

## **Giuseppe Pellizzi Prize 2020**

### **[F] PhD Extended Abstract Form** *(Please select the Calibri 10 typeface)*

**FULL PHD THESIS TITLE: DESIGN, DEVELOPMENT AND EVALUATION OF TRACTOR OPERATED SEEDER FOR MAT TYPE PADDY NURSERY**

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#### **Extended Abstract**

*[10000 characters max, spaces included]*

#### **1. Chapter 1: Introduction**

Paddy is India's preeminent crop grown on more than 43.78 million-hectare area with the production of 168.50 million tonnes. Presently, transplanting of paddy is mainly depended on the labour migrated from other states of India. Manual transplanting of paddy is higher labour intensive operation involving various operations i.e. nursery raising, seedlings uprooting, transporting and transplanting the seedlings in the field and require about 250-320 man-h/ha. Due to the labour scarcity, now the farmers have an inclination towards mechanical transplanting of the paddy. Mechanical transplanting is found to be an efficient substitute for traditional transplanting while reducing human drudgery, getting uniform and desired plant population that is impossible with manual transplanting by hired labour. In general, mechanical transplanting saves about 78-88 % labour as compared to conventional manual transplanting. Efficient paddy transplanters are available in the market which can transplant the seedlings in a line by allowing better intercultural operations after transplanting. Mechanical paddy transplanters require mat type nursery having uniform mat thickness and uniform seedling growth. At present, mat type nursery is grown manually in open field either on the polythene sheet or either in trays. Manual method for raising mat type nursery labour intensive and require skill as it requires several operations namely laying of polythene sheet, placing of frames on the polythene sheet, putting the soil in the frames, levelling of soil, putting the seed on the soil, then covering of seed with thin layer of soil, sprinkling of water for setting and then uplifting the frame for further sowing. In case of tray, instead of polythene sheet and frames, the trays are directly placed in line in the field and same process is repeated. Sometimes sieving of soil is also required to remove clods and previous crop residues. In North-West India, paddy transplanting window has only 20 days to raising the nursery and transplanting it in the field. Higher labour requirement throughout the peak periods badly affects the timeliness of operation, thus reducing the grain yield. The mechanization level is low in sowing or transplanting (20 %) as compared to all other farm operations in paddy cultivation. The research done on mechanical method of sowing mat type nursery directly in the field is either nil or limited in India as well as in abroad except the stationary method as stated above. To address this issue, there was a need to design, develop and evaluate a simple and cost effective tractor operated machine for raising mat type seedlings of paddy to accomplish all the operations in one go and can help in timely and uniform sowing of nursery.

Hence, keeping in the view above mentioned facts, study was undertaken with the following specific objectives:

- i. To design and develop the tractor operated seeder for mat type paddy nursery.
- ii. To evaluate the performance of developed tractor operated seeder for mat type paddy nursery in laboratory/ field conditions.

#### **2. Chapter 2: Review of literature**

The literature cited in this chapter clearly showed that mat type nursery sowing operation is manual, considerably consuming both labour and time. However, mat type nursery is a prerequisite of mechanical transplanting whose preparation requires more drudgery and time. There are two methods of growing mat type nursery in open field, one using frames and polythene sheet and second using plastic trays. The first one is mostly adopted due to lesser initial cost and labour requirement as compared to later one. Due to lack of knowledge as well as mechanization in growing mat type nursery for paddy resulted in failure of raising nursery which consequently became a constraint in adoption of mechanical

transplanting. So there was a need to develop a mechanized on farm nursery sowing machine to do all the operations of nursery sowing in one go making it easy, efficient, uniform and of good quality.

### 3. Chapter 3: Materials and Methods

In order to cater the mechanization and boost the adoption of mechanical transplanters, a tractor operated seeder for mat type paddy nursery was designed and developed. The development of tractor operated seeder for mat type paddy nursery involves the designing of soil cutting unit, soil conveyor unit, soil conveyor auger, soil metering and seed distribution unit suitable for sowing mat type paddy nursery in one go. An explicit focus was given while designing, developing and evaluating the machine. Besides from the suitable design parameters the prototype of the nursery seeder was fabricated using developed CAD models. The machine lays a polythene sheet and prepares one meter wide soil bed with simultaneous uniform seed placement. The machine consisted of two cutting units on both sides with 1.2 m spacing in between them. Soil conveyor units were attached on the back side of the respective cutting unit. A screw conveyor was placed below the rear end of soil inclined conveyor for conveying the soil. The sieving system for removal of soil clods/foreign matter was attached in the frame in such a way that it received the soil coming from the screw conveyor. The soil metering unit (fluted roller having 18 cm diameter and 13 flutes) was attached below the sieving system. At the rear side, seed metering unit (fluted roller having 4 cm diameter and 14 flutes) was attached and drive was taken from the ground wheel. The machine was mounted on supporting roller and wheel assembly at the front and rear side, respectively. The power to rotating drives of the machine was provided from tractor PTO. The developed machine was evaluated in the laboratory/controlled field conditions on the Departmental Research Farm, FMPE, PAU, Ludhiana. The independent parameters were depth of soil cut (D1 and D2), sieve opening size (S1 and S2) and sieve oscillation (O1, O2 and O3) on the selected dependent parameters. The field evaluation was conducted on three locations namely two locations at Research Farm, Deptt of FM&PE, PAU, Ludhiana and one location at University Seed Farm, Ladhawal, PAU, Ludhiana having different soil types ST1 (sandy loam), ST2 (loam) and ST3 (silt loam) using three forward speeds FS1 (1.7 km/h), FS2 (2.2 km/h) and FS3 (2.7 km/h). The control was manual method of raising mat type nursery using frames. The data for the laboratory/controlled field study analyzed using MCRD and data for field studies analyzed using RBD in SAS 9.3.

### 4. Chapter 4: Results and Discussion

The results obtained from laboratory/controlled field evaluation indicate that the effect of sieve oscillation (O), sieve opening size (S) and depth of soil cut (D) significantly ( $p < 0.05$ ) affected the uniformity of seed spread, soil mat thickness and pulverization index whereas non-significant on both seed and plastic sheet damage. The operational parameter obtained for better performance of machine was sieve oscillations O3 (398 spm), sieve opening size S1 (25×20 mm) and depth of soil cut D2 (80 mm). The speed of operation was constant i.e. 2.2 km/h in the laboratory/controlled field study.

The results obtained from actual field evaluation indicate that the effect of forward speed (FS) significantly ( $p < 0.05$ ) affected the seed spread, soil mat thickness, fuel consumption and actual field capacity. The best suited operational parameter obtained from actual field performance for better performance of seeder for mat type paddy nursery was forward speed FS1 (1.7 km/h) and FS2 (2.2 km/h) gave better results. The forward speed FS1 was better to give higher values of studied dependent parameters except fuel consumption where values were contrast. The higher values of overall seed spread at middle bite of transplanter cut was 90.93 % and overall soil mat thickness at bed width of 900 mm was 99.90 %. It shows that the forward speed FS1 gives better and non-significant results as compared to control except for actual field capacity. Thus, forward speed FS1 (1.7 km/h) was selected from the actual field evaluation irrespective of studied soil type. Economics of the tractor operated seeder for mat type paddy nursery was carried out to estimate the cost of operation per hectare. Total cost of nursery sowing was found to be 9888.99 Rs/ha (131.42\$/ha) or 1087.79 Rs/h (14.46\$/h). Saving in cost of sowing mat type nursery and labour using developed tractor operated seeder for mat type paddy nursery was observed 87.79 % and 96.36 % respectively as compared to manual method of sowing mat type nursery.

### 5. Chapter 5: Conclusions

Different metering mechanisms/units for proper operation of tractor operated seeder for mat type paddy nursery were designed. Important units of this machine such as soil metering unit and seed metering unit were designed for delivering 20-30 mm soil bed thickness and 2-3 seeds/cm<sup>2</sup> on the prepared soil bed in the field, respectively. The machine was developed based on designed mechanisms for soil and seed and evaluated in laboratory/ controlled as well as actual field conditions. Controlled field evaluation in loamy soil, the operational parameter for better performance of machine for middle obtained bite of transplanter cut was obtained for the operational combination of O3S1D2. At this setting, the higher overall seed spread at the middle bite of transplanter cut was 91.00 % and overall soil mat thickness at 950 mm bed width was 92.93 %. The pulverization index was 2.01 mm whereas seed damage and plastic sheet damage was observed negligible. The best performance of the machine was obtained at a forward speed of 1.7 km/h with overall seed spread of 90.93 %,

overall soil mat thickness 99.90 %, fuel consumption 4.36 l/h and effective field capacity 0.11 ha/h. Saving in cost and labour for sowing mat type nursery using mat nursery seeder was observed 87.79 % and 96.36 %, respectively as compared to conventional method with frames.

**Final remarks concerning the competition benchmarks and strength points**

*[compulsory chapter to fill with 500 characters max, spaces included]*

An innovative tractor operated seeder for mat type paddy nursery designed, developed and evaluated. The machine dig and convey the soil from both sides, sieve the soil, press the soil before laying the polythene sheet, lay polythene sheet, put the soil of uniform thickness on polythene sheet to make a mat and then put the seed uniformly on the soil mat in one go. Saving in cost and labour for sowing mat type nursery using mat nursery seeder was observed 87.79 % and 96.36 %, respectively as compared to conventional method. This machine will boost the mechanization in paddy transplanting which increases the farm mechanization in Indian paddy cultivation. There is higher demand by farmers of the developed technology in the region and patent has been filed for the same.