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Comparative Assessment of the Developed Animal Drawn broad bed Former cum Planting System with Existing Planting Methods for Sowing of Pea Crop

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ABSTRACT: In the current landscape, tractor power dominates in most areas. However, mechanized agricultural farming, driven by draught animal power, is still used in some parts of the country. Agricultural practices mainly performed in hilly and remote terrain often fail to facilitate early planting due to waterlogging, adversely affecting crops. Therefore, broad bed farming is an effective way to enhance crop growth. Present study assessed the performance of an animal-drawn broad bed former, along with the attachment of sowing mechanisms like a ferti drill and inclined plate planting mechanism for the pea crop. Pea crop was chosen for its vital role in improving crop growth and enhancing fertility through nitrogen fixation as part of crop rotation practice. Uniformity was observed in inclined plate planting along with broad bed cultivation. The machine performed better in the broad bed system with inclined plate planting system. The operational speed attained was lower at 0.49 km/h, and the draft was higher at 780 N due to the additional attachment of the broad bed former. Nevertheless, the germination rate was higher than flatbed cultivated treatments. The yield of the pea crop was also higher at 1.8 t/ha under this treatment, and irrigation water savings were observed to be 7.3% more than flatbed planting. Despite the maximum cost of cultivation being 640 ₹/ha under the broad bed former with inclined plate planting, the economic advantages of water saving and higher yield compensate for the additional cultivation expenses.

Keywords: Animal drawn, broad bed farming. Inclined plate, Planting, Flatbed cultivation, Seed drill.

INTRODUCTION

Pea crop cultivation holds significant importance in agriculture due to its various benefits and contributions to food production and economic growth. Among the global scenario of pea production, India is the sixth largest producer of pea crops. According to the annual report of 2021-22, pea production was found to be 0.88 million tons, where the cultivation area was 0.64 million ha. Major contributing states are Uttar Pradesh, Madhya Pradesh, Jharkhand, Himachal Pradesh, Rajasthan, Assam, Odisha, and Bihar. More than 96% of production was coming from this state. Peas are technically legumes, commonly referred to and consumed as vegetables. With the increase in population, pulse crop demand is increasing to fulfill the demand of a larger population for protein fulfillment. Thus, the cultivation of pulse crops needs to be focused. Pea cultivation improves soil fertility through nitrogen fixation by Rhizobium leguminosarum, enabling the subsequent crop to benefit from nitrogen without needing additional costly fertilizers. Pea crops played a vital role in crop rotation.

In the present crop cultivation scenario, most areas are dominated by tractor power. The Bullock population in India has dropped by 45 % in the past two decades. Mechanization benefits large farmers, who make up 15% of the country's farmers and own 75% of the farmland. However, small and marginal farmers with landholdings less than 2 hectares cannot afford it. Small and marginal farmers still use the draught animal power for crop cultivation. Nonetheless, 54.54 million draught animals are available for crop cultivation in various regions of the country.

Draught animals are still being used as a power source in crop cultivation globally, despite efforts to increase mechanization in other countries. Mechanization was also incorporate with using of animal power. Several studies have been conducted on the design and assessment of animal-drawn machinery. Ghebreyesus *et al*. (2023) developed a cereal grain no-till planter specifically for planting maize crops. This planter can exert a pulling force of 715 N and achieve a forward speed of 2.6 km/h. Notably, the planter was fabricated using locally available materials, resulting in lower production costs. Alhassan *et al*. (2023) did modifications to an animal-drawn maize planter to accommodate the planting of soybeans in Nigeria. Adjustment was necessary due to the higher investment cost associated with imported planters. The modified planter demonstrated an effective field capacity of 0.12 ha/h, with a planting speed of 2.88 km/h. Additionally, it achieved an impressive germination percentage of 83%. Modified planter excelled in all aspects, offering a viable alternative to relying on expensive imported planters. Ahmad *et al*. (2021) was also developed the 4-row animal drawn precision planter for maize crop plantation in the region of Nigeria. Developed planter showed the higher field capacity of 0.54 ha/h, where the germination percentage was also observed to be higher as 88 %. Findings revealed that the planting speed highly impact the effective field capacity, seed rate and thus affected the germination count.

In India, mechanized crop cultivation utilizing draught animal power is also being employed. Animal-operated planters and seed drills were evaluated to enhance performance in different climate and soil conditions across the country. Many researchers have conducted experiments to assess the performance of designed planters for specific crops (Kambale *et al*., (2023); Bisen *et al*., (2021); Dhruwe *et al*., (2018). Most of the studies under animal-operated equipment were conducted in flatbed farming systems. Kambale *et al*. (2023) developed a 'UAE-developed bullock-drawn turmeric planter' and evaluated the performance in different fields of the Maharashtra region. The acquired forward speed was observed to be 1.2 km/h, where the effective field capacity was observed as 0.30 ha/h. This was found to be economical for turmeric cultivation with animal-drawn equipment. Bisen *et al*. (2021) developed the animal-operated 3-row multi-crop planter cum herbicide applicator using locally available material. Thus, the lower fabrication cost was noted as compared to the commercially available planter. The effective field capacity was observed to be 0.12 ha/h. The average draft requirement fell within the pulling capacity of medium-sized bullocks in this region. Similarly, Dhruwe *et al*. (2018) assessed the performance of animal-drawn multi-crop planters in the region of Chhattisgarh. Performance was evaluated for various crops such as wheat, chickpea, green gram, ground nut, and pigeon pea. The acquired field speed was found to be 1.75 km/h, where the pulling force was found to be 404 N. Findings revealed that the seed rate was found to be lesser as compared to the traditional planting method and provided the flexibility corresponding to the specific crop planting system. Jena and Khandai (2017) evaluated the performance of a three-row inclined plate planter made by CIAE (Central Institute of Agricultural Engineering) in the fields of OUAT (Orissa University of Agriculture and Technology) in Odisha. The evaluation included various parameters such as draft requirement, depth of placement, forward speed, field capacity, efficiency, and cost of cultivation. The study revealed the adaptability of the animal-drawn planter in Odisha farms.

Similarly, Nirala (2011) assessed an animal-drawn multi-crop planter in the Pusa Samastipur, Bihar laboratory. All machine performance parameters were evaluated, and the field capacity was reported to be 0.23 ha/h, while the field efficiency reached approximately 51.1%. The cost of cultivation was observed to be 3.5 times more economical than the traditional cultivation practice. The animal-drawn multi-crop planter was designed and developed by Singh *et al*. (2017). The machine was designed as an aspect of adaptability in hilly regions and tested the planter with various crops. The effective field capacity was observed at 0.0378, 0.05, 0.058, and 0.056 ha/h in wheat, lentil, mustard, and pea. Findings revealed that the cultivation cost was 42 percent less and improved the yield from 21 to 33 % compared with the traditional farming practice.

Due to the region's prevalence of waterlogging and fungal diseases, early planting is not feasible under most traditional practices as it adversely affects the crops. In areas with heavy rainfall or poorly drained soils, broad bed farming proves beneficial as it enhances soil drainage by creating raised beds with furrows in between and facilitating the movement of the implements for minimum tillage. This arrangement allows excess water to drain quickly, preventing waterlogging and improving soil aeration. The planter attachment provided labour savings, reduced erosion, reduced seed and fertilizer rate and maintained crop productivity (Astatke *et al.*, 2002). A plating system attachment for the broad bed former has been developed. However, more studies needed to be assessing the bullock-operated broad bed farming system compared to the flatbed cultivation practice. In order to address this gap, the present study was conducted to assess different methods of pea crop cultivation, comparing the performance between flatbed and broad bed farming. The primary objective of this study was to assess the effectiveness of the animal-drawn cultivation method on the broad bed and flatbed system based on its overall performance. The pea crop was sown using the ferti drill and inclined plate planting mechanisms. The assessment encompassed various stages, from sowing to harvesting, to evaluate the outcomes of the different growth periods.

MATERIALS AND METHODS

An experiment was conducted in the field to evaluate the performance of existing cultivation methods (flatbed method) compared to the performance of cultivation using an animal-drawn broad bed former. The initial step involved developing the prototype of the animal-drawn bed former and assessing its performance in the experiment. An experiment was performed at a farmer's farm during the rabi season in 2017, where the area of each experiment was selected to be 0.20 ha. Two treatments were carried out in the field using a two-row seed cum fertilizer drill (bed drill) and an inclined plate planter, both with the attachment of the bed former. Additionally, another two treatments were prepared without the attachment of the bed former and performed on a flatbed. The adoption of broad-bed farming assisted in overcoming the moisture stress problem in the field (Verma *et al*., 2017). Broad bed farming provided several merits for crop cultivation, such as improved soil drainage, better irrigation control, weed management, soil conservation, and potential crop yield and quality increases.

Table 1: Different treatment selected under.

Treatments	Particular's
T1	Ferti drill on flat bed (FDFB)
T2	Ferti drill with the attachment of bed former (FDBB)
T3	Inclined plate planting on flat bed (SPFB)
T4	Inclined plate planting with the attachment of bed former (SPBB)

It was also helpful to reduce the runoff and soil erosion in the field. Thus, an assessment was conducted to compare the impact of cultivation techniques, specifically seed cum fertilizer drill and inclined plate planting, in conjunction with bullock-operated broad bed farming, with the conventional method of pea farming. Animal-drawn raised bed former was designed and developed, which has a provision for adjustment according to the compatibility with two-row and three-row sowing machines.

A. Mechanism of animal drawn bed former with planting system

Animal-drawn bed formers was attached to the main frame. The shaper of the bed former was made having a dimension of 800 x 200 mm (length x width), as shown in Figure 1. The Effective length of the shaper board for soil coverage was considered to be 650 mm. The broad bed former's structure was connected to the mainframe, with separate attachments for sowing mechanisms for drilling and planting pea crops. The seed cum fertilizer drill consists of a fluted roller mechanism (metering of seed), fitted in the unit, which gets driven from the ground drive wheel through a chain sprocket. The screw lever system adjusted the seed rate. Similarly, an inclined cell plate was used to plant the pea in the field, which was also powered by ground wheel drive using a chain and sprocket mechanism and mounted on the main frame on the front side. To place the seed at the desired depth, a shoe-type furrow opener with a non-clogging boot was utilized.

B. Field performance assessment

A comparative evaluation of the broad bed forming system and flat-bed system was done. To assess the performance of the bullock-operated broad bed former, along with the attachment of the seed drill and inclined plate planting mechanism (Figure 1), the sowing mechanisms were initially calibrated in the laboratory as the procedure was reported by Jena et al. (2017) and Revanath *et al*., (2020). Field performances were conducted in the clayey soil (Sand 14.79 %, slit: 30.51 %, and clay: 54.70%). Tillage operations were performed on the field three times, by using animal-drawn bakhar of 500 mm size blade were performed at a depth of operation varying between 50-100 mm to prepare the seed bed.

In a flatbed planting system soil mulch is left to assist for conserved moisture and improve emergence. However, the broad bed system required deep tillage and a greater level of soil pulverization to remove debris. Therefore, an additional deep tillage operation was conducted prior to the planting process. A broad bed was constructed in the field, and measurements of the top width, bottom width, and height were taken as performance parameters. This was constructed simultaneously with the sowing process. All performance parameters from the seed sowing process to yield were observed to assess better growth among all treatments. Various parameters such as speed, draft, field capacity, field efficiency, saving of irrigation water, germination, weed dynamic, yield, and cost of saving were recorded as followed by the procedure elaborated below.

C. Operating speed

The speed of operation of the planter was determined by recording the time using a stopwatch and it took to travel a distance of 30 m between two marks defined on the field, which were placed 30 m apart (Sachan & Jogdand, 2020).

D. Draft of the implement

Draft of animal-drawn implements along with the operation of drilling and planting were measured on the field.

Fig. 1 a. Animal drawn broad bed former with seed cum ferti-drill; b. Broad bed former cum inclined plate planter.

By observing the pull using a load cell and the angle of the inclination of the beam was measured with the help of 'Abney level'; the draft of the implement was measured by using the below equation.

$$D = P \cos \theta \qquad (1)$$

Where,

D: Draft of the implement, kg

P: Pull of the implement, kg

θ: Angle of inclination of the beam, Degree

E. Machine planting performance

To assess the performance of the selected treatments, Theoretical field capacity, effective field capacity and efficiencies were observed as the method reported by Jena and Khandai (2017). Similarly, yield of the pea crops for the selected treatments was also assessed (Singh *et al*., 2017) to find the effective solution for pea crop cultivation.

F. Weed dynamics

Weed population among the crop is the critical factor which influence the plant's growth, consequently affecting the yield. Thus, weed populations were also observed 45 days after sowing for the comparative evaluation of flatbed and raid bed planting. The cultivation of pea crops followed the recommended agronomic practices.

G. Assessment of irrigation water

Flood irrigation was applied in the flat fields, while furrow irrigation was employed in the raised beds. A bed former was used to create furrows of size 300 mm x 150 mm to facilitate the horizontal/lateral movement of irrigation water. The irrigation duration in each plot was noted, and measuring the time it took for water to cover the plot area. To estimate the quantity of water applied during each irrigation, the discharge of water at the delivery pipe outlet was measured by recording the time taken to fill a known volume of container.

H. Cost of cultivation

Sowing cost per hectare was evaluated to obtain the optimum cost-effective method for pea crop cultivation among the selected treatments. All parameters were analysed by following the standard agronomical procedure.

RESULT AND DISCUSSIONS

The field performance of animal-drawn implements under the selected treatments was analysed based on the data collected from the field. Flat bed and broad bed were prepared properly to perform the implement. The area of each treatment was equally divided on the field. Experiment was performed on clayey soil with an average moisture content of 19.93 % (d.b.). The seed rate of the animal-drawn (AD) seed cum fertilizer drill was observed to be 100 kg/ha, while an 80 kg/ha seed rate was observed for AD Inclined plate planting system (Table 2). The seed rate was found to be lower for the AD inclined plate planting system compared to the AD seed cum fertilizer drill.

Table 2: Performance of seed establishment and its effect of germination.

Particulars		Ferti Drill Sowing		Inclined Plate Planting	
		Flat Bed T1	Broad Bed T2	Flat Bed T3	Broad Bed T4
Seed rate, kg/ha		100	100	80	80
Plant Spacing, mm	Avg.	49.5	62.5	81.9	92.9
	SD	4.57	2.98	2.95	0.91
	CV, %	9.23	4.77	3.6	0.98
Row spacing, mm		250	250	250	250
Seed germination, %		69	72	68	71
Soil Moisture, (d.b.), %		20.92	18.82	20.16	19.82

** DAS: Days after sowing

Plant spacing for the selected treatment was reported in table 2. Higher plant spacing was found under AD inclined plate planting implement. 92.90 mm plant spacing was reported for T4 (SPBB) treatment and later followed by 81.90, 62.50, and 49.50 mm for T3, T2, and T1 treatment, respectively. When the comparative assessment was done based on the flatbed and broad bed systems, a higher deviation in plant spacing was observed in the flatbed planting system compared to the broad bed planting system. This might be attributed to more pulverized soil in the broad bed, resulting in a smoother surface and providing uniform performance compared to the flatbed. However, the average forward speed was observed to be lower as compared to the flatbed system. A higher forward speed (0.58 m/s) was observed in the T1 treatment (FDFB), while a lower forward speed (0.49 m/s) was reported under T4 (SPBB) treatment, as shown in Table 3. Acquired lower forward speed in the broad bed planting system might be due to the additional weight and drag, the need for precision in shaping larger beds, and the requirement for careful navigation. A similar finding was reported by Sing *et al*. (2017), where the planting speed of bullock operated inclined plate planting system in a flatbed was observed to be 0.69 m/s. It was slightly higher than the present study findings. It might be due to the environment and soil condition varied in a different region.

The AD ferti drill's placement depth was noted in flat bed and broad bed. It was observed to be 35 mm in flatbed (T1), while it was observed to be 45 mm for broad bed (T2). A similar trend was noted in the case of AD-inclined plate planting systems performed on flatbed and broad beds. 45 mm planting depth was observed in flatbed planting, while 75 mm planting depth was observed in broad bed planting. This was might be due to smooth surface availability and pulverized soil on the bed as compared with flatbed planting systems. Similar finding was quoted by the Jena and Khandai (2017) where the planting depth of bullock operated inclined plate planter for maize crop was reported to be 80 mm.

Table 3: Performance of the bed drill and bed planting machine for pea planting.

Particulars	Ferti Drill Sowing		Inclined Plate Planting	
	Flat Bed	Broad Bed	Flat Bed	Broad Bed
Depth of operation, mm	35	45	45	75
Mean speed of operation, m/s	0.58	0.51	0.54	0.49
Avg. draft, N	642	845	580	780
Field capacity, ha/h	0.112	0.095	0.105	0.09
Field efficiency, %	72	59	63	59

A. Draft of implements

The draft of animal-drawn implement performed under the flatbed and broad bed condition was assessed. Comparative analysis of flatbed and broad bed systems revealed that the higher draft was reported under the broad bed system, as depicted in Table 3. The draft was observed to be 845 N and 780 N for ferti drill sowing (T2; FDBB) and Inclined plate planting (T4; SPBB) system. The higher draft is likely a result of multiple factors, including the increased soil displacement needed for bed formation, the additional weight and drag from combining multiple functions, the presence of challenging soil conditions, and the pulling capacity of the animals. The finding was found to be similar, as quoted by Solanki *et al*. (2017) and Thakare et al. (2014). During the field test performed by Solanki *et al*. (2017), the animal-drawn planter cum fertilizer drill exhibited an average draft requirement of 639.19 N for a 90 cm spacing and 594.28 N for a 120 cm spacing. The machine draft was observed without attachment of the broad bed former. The draft of the present study lay under a similar range. Although the draft of the broad bed former cum fertilizer drill sowing was found to be slightly higher at 845 N, this might be due to the inclusion of the broad bed former attachment along with it. On the other hand, it might be due to the change in climate conditions, soil conditions, and performance parameters of the developed machine.

B. Machine planting performance

Both types of mechanisms were tested under flatbed and broad bed conditions. Data revealed that the field capacity was higher for a flatbed system. Using a flatbed planting system, the mean field capacity for T1 and T3 treatments was determined to be 0.12 and 0.11 ha/h, respectively. Additionally, the field efficiency for both treatments was recorded at 72% and 63%, correspondingly. Under the broad bed planting system, the field capacity and field efficiency for the T2 (SPFB) and T4 (SPFB) treatments were reported as 0.09 ha/h and 59%, respectively (Table 3). The lower field capacity under broad bed sowing was likely due to the lower forward speed obtained under the broad bed system. The 15.8%-time loss was observed during turning, which reduced the speed of operation. Thus, it also increases labour requirements. The observed result agreed with findings quoted by Reddy *et al*., (2015), where bullock-operated groundnut planter was developed and evaluated in the field for summer season. The planter's field capacity was observed to reach 0.15 ha/h while operating at an average speed of 0.72 m/s. Observed findings in the present study were found to be lower due to additional attachment for broad bed forming system, and other factors such as climate and soil condition may also affect the performance of crop cultivation.

C. Germination of the crop

In the flatbed system, emergence was detected 12 DAS because the seeds were placed in moist soil, but in the broad bed system, emergence was not observed until one post-sowing irrigation was performed because the seeds were placed in a deeper layer of the bed that had been well pulverised. Thus, initially, it had lower germination (12 DAS) as depicted in Figure 2. Only 8 plants per square meter germinated in the broad bed system, while 12 plants per square meter were reported for the flat bed ferti-drill system.

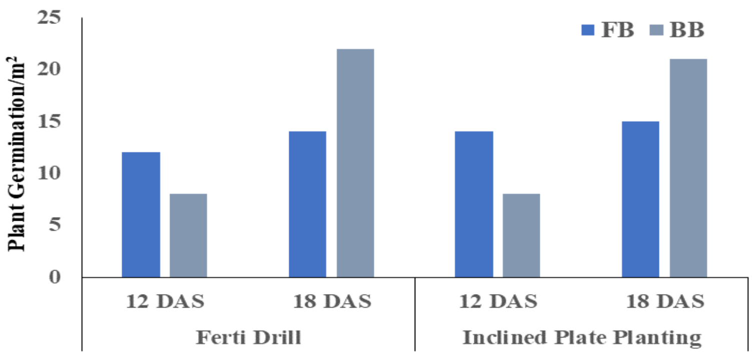

Fig. 2: Germination of plant growth per meter square of pea crop of 12 days after sowing (before irrigation) and 18 days after sowing (post irrigation).

After 18 days of seeding, a higher plant population was found in the broad bed system (T2 and T4), as nearly all of the seeds placed on the beds emerged. The seed emergence was higher, with 22 plants per square meter in the broad bed system, whereas seed germination was lower for flatbed sowing (T1 and T3). It was only about 15 plants per square meter for the T3 treatment. This might be attributed to insufficient moisture content availability in the field and waterlogging conditions in some areas of the flat bed system. In the case of the broad bed system, irrigated water was equally distributed, and excess water was drained, ensuring optimum moisture content for plant germination. Thus, higher germination was observed in the broad bed planting system, along with the performance of both types of mechanisms.

D. Weed dynamics

Weed dynamics of the experiment depicted that distinction was observed vividly between the flatbed and broad bed sowing system. A higher weed population was observed in the flatbed sowing system, while lower weed growth was noted in the broad bed system, as shown in Table 4. The weed population was assessed before and after irrigation, revealing that the broad bed planting system exhibited fewer weeds. After post-irrigation, only 10 and 8 weed plants were observed in the broad bed planting system. In contrast, the flatbed sowing plots (T1 and T3) displayed a larger weed population. The broad bed system resulted in reduced weed presence due to limited wetting of the entire soil surface where the crop was planted and the unavailability of soil moisture for weed germination.

E. Water saving

Regarding crop length and flower production, furrow irrigation demonstrated superiority over other irrigation methods. This particular method led to a higher pea yield. Specifically, the advantage of furrow irrigation over flood irrigation was 7.3 % in pea crops that were planted using a planter (Table 5). Furrow irrigation provided an adequate supply of soil moisture, which likely facilitated improved drainage, flowering, and root penetration, thereby benefiting a larger volume of the soil's root system. This favourable condition likely contributed to the enhanced yield. Conversely, flood irrigation resulted in excessive soil moisture stress.

Table 4: Weed dynamics in different treatment.

Sowing method	Particulars	Before weeding		After weeding	
		Weed Population per square meter	CV, %	Weed Population per square meter	CV, %
Ferti Drill Sowing	Flat Bed	36	4.90	13	12.10
	Broad Bed	30	6.80	10	23.90
Inclined Plate Planting	Flat Bed	34	8.60	18	7.90
	Broad Bed	14	8.20	8	18.1

Table 5: Quantity of irrigation dispense water during pea crop cultivation.

Particulars	Ferti Drill Sowing		Inclined Plate Planting	
	Flat Bed	Broad Bed	Flat Bed	Broad Bed
Duration of Ist irrigation, h/ha	24.82	20.12	22.82	21.12
Quantity of irrigation, ha-cm	2.39	2.26	2.35	2.16
Duration of IInd irrigation, h/ha	22.16	19.82	21.11	19.21
Quantity of irrigation, ha-cm	2.40	2.12	2.15	2.01
Total Quantity of irrigation, ha-cm	4.79	4.38	4.50	4.17
Saving of irrigation water, %	-	8.55	-	7.3

F. Productivity of crop

The yield of the pea crop per unit area clearly highlighted the productivity difference resulting from the adoption of a specific treatment. Among the different mechanisms tested, the inclined plate planting system demonstrated a higher yield. The maximum yield observed was 1.8 t/ha (T4 treatment), as depicted in Fig. 3. Similarly, a comparison was made between flatbed and broad bed farming systems under both mechanisms. The findings revealed a consistent trend in performance, with higher productivity observed in the broad bed farming system under T2 and T4 treatments. On the other hand, lower productivity was observed in the flatbed sowing method (T1 and T3 treatments).

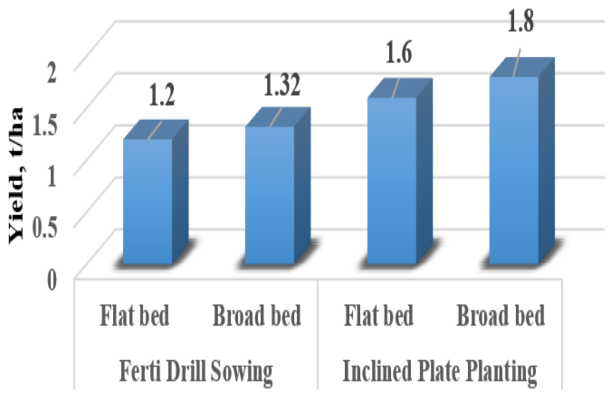

Fig. 3. Yield of pea crop under different treatment.

The productivity values were determined to be 1.2 t/ha for the AD flatbed ferti drill system (T1) and 1.6 t/ha for the AD flatbed inclined plate planting system (T3). These findings align with those reported by Singh et al. (2017), who conducted a study on a bullock-operated multidrop planter. They reported potential yields for rainfed wheat crops in the range of 1.7 to 1.9 t/ha.

G. Cost of cultivation

The operational costs under different treatments were assessed, and it was observed that the ferti drill mechanism had the lowest cost of operation (467 ₹/ha) for flatbed cultivation (T1), while it was higher (574 ₹/ha) for broad bed cultivation. A similar trend was observed with the inclined plate planting mechanism. The maximum cost of operation (640 ₹/ha) was observed for broad bed planting (T4), and the minimum cost of operation (555 ₹/ha) was noted for flatbed planting (T3). The higher cost of operation in the broad bed farming system may be attributed to the additional attachment of the broad bed former along with the sowing mechanism, which reduces the forward speed of the operation, increases the time and labor requirements, and consequently, raises the total cost of operation for the farming system. These findings are consistent with a previous study by Singh *et al*. (2017) where an animal-drawn multi-crop planter was used for pea crop, although the cost of operation in the present study was slightly lower than the reported value.

Although, the cost of operation under broad bed cultivation was found to be higher. Nevertheless, the adoption of the broad bed system offers several advantages, including improved soil drainage, enhanced moisture management, better weed control, and adequate soil conservation. These beneficial features contribute to creating optimal growing conditions for crops. As a result, the broad bed system can potentially lead to higher crop yields, improved crop health, and enhanced quality of produce.

CONCLUSIONS

Adopting an effective cultivation system is a crucial factor that directly or indirectly impacts various aspects, such as the overall farming system's machine performance, yield, and cost efficiency. The study among the selected treatments revealed that the broad bed system, combined with the inclined plate planting mechanism, proved to be suitable. This is attributed to the adequate drainage facilities offered by the broad bed system, which resulted in a higher germination rate of the pea crop. Specifically, a germination rate of 72% was observed under treatment involving an animal-drawn broad bed former combined with an inclined plant planter. Additionally, this treatment showed reduced weed competition. Although the cost of cultivation was found to be higher, the benefits of water savings in irrigation (7.3%) and increased yield (1.8 t/ha) provided economic advantages that offset the additional cultivation expenses.

FUTURE SCOPE

The findings of the research may be further utilised to optimised the design of broad bed former and inclined plate planting system adapted for various cropping patterns, in animal-drawn attachments.

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Conflict of Interest. None

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