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EFFICIENCY TEST AND ECONOMIC ANALYSIS OF SEEDER FOR PAPAYA-SOWING TRAY

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Abstract

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The objective of this project was to develop the seeder for sowing tray to reduce the labor cost and the operation time for preparing sowing tray. Papaya seeds were selected for test on this machine. The sowing tray used for test has 60 cells per one tray. The dimensions of seeder developed have a width of 1,044 mm, a length of 679 mm. and a height of 1,348 mm. The important components of machine consisted of seed hopper, seed metering device, seed releasing units, soil compressing units and depth controlling units. The seed metering device was established by plastic sheet. The plastic rods cut into keyway along its axis for keeping seeds were inserted into the seed metering device in order to convey the seeds from the seed hopper to the flexible tube. The flexible tubes brought the seeds into seed releasing units located under the part of seed metering device in order to drop the seeds 1–2 seeds per cell of sowing tray. The seed metering devices were set 3 units, 1 unit for releasing seeds on 20 cells of sowing tray, on the seeder frame. Chain drive mechanism was set to drive the system for releasing seeds on sowing tray. The efficiency test of releasing seed on sowing tray of this seeder was equal to 79%. For operation time of releasing seeds on sowing tray, Comparing between this seeder and human hand found that the sowing by the seeder was 7.88 times quicker than the sowing by human hand. In parts of economic analysis of seeder, breakeven point, payback period and benefit cost ration were considered for economic analysis. Their results found that were 152,050 trays, 0.03 year and 3.05 respectively. Therefore, the seeder of papaya sowing tray developed is suitable for using in local farmers in Thailand.

Keywords: seeder, sowing tray, seed, pneumatic seeder

INTRODUCTION

At present for planting in Thailand, Most farmers have sown the seeds on soil surface directly. This method certainly affects pre-germination of seed sown on soil due to unsuitable condition for germination such as inconsistency of germinating seed on ground, the problems of pest and weed management and low germination rate that effect to the quantity of production after harvesting. For solving these problems, the agricultural extension officers in Thailand try to suggest farmers another method for sowing in order to increase their agricultural product. Therefore, the seed sowing on sowing tray is promoted to the farmers (Banyat, 2010). Normally, the seed sowing on sowing tray can be divided into 2 types. 1) The seeds sown in sowing tray by human hand are usually used to prepare sowing trays in small scale farming because it has to spend a lot of time to drop seeds into each cell of sowing tray by hand, but it is inexpensive to operate in this way. 2) The seeds sown in sowing tray by machine are normally used for preparing sowing trays in middle or big scale farming and also their operation time are quicker than hand sown seed method (J R Murray, 2006), but the cost of seeding machine are so expensive for local Thai farmers to buy them and the complexity of machine in working system is the main problem for maintenance by local Thai farmers also. According to these reasons,

this machine were established to develop the seeder for sowing tray in order to be newly alternative way of seeding machine for local Thai farmers.

MATERIALS AND METHODS

1 Types of seed used with this seeder

The development of seeder is initially designed to sow the seeds which have quite spherical shape and are practically sown in sowing tray. The seeds selected for using with this seeder will be tested to study their physical properties in the following sequence. 1) The average size of seeds. 2) Angle of repose of seeds. 3) The angle of friction between seeds and materials used for design machine. All factors will be used to design this machine further.

2 Design consideration of seeder for sowing tray

Dimension of sowing tray is important to define the size of seeder. The sowing tray used for design seeder must be easily purchased and generally used for sowing in local Thai farmers. The seeder developed will be mainly consisted of 1) Seed hopper, to keep seeds in suitable condition. 2) Seed metering device, to define the amount of seeds released into each cell of sowing tray. 3) Soil compressing units and seed releasing units, to indent soil surface and release seeds in soil all cells of sowing tray, respectively. 4) Depth controlling units, to be able to define the depth of released seed from soil surface. 5) Machine controlling unit, to control a seeder for releasing seeds on the sowing tray. However, the present study was undertaken to develop the seeder for sowing tray, using indigenous materials, getting convenient operation and saving energy.

3 Testing of the seeder of sowing tray

The efficiency evaluations of the seeder is carried out by sowing the seeds selected for testing into the sowing tray selected are as follows.

3.1 The efficiency of seeder in terms of released seed in the sowing tray.

The efficiency of seeder for releasing seeds (%) =

$$= \frac{\text{Amount of cells have seeds released}}{\text{Total cells of a sowing tray}} \times 100$$

3.2 The operation time of seeder

The operation time of seeder (trays/time) =

$$= \frac{\text{Amount of sowing trays were operated}}{\text{Operating duration}}$$

4 Economic analysis for seeder for sowing tray

The seeder developed was considered by economic analysis to find the suitable investment point for this seeder. Economic analysis was used to calculate for seeder for papaya sowing tray as follows.

4.1 Break Even Point

$$\text{BEP} = \frac{\text{Fixed Costs}}{\text{Price/Unit} - \text{Variable Cost/Unit}}$$

4.2 Payback Period

$$\text{PBP} = \frac{\text{Costs of Project}}{\text{Annual Cash Inflows}}$$

4.3 Benefit Cost Ratio

$$\text{B/C} = \frac{\text{Present Value of Benefits}}{\text{Present Value of Costs}}.$$

RESULTS AND DISCUSSION

1 Types of seed used with this seeder

The seeds used for test in this seeder have to be quite spherical shape in order to be easy to design the prototype seeder. From study in this point found that papaya seeds were suitable to bring for design and test of the seeder of sowing tray because it was necessary to sow papaya seeds into sowing tray before planting in the soil and also papaya seeds is cash crop in Thailand. The test results of physical properties of papaya seeds were as follows.

1.1) Average size of papaya seeds were carried out by measuring of 100 samples of papaya seeds which is shown in Fig. 1. The results of measured seeds found that the average width of papaya seed was equal to 4.5± 0.5 mm. and the average length was equal to 6.6 ± 0.82 mm.

1.2) Angle of repose of papaya seeds was carried out by specific instrument which is shown in Fig. 2. This test was repeated of 5 times. Its result found that the papaya seeds tested had the average angle of repose of 33.02 ± 2.1 degree.

1.3) Angle of friction, AOF, between papaya seeds and materials used for design this seeder were tested by specific instrument which is shown in Fig. 3 in order to be pre-data for design and development this seeder. This experiment was repeated to test of 3 times and the materials which were tested with papaya seeds for finding the AOF values were metal sheet, Acrylic sheet and Flexible tube. Their results found that AOF of each material with papaya seeds were equal to 35.7 ± 3.27, 37.7 ± 2.75 and 39.1 ± 2.6 degree, respectively.

In the results of the above, average size of papaya seeds, angle of repose of papaya seeds and AOF of between papaya seeds and materials used for design this seeder. They would be important data to design and develop this seeder further.

1: *Measuring the size of papaya seeds*

2: *Measuring of angle of friction of papaya seed*

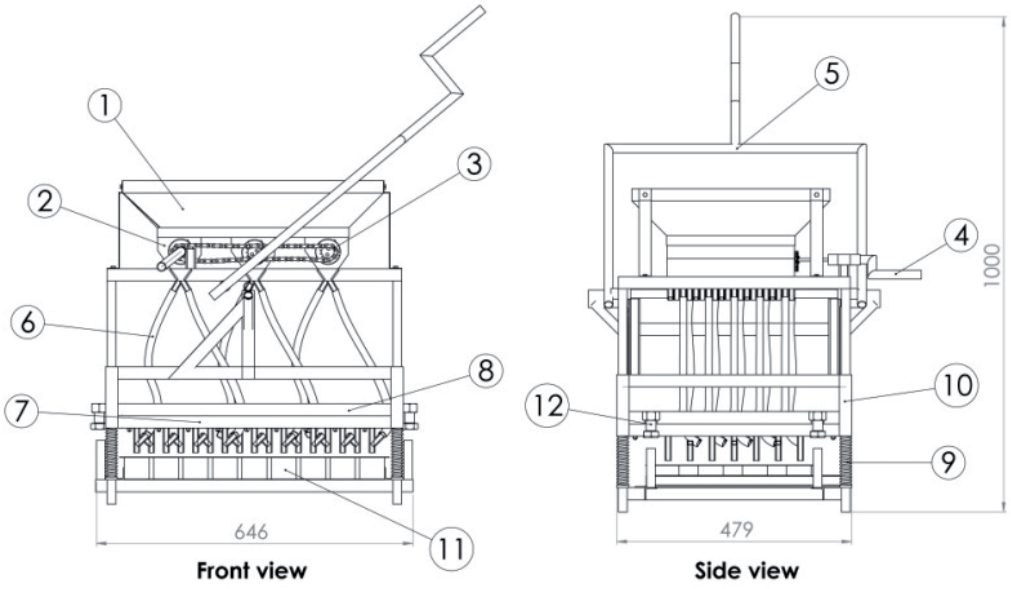
a) Metal *b) Plastic sheet (Acrylic)* *c) Flexible tube*

3: *Measuring of angle of friction between seeds and other materials*

2 Design results of seeder for sowing tray

From studying sowing tray which is suitable for using with this seeder found that the sowing tray selected had a size of 60 cells (75 × 45 cm.) because this plug tray is generally used by Thai farmers for preparing nursery sowing tray in Thailand. The important components of seeder for sowing tray developed are shown in Figs. 4 and 5.

The operational sequence of seeder for sowing tray began to place the sowing tray into the tray receiving channel of prototype seeder. The seed hopper was filled by seed selected for sowing on sowing tray. The depth controlling units were adjusted to define the depth of released seed in the cell of sowing tray. Hand-1 was rotated around 180 degrees clockwise by hand to control the seed metering device in order to move seeds from seed hopper to seed releasing units equipped below the seed metering device and then hand-1 had to be rotated around 180 degrees counterclockwise for keeping original position. Hand-2 was halfway pressed by hand to control the soil compression units to indent the soil on all cells of sowing tray. Finally, pressing hand-2 all the way for controlling the seed releasing units to release



4: *Prototype seeder for sowing tray*

I: *Parts of prototype seeder for sowing tray*

Number	Part
1	Seed hopper
2	Seed metering device
3	Chain driven system
4	Handle-1
5	Handle-2
6	Flexible tube
7	Soil compression units
8	Seed releasing units
9	Compression spring units-1
10	Compression spring units-2
11	Sowing tray
12	Depth controlling units

seeds into all cells of sowing tray. The hand-2 would be moved to initial position by compression spring units-1 automatically. Seeds would be completely released into all cells of sowing tray in one operation cycle of seeder.

3 Test results of seeder for sowing tray

The sowing trays of 10 trays were conducted to test about the efficiency of seeder in terms of released seed in sowing tray and the operation time of seeder. Testing found that the efficiency of seeder in terms of released seed in sowing tray was equal to 79%, and the operation time of seeder was equal to 117 second (10 trays) or 11.7 second per tray. On other hand, the operation time of seed sown in sowing tray by human hand was equal to 921.53 second (10 trays) or 92.15 second per tray.

5: *Prototype seeder for sowing tray*

4 Economic analysis results of seeder for papaya sowing tray

In this economic analysis for seeder was assumed as follows: 1) Seeder cost of 10,950 baht 2) Operating time amount to 6 hours/day and 300 days/year 3) Annual interest rate of 7% 4) Seeder lifespan was equal to 3 years 5) Variable cost for preparing a sowing tray of 0.1 Baht/tray. 6) Maintenance cost for seeder of 10% of seeder cost 7) Seeder developed have terminal salvage values totaling 10% of seeder cost and 8) Operation cost for sowing in a papaya plug tray was found to be equal to 0.75 baht/tray.

For Tab. II, the results of economic analysis for seeder of papaya sowing tray was found that breakeven point of seeder was equal to 152,050

II: *Economic analysis results for seeder of papaya sowing tray*

Item	Value
Net present value (Baht/year)	3,832
Maintenance cost (Baht/year)	5,000
Labor cost (Baht/year)	90,000
Annual cost (Baht/year)	98,832
Revenue (Baht/year)	415,800
Net profit (Baht/year)	316,968
Breakeven point (tray)	152,050
Payback period (year)	0.03
Benefit cost ratio	3.05

trays and payback period of seeder was equal to 0.03 year and benefit cost ration of seeder was equal to 3.05. Therefore, the seeder of papaya sowing tray developed is suitable for investment to prepare papaya sowing trays for local farmers in Thailand.

For these results of economic analysis, some data was assumed to calculate these results. Farmer who will bring these results to use in this seeder should be aware that the results of economic analysis importantly depend on many variables such as constant interest of economic analysis, wage of sowing, and amount of actual demand. Therefore, it is necessary to consider about the risk as well. However, the researches extremely try to assume those variables with actual value in current situation in order to decrease the error of results of this analysis.

CONCLUSIONS

By means of this study the seeder was applied into agricultural production. For further study on this research, the percentage of actual germination of seeds using this seeder should be examined and the plastic rod, which is assembled with seed metering device, should be designed to be many patterns that are possible to employ the other kinds of seed.

SUMMARY

The seeder for papaya sowing tray developed was initially tested in order to sow the papaya seed into the sowing tray of 60 cells. Resulting founds that their efficiency for releasing seeds on sowing tray have a value of 79%. For operation time of sowing of seeder and human hand, Comparing the operation time of sowing in sowing tray between this seeder and human-hand found that the sowing by the seeder was 7.88 times quicker than the sowing by human-hand. Moreover, the this seeder was analyzed by economic analysis in order to find some value such as breakeven point (BEP), payback period (PBP) and Benefit cost ratio (B/C). This analyze founds that the seeder of papaya sowing tray developed is suitable for investment to prepare papaya sowing trays for local farmers in Thailand.

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