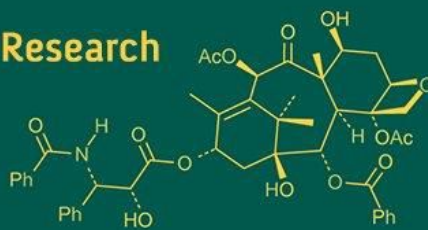


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(2): 705-711
www.biochemjournal.com
Received: 02-12-2025
Accepted: 04-01-2026

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Development of tractor drawn multi crop planter

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i2Si.7704>

Abstract

Indian economy is based on agriculture. In India farmers are facing problems due to unavailability of labour, non-efficient farming equipment's which takes lot of time and also increases labour cost. Sowing seeds at recommended spacing and depth is important for the proper establishment, growth and yield of plants. As per change in shape and size of different seeds the parameters like row spacing and seed to seed spacing, depth of seed, seed rate changes. This research is taken to produce multifunctional and highly efficient multi crop seed sowing machine which will reduce time of sowing, cost of labour and enhances yield and maintain seed to seed and row to row spacing. In the existing planters, the seeds are dropped on the soil behind furrow opener from the end of seed tube having turbulent flow. However, due to improper seed singulation, vibrations of tractor and forward drag of seed along with soil by the furrow openers which causes deviation in uniformity of seed spacing. In the existing planters, the seed metering mechanism gets drive from ground wheel. Slippage of ground wheel affects the uniformity of spacing. The hand push seeder available in the market commonly used for sowing cotton, maize, soyabean, gram etc. are hand push type and requires human power for operating in field which causes fatigue to operator and requires hard work. These research address to eliminate all the above challenges, remove hard work and reduce requirement of labour or human power, increases speed of sowing, helps in reducing the motion losses and maintain uniform seed spacing and desire seed rate and can used for different crops, gram, cotton, maize, soyabean, gram etc. by making adjustment. The sowing of different crop seeds by single planter can be easily done by adjusting the seed rollers and number of teeth or nozzles on drum. During laboratory testing, In stationary calibration of planter the seed rate was found to be 37.088 kg/ha for chickpea (Jaki 9218) and fertilizer rate was found to be 78.68 kg/ha for (DAP Godavari). The sticky belt method is performed at three different speeds i.e. 2.5 km/h, 3km/h and 3.5 km/h. For each speed the test is performed for three times and missing index, multiple index, and quality feed index is calculated. The maximum quality feed index was found at a speed of 3 km/h is 100%. Thus, forward speed of 3 km/h is taken further for field trials. During field trials, Overall performance of machine was satisfactory. The three trials are taken to get accurate observations. The average theoretical field capacity, effective field capacity was found to be 0.592 ha/h, 0.467ha/h respectively and field efficiency was found to be 78.33 %. The moisture content of soil and bulk density of soil was found to be 11.71 % and 1.66 g/cc. The mean seed spacing was found to be 15.22 cm. The coefficient of uniformity for field trial was found 88.71 %. The average missing index, Multiple index and quality feed index was 1.01%, 0.66%, 88.31%, respectively. The average seed rate and fertilizer rate for three field trials was 46.55 kg/h and 83.32 kg/h. The average draft of the machine is found to be 0.312 kg-f. The average ground wheel slippage of planter was found 3.56. The average tractor wheel slippage of planter was found 6.63. For three field trials, the average fuel consumption was found to be 5.637 l/ha and 2.46 l/h. The average cost of the sowing operation was 223.4 Rs per hour.

Keywords: Tractor drawn multi crop planter, precision seed sowing, seed metering mechanism, seed spacing uniformity, field efficiency

1. Introduction

Sowing of seeds in the farm is one the most important and prime operation in farming. The basic objective of sowing operation is to put the seed and fertilizer in rows at desired depth and maintains seed to seed spacing, cover the seeds with soil and provide proper compaction over the seed. Manual method of seed sowing results in low seed placement, spacing efficiencies and serious back ache for the farmer. The traditional planting method is time-consuming, causing fatigue. It effects on rising of crops, uniformity in seed spacing, germination of seeds, plant growth, plant population, and crop yield in the field. The labour

requirement for planting any crop manually is high which results in a higher cost of cultivation. In the existing planters, the seeds are dropped on the soil behind furrow opener from the end of seed tube having turbulent flow. However, due to improper seed singulation, vibrations of tractor and forward drag of seed along with soil by the furrow openers which causes deviation in uniformity of seed spacing. To eliminate the above challenges hand push seeder machine is used as the seed is directly sown from the teeth inside soil. In the existing planters, the seed metering mechanism gets drive from ground wheel. Slippage of ground wheel affects the uniformity of spacing. These planters will eliminate the effect of slippage due to ground wheel and maintain accurate seed spacing. The seed drum including roller of the planter helps in reducing the motion losses and the uniform seed spacing and speed. The seed rate is easily controlled with adjusting the distance between the nozzles and variation in different number of nozzles and spacers on the seed drum. In the existing planter, a single crop can be sown. This tractor drawn planter will be used for different crops, gram, cotton, maize, soyabean, gram etc

by making adjustment. The sowing of different crop seeds by single machine can be easily done by adjusting the seed rollers and number of teeth or nozzles on drum. The hand push seeder available in the market commonly used for sowing cotton, maize, soyabean, gram etc. are hand push type and requires human power for operating in field which causes fatigue to operator and requires hard work.

These projects address to remove hard work and reduce requirement of labour or human power. These projects address to increase the speed of sowing by covering a more number of rows at a time instead of sowing a single row in a single pass by hand push seeder machine. Research is attempted to produce multipurpose and highly efficient tractor drawn planter machine which reduces time required for sowing, cost of labour, and enhances production and maintain uniformity in seed spacing. Tractor drawn planter is an important tool for managing areas where labours are not easily available.

2. Development of Tractor Drawn Multi Crop Planter.

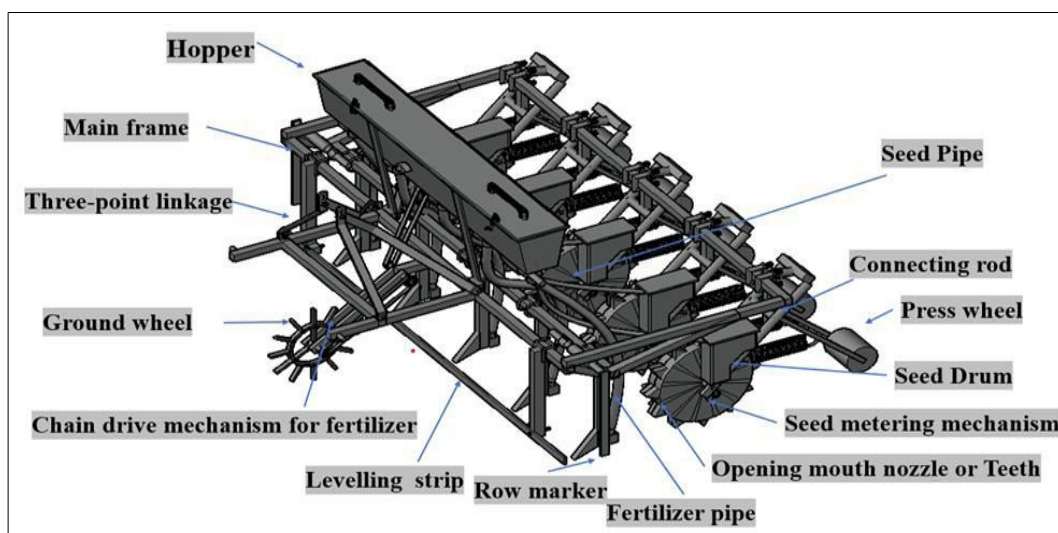


Fig 1: Components of tractor drawn multi crop planter

1. Main frame

The main frame is the skeletal structure of the planter on which all other components are mounted to provide support for mounting of all the sub-assemblies. The length of the frame is 8 feet 3 inch i.e. 252.9 cm so that five rows of soyabean, chickpea, etc. are sown having adjustable row to row spacing up to 50 cm (recommended 45 cm for soyabean) and three rows of cotton having adjustable row to row spacing up to 122 cm (4 feet). The width of the frame is 122 cm.

2. Hopper: The hopper is divided into ten equal parts, five parts for seed and another five parts for fertilizer. The hopper was made with GI (Galvanized Iron) sheet of one mm thickness. The hopper is rectangular with a trapezoidal bottom. The capacity of the hopper for seed is 25 kg i.e. 5 kg in each box. And for fertilizer 35 kg i.e. 7 kg in each box.

3. Seed and fertilizer pipe

A 3.5 cm outside diameter plastic pipe is used as the seed tube of the planter. A seed tube connects the funnel-like structure made of GI sheet at the bottom of the seed hopper to the seed drum. The seed tube is attached to the seed box

of the seed drum. A 2.5 cm outside diameter plastic pipe is used as the fertilizer tube of the planter. A fertilizer tube connects the metering mechanism or roller placed at the bottom of the fertilizer hopper to the tines from behind.

4. Seed drum

The seed drum is circular in shape. The seed drum is made up from plastic polycarbonate material which has high resistance to corrosion, rust. The dibbling machine consists of a seed metering mechanism having different types of seed roller for different mechanisms, seed nozzle (adjustable ranging from 6 teeth-12 teeth or nozzle), brush roller and gearbox. The seed drum is provided with arrays of 5 to 7 mm on its surface. The teeth are attached on the periphery of the drum. The spacers are provided in between the teeth on the periphery. The distance between the teeth can be adjusted by using different spacers. The number of teeth is equal to the number of spacers on the periphery. The diameter of the drum without nozzle is 40 cm and with nozzle is 56 cm.

5. Seed metering mechanism

The seed metering mechanism consists of a seed roller and an opening mouth nozzle. The half-circular plastic strip presents

in the gap on the roller puts the seed in the nozzle. The brush wheel removes the surplus seed in the hole of roller.

6. Opening mouth nozzle or teeth

The nozzle is conical shape and 12 number of nozzles is provided. Teeth are made up of steel to protect corrosion as it repeatably come in contact with the soil. The height of nozzle is 8 cm. The number of nozzles is adjustable from 6 to 12 nozzles.

7. Connecting rod

It is used to connects the seed drum to the main frame of planter. The connecting rod is made up of MS rod. The length of connecting rod is 55 cm. The distance between two connecting rod is 18 cm (without rod) and 22 cm (with rod). Diameter of rod is 2 cm.

8. Seed covering roller or press wheel

It is cylindrical in shape. The diameter of press wheel is 16 cm and width of press wheel is 15 cm. The horizontal iron bar (6 mm diameter) is provided on upper side of press wheel to remove the soil stuck on surface of press wheel. The exposed seed after sowing is covered by press wheel for protection.

9. Seed box

The seed box is attached by the side of seed drum. The dimensions of seed box are width 10 cm, upper length 26 cm and height 28 cm. The capacity of the seed box is 2.5 kg.

10. Furrow opener

The shoe type furrow opener is used for fertilizer. The furrow opener is made up of MS flat of 50 mm width and 20 mm thickness. The main aim is to open the furrow having 5 to 7 cm depth so that the fertilizer can be placed at a depth of 5 to 6 cm. The fertilizer tube is attached to furrow opener from behind

11. Ground wheel

Ground wheel is use to provide motion to the agitators in hopper through chain sprocket mechanism. The ground wheel has 12 number spines on its periphery. The diameter of ground wheel is 490 mm. It was made up of mild steel flat of 30 mm×5 mm thickness and spikes are made up from rods of 10 mm diameter and length of spike is 105 mm.

12. Chain drive mechanism for fertilizer

The drive from ground wheel to the fertilizer metering mechanism given by chain and sprocket. Use of roller chain is done as roller chain. Power transmission is done by the gear sprocket and chain. When ground wheel rotates then sprocket of ground wheel rotates, it transfers the power with the help of chain, rotates the shaft of fertilizer metering mechanism and fertilizer gets dropped. The total length of chain is 194 cm. the chain pitch is 1.5 cm.

13. Hitch point or three-point linkage

Three hitch points is provided to the planter to the front side of frame to attached the planter to the tractor. The developed tractor drawn planter is attached to the tractor through three-point linkage one upper link and two lower links.

14. Levelling strip

It is made up of iron. It is made up of MS flat of 40 mm width, 10mm thickness and It is attached to the frame at bottom with tynes by nut-bolt in front of hand push seeder machine. It levels the soil in front of the planter and also act as secondary tillage implement.

15. Row marker

The function of the planter row marker is help to the operator maintain a more accurate or constant accurate row spacing.

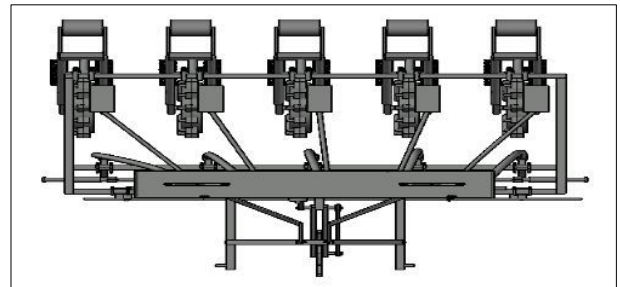


Fig 2: Top view of tractor drawn multi crop planter

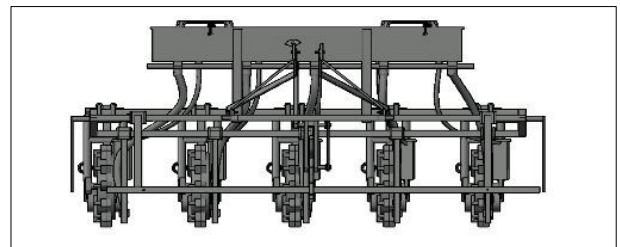


Fig 3: Front view of tractor drawn multi crop planter.

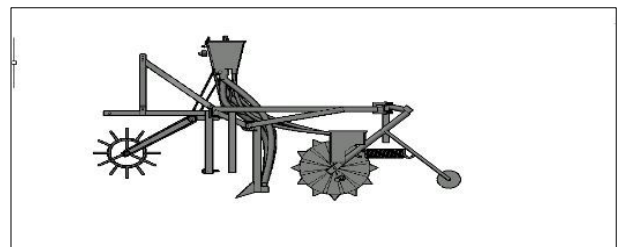


Fig 4: Side view of tractor drawn multi crop planter.

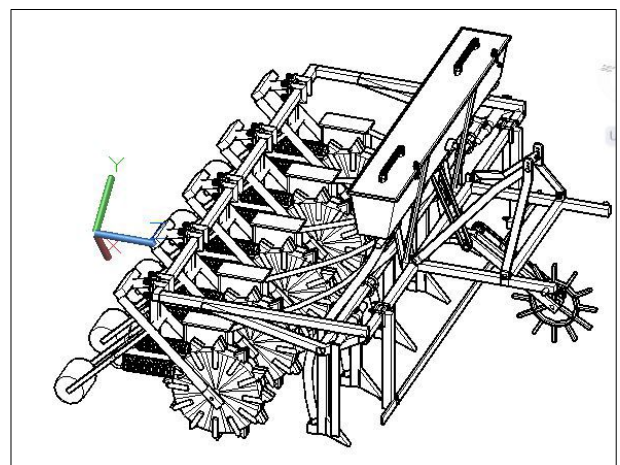


Fig 5: Isometric view of tractor drawn multi crop planter.

3) Performance evaluation of developed multi crop planter

3.1 Laboratory test

The following tests is conducted in the laboratory at Department of Farm Power and Machinery, Dr. PDKV, Akola:

A) Stationary calibration test of Multi crop planter

The stationary calibration of multi crop planter is performed at FMTTC, Dr. PDKV, Akola. For stationary calibration chickpea seeds (Jaki 9218) are taken. and fertilizer variety DAP (Godavari) is used.

a) For seed (Jaki 9218)

Following procedure is followed for calibration test:

1. The distance (d) between two adjacent seed drum at nozzle tip = 45 cm
2. The number of seed drum (N) attached = 5
3. Effective working width of planter (W) = $W = \frac{N \times d}{100}$, meters = $\frac{5 \times 45}{100} = 2.25$ meters
4. Circumference of seed drum including nozzle $L = \frac{\pi D}{100}$, Where, D= diameter of seed drum i.e $L = \frac{(3.14)(56)}{100} = \frac{175.84}{100} = 1.75$
5. Area sown in one revolution of the drive wheel (A) : A = WL, A = $2.25 \times 1.75 = 3.9375 \text{ m}^2$
6. Number of revolutions required to sow one hectare (R): $R = \frac{10000}{A} = \frac{10000}{3.9375} = 2539.68$ rev i.e. approx. 2540 rev of each seed drum are required to sow one hectare.
7. Number of revolutions actually required to sow one hectare (M) considering 10% slippage of seed drum : $M = \frac{R(100-10)}{100} = \frac{2539.68 \times 90}{100} = 2286$ rev i.e. approx. 2286 rev of each seed drum are required to sow one hectare.
8. Now, seed quantity collected after completing 50 revolutions of each seed drum = 811.22 gm .

Hence seed quantity required for 2286 revalutions = $\frac{2286 \times 811.22}{50} = 37088.97 \text{ gm} = 37.088 \text{ kg/ha}$

Hence, approx. 37.088 kg of seed is required to sow one hectare.

b) For fertilizer (DAP)

1. The distance (d) between two adjacent seed drum at nozzle tip = 45 cm.
2. The number of furrow opener for fertilizer (N) attached = 5
3. Effective working width of planter (W) = $W = \frac{N \times d}{100}$, meters = $\frac{5 \times 45}{100} = 2.25$ meters
4. Circumference of ground wheel $L = \frac{\pi D}{100}$, Where, D= diameter of seed drum i.e $\frac{(3.14)(49)}{100} = 1.5386$
5. Area sown in one revolution of the drive wheel (A) : A = WL, A = $2.25 \times 1.5386 = 3.457 \text{ m}^2$
6. Number of revolutions required to sow one hectare (R): $R = \frac{10000}{A} = \frac{10000}{3.457} = 2892$ rev i.e. approx. 2892 rev

7. Number of revolutions actually required to sow one hectare (M) considering 10% slippage: $M = \frac{R(100-10)}{100} = \frac{2892 \times 90}{100} = 2602$ rev i.e. approx. 2602 rev Now, fertilizer quantity collected after completing 50 revolutions of ground wheel is 1.512 kg. Hence fertilizer quantity required for 2602 revalutions = $\frac{2602 \times 1.512}{50} = 78.68 \text{ kg/ha}$.

Hence, approx. 78.68 kg of fertilizer is required to sow one hectare.



Fig 6: Stationary calibration



Fig 7: Sticky belt set up

B) Sticky Belt method

The sticky belt method is a laboratory test used to measure seed spacing and uniformity. It involves placing a sticky belt under a planter and observing how many seeds fall on belt. It includes

1) Missing index, %

Miss index (M) which is the percentage of spacing greater than 1.5 times the theoretical spacing, and expressed as (Gautam *et al.*, 2017) ^[10]

$$M = \frac{n1}{N} \times 100$$

Where,

N = Total number of observations

n1 = Number of spacing's in the region > 1.5 times of the theoretical spacing

2) Multiple index, %

Multiple index (D) is an indicator of more than one seed dropped within a desired spacing (Gautam *et al.*, 2017)^[10]

$$D = \frac{n_2}{N} \times 100$$

Where, N = Total number of observations, and n_2 = Number of spacing's in the region less than or equal to 0.5 times of the theoretical spacing.

3) Quality feed index, %

The quality of feed index is an alternate way to present the performance as a result of combined effect of misses and multiples. The quality of feed index (A) is the percentage of spacing's that are more than half but not more than 11/2 times the set spacing. (Singh *et al.*, 2012)^[33]

$A = 100 - (\text{miss index} + \text{multiple index})$ the readings were taken for a run of 3m on conveyor belt. The sticky belt method is performed at three different speeds i.e. 2.5 km/h, 3 km/h and 3.5 km/h. At each speeds the test is performed at three times and observations are recorded. The observations of seed spacing between the seeds delivered on sticky belt by seed metering mechanism were recorded to study the parameter.

C) Effect of forward speed on seed uniformity

The seed uniformity is get affected by the variation in forward speed as the speed increase the vibrations get increased. For forward speed 2.5 km/h, 3 km/h 3.5km/h, the uniformity is found to be 88.3 %, 100%, 68.86%. As the uniformity is more at speed 3 km/r, the field trials are performed at 3 km/h. As speed increased uniformity decreases more rapidly, as speed decreases uniformity decrease slowly.

D) Coefficient of variation (CV)

The observations of seed to seed spacing are taken for a run of 4 m on sticky belt and standard deviation, coefficient of

variation is calculated. Coefficient of variation (CV) is a mathematical equation used to measure the precision of seed placement. The seed to seed spacing observed for a run of 4m on sticky belt at a speed of 3 km/h are (in cm) resp. as follows:

15, 16, 15, 15.5, 14, 14.5, 14.5, 14, 13.5, 14.5, 15.5, 15, 15.5, 14, 14.5, 15, 15.5, 16, 15.5, 15, 14.5, 15.

From these observations, the standard deviation is found to be 0.779. More specifically, CV is the standard deviation of seed spacing divided by average seed spacing.

$$CV = \frac{\text{Standard deviation of seed spacing (variation between seeds)}}{\text{average distance between seeds}}$$

i.e.

$$CV = \frac{0.779}{15} = 0.051$$



Fig 8: Measurement of spacing's.

1) For forward speed 2.5 km/h

Table 1: Result of sticky belt method at a forward speed of 2.5 km/h.

Sr. No.	Trials	Trial 1	Trial 2	Trial 3	Mean
1)	Miss index, %	4.5	4.5	4.5	4.5
2)	Multiple index, %	4.5	4.5	13	7.3
3)	Quality feed index, %	91	91	82.9	88.3

2) For forward speed 3 km/h

Table 2: Result of sticky belt method at a forward speed of 3 km/h.

Sr. No.	Trials	Trial 1	Trial 2	Trial 3	Mean
1)	Missing index, %	00	00	00	00
2)	Multiple index, %	00	00	00	00
3)	Quality feed index, %	100	100	100	100

3) For forward speed 3.5 km/h

Table 3: Result of sticky belt method at a forward speed of 3.5 km/h.

Sr. No.	Trials	Trial 1	Trial 2	Trial 3	Mean
1)	Missing index, %	16.66	15	42	24.55
2)	Multiple index, %	5.55	00	14.2	6.58
3)	Quality feed index, %	77.79	85	43.8	68.86

Table 4: Effect of forward speed on seed uniformity:

Sr. No.	Speed / index	2.5 km/h	3 km/h	3.5 km/h
1)	Missing index, %	4.5	00	24.55
2)	Multiple index, %	7.3	00	6.58
3)	Quality feed index, %	88.3	100	68.86

3.2: Field Test

The field trials of the developed planter were conducted during rabbi season of year in the well prepared field near, Dr. PDKV, Akola. The field was well prepared using rotavator. The tests were conducted for sowing of chickpea (Jaki 9218) During the field test, the three field trials of

sowing are taken to get the more accurate results. During the field trial the planter was operated at optimized combination of forward speed of 3.0 km/h as more quality feed index is obtained during laboratory test. Before the field trials, the independent parametrs such as shape and size of field, type of soil, moisture content of soil, bulk density of soil are recorded before trials. The overall performance of the machine was evaluated on the basis of field capacity, field efficiency, fuel consumption.



Fig 9: Field Trials on research field, Dr. PDKV, Akola

**Fig 10:** Measurements in field trials

Performance evaluation of tractor drawn planter for chickpea (Jaki 9218)

Table 5: Results of field performance evaluation of planter. (chickpea Jaki 9218)

Sr. No.	Parameter	Trial 1	Trial 2	Trial 3	Average
1.	Type of soil	Black cotton soil			
2.	Soil moisture content, %	11.71			
3.	Bulk density of soil g/cc	1.66			
4.	Row spacing, cm	45			
5.	Mean seed spacing, cm	15.72	15.1	14.86	15.22
6.	Coefficient of uniformity %	86.07	89.3	90.8	88.71
7.	Depth of seed placement, cm	6.9	6.8	6.5	6.73
8.	Theoretical field capacity, ha/h	0.564	0.619	0.595	0.592
9.	Effective field capacity, ha/h	0.429	0.482	0.491	0.467
10.	Ground wheel slippage, %	3.67	3.46	3.55	3.56
11.	Tractor wheel slippage, %	8.4	5.7	5.8	6.63
12.	Field efficiency, %	76	77	82	78.33
13.	Draft, kgf	0.305	0.317	0.315	0.312
14.	Fuel consumption, l/ha	5.970	5.828	5.115	5.637
15.	Fuel consumption, l/h	2.56	2.32	2.51	2.46
16.	Missing index, %	2.00	1.05	0.00	1.01
17.	Multiple index, %	2.00	0.00	0.00	0.66
18.	Quality feed index, %	96	98.95	100	88.31
19.	Seed rate, kg/ha	45.95	44.20	49.50	46.55
20.	Seed rate, kg/acre	18.60	17.89	20.04	18.84
21.	fertilizer rate, kg/ha	80.37	83.69	85.90	83.32
22.	fertilizer rate, kg/acre	32.53	33.88	34.74	33.71
23.	Cost of operation, Rs /h	232.2	210.4	227.7	223.4

3.3 Cost of tractor drawn multi crop planter

Table 6: Fabrication cost of tractor drawn multi crop planter.

Sr. No.	Components	quantity	Rate (Rs)	Total price (Rs)
1	Hand push seeder	5	6000	30000
2	Square pipe	3 pieces	2800	8400
3	Hard MS Flat	2 pieces	2500	5000
4	Leveller	1 piece	1100	1100
5	Iron sheet	1 piece	3400	3400
6	Sprocket	3	330	990
7	Chain	9 feet	130rs per feet	1170
8	Pipes	30 feet	23 rs per feet	690
9	Nut and bolts	24 U- bolt	35	840
10	Fabrication cost	-	-	12000
Total				63590

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