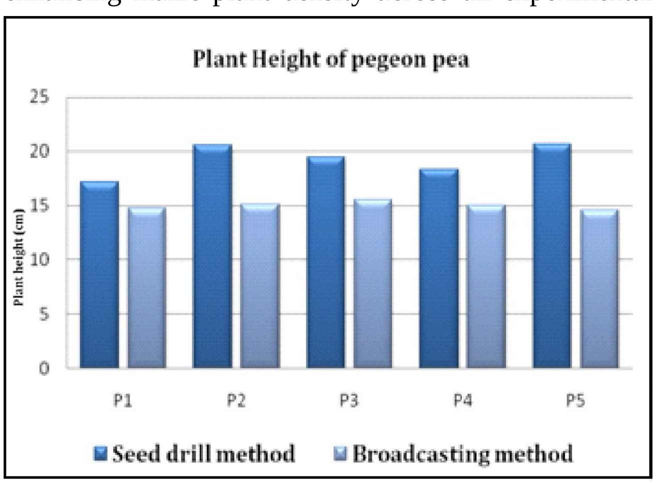

Fig. 13: Plant height of pigeon pea crop.

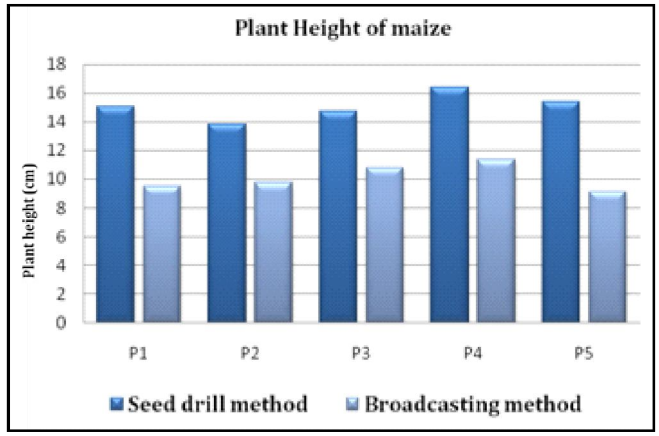

Fig. 14: Plant height of pigeon pea crop.

Plant Height of Pigeon Pea Crop by Seed Drill and Broadcasting

The bar graph (Fig. 13) illustrates pigeon pea plant height (in centimeters) across five plots (P1 to P5) using two sowing methods: seed drilling and broadcasting. The y-axis indicates plant height (0-25 cm), while the x-axis represents the plots. The seed drill method consistently produces greater plant heights than broadcasting across all plots. Plot P2 shows the highest height at approximately 22 cm for seed drilling, compared to 18 cm for broadcasting. In plot P5, seed drilling achieves 21 cm, while broadcasting reaches only 16 cm. Overall, the findings suggest that seed drilling enhances pigeon pea growth, resulting in taller plants compared to broadcasting.

Plant Height of Pigeon Pea Cropby Seed Drill and Broadcasting

The graph (Fig. 14) illustrates a comparison of maize plant heights under two different planting methods: the seed drill method and the broadcasting method. It presents data across five planting plots (P1 to P5), with the plant height measured in centimeters (cm). The seed drill method consistently results in taller plants compared to the broadcasting method, highlighting its potential advantage in optimizing growth conditions for maize. In particular, the seed drill method achieves its highest plant height in P4 (approximately 17 cm), whereas the broadcasting method lags behind, achieving its highest height of about 13 cm in the same plot. Overall, this pattern suggests that the seed drill method is more effective in promoting taller maize plants, possibly due to better seed placement, spacing, and soil contact, leading to enhanced growth conditions. The observed trend in plant height differences across all plots may support the argument that the seed drill method is more favorable for maize cultivation, offering insights for agricultural practices aimed at improving crop yields.

Conclusion

From calibrating the power tiller operated seed cum fertilizer drill it is found that row to row spacing 60 cm and seed rue 60 kg/ha for sowing of pigeon pea and maize. The depth of sowing was obtained 5 cm in seed cum fertilizer drill and 4-6 cm in dibbling method. So, about 43.71% of cost saves in seed drill compare to dibbling method. Operations time saved by power tiller operated seed cum fertilizer drill was found that 55% when in comparison with dibbling method. The average plant population of pigeon pea and maize was 14.00 plant/m^2 and 11.00 plant/m^2 power tiller operated seed cum fertilizer drill and 12.00 plant/m^2 and 8.00 plant/m^2 in dibbling method, respectively. The average plant height of pigeon pea and maize was 19.20 cm and 15.07 cm in power tiller operated seed cum fertilizer drill and 14.95 cm und 10.11cm in dibbling method, respectively. The average seed to seed spacing was observed 90.66 mm and 93.73 mm in pigeon pea and maize crop at actual field condition which is not greater than 1.5 times of the theoretical spacing (10cm), so the missing index is zero. Cost of economics of power tiller operated seed cum fertilizer drill compared with dibbling method was found 1351 per ha and the operational cost for seed sowing by dibbling method was 2400 per ha.

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