

# **TECHNICAL REPORT**

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**on**

## **Design & Development of a Pneumatic Precision Planter for Vegetables**

**Funded by**



**SERB, DEPARTMENT OF SCIENCE AND TECHNOLOGY (DST)**

**NEW DELHI, 110 016**

### **Participating Agencies**

**ICAR - Indian Agricultural Research Institute, New Delhi**

**CSIR - CMERI Centre of Excellence for Farm Machinery, Ludhiana**



**CSIR-CMERI CENTRE OF EXCELLENCE FOR FARM MACHINERY**

**OPP. GNE COLLEGE, GILL ROAD, LUDHIANA - 141 006**

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1. **Title of the project:** Design & Development of a Pneumatic Precision Planter for Vegetables
2. **Principal Investigator(s) and Co-Investigator(s):**  
Dr. Pramod Kumar Sahoo, Principal Scientist, IARI, New Delhi  
Dr. Pradeep Rajan, Principal Scientist, CoEFM, Ludhiana
3. **Implementing Institution(s) and other collaborating Institution(s):**  
ICAR - Indian Agricultural Research Institute, New Delhi  
CSIR-CMERI Centre of Excellence for Farm Machinery, Ludhiana
4. **Date of commencement:** 01.01.2010
5. **Planned date of completion:** 31.03.2013
6. **Actual date of completion:** 31.10.2017
7. **Objectives as stated in the project proposal:**
  - ✓ Studies on the existing planting machines to prepare a detailed design brief.
  - ✓ Design and development of a pneumatic precision planter for vegetables.
  - ✓ Evaluate the performance of the developed planter under simulated conditions in lab and actual field conditions.
  - ✓ Demonstration and field trials at farmer's fields.
8. **Deviation made from original objectives if any, while implementing the project and reasons thereof:** No
9. **Experimental work giving full details of experimental set up, methods adopted, data collected supported by necessary table, charts, diagrams & photographs:**

For developing a precision planter, design of proper metering mechanism is the most important task. Metering of single seeds at predetermined intervals is carried out by different mechanisms, viz. pneumatic singulation, belt seeding, finger pickup, and horizontal & inclined plates as well as vertical rotors with cells. Out of these mechanisms, pneumatic singulation using suction pressure is the best method for seed singulation of small seeds. Use of vacuum seed pickup offers certain advantages with regard to the selection of single seed and the capability of the mechanism to deal with small and irregularly shaped seeds.

### Constraints

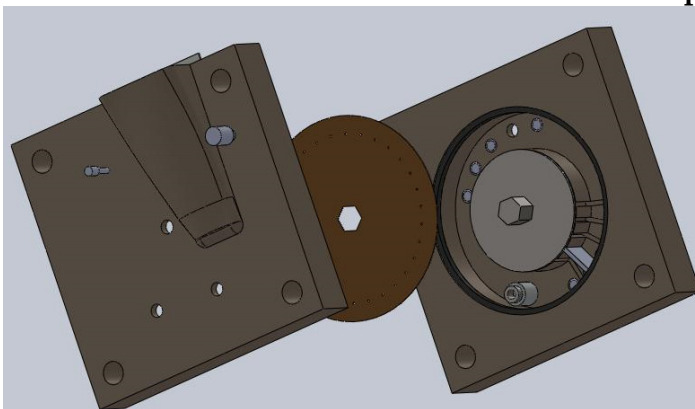
- Tractor range: 35-45hp.
- Total cost of the machine (pref. < 1 lakh).
- Non-uniformity of seed sizes of each vegetable & its varieties.
- Diverse agricultural practices across the country.

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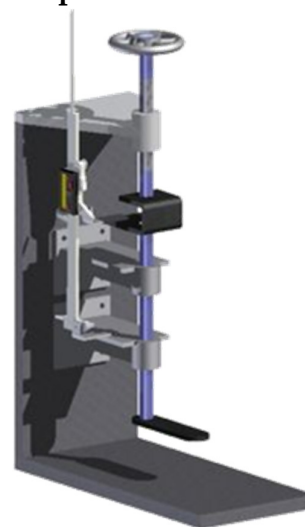
### Seed types and properties

Seed Type	1000 Seed mass, g	Seed Diameter (mean), mm	Geometric Mean Diameter, mm	Sphericity	Projected Area, mm <sup>2</sup>
Cabbage	2.674	1.722	1.722	0.988	2.8
Cauliflower	2.654	1.704	1.703	0.975	2.31
Onion	3.781	1.854	1.844	0.901	4.97
Carrot	2.057	1.801	1.489	0.452	5.54
Tomato	2.611	1.984	1.623	0.493	7.05
Brinjal	4.313	2.234	1.949	0.596	6.57
Spinach	11.124	3.053	3.046	0.983	10.61

### Experimental Seed Metering System



### Experimental Setup for seed pickup studies



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### 10. Detailed analysis of results indicating contributions made towards increasing the state of knowledge in the subject:

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#### **Radish**

The average plant spacing is more than the recommended spacing. Seed plate with more number of holes need to be used for planting radish. Yield recorded for radish is 1.58t/ha. The length of root during harvesting is in the range of 16-24cm.

#### **Spinach**

The average plant spacing is more than the recommended spacing due to higher missing percentage. The seed plate with hole size 1.3mm may be used for plating spinach. Yield recorded for spinach is 4.98t/ha.

#### **Cauliflower**

The average plant spacing for cauliflower is 21.46 which is much lower than the recommended plant spacing. Hence, the planter was used by sealing alternate hole by adhesive tape and the average plant spacing was recorded 41.89cm. The yield recorded for both the treatment was 25.47t/ha and 22.68t/ha respectively.



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### **Evaluation of pneumatic precision planter at farmers' field**

The pneumatic precision planter was evaluated at three locations in two states adjoining Delhi. In Pilkhuva, Hapur, Uttar Pradesh the machine was

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demonstrated in two farmers' fields and in Haryana it was demonstrated in Jhajhar and Sonapat. Cabbage crop was grown at Pilkhuva and Rajpur, whereas fenugreek seed was sown at Jhajhar. The effective field capacity of the planter was found in the range of 0.19 to 0.26 ha.h<sup>-1</sup>.

The planter required 3.85 to 5.26 hours for planting one hectare of land with field efficiencies ranging from 67.86% to 79.31%. The plant spacing and yield parameters were recorded for cabbage. The average plant spacing for cabbage was recorded as 27.46 ± 2.11cm. The recommended plant spacing for cabbage was 30-45 cm. The yield recorded for cabbage was 25.47 t.ha<sup>-1</sup>.

Table 1: Field Demonstrations at Farmers Field

Farmer	Place	Crop	Speed (km.h <sup>-1</sup> )	EFC (ha.h <sup>-1</sup> )	TFC (ha.h <sup>-1</sup> )	FE (%)
Mr. Bhagraj	Pilkhuva , Hapur	Cabbage	1.77	0.19	0.28	67.86
Mr. Bijendra Singh	Pilkhuva , Hapur	Cabbage	2.34	0.26	0.37	70.27
Mr. Satish Kumar	Majra Dubaldhan, Jhajhar	Fenugreek	1.59	0.23	0.29	79.31
Mr. Raj Singh	Rajpur, Sonapat	Cabbage	2.20	0.25	0.35	71.43

### Adjustment for raised bed planting

The developed planter is suitable for flatbed planting. In Hapur district cabbage is grown in raised bed condition. Following adjustment were made in pneumatic planter to suit the raised bed planting conditions:

- Matching the width of machine according to the bed width and track width of tractor.
- Adjusted the height of module according to the bed height.
- Size of side slot was increased for proper contact of ground wheel as in that position the ground wheel was in lifted condition at some places and the seed plates were not rotating properly.
- Two springs were provided in compaction wheel so that the positioning did not alter on turning.



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Fig. 1: Demonstration at Farmer's Field in Pilkhuva, Dist. Hapur U.P.



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Fig. 2: Demonstration at Farmer's Field in Majra village, Dist. Jhajar Haryana



Fig. 3: Display of Pneumatic Vegetable Planter in Krishi Unnati Mela 2016  
at ICAR-IARI, New Delhi



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### 11. Conclusions summarizing the achievements and indication of scope for future work:

A Three-row Precision Planter is developed which is suitable for majority of vegetable seeds and Indian production practices. Seed metering is through a vacuum system having a minimum & easy to replace wear parts. A viewing window in the metering unit allows operators to check the vacuum on the seed plate and proper singulation. Due to the modular design of planting units, planter can be easily modified to have 3/4/6 rows as per the tractor HP. Simple adjustments like seed plate change, plant spacing, depth and vacuum can be undertaken by unskilled farmers. Terrain following furrow opener (due to parallelogram linkage system) ensures uniform depth of planting & germination. Height of the drive wheels can be adjusted for bed planting, furrow planting and ridge planting. Pneumatic tyres for improved transmission from ground and easy for transportation.

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#### Specifications

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Tractor range : 45hp range

Less than 2% misses & 3-4% multiples [25 cm - max height adj.] (incl. doubles)

Depth adjustment – 1mm step (upto 7cm)

Plant spacing : 5 – 60 cm

Seed Singulation: 98-99%

Bed planting & ridge planting

Row spacing : 20 – 120 cm

Planting speed : 4 - 5 km/h

#### Achievements

- ✓ Technology package prepared
- ✓ Technology has been transferred to three industries.
- ✓ Subsidy scheme under Department of Agriculture (DoI), Punjab Government
- ✓ ISAE Team Award (2016) for Design & Development for Precision Planter for Vegetables (Indian Society of Agricultural Engineers)
- ✓ KC Das Memorial Award (2016) for Development of Pneumatic Precision Planter for Vegetables during the 57th Annual Technical Session (The Institution of Engineers)

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### Technology Transfer



**M/s Parmjot Industries**

F-47, Phase-VII, Focal Point,  
Dhandari Kalan,  
Ludhiana-141 010, Punjab



**M/s C. J. Enterprises**

1228/7, Industrial Area-C,  
Mittal Dharam Kanda Road,  
Dhandari Khurd,  
Ludhiana-141 010, Punjab



**M/s Ashlyn Chemunoor Instruments Pvt. Ltd.**

Karikkath Lane, M.G.Road,  
Thrissur-680001, Kerala

### 12. S&T benefits accrued:

#### I. List of Research publications

S No	Authors	Title of paper	Name of the Journal	Year
1.	Sahoo P.K., Rajan Pradeep	Development of Pneumatic Precision Planter for Vegetables	57th Annual Technical Session (Institution of Engineers)	2016
2.	Rajan Pradeep, Kaur Tejinder	Rapid Calibration System for Vegetable Seeds Metering Unit of Precision Planters	18th World Congress of CIGR – Beijing, (Abstract)	September 2014

#### II. Manpower trained on the project

- a) Research Scientists or Research Associates: 03 nos
- b) No. of Ph.D. produced: Nil

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No. of M.Tech produced: 01 nos.

No. of B.Tech produced: 06 nos.

c) Other Technical Personnel trained: Nil

III. Patents taken, if any: No