DESIGN AND DEVELOPMENT OF A GARLIC PLANTER IN THAILAND

Jarudchai Yenpayub[1], Sonluck Kingthong[2] and Jiraporn Benjaphragairat[3]
[1] Master student, [2] Lecturer , [3] Assistant Professor
[1,2,3]Agricultural Engineering Department, Faculty of Engineering, King Mongkut's Institute of Technology Lardkabang, Bangkok, Thailand 10520.

ABSTRACT

The main concept of design and development of garlic planter is fabrication the drilling planter and its metering device is simple in their structure and easy to manufacture. This study followed research after the 3 types of garlic planter was fabricated in 2001 which included; 1) inclined metering plate garlic planter 2) vertical metering plate garlic planter and 3) spring plate garlic planter. In this study, 2 model were constructed which included; 1) the vertical metering plate with triangular grooves and 2)the bucket type garlic planter. The uniformity of metering system test for the 2 models , the bucket type garlic planter presented the most impressive results. The percentage of broken was very low, about 0.23%. The new prototype garlic planter had 12 rows and was attached to 5 HP power tiller. The garlic planter was tested under actual field conditions at Maetang district, Chiengmai province. The result indicated that the optimum width of garlic planter was 0.8 meter or 8 rows. The suitable soil condition was dry soil. Farmer should apply water after planting. The maximum forward speed was 2.63 km/hr and wheel skid was high about 23.32%. The average depth and width of planting was 2.62 cm. and 4.66 cm. Time for turning at head land was 37 seconds. The field capacity was 0.31 ha/hr and there were three operators. Hence, the capacity of planter was 0.83 ha./man/day.

Keyword: garlic planter, drill planter, metering device, bucket metering.

INTRODUCTION

The production area of garlic in Thailand is 22,556 ha. It has been grown on the north country. In 2002, the product of garlic 126,423 tons and the value was 2,533 million baths. Garlic is an economic crop which trend of export is upwards. Farmer start to plant in the early of winter (from end of October to February). After preparation of soil the grower will put the cloves in the saturated soil. Cloves are planted vertically with the basal root plate down and space between cloves in rows about 10 cm. After plant by hand farmer cover the beds with rice straw for maintain moisture. In planting garlic, the major problem was a very expensive payment for employment of man power to plant by hand. The capacity of man power is very low about 0.05 ha./man/day, and payment for planting is 11.9% of total cost of production.

According to the problems above, the development of garlic planter has been started in 1999 by Jiraporn et. al, . After the gathering of data about traditional garlic planting method, the study of effect of planting method to yield were tested in the farmer field. The

result shown that the drilling method was appropriated for fabricate the garlic planter (Jiraporn,2002). Hence, the design and development of garlic planter was started with the concept of the drilling planter attached to 5 HP power tiller.

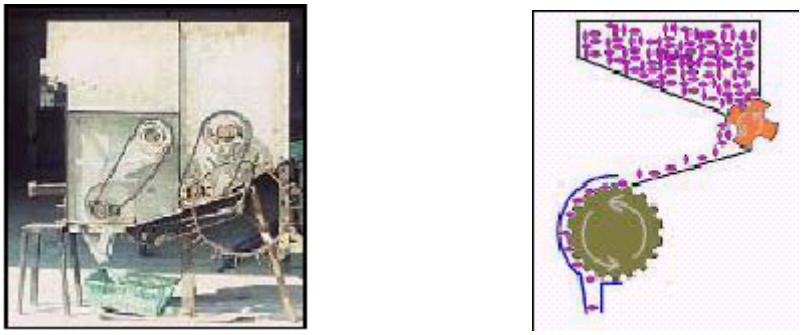
OBJECTIVE

1. Study and evaluation of the efficiency of 3 types of garlic planter's precise.
2. Design and development the metering units for precise planting.
3. Fabrication of the garlic planter attached to the power tiller and testing on farmer's field.

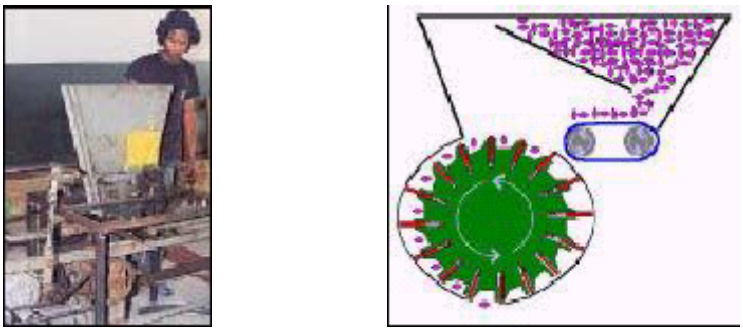
MATERIAL AND METHOD

1. Study and evaluation of the efficiency of 3 types of garlic planter's precise.
   1.1 . The mechanism has been presented on figure 1.

(a)Inclined plate garlic planter and the schematic view.



(b) Vertical plate garlic planter and the schematic view.



(c) Spring plate garlic planter and the schematic view.

Figure1: The illustration of 3 types of garlic planters.

1.2 . Testing and evaluation of the 3 types of garlic planter followed Thailand Industrial
Standard for Thailand Seeder (TISI1236-2537).

The test method for determination of performance used the uniformity of seed metering test and 3 mechanical damage test to compared the result. In making an assessment of drill performance it is necessary to consider 1) seed rate , 2) percentage of the broken and 3) coefficient of variance .The test was run at forward speed 3 levels : 1.5, 2.5 and 3.5 km/hr.

Table 1: The test method and criteria follow TISI 1234-2537

Test Method	Criteria
Uniformity of metering system.	Quantity of seed dropped per meter is 10 and variation in quantity dose not exceed +3 or -2 .
Mechanical damage	The percentage of visible damage to seed after drilling shall not exceed 5% when compare with before drilling.

2. Design and development of metering system.

2.1 Design of the vertical metering plate with triangular grooves.

The prototype was adapted from the vertical plate planter with 2 rolls in the metering system. Design of size, shape of grooves and 2 brushes were located for remove the seed over the grooves and assign the position of released point of seeds. A schematic view for new vertical plate metering system present on figure 2

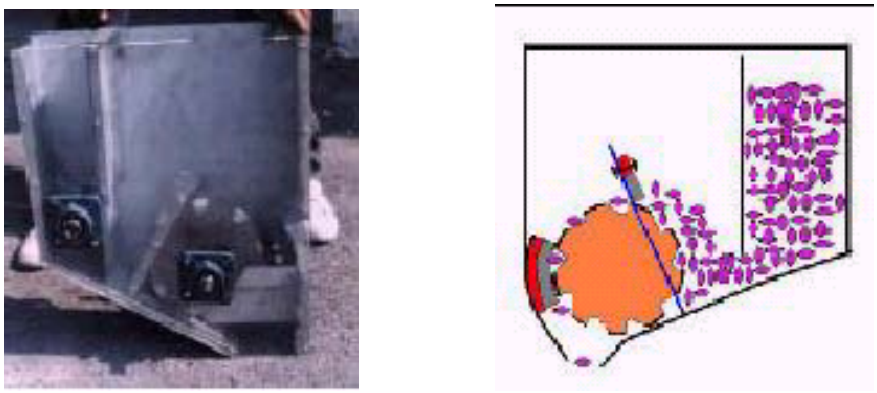


Figure 2: New vertical plate metering system.

2.2 Design of bucket type metering system.

Based on reducing seed broken, it was hypothesized that a bucket type could be caused garlic cloves damage less than the vertical metering plate. The following presents a schematic view of bucket type metering system.

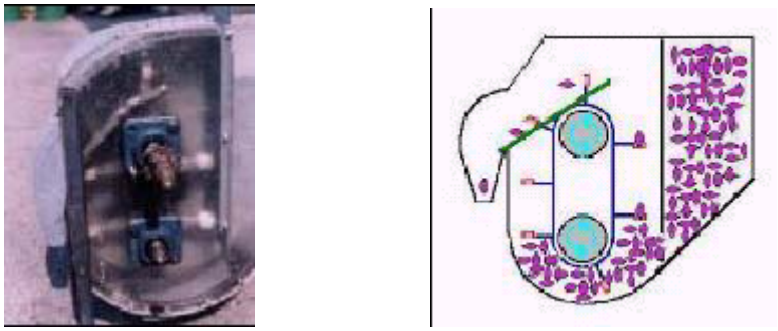


Figure 3: Bucket type metering system.

2.3 Comparison test and development of the bucket type for precise drill.

1. The comparison of metering system performance between new vertical plate planter and bucket type planter.

Tested the uniformity of the metering systems and checked percentage of the broken after operating the planter at the revolution of seed metering as: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110 and 120 rpm.

2. Comparison of the appropriate bucket size.

Tested the uniformity of the metering device using 2 sizes of bucket, 10 and 12 mm. depth. The test was done at the revolution of seed metering as: 40, 50, 60, 70, 80, 90, 100, 110 and 120 rpm.

3. Fabrication of the 12 – row garlic planter and testing in farmer field.

3.1 Fabrication of the 12-rows garlic planter attached to the power tiller.

The design conditions are based on the results from the experiment and the study earlier . The conditions are as follow :

i) The bucket type metering device was used to fabricate the 12-rows garlic planter.

ii) The depth of bucket was 12 mm.

iii) The suitable revolution of metering system was 40 to 80 rpm at travel speed 1.5 to 3.5 km./hr.

iv) Shoe type furrow opener was selected for fabrication of the 12-rows garlic planter. (Kampanart, 2000)

v) The optimum width was calculated from optimum width equation (Hunt,1995). The solution of this equation is 1.2 meter or 12 rows.

Based on these results, the 12-rows garlic planter was designed and fabricated as shown in figure 4

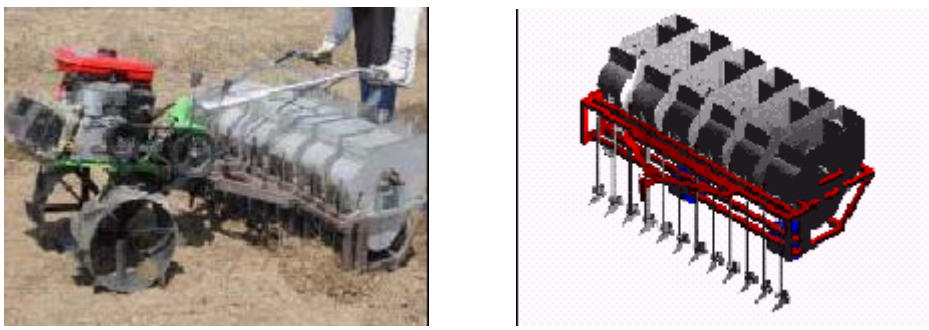


Figure 4: Show 12-rows garlic planter attached to small power tiller.

- Specification of garlic planter.
- Dimension width x length x height : 1250 x 925 x 705 mm.
- Bare weight 150 kilograms.

3.2 Field test

Field test of the garlic planter was conducted to determine the performance of planter under the actual field conditions at Maetang district, Chiengmai province. Land preparation was done by 1 travel of rotary tiller. The field plot was 3.2 meter width , 27.9 meter length. It is sandy soil and the soil moisture is 19.31% dry basis. The purpose of this test was determination the parameters including the optimum width , the soil moisture level that was suitable for the planter and the appropriate travel speed.

The testing procedures were summarized as the following:

- Assigned three levels of the garlic planter speed.
- Two levels of the soil moisture were dry soil which was watered one day before planting.
- Ease of operation assessed the optimum width.

RESULT AND DISCUSSION

1. The evaluation of the efficiency of 3 types of garlic planter.

Table 2. Testing of the performance for 3 types of the garlic planter

Full hopper						
Forward speed km./hr.	Average seed rate (cloves/ meter)			Average percentage of the broken		
	(1)*	(2)*	(3)*	(1)*	(2)*	(3)*
1.5	9	31.17	11	4.32	0.9	4.73
2.5	7.5	15.83	18.67	11.61	1.16	13.52
3.5	3.11	9.67	10.28	14.46	1.65	12.53
1/5 of volume of hopper						
Forward speed km./hr.	Average seed rate (cloves/meter)			Average percentage of the broken		
	(1)*	(2)*	(3)*	(1)*	(2)*	(3)*
1.5	11.5	23.44	16	6.83	6.11	6.63
2.5	5.5	15.5	15.94	20.69	2.85	7.74
3.5	2.33	9.78	14.44	34.7	4.11	15.42

* Notes (1) Inclined plate garlic planter
(2) Vertical plate garlic planter
(3) Spring plate garlic planter

The number of the cloves per meter and the percentage of the broken were used to evaluate. The vertical plate garlic planter was selected for modification as shown on table 3

Table 3: Summarized the problems of each prototype

Prototype	Problem
1. Inclined plate garlic planter	Overflow of the garlic cloves on the seed plate caused unsmooth of transmission. The peripheral speed of the seed plate was too high and caused mechanical damage up to 35%.
2. Vertical plate garlic planter	Too large groove caused the over seed drill 31 cloves per meter. The percentage of the broken was about 6%.
3. Spring plate garlic planter	Unsmooth of the metering unit and clogging of the garlic cloves at the release point of the hopper caused high percentage of the broken about 15%.

2) The comparison of metering system performance between new vertical plate planter and the bucket type planter.

Table 4: The uniformity of the metering systems of 2 types of the garlic planter.

Revolution of metering unit (rpm)	Average seed rate (cloves per meter)		Percentage of the broken		Coefficient of variance (%CV)	
	New vertical type	Bucket type	New vertical type	Bucket type	New vertical type	Bucket type
10	*	**	*	**	*	**
20	36.39	**	0.6	**	14.9	**
30	33.61	**	0.33	**	11.19	**
40	34.06	44.33	0.36	0.12	18.97	9.98
50	28.11	45.61	0.15	0.23	14.64	10.22
60	24.89	45.44	1.1	0.12	22.24	9.99
70	16.56	40.89	0.31	0	21.26	13.2
80	9.72	41.72	0.36	0.15	39.45	13.79
90	12.56	42.67	1.91	0	32.81	14.73
100	-	31.61	-	0	-	11.04
110	-	25.5	-	0	-	15.47
120	-	27.72	-	0	-	15.76

* The speed was too slow and caused the testing set (sticky belt) fail.

** The speed was not high enough to test the bucket type garlic planter.

From the data, it appared that the bucket type garlic planter was better than new vertical plate planter. By checking the percentage of the broken, we found that both of them have

percentage of the broken not exceed 5%. The bucket type garlic planter was better because its maximum percentage of the broken was 0.23% at the speed of 50 rpm. When compared the coefficient of variance, we found that the bucket type garlic planter had less value, about 9.98 to 15.76%, than the new vertical plate planter which had the value about 11.19 to 39.45%

4. The uniformity test of the metering system to find the appropriate size of the bucket between 10 mm. depth and 12 mm. depth.

Table 5: The comparison of the uniformity of the metering system using the buckets of 10 and 12 mm. depth.

Revolution of metering unit (rpm)	Average seed rate (cloves per meter)		Coefficient of variance (%CV)	
	10mm.bucket depth	12mm.bucket depth	10mm.bucket depth	12mm.bucket depth
40	8.94	15.17	18.62	17.08
50	10.06	13.44	23.32	17.42
60	8.39	16.17	13.3	19.58
70	8.72	16.06	19.36	14.24
80	7	12.83	27.43	21.5
90	5.33	12.78	30.49	20.31
100	6.44	11.94	32.81	25.2
110	5.5	11.67	43.51	16.13
120	6.06	11	31.77	22.15

From the experiment, we found that the 10mm.bucket depth delivered maximum seeds 10.06 cloves per meter at speed 50 rpm only. Other speeds could not deliver seeds up to 10 cloves per meter which was the target seed rate. The 12 mm. bucket depth delivered seeds more than 10 cloves per meter which vary in range 11 to16.17 cloves per meter. When compare the coefficient of variance, we found that 12 mm. bucket depth had the value in the range 14.24 to 25.2 % and 10 mm. bucket have the value in the range 13.3 to 43.51 % .The conclusion is that the suitable depth of bucket is 12 mm.

Based on the overall experiment, we conducted the concept of garlic planter design as:
1)The metering device of the garlic planter is the bucket type.
2) Depth of the bucket is 12 mm.
3)The revolution of the metering device is in the range 40 to 80 rpm.

5. Field tests

Under field condition the 12-row garlic planter was performed at 2.62 cm. depth, 4.66 cm. width and the forward speed of 2.63 km./hr. The draft planter was too high so the number

of 12 rows was reduced to 8 rows. Hence the 8-row garlic planter was tested in the farmer field. The summary of the results can be presented. The optimum width of the garlic planter was 0.8 meters or 8 rows. The suitable soil condition was dry soil. And the farmer should apply water after planting. The maximum forward speed was 2.63 km/hr and the wheel skid was high about 23.32%. The average depth and width of planting was 2.62 cm. and 4.66 cm. respectively. The time for turning at head land was 37 seconds. The field capacity was 0.31 ha/hr and there were 3 operators. Hence, the capacity of planter was 0.83 ha./man/day.

CONCLUSION

The procedure of these study can put in order as shown in the table.

Table 6: Laboratory test.

Problems	Implementation	Notes
1. Percentage of the broken of 3 types of the garlic planter was too high. (Mechanical damage up to 35%)	Developed the new vertical plate garlic planter and the bucket type garlic planter. Test the uniformity of each metering system.	After testing, we selected the bucket type garlic planter because its low mechanical damage .(Max value is 0.23%)
2. Seed rate of the bucket type garlic planter was too high.(About 26-46 cloves per meter)	Reducing bucket volume 67.9%	Seed rate was about 11-16 cloves per meter.

Bucket A
(made from plastic pipe ,19 mm. diameter)

Bucket B (new bucket shape)

Fig 5: Bucket A and B.

Table 6: Field test.

Problems	Implementation	Notes
3. Seed size variation could cause the problem of logging in the metering system.	Change of the bucket shape.	The bucket shape have been changed from A to B.(picture of bucket A and B shown in figure 5)
4. Others conditions which cause the error on the field test. 4.1 Land preparation was not completed. 4.2 The design of some parts was not suitable for farmer's field. i) Locating the furrow opener. (Space between opener was not large enough for soil movement.) ii) The operation width of the garlic planter was too large. iii) Covering devices were not performed well. iv) Slip of ground wheel was too high.	Should plow at least 2 times for rotary tiller. Rearrange the opener to make more space. Reduce the operation width from 12 rows to 8 rows. Fabricate the covering device separate from the opener. Transmit driving power directly from power tiller wheel.	These will be done in the next season.

REFERENCES

1. DONNELL HUNT , **Farm Power and Machinery Management**, 9th Ed. ,Iowa State University Press, AMES, 1995 , pp.263-269.

2. I.H.RYU AND K.U.KIM , **"Design of Roller Type Metering Device for Precision Planting"**. Transactions of The ASAE, Vol 41(4),1998 ,pp. 923-930

3. J.M.WILSON , **"The Effect of Release Errors and the Release Point on the Design of Precision Seed Drills."** , J. agric Engng Res.,Vol 25 , 1980, pp.407-419

4. KAYSORN CHUNKRATOKE et al., 1999. **Garlic Planter**. Bachelor's thesis King Mongkut's Institute of Technology Ladkrabang,Thailand.

5. KAMPANART WISETUDOMSAK et al., 2000. **The development of garlic planter** Bachelor's thesis King Mongkut's Institute of Technology Ladkrabang,Thailand.

6. JIRAPORN BENJAPHRAKAIRAT et al., 2001. **Studies on factors affecting design of mechanized planting of garlic blubs**. Proceedings of the 39th Annual Conference of Kasetsart university.

7. JIAPORN BENJAPHRAKAIRAT et al.,2002. **Final report " Design and Development of Garlic Planter attached to 5 HP power tiller."** Project. Department of Agricultural Engineering, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang,Thailand.(Mimeographed).

8. Thai Industrial standards Institute,1994. **Test code for Seeders** TISI 1236-2537, Ministry of Industry, Thailand.