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Garlic planting machineries

■ **Smita N. Solanki, S. H. Thakare and R. T. Ramteke**

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See end of the Paper for authors' affiliation

Correspondence to :

Smita N. Solanki
Department of Farm Power and Machinery, College of Agricultural Engineering and Technology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, **Akola (M.S.) India**
Email : smitansolanki@yahoo.com

■ **ABSTRACT :** Mechanization ensures timely farm operation that brings numerous benefits to garlic growers apart from increased crop yield. Among various farm operations performed in onion and garlic cultivation only land development and bed making has been successfully mechanized. Semi-automatic transplanters have been successfully demonstrated but its adoption by farmers has been very limited. There is need to further refine these transplanters for more precision and accuracy and develop automatic transplanters to reduce the labour cost. Intercultural, fertilizer application, plant protection are some of the operations in onion and garlic cultivation, which needs immediate attention for mechanization, Tractor operated garlic planters are being widely used by large farmers. Harvesters and diggers for onion and garlic are still to be adopted by farmers at a large scale. In onion and garlic cultivation, mechanization is mainly limited to the land preparation machines and to some extent planting machines. Other machines to mechanize the operations like transplanting, intercultural, harvesting/digging, which involve a lot of human drudgery when performed manually, need to be developed, demonstrated and popularized amongst the garlic growers. This paper briefs about the current status of development of different types of machines useful for garlic cultivation and expected to be useful for mechanization in garlic cultivation in order to facilitate garlic cultivating farmers.

■ **KEY WORDS :** Metering device, Mechanization, Garlic, Planter, Drill planter

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Garlic (*Allium sativum* L.) is the second important bulb crops grown after onion and contributes 14 per cent of world area and 5 per cent of production. India, although ranks second by area and production, is the lowest as far as productivity is concerned (5.29 t/ha). Over last 25 years the production of garlic has increased to 2.16 to 8.34 Lakh tons. The productivity of garlic is far low (5.43 t/ha) as compared to Egypt, USA and China. Though the Madhya Pradesh is highest garlic producing (270000 MT) state covering area 60000ha, but the productivity (4.5 t/ha) is very low, whereas area of garlic in Maharashtra (3500 ha) is very less but the productivity (11.43 t/ha) is extremely good.

Sowing techniques and type of seeding machines play an important role in seed placement and seedling emergence which ultimately affect crop growth and grain yield. The selection of suitable planting methods is dependent upon the time of planting, irrigation methods, amount of residue in the field and type of planting machines. Crop establishment using bed planting system is a new technique in the farming system. The recent trend is to develop a set of improved implements for different ecological regions and major crop rotations to facilitate adoption of advanced technology of farming and to overcome its timeliness constraint.

Manual planting is labour intensive and require 543

Cell type | Cup type | Spoon type

Fig. 1 : Commonly used metering mechanisms in garlic planter

man hr/ha sowing by manually planter demand 166-170 man hr/ha. There is acute shortage of manpower availability in the farmer's field during season. These factors have imposed a limitation on the size of farms, they should not be larger than 0.96 hectare per household. This limitation subsequently curtails the possible production output. Furthermore, farmers have a limited time frame in which to prepare the soil so that it has sufficient moisture for planting. This activity requires substantial manpower for planting the garlic cloves before the soil dries up. The shortage of labour is again a factor to limiting the farm size to be not larger than 0.96.

Following are different types of machines useful for garlic cultivation and expected to be useful for mechanization in garlic cultivation in order to facilitate garlic cultivating farmers.

Magar and Tiwari (2017) reported the following machines for planting of garlic manually involves very high labour (56-62 man-days/ha). Moreover, due to non-availability of labour, sowing gets delayed, which leads to reduction in yield. Therefore, under mentioned machines developed for planting of garlic may be helpful for planting of garlic. These machines are frequently equipped with either of the metering mechanisms presented in Fig.1.

Falcon garlic planter*:*

It is a light weight single row garlic planter (Fig. 2). Easy to use and can be used to drill other seeds like soybean, sunflowers, rapeseed etc.

Gajakos *et al.* (2015) designed manually operated garlic planter and it comprises, main frame, seed box, metering mechanism, ground wheel with lugs, adjustable

Fig. 2 : Falcon garlic planter

furrow opener and seed tube, covering bracket and marker. The field evaluation of manually operated garlic planter was undertaken. The weight of unit without cloves is 12 kg. Two persons are required for operating the planter. One person require for pulling the implement in forward direction and another for direction control. The laboratory and field test were conducted for the evaluation of the planter. The field test was done for calculating the field performance in terms of field efficiency and missing hills percentages. This planter was also tested for cost of operation and depth of placement of cloves, missed hill percentage and ground wheel slippage. Result shows that the field efficiency was 84.79 per cent. The cost of operation was found to be Rs.1214 /ha, depth of placement of cloves was 4-5 cm. Time required and cost of sowing by planter was effectively less than manual sowing. Yield and returns of planter were found to be more than

Fig. 3 : Manually operated garlic planter

manual sowing.

ICAR-CIAE bullock drawn garlic planter:

To introduce cultivation of garlic crop on a large scale at the level of small and marginal farms especially in animal dominated areas, animal drawn three-row garlic planter (Fig. 3) was developed by ICAR-CIAE, Bhopal (Kumar *et al.*, 2015). The planter is suitable for planting the garlic at depth range of 25-40 mm. The field capacity of the machine is 0.13 ha/h at an average operating speed of 2.5 km/h. The draft and labour requirement are 425 N and 13 man-h/ha. The operating cost of the machine is Rs. 725/ per ha.

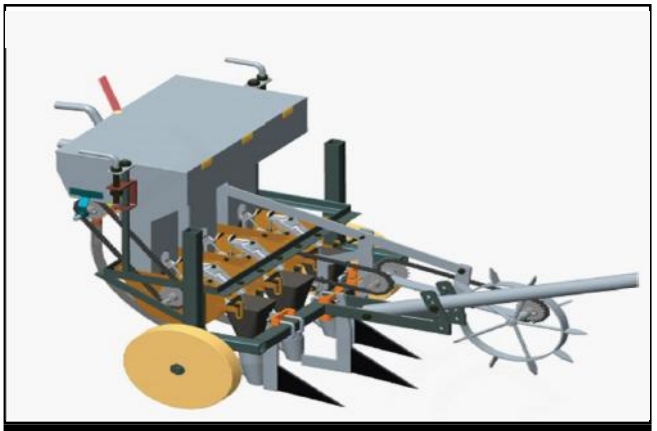

Fig. 4 : ICAR-CIAE bullock drawn garlic planter

Tractor drawn garlic planters:

Many manufacturers are manufacturing garlic planters using different metering mechanisms as shown in Fig. 1. Some of these machines with the manufacturers of tractor drawn garlic planters are shown in Fig. 4, 5 and 6.

Power operated garlic planter:

Tractor-operated garlic planter has been developed by MPUAT, Udaipur centre. It is provided with star wheel type seed and fertilizer metering mechanism. The two-row paired hopper and adjustable seed rate are the main features of 12-row unit which has minimum row spacing of 150 mm. The observed seed rate during testing varied from 500 to 700 kg/ha mainly dependent on size of garlic cloves. The spacing of garlic cloves ranged from 50 to 100 mm. The field capacity, field efficiency and cost of planting were 0.35 ha/h, 70 per cent and Rs. 1,300/ha, respectively. Tractor-mounted garlic planter. The observed seed rate during testing varied from 500 to 700 kg/ha depending on size of garlic cloves.

Praditsuwan *et al.* (2007) designed and develop a garlic planter installed with 5 hp engine power tiller.

Seth Agro Industries, Yeshwant Plaza, Indore, MP Orange Tractors, Kanad, Shajapur, MP Shree Gujrati Engineering Works, Ujjain, MP

Fig. 5 : Tractor drawn garlic planters

Fig. 6 : Self - propelled garlic planter

Fig. 7 : Tractor operated MPUAT, Udaipur garlic planter

Fig. 8 : Tractor mounted garlic planter in operataion

Spacing between cloves and row are 10 cm. The developments of metering systems were aimed at the least seed damage and the accuracy of seed spacing.

The most impressive model was 8-row garlic planter with a plastic bucket disk metering system. The bucket disk with 6 triangular plastic buckets located at the peripheral disk. Each bucket has 80 degree scoop angle. The furrow opener of planter is shoe type. In laboratory test, it was found that the appropriate speed of the power tiller engine was 1300 rpm at gear number 1. In field test, the best land preparation is 1 travel of rotary tiller. The average forward speed of planter is 1.68 km/hr whereas its field capacity is about 1.08 ha/day and average seed spacing is about 11.73 cm. Moreover, the average percentage of slip is found to be 10.36 while the percentage of the germination and average yield are found to be 74.57 and 13,856 kg/ha, respectively. The economic analysis have shown that the breakeven point of this planter is approximately 0.32 ha.

Specification of the 8 rows garlic planter

Dimension (W×L×H)	1300× 1600×1000 mm.
Method of planting	Single seed drill with cloves spacing,10 cm.
Type of power	5 HP engine power tiller
Weight(included power tiller and engine)	200 kg
Volume of hopper	15kg of garlic cloves
Type of metering system	Bucket disk type
Type of furrow opener	Shoe type (V-shape furrow)
Covering device	Scraper
Working width	0.8 m.
Working velocity	1.68 km/hr
Field capacity	1.06-1.09 ha/day

Fig. 9 : Garlic planter with 5 HP engine power tiller

Kumar *et al.* (2017) studied the performance of a garlic planter in Uttar Pradesh. This study followed research after the 3 types of garlic planter was fabricated in 2001 which included, inclined metering plate garlic planter, vertical metering plate garlic planter and spring plate garlic planter. In this study, 2 model were constructed which included, vertical metering plate with triangular grooves and bucket type garlic planter. The broken percentage was very low, about 0.25 per cent. The new prototype garlic planter had 10 rows and was attached to 5 HP power tiller. The garlic planter was

tested under actual field conditions and results indicated that the optimum width of garlic planter was 0.9 meter or 9 rows. The suitable soil condition was dry soil. Farmer should apply water after planting. The maximum forward speed was 3 km/hr and wheel skid was high about 24.34 per cent. The average depth and width of planting was 2.65 cm. and 4.68 cm. Time for turning at head land was 39 seconds. The field capacity was 0.32 ha/hr and there were three operators. Hence, the capacity of planter was 0.84 ha./man/day.

The same type of work was reported by Jarudchai *et al*. (2002) for 12 – row garlic planter
Specification of 12 row garlic planter
Dimension (W x L x H) : 1250 x 925 x 705 mm
Bare weight: 150 kg

Fig. 10 : Twelve row garlic planter

Bakhtiari and Loghavi (2009) developed a garlic clove precision planter. In this study an innovatively designed tractor-mounted, ground-wheel driven, triple unit, row crop precision planter capable of planting three rows of garlic (*Allium sativum* L.) cloves on each raised bed was designed, fabricated and tested. The major components of this planter include; chassis and transport wheels, lister-bedder unit, seed hopper, seed metering drum, sweeper, knocker, seed tube, furrow openers and seed coverers. The metering drums and sweepers are driven by two ground wheels through a chain drive system. Laboratory evaluation of the planter components, especially the seed metering mechanism revealed a satisfactory performance of the planter components, except a few modifications which were needed before conducting field tests. The performance parameters measured/calculated during the field tests included: seeding mass rate, seeding depth, seed spacing, miss index, multiple index and seed damage. The results showed that the new machine is capable of planting 220,000 plants per ha at the seeding depth and spacing of 12.3 and 22.7 cm, respectively. Also, miss index, multiple index and seed damage were measured as 12.23, 2.43 and 1.41 per cent, respectively.

Table 1: Technical specifications of the garlic clove planter developed in this study

Parameter	Units	Specification
Planting width	cm	180
Raised beds	Number	3
Plant rows on each bed	Number	3
Furrows	Number	4
Bed shapers	Number	2
Row spacing on each bed	cm	10
Nominal plant spacing on the row	cm	22
Furrow spacing	cm	60
Furrow width	cm	18
Sowing depth	cm	5-15 (adjustable)
Type of furrow opener		Shoe-type
Seed hopper capacity	kg	200
Planter weight (empty)	kg	530
Hitching type		3-point hitch

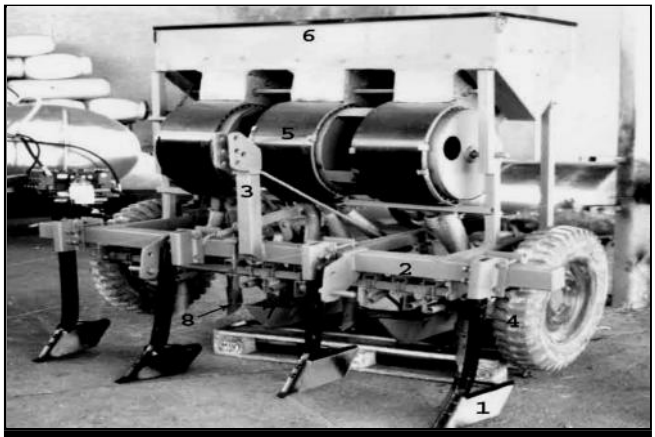

Fig. 11 : Actual picture of the garlic planter (front view): (1) Furrower; (2) Chas- sis; (3) Three- point hitch mast; (4) Ground-driven wheel; (5) Metering drum, (6) Seed hopper

Benjaphragairat *et al*. (2010) design different types of furrow openers for garlic planting. This research has focused on increasing the planter capacity by reducing the draft of the planter, increasing the field efficiency by

increasing the optimum number of rows and increasing the uniformity of the seed. For the10-row garlic planter, the test results obtained from the farmer's field were based on the following criteria: working speed 1.68 km/h, height of the seed delivery tube above ground level 30 cm, which was the lowest variation. The field capacity was 0.13ha/man-h and plant spacing was 11.73 cm. The percentage of slip was 10.36 per cent. The furrow opener is a shoe type, placed in two lines with spacing of 250 mm between the lines. It gave a constant draft force of about 1.05 kgf/row. The percentage germination was 74.57 per cent. The average yield was 26,919 kg/ha, whilst the average yield of planting by the farmer was 30,419 kg/ha. The precision value for human planting was 20.93 per cent while the 10-row garlic planter was 21.0 per cent, on average.

Francisco *et al.* (1990) developed a new garlic seeder using a conveyor lug belt as a clove distribution system. Two sprocket wheel combinations 46:17 and 46:26 were used on the machine performance evaluation. For both sprocket wheel ratios the garlic clove distribution on the soil were practically the same. The percentage of long spacing (gaps) and short spacing (double cloves) between two cloves was bigger than that obtained by conventional precision drill. The percentage of acceptable spacing hill this drill could have been bigger if the glove size had been more uniform.

Nare *et al.* (2014) designed and developed self-propelled precision garlic planter capable of planting three rows of garlic cloves at a spacing of 10×15 cm. The theoretical seeding rate and seeding mass rate was calculated to 6,66,667 cloves/ha and 0.573 t/ha by taking crop geometry of 10 × 15 cm. The overall length × width × height of the machine is 1,937 × 620 × 922 mm. Twelve elliptical spoons having 180 fitted in round plate of diameter 200 mm were used for metering of cloves. A 3 hp diesel engine was used as prime mover of the garlic planter. The theoretical field capacity (TFC) was calculated as 0.081ha/h, at a speed of 1.8 km/h, whereas, the actual field capacity (AFC) was found to be 0.065 ha/h with field efficiency of 79.84 per cent. It was observed that the placement of garlic cloves were at uniform depth under a range 4.2 cm to 5.2 cm with a minimum SD and CV of 0.33 cm and 6.92 per cent, respectively. The miss index, multiple index and seed damage was found to be only 2.67, 8.0 and 1.46 per cent, respectively, which was within acceptable limit. Operating cost per hour of the machine was calculated

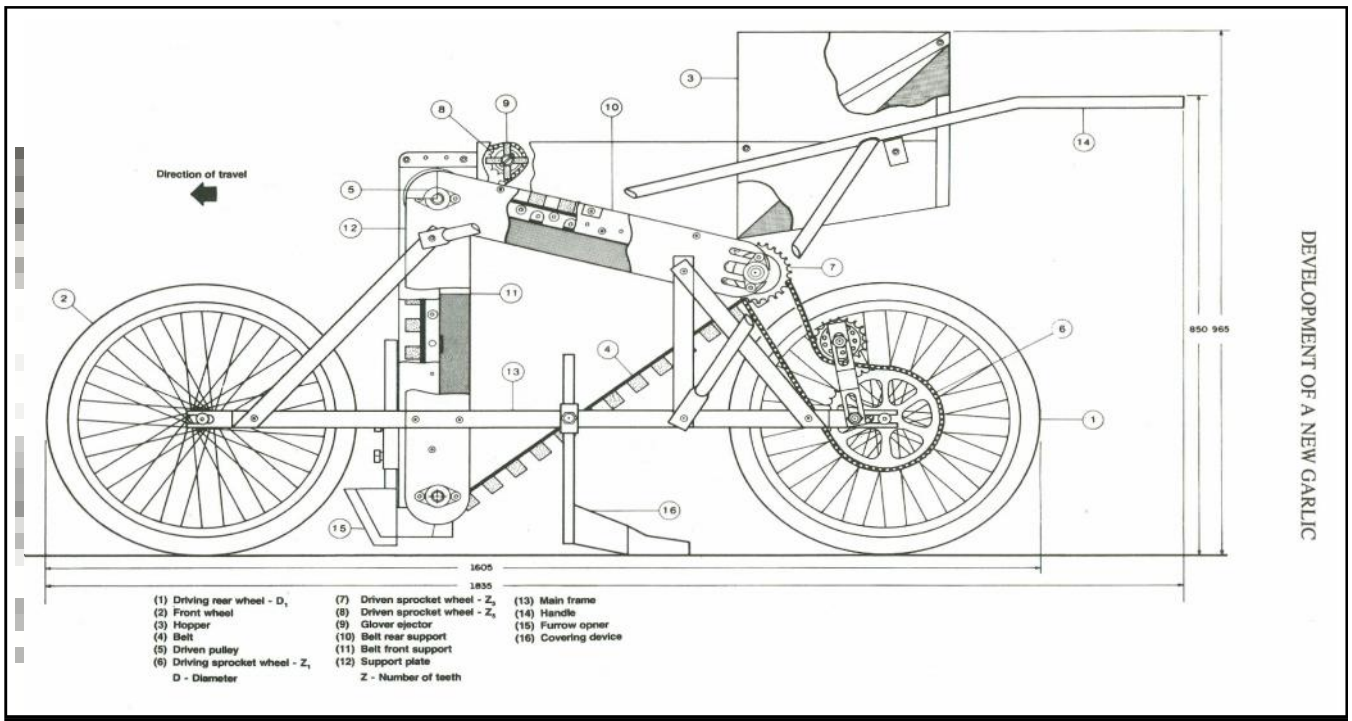

Fig. 12 : Garlic planter using a convey or lug

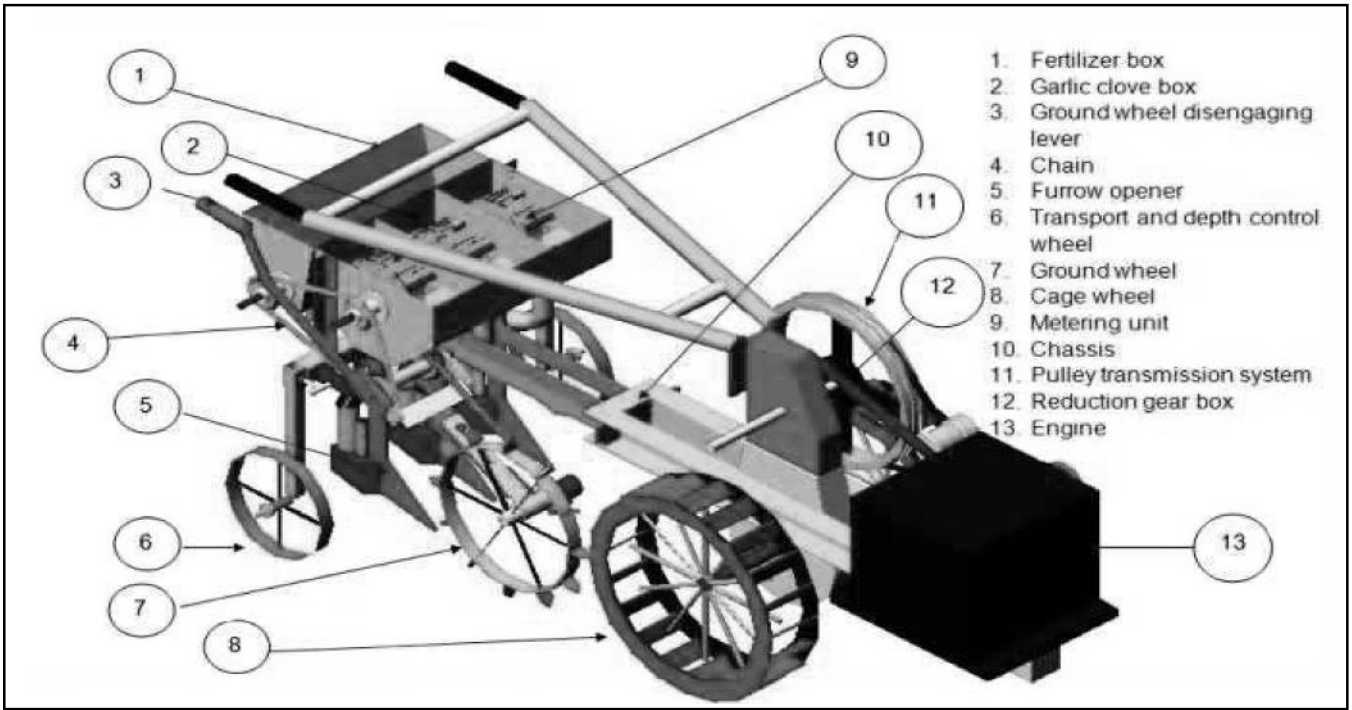

Fig. 13 : Precision 3 row garlic planter

as Rs.151.00/h. For sowing one ha of land the planter required Rs. 2,321.50 per ha which was much more less as compared to manual dibbling method which required 65 man days and required additional of Rs. 2,878.00. Thus, the newly developed machine saves 55.35 per cent of money over traditional methods.

Conclusion:

Due to the lack of appropriate planting, cultivation and harvesting machinery for mechanizing its production, it is still grown in relatively small fields using traditional methods. Also, owing to its nutritional and pharmaceutical values, it has received economic interest worldwide. In recent years, many farmers have shown great interest in garlic plantations. Successful garlic crop with increased yield and better quality can be taken up by using drip irrigation by planting on raised beds also harvesting require less labour and time. Pest attack is also get reduced due to raised bed planting.

This review, therefore, concern the need to improve the precision of the garlic planter, which directly affect the yield and farmers acceptance . This will help to design and develop a tractor mounted precision planter capable of singulating and planting garlic cloves at predetermined depth, row and plant spacing on raised bed.

Authors' affiliations:

S. H. Thakare, Department of Farm Power and Machinery, College of Agricultural Engineering and Technology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, **Akola (M.S.) India**

R. T. Ramteke, Department of Electrical and Other Energy Sources, College of Agricultural Engineering and Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, **Parbhani (M.S.) India**

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