Print ISSN : 0972-8813
e-ISSN : 2582-2780

[Vol. 20(3), September-December, 2022]

Pantnagar Journal of Research

(Formerly International Journal of Basic and Applied Agricultural Research ISSN : 2349-8765)

G.B. Pant University of Agriculture & Technology, Pantnagar

PANTNAGAR JOURNAL OF RESEARCH

Vol. 20(3) September-December, 2022

CONTENTS

Comparative analysis of Traditional Method and Mechanical Method of Cotton Sowing

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ABSTRACT: Cotton (*Gossypium hirsutum* L.) is an important commercial crop that contributes virtually 80 per cent of raw material to textile industries. Initial stages of cotton cultivation i.e., sowing of cotton seeds involve large manpower (15%) and are tedious, causing fatigue, backache, high investment cost and energy consuming operation. A comparative study was conducted for combined operation of sowing of cotton seeds and fertilizer placement between mini tractor (25 HP) operated cotton planter cum fertilizer applicator developed at JAU, Junagadh and traditional method i.e., using farm labour and machinery. The performance of cotton planter cum fertilizer applicator for combine operation showed better outcome as compared to traditional sowing and fertilizer application method. The field efficiency for the mechanical method was observed as 84.52 % at an operating speed of 2.5-2.8 km/h. The field experiment revealed the comparative parameter viz., operational time, energy consumption and operational cost were found to be4.69 man-h/ha, 249.02 MJ/ha and ₹1215.13/ha, respectively, which was significantly less when compared withthe traditional cultivation method.

Key words: Cotton,cotton planter,fertilizer application, field evaluation, traditional

Cotton (*Gossypium hirsutum* L.) is an important commercial crop of our country and contributes virtually 80 per cent of raw material to our textile industries i.e., the second largest employer after agriculture sector. India has the distinction of having the largest area under cotton cultivation which is about 42% of the world area under cotton cultivation between 12.5 million hectares to 13.5 million hectares. India is one of the largest producers of cotton in the world accounting for about 26% of the world cotton production. The yield which is presently 459 kg/ha, still it is less against the world average yield of about 757 kg/ha (Anon., 2021).

By adopting mechanization in the required areas of agriculture, timely operations with reduced drudgery and cost of cultivation can be achieved. The mechanization raises agricultural productivity, increases profitability and also improves quality of life of farming community. In dryland areas of central India, cotton farmers still use traditional farm implements that have low field capacity and demand lot of energy.

Several operations like planting, weeding and picking are labours intensive and during these operations shortage of labours frequently occurs. The delay in completion of operations leads to a loss of yield. Cotton yields increased significantly as a result of mechanical sowing. Consequently, despite the time and seed rate advantages, mechanical sowing by planter/drill should be suggested (Sheikh and Gadir, 2005).

Cotton is being traditionally sown by hand dibbling or using manual dibblers. Two seeds per hill are dibbled in lines at a depth of 30-50 mm, keeping the required spacing between the rows and plants. Even currently this method of sowing of cotton is being carried. In the initial stages of cotton cultivation, sowing and pre-fertilizer application involves large man power (15%), which is second after harvesting (44%). Moreover, the traditional planting method is tedious, causing fatigue and high investment cost and energy consumption in the form of farm workers and fuel due to the longer hours required for the combine action (Vaiyapuri, 2004).

Cotton plant has the slowest early growth and the lowest initial nutrient uptake, which increases rapidly afterwards. Approximately, the uptake of 76% of total N, 86% of P and 82% of K take place in cotton between 49-99 days after planting (Schwab *et al*., 2000). Cotton has primary taproot structure with many laterals root, branch root, etc. Approximately 58-71%, 30-40% and less than 2% of total cotton growing roots are located in the top 20, 20-40 and below 40 cm soil depth, respectively (Reddy *et al*., 1997). Therefore, major focus on fertilizer placement between 10-20 cm depth should be given.Broadcasting of fertilizers, especially P and K, causes fixation problems due to more soil contact. Only 20 to 30% of P and K fertilizers are effectively used by crops, while the remaining gets fixed within the soil as per the properties of their contents (Olsen *et al.,* 1971; Rowse and Stone, 1980).

The application of fertilizers using planters and seed-drills is more effective, but the application of fertilizers even by these methods does not distribute fertilizers evenly as per the need of crop roots. Deep placement in band is also a similar and advanced practice to the concept of applying fertilizer within intended root zone (Nathan *et al*., 1990). Sharma and Pannu (2013) revealed in the field experiments at two different locations that placement of 70 % and 30 % of the recommended dose of fertilizer at 10 and 20 cm depths, respectively, showed significantly higher seed cotton yield (2.74 t/ha) than manual broadcasting of fertilizer (2.30 t/ha).

Raghavendra *et al.* (2013) developed and evaluated tractor operated ridge planter. The average draft and fuel consumption of the planter was 2300 N and 3.83 l/hr respectively. The field capacity of the planter was 0.89 ha/hr with field efficiency of 73.55 per cent. The cost of operation of ridge planter for sowing cotton was found to be 433 Rs/ha compared to 1013 Rs/ha for conventional method. Sanjaykrishnan (2018) developed a mini-tractor drawn multi crop planter with adjustable inclined plate metering mechanism. Author evaluated the developed planter with castor, cotton, and pigeon pea seeds in the laboratory test as well as in field tests. The effective field capacity was found to be 0.52, 0.51 and 0.57 ha/h for castor, cotton and pigeon pea seeds, respectively. Average field efficiency observed was 72.78 %.

Fig. 1: Sowing and fertilizer application simultaneously in mechanical method

The present research work was, therefore, conducted to study the comparative analysis of mechanical method with traditional method for combined operation of sowing and fertilizer application in cotton cultivation.

MATERIALS AND METHODS

The field evaluation was conducted on research plot of Educational & Research Farm, Dept. of S.W.C.E., Junagadh Agricultural University, Junagadh. The plot size of (36 ×30 m) 0.108 hectare was selected and different field data were taken on it. The performance parameters of planter such as speed, field capacity, field efficiency and draft requirement were observed.

The comparative performance evaluation of developed mini-tractor operated two row cotton planter cum fertilizer applicator and traditional method of cotton cultivation was carried out as shown in Fig. 1 and 2, respectively. The test results like time requirement, energy consumption, labour requirements and cost of operation were compared.

Mechanical Method

A mini tractor operated two row cotton planter cum fertilizer applicator was used for simultaneously sowing and fertilizer application in the experimental field as shown in Fig. 1 and its effect on combine operation was recorded for the determination of operational time, energy consumption and cost of operation.

Traditional Method

In traditional method, which is beingfollowed by the farmers involves sowing of cotton seeds manually with the help of farm labours 10-12 days after the fertilizer application in the field using broadcasting technique or with the help of tractor drawn seed cum fertilizer drill upto the depth of 8-10 cm in fieldas in shown in Fig. 2.

Performance parameters studied for both the methods under this study are as follows:

Operational Time

The value of operational time per hectare for both the cultivation methods, were calculated using area of experimental plot and the time taken for the operation in particular method.

EnergyConsumption

Energy consumption for sowing and fertilizer application will be calculated by standard energy consumption for tractor in MJ/h. The mechanical energy utilized in mini-tractor operated cotton planter cum fertilizer applicator was evaluated by the following formula (Umar, 2003). It was calculated by following formula:

$$E_f = 47.78\,D \qquad \ldots(1)$$

Where,

E_f = Fuel (diesel) energy expended, (MJ/h);

47.78 = Unit energy value of diesel, (MJ/l);

D = Amount of fuel consumed, (l/h);

The human energy utilized in sowing operation in the field for developed planter cum fertilizer applicator was evaluated using following formula (Chaudhary *et al.*, 2006).

Fig. 2: Sowing and fertilizer application in traditional method

E_m=1.96 $N_m \times T_m$ (2)

Where,

E_m = Manual energy expended (MJ/ha);

N_m = Number of labours utilized;

T_m= Useful time spent by a labour (h/ha);

So, Total energy consumption of the machine was calculated by adding manual energy expended and fuel energy consumed which is given as follows:

$E = E_f + E_m$ (3)

Where,

E = Total energy consumption (MJ/ha);

E_m = Manual energy expended (MJ/ha);

E_f = Fuel energy expended (MJ/ha);

Operational Cost

Cost analysis was made for estimating the cost of different operations. The fixed and variable costs were taken into consideration to estimate the cost of operations. Straight line method of cost analysis (to find depreciation cost) was adopted.

Cost analysis was made for estimating the cost of different operations.The fixed and variable costs were taken into consideration to estimate the cost of operations. Straight line method of cost analysis (to find depreciation cost) was adopted. The following variables were considered in determining the cost of operation. Accurate cost estimates play an important role in every machinery management decision namely when to trade, which size to buy, how much to buy, etc.

Fixed Cost:Fixed costs of a machine include depreciation, costs of interest, taxes, insurance and shelter. Depreciation is usually the largest component of machines total costs. It measures the amount, by which the value of a machine decreases with time, whether it is used or not (Hunt, 2001).

Table 1: Energy consumption in sowing using planter cum fertilizer applicator

Sr. No.	Forward Speed (km/h)	Depth of fertilizer placement (cm)	Total energy consumption (MJ/ha)
1.	2.5-2.8	10	259.94
		15	338.74
2.	2.9-3.2	10	211.92
		15	285.15
3.	3.3-3.6	10	171.43
		15	226.94
4. Average energy consumption (MJ/ha)			249.02

Assumptions:

Average annual use = 100 h

Life of machine = 10 years

Salvage value = 10% of initial cost

Rate of interest @ 12 % of capital cost

Taxes, housing and insurance cost @ 3 % of the initial investment per year

Depreciation: It means a loss in the value of a machine owning to time and use. Often, it is the largest of all costs. In the straight-line depreciation method, an equal reduction of value is used for each year the machine is owned. Useful life of planter was considered as 10 years and use 100 h per year. The annual depreciation value can be calculated from the following expression.

$$D = \frac{(p - s)}{(L \times H} \quad \ldots(3.46)$$

Where,

D = Average annual depreciation, ₹/h;

P = Purchase price, ₹;

S = Salvage value, ₹;

L = Life of machine, years and

H = Annual use of machine, h

Interest on investment: In the agricultural machinery management interest is the secondary largest item of expanses. The interest is calculated on the average value of the machine.

$$I = \frac{(p + s)}{2} \times \frac{i}{100} \quad \ldots(3.47)$$

Where,

I = Interest on investment, ₹;

P = Purchase price, ₹;

S = Salvage value, ₹; and

i = Rate of interest

Taxes, housing and insurance: The values of taxes, housing and insurance is considered as 3 % of the

Table 2: Energy consumption in traditional method of sowing

Sr. No.	Time for manual sowing (h/ha)	Energy consumption in manual sowing (MJ/ha)	Time in fertilizer application (h/ha)	Energy consumption in fertilizer application (MJ/ha)	Total energy consumption in traditional method (MJ/ha)
1.	8.02	157.19	2.51	301.20	458.39
2.	7.55	148.07	2.45	289.11	437.18
3.	7.59	154.41	2.55	310.97	465.38
4.	Average energy consumption (MJ/ha)				453.28

Table 3: Operational cost of sowing using planter cum fertilizer applicator

Sr. No.	Speed (km/h)	Depth of operation (cm)	Cost of operation (₹/ha)
1.	2.5-2.8	10	1130.60
		15	1215.13
2.	2.9-3.2	10	1019.31
		15	1111.29
3.	3.3-3.6	10	902.24
		15	1003.59

initial investment.

Variable Cost**:** The variable costs of a machine as it names suggests vary with its use and they are expressed as costs per area worked or hour of operation. They are divided into maintenance and repair costs and labour cost.

Assumptions:
Labour cost per day = ₹ 350 / person
Repair and maintenance cost @ 5 % of initial investment per year.

The total cost of operation was determined as the sum of fixed and variable cost. The total cost of operation per hour of machine operation was calculated. The total cost of operation in terms of rupees per hour and rupees per hectare for the planter was determined.

Similarly, the cost of operation of fertilizer application in traditional method was determined using the above method and cost of manual sowing was calculated separately. The total operational cost in traditional method was obtained by adding the cost of both the operations.

RESULTSAND DISCUSSION

The results obtained during field performance evaluation of developed cotton planter cum fertilizer applicator were compared with that of traditional method in terms of operational time, energy consumption and cost of operation.

Operational Time

The maximum value of operational time is 63.95 man-h/ha for traditional method whereas the minimum value of operational time is 4.69 man-h/ha for mechanical method using developed planter as shown in Fig. 3. Operational time for developed planter is found to be 89.85% less than that of traditional method, respectively. Selection of mechanical method upon traditional method with respect to operational time should be preferred.

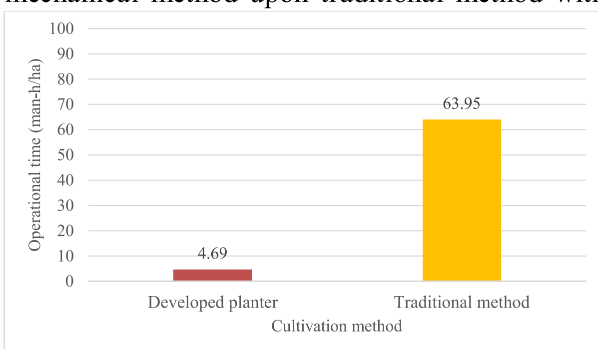


Fig. 3: Graphical representation of operational time of mechanical and traditional method

Energy Consumption

The average value of energy consumption is 453.28 MJ/ha for traditional method whereas the average value of energy consumption is 249.02 MJ/ha for mechanical method using developed planter given in Table 1 & 2. Energy consumption for developed planter is found to be 45.06 % less than that of traditional method, respectively, shown in Fig. 4.

Operational Cost

The cost of operation is found to be the highest for traditional method followed by developed planter,

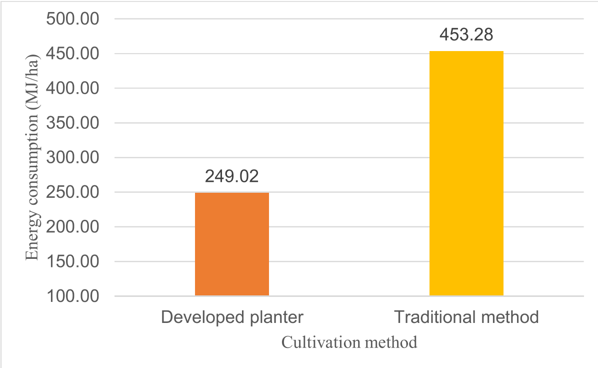
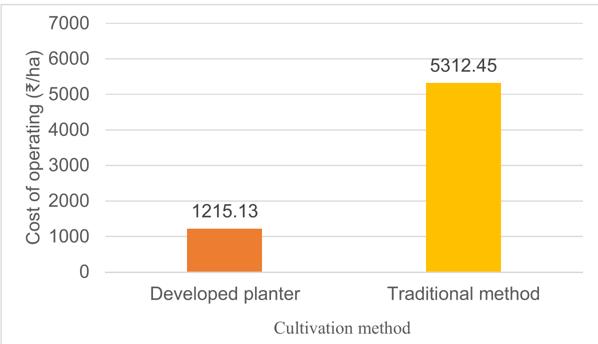


Fig. 4: Graphical representation of energy consumption of mechanical and traditional method

respectively. The maximum value of cost of operation is 5312.45 ₹/ha for traditional method whereas the minimum value of cost of operation is 1215.13 ₹/ha for developed planter as given in Table 3. Cost of operation for developed planter is 77.13 % less than that of traditional method because cost of operation for developed planter mainly depends



on the fuel cost.

Fig. 5: Graphical representation of operational cost of mechanical and traditional method

Since, traditional method gives less effective field capacity and more cost of operation, energy consumption and time of operation, than mechanical method using developed planter. Therefore, observations of the study showed that mechanical method is better than traditional method of cotton cultivation.

CONCLUSION

Indian agriculture is still dealing with a serious labour shortage specially during the peak periods of farm operations like sowing, harvesting, etc. In India, mechanization of agriculture should be focused mainly for small and medium land holding farmers as they hold maximum percentage in country's agriculture. So, as the overall performance of the planter cum fertilizer applicator used in mechanical method was found satisfactory and significantly better than traditional method for combine operation of sowing and fertilizer application in case of cotton cultivation. The mechanical method is technically viable and has great potential for adoption in cotton cultivation. Comparative analysis of both the methods indicated that adaptation of mechanical method using developed implement over traditional method would be more economically feasible and beneficial for farmers and also increase the level of mechanisation in cotton cultivation.

ACKNOWLEDGEMENTS

This research study was conducted as a part of the Master degree program of the first author at Department of Farm Machinery and Power Engineering, C.A.E.T., Junagadh Agricultural University, Junagadh (Gujarat). The authors are thankful to the Indian Council of Agricultural Research (ICAR), New Delhi and Junagadh Agricultural University for providing all the necessary facilities during the course of the study. The first author is deeply thankful to Prof. A. L. Vadher for his valuable guidance, suggestions and critical reviews during complete period of study.

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Received: October 17, 2022
Accepted: December 7, 2022