

Need for automation

in vegetable transplanter for Indian agriculture

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Vegetable transplanting is very tedious and labour intensive operation. In India, it is generally done traditionally, i.e. by manually placing seedlings at specified distance and depth. Recent developments in the area of automatic and semi-automatic type vegetable transplanters have shown increased avenues of mechanization possibilities in vegetable cultivation in Indian agriculture. By considering practical use of vegetable transplanting mechanism, it can be concluded that semi-automatic mechanism should be replaced with automatic mechanism due to lower field capacity as well as field efficiency of semi-automatic transplanters. The lower field capacities in semi-automatic transplanter are due to limitations on manual feeding rates of seedling which vary with respect to time and skill of the operator. This article is aimed to highlight the developments in the area of automation in vegetable cultivation in Indian agriculture. It also highlights the need to develop an automatic vegetable transplanter for commercial use to enhance the work output.

Keywords: Automatic, Indian agriculture, Semi-automatic, Transplanter, Vegetable cultivation

VEGETABLE is considered as one of the important food of our day-to-day diet without which the Indian meal is incomplete. Due to this need, the cultivation and production of vegetables is increasing day-by-day. India is second in production of fruits and vegetables in the world contributing 14% of the global vegetable production both in terms of area and production. As per National Horticultural Board, the total area under horticultural crops is 24.19 million hectare (mha) with production of 277.35 million tonnes (mt). More than 70 types of vegetables are grown in India but, vegetables like tomato, brinjal, chilli, cauliflower, cabbage, okra, onion, radish, carrot, garden pea etc are common. Vegetable production in the country increased from mere 16.5 mt (1950–51) to 162.89 mt (2013–14) mainly due to introduction of vegetable hybrids and technological interventions in cultivation practices. India produces 14% of world's vegetable on 15% of

world's area under vegetables and the productivity of vegetables in India is about 17.3 tonnes/ha.

General practice of raising seedlings in nursery or in portray and transplanting of young seedlings in main field are now practiced for vegetables like tomato, brinjal, chilli, cabbage, cauliflower, etc. The transplanting of vegetable seedlings is done manually and accounts for 40% of total working hours of cultivation. The transplanting operation is very drudgerious and laborious as the operation is done in a bending and squatting posture. The labour requirement in manual transplanting of vegetable seedlings varies from 180–420 man-h/ha. As the vegetable crops are very sensitive to higher temperature and require timely operations, the transplanting should be completed as early as possible after removing the plants from the nursery. However, labour shortage during peak season causes delay in transplanting, leading to mortality and reduction in yield.

Raising of vegetable seedling in pro-trays

The vegetable crops like tomato, chilli, cauliflower, brinjal, cabbage are raised on beds in nursery or in portrays in which seeds are dibbled or broadcasted in rows. The 30–40 days old seedlings are usually uprooted and transplanted on raised beds in fields manually. The pro-trays are generally made out of low density polyethylene or plastic material. These cells are either arranged in rows and columns or sometimes arranged in staggered manner to increase the number of seedlings raised per unit area. These pro-trays are generally kept in poly house or shade nets for filling the media, seeding, germination and hardening. The cost of production of raising one vegetable seedling in pro-tray is about ₹0.5–2.0.

Transplanting of vegetable seedlings

Manual transplanting: The vegetable seedlings are transplanted manually with the help of hand tools like spade, shovel or khurpi



Traditional practices of transplanting vegetable seedlings

in field. The traditional practice is to hold a bunch of seedlings/ seedling tray in one hand and separate seedlings by the other hand and press down the roots in the soil with bare hand. However, some hand held tools have been developed by local manufacturers to ease the transplanting operation and to reduce the drudgery involved in manual transplanting method. Few low cost hand held developed vegetable transplanters have field capacity of about 0.02 ha/h.



Tractor drawn semi-automatic vegetable transplanter for vegetable seedlings developed at Punjab Agricultural University, Ludhiana (left) and Maharana Pratap University of Agriculture and Technology, Udaipur (right)

Mechanical vegetable transplanting: Some mechanical vegetable transplanters have been developed in order to reduce

drudgery and labour requirement. These transplanters are semi-automatic type consisting of either pocket-type, cup or bucket-type

metering mechanism that uses bare root or plug type seedlings for transplanting. A mechanical transplanter should perform the following three functions: i) Open the soil in form of narrow furrow; ii) Place seedlings vertically upright in it and; iii) Close and compact soil around it without damaging it. A tractor operated semi-automatic transplanter uses a cone-type or pocket-type metering mechanism that has a rotating plate which opens the cone to drop the seedling by gravity in the furrow made by furrow opener shoe. The soil is compacted around the plants with the help of two inclined press wheels. Whereas in automatic transplanter, seedlings are fed to the delivery unit by an automatic mechanism.



Hand tools for transplanting vegetable seedlings
Source: CIAE Newsletter, 2017

Table 1. Vegetable transplanters with metering mechanism

Type of system	Metering mechanism	Vegetable seedlings
Semi-automatic	Pocket-type	Bare root vegetable seedlings, viz. tomato, brinjal, cauliflower, tomato, chilly, onion, etc
Automatic	Rotary cup-type, Conveyor-type, Linked chain-type	Plug type seedling, viz. chilli, tomato, brinjal, etc
	Linked chain-type	Paper pot seedling, viz. chilli, tomato and brinjal
	Gripper-type or Pincette-type	Plug-type seedling, viz. chilli, tomato, brinjal, etc

Recent trends in the development of automatic transplanters are taking up pace as they can increase the transplanting speed, thereby utilizing the tractor power effectively and reducing the cost of cultivation. The most advanced type of vegetable transplanter uses automatic pick-up mechanism and is mostly controlled with



Automatic vegetable transplanters for vegetable seedlings developed at Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur (left) and Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri (right)

electronics and gear train. This type of mechanism is gaining attention for efficient planting of seedlings and maintaining accuracy, precision and effectiveness in planting them with minimum human intervention. A robotic transplanter for plug seedlings is developed at CIAE Bhopal. Here, seedling pick-up is an important concept, where a single seedling is extracted automatically from the tray with the help of a pair of pins or forks, then discharged into the furrow and again retracted to its starting position. This type of mechanism uses computer graphics or machine vision system and end-effector mechanism for extracting the seedling; gripper and a manipulator; indexing drum-type seedling removal device with ejector, or a pick-up system, planting system and feeding system.



Robotic transplanter for plug seedlings
Source: CIAE Newsletter, 2021

Field capacities, labour requirement and speed of operation

The average field capacity of

the transplanters developed in India ranges from 0.08–0.17 ha/h for tomato, brinjal and chilli crop at a forward speed of 1.0–1.2 km/h, respectively. The semi-automatic transplanters require significant hand labour to feed the seedlings and operate. Saving in labour in the range of 70–93% has been reported for the tractor operated 2-row semi-automatic vegetable transplanters (SVTs) in India. The labour requirement for transplanting seedlings by manual method is reported to range 229–300 man-h/ha for tomato, chilli, brinjal, cabbage and cauliflower seedlings.

Furrow openers

The most commonly used furrow openers for mechanical transplanters are the shoe-type, runner-type and reversible shovel-type. Shoe-type furrow opener has been used in transplanting thin seedlings like onion, whereas shovel-type have been mostly adopted in vegetable transplanters developed in India across different soil types. Most of these have a widened boot to allow passage of vegetable seedling and are tailored to match the shapes of plug seedling cell.

Soil covering and compaction devices

Vegetable seedling needs immediate soil covering and compaction after transplanting. The size of furrow closing cum compaction mechanism should allow narrow row transplanting. The main function is that it should cover the roots of the seedlings with soil completely, and subsequently compact the soil around the seedling

without damaging its leaves, stem and roots. Press wheel is most commonly used soil covering and compaction device for vegetable transplants.

Economic benefits

Major reason of the high cost of operation in semi-automatic transplanters is due to use of prime mover as well as skill labour for feeding the seedling into the delivery unit, which increases the cost of operation significantly. Moreover, most of the time self-propelled/engine equipped transplanters may be the good option for transplanting. The major economic benefits are given below:

- Higher field capacity obtained with increased transplanting rates per person was achieved as compared to conventional method.
- Ensures timeliness of operation during peak season when manual labour is hard to acquire.
- Saving labour requirement of about 70–80% and upto 50% saving in cost of operation can be achieved.
- Leads to reduction in drudgery compared to the conventional method of transplanting.

Way forward

- In India recent developments on vegetable transplanters are still under research phase and need to revitalize their basic designs for reduction in initial costs. Other solutions could be developing automatic innovative technologies which can reduce the operational costs. Another alternative may be establishing a parallel line of mechanization from start of unit operations (like seedling preparation to transplanting), so that conventional practice gets reduced.
- There is large variation in allocation of area under cultivation of vegetables, in that concern solution for large area may not be applicable to all sizes of area. Therefore, technologies based on the small power

sources must be taken up. Once such technology gets developed then it would be easy to multiply them with compatible sources of power to address the large farms. Limitation in semi-automatic transplanters can be addressed by developing a low cost robust automatic seedling extractors for pick-up and placing the devices which could be retrofitted with available semi-automatic transplanters. This would help to substantially reduce the cost of operation and help adopt them.

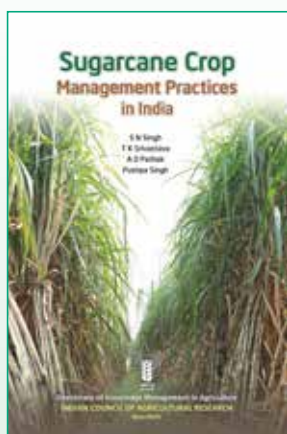
SUMMARY

The developed vegetable transplanters have low field efficiencies. One of the major constraints in increasing vegetable productivity is the low level of mechanization. Manual transplanting on a large commercial scale is labour intensive, expensive, and often does not result in uniform distribution of plants compared with mechanical transplanters. Also, feeding of seedlings to the delivery unit is difficult for bare-root seedlings due to singulation, selection, alignment and manual transfer of seedlings. These suggest an ample

scope of working on automatic metering mechanisms for vegetable seed pickup and drop. Investigations on developing automated seedling feeding mechanisms can increase the transplanting speeds, thereby utilizing tractor power effectively and reduce cost of cultivation. Further research in this direction can lead to research work pertinent to present bottlenecks of adoption of mechanization options available till date.

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Sugarcane Crop Management Practices in India



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TECHNICAL SPECIFICATIONS

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