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Effects of Harvest Methods on Seed Yield and Qualities of Lopburi 84-1 Soybean

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Abstract

The labor shortage of soybean harvesting has greatly affected soybean seeds production and the use of machinery to replace labor can reduce the problem. The study of the effect of harvesting method using combine harvester on seed quality of Lopburi 84-1 soybean was conducted and compared the seed quality according to standard of seed with labor harvesting followed by using a thresher. Threshing speed of combine harvester was set at 395 rpm (12.83 $m.s^{-1}$) and 330 rpm (10.72 $m.s^{-1}$) while the speed of 400 rpm (11.73 $m.s^{-1}$) was set for the thresher using in manual harvest method. Results showed that manual labor could harvest more efficiently at a lower first pod stage than a combine harvester. The loss from the use of the thresher 2.39%, while the combine harvester was 14.64% (395 rpm) and 16.98% (330 rpm) respectively. Quality and yield obtained from the labor harvesting were higher than those from thresher with less seed moisture. The percentage of humidity after harvesting, germination percentage were not statistically difference. In terms of seed quality after harvest, it was found that there was difference in percentage of seed purity between thresher and combine harvester while germination after 6 months of storage was not statistically different and was within germination standard of not less than 65%.

Keywords: soybean seed quality; soybean combine harvester; soybean thresher

Introduction

Soybean is an economic crop that creates food security which should be sufficient to sustainably meet domestic consumption demand But at present, Thailand imports up to 98% of soybeans from foreign countries only 2% can be produced domestically, which is imported from important trading partners such as Brazil, the United States and Canada in the year 2020, the demand for soybean seeds in the country was 4.04 million tons, an increase of 3.24 million tons from the year 2019, representing 24.69% due to the oil extraction industry and the animal feed industry has expanded in 2020, the total soybean planting area in the country was reduced to only 17,400 hectare, producing only 37.9 tons of soybean (Office of Agricultural Economics, 2019) in addition, commercial soybean seed produced domestically could support the demand for soybean seed only 1.74%, insufficient for domestic use and from the problem of labor shortage in the agricultural sector it affects the production of crops in every step from planting, caring and harvesting Thailand's main economic crops are also affected by this problem. Therefore, increasing domestic soybean production to meet domestic demand therefore it is very necessary to create food security of the country.

Soybean harvest which is a major problem for producers due to the process of planting and caring Farmers have machines that can be used to operate but the harvesting process still lacks labor and efficient harvesting machinery it has a great impact on the quantity and quality of soybean yields to harvest soybeans for high yield and good quality must take into account the maturity of the seed environment during physiological maturity as well as harvesting methods (Nilubon and Laondao, 2010), Lopburi 84-1 soybean variety was

a chemical quality soybean variety and on the sensory side (taste and smell) It is acceptable for the production of soy milk and high productivity little green smell and the aroma of soybeans is quite pronounced, which is accepted by soymilk manufacturers. (Anon et al., 2011) causing farmers to have high demand for seeds but producers seed production was insufficient to meet the demand due to labor problems harvesting There was a study on the use of a combine harvester to harvest soybean (Anuchit, 1996) and the use of different types of harvesting machinery, including the design of a soybean harvester attached to a tractor (Tanisorn, 1994), and the adjustment of a combine harvester to harvest soybean (Anusorn, 2013) to solve such problems in addition to government agencies that have already taken action private sectors that produce and sell combine harvesters have also taken action (Siam Kubota Company, 2018) by improving the threshing system, conveying system or other parts in order to have good efficiency but there was also a loss caused by seed breakage loss from massage system and losses due to incomplete harvesting this problem affects the acceptance of the use by farmers in the area.

At present government agencies that produce seeds tried the combine harvester used for harvesting for the production of soybean seeds by the characteristics of the improved combine harvester the threshing system is a threshing spokes and the threshing device is a wheel use a spoke or a flexible plastic spring to pull the stem of the plant. These methods play an important role in affecting seed quality. The purpose of this experiment was to study the efficiency of soybean harvesting by manual labor and the use of combine harvester at threshing speed of 395 rpm and 330 rpm on yield and seed quality of Lopburi 84-1 soybean, to be used as information for farmers or seed producers to apply in seed production soybean varieties and further reduce the labor shortage problem.

Aims and Objectives

To test and develop the use of agricultural machinery that has been researched and used today for soybean seed production effectively.

Specific Objective of the study

To study the method of harvesting soybean using a combine harvester. Appropriate effects on yield and quality of soybean seeds Lopburi 84-1

Study location

- Farmer's farm, Phra Phutthabat District Saraburi Province Thailand.
- Research and development center Lopburi Seeds Lopburi Province Thailand.

Methodology

Prepare the test plot

Preparing soybean planting plots at farmers' farms Saraburi Province By dividing the soybean plots for testing into 7 sub plots, size 10 x 40 meters. Plant soybean variety Lopburi 84-1 using the sowing method at a rate of 75-93 kilograms/Hectare Proceed with planting soybeans and take care of the soybean seed production process, including plowing and preparing the soil before planting Apply chemical fertilizers according to the recommendations of the Department of Agriculture. Mix soybean seeds with rhizobium biofertilizer before planting. Grow using a seed sowing machine, planting spacing 0.5x0.2 meters. After planting, spray herbicides. Spray soybean pest control chemicals according to the instructions and evaluate the harvest at 60 days after flowering or the stage of mature pods turning brown 95 percent (R8), with a storage area size 10x40 meters (Kantima et al., 2015).

Comparison of efficiency of soybean harvesting methods.

The experiment was planned using a Randomized Complete Block Design, consisting of 3 methods, 7 repetitions, as follows.

Method 1: Harvesting by manual labor and threshing with a soybean threshing machine at a speed of 400 rpm. (rice thresher brand

kasetpattana).

Method 2: Harvest with a combine harvester at a thresher speed of 395 rpm (Kubota combine harvester, model DC 70), engine speed ~2,400 rpm.

Method 3: Harvest with a combine harvester at a thresher speed of 330 rpm (Kubota Combine Harvester, model DC 70), engine speed ~2,200 rpm.

Detailed features of the threshing machine and combine harvester are as follows

Rice threshing machine, Kaset Phatthana brand with a threshing ball length of 1.23 meter (4 feet), by modifying the parts for threshing soybeans as follows.

1. Adjust the rotation of rotor using a speed of 400 rpm (11.73 m/s) (this is the recommended speed suitable for kneading soybeans).
2. Change the seed screening sieve is hole diameter of 9 mm.
3. Adjust the speed of screening sieve crank from 450 rpm to 380 rpm (this is the recommended speed suitable for threshing soybeans).

Figure 1: Rice thresher machine Kasetphattana Model tested on Soybean.

Kubota combine harvester model DC 70 which is a massage system that flows along the shaft (Threshold teeth) has a threshing ball size of 0.62 x 1.65 meters. The machine has been improved for use in harvesting soybeans according to the manufacturer's method. (Siam Kubota Phetchabun Company, 2018) as follows:

1. The wheel finger set is flexible plastic.
2. The crescent fin angle has been adjusted to 10 degrees from the original 27 degrees.
3. Adjust the rotation speed of the massage ball from 560 rpm and study two speed levels: rotation speed 395 rpm (12.83 $m.s^{-1}$) and rotation speed 330 rpm (10.72 $m.s^{-1}$).
4. Modify the bean seed conveying system to a ladle conveyor type.
5. Sieve type cleaning screen hole diameter 9 mm.

Figure 2: Kubota combine harvester model DC 70 tested on Soybean.

Data recording

1. Collect naturally fallen seeds before harvesting by weight in an area of 1 square meter and after harvesting according to the experimental method record the weight of the product and yield components include plant height, number of pods/plant, number of seeds/pods, weight of 100 seeds.
2. Collect lost seeds from the threshing system by using the net to support the harvester within a distance of 5 meters, time the movement while harvesting for methods 2 and 3, distance 40 meters.
3. Check seed quality to meet standards. International Seed Testing Association (ISTA, 2020) including moisture, germination, purity and strength after harvest both before and after seed conditioning and after storage at ages 0, 1, 2, 3, 4, 5, and 6 months.

Statistical data analysis of variance and comparison of mean differences were performed using Duncan's new multiple range test (DMRT).

Results

Total loss from harvest

Total harvest loss = harvest loss + threshing system loss (1)

$$\text{Harvest loss} = \frac{\text{weight of fallen soybean seeds + not completely harvested (2)}}{\text{Total weight of soybean seeds}}$$

$$\text{Loss of combine harvester system} = \frac{\text{weight of soybean seeds falling from scrap outlet (3)}}{\text{Total weight of soybean seeds}}$$

$$\text{Loss of thresher} = \frac{\text{weight soybean seeds falling through + falling in front of the cleaning screen (4)}}{\text{Total weight of soybean seeds}}$$

Harvest loss is weight of fallen soybean seeds when harvested by harvester or caused by other methods of harvesting however, the weight of seeds that fall naturally is not included.

Loss of massage system is the weight of the seeds that fall out of the scrap opening and the weight of the beans falling from the sieve for cleaning.

Seed quality

Check seed quality according to the standards in the seed quality inspection laboratory, including purity, moisture, germination, weight of 100 seeds, and checking the strength of the seeds by means of accelerated aging and finding the germination index seed cracking test using ammonium acetate method physical separation of seeds to find the weight of good seeds spoiled seeds include purple seeds, green seeds, wrinkled seeds, broken seeds, and another 4 parts to check seed quality purity, humidity, germination, weight of 100 seeds after being stored in a temperature and relative humidity controlled room (20°C 60%RH) by the distribution grade standards must have 98% purity, 10% humidity, 75% germination, along with checking seed germination after storage the various periods are 1, 2, 3, 4, 5 and 6 months.

Experimental results

Comparison of efficiency of soybean harvesting methods

Output and output componentsf from harvesting soybeans according to the specified method, method 1, it was found that the yield weight and yield components of soybean plants, including the number of pods/plant, the number of seeds/pods, and the weight of 100 seeds, were not statistically different among the 3 methods (Table 1) method 1 harvesting soybeans by manual labor and threshing them with a soybean threshing machine at a speed of 400 rpm/minute, the highest yield was 1,220 Kg/hectare And when the seed yield was improved, it was found that there was no difference between the three harvesting methods. Statistically as well, method 1 gave the highest seed yield of 1,024.4 kg/hectare, followed by method 2, while method 3 gave the lowest seed yield (Table 1).

Treatment	*Grain yield (kg/ha)*	*Seed yield (kg/ha)*	*Pods/ plant*	*Seeds/ pods*	*Weight 100 Seeds (g)*	*% seed moisture*
1. Labour + threshing machine	1220.0	1024.4	34.42	2.18	16.4	9.80 b**
2. combine harvester (395 rpm)	1216.9	972.5	33.22	2.22	18.1	11.30 a
3. combine harvester (330 rpm)	1163.1	958.8	34.70	2.12	17.2	1 1.32 a
CV (%)	2.66	3.51	2.30	2.32	5.88	8.07

** Mean in the same column follow by a common letter are not significantly different at the 5% level by DMRT.

Table 1: Number of branches/pods/plant. Seed/pods. Weight 1000 seed/plant of Lopburi 84-1 soybean at farmer's field.

The moisture content of seeds after harvesting was statistically different it was found that seeds from process 1 had seed moisture of 9.80%, lower than those of process 2 (11.30%) and process 3 (11.32%), indicating that process 1 had harvested by manual labor, soybean plants must be dried in the sun first then continue massaging with a massager this causes the seeds to have lower moisture content and is different from harvesting with a combine harvester.

The pre-harvest height of soybean plants was not significantly different as for the height of the first joint after harvesting, it was found that manual labor can be harvested at a distance of 8.12 centimeters from the soil surface, which is lower than harvesting with a combine harvester significantly (Table 2) shows that using manual harvesters can harvest at a lower distance than using combine harvesters and resulting in lower yield losses.

Treatment	*Early height (cm)*	*cutting height above the soil surface (cm.)*	*% Total loss*
1. Labour + threshing machine	53.48 a	8.12 b**	2.39 a
2. combine harvester (395 rpm)	51.30 a	9.80 a	14.64 b
3. combine harvester (330 rpm)	49.06 a	9.22 a	16.96 b
CV (%)	4.31	9.43	69.12

** Mean in the same column follow by a common letter are not significantly different at the 5% level by DMRT.

Table 2: Plant height and first pod height of Lopburi 84-1 soybean at farmer's field.

Total losses from the harvesting process were found to be significantly different by method 1, harvesting using human labor and threshing with a soybean threshing machine at a rotational speed of 400 rpm, there was only 2.39% loss, while in the second method, using a combine harvester at rotor speed of 395 rpm and in the third method, rotor speed of 330 rpm, there was a loss of 14.64% and 16.98%, respectively (Table 2) shows that using a combine harvester causes more seed loss compared to manual harvesting this is consistent with Wuttiphon et al. (2021) who developed a soybean combine harvester for use with a small tractor and reported that the combine harvester caused a total seed loss of 18.86%, but the seeds were clean 85.50%.

Seed quality after harvest including moisture percentage, germination, strength, and cracking of soybean seeds there was no statistical difference after harvesting from all 3 methods (Table 3) however, it was found that the purity of soybean seeds from method 1 was the highest at 84%, which was significantly different from the harvested seeds methods 2 and 3 show that manual labor is used to harvest and thresh with a threshing machine this causes the seeds to have fewer other impurities than using a combine harvester however, the obtained seeds must be cleaned again to improve the condition.

Treatment	*% Moisture*	*% Germination*	*% Purity*	*% Strength*	*% Cracking*
1. Labour + threshing machine	9.21 a**	81.4 a	84 a	28.6 a	70.40 a
2. combine harvester (395 rpm)	9.22 a	76.0 a	67 b	28.6 a	67.80 a
3. combine harvester (330 rpm)	9.11 a	76.4 a	68 b	29.8 a	62.00 a
CV (%)	0.66	3.86	13.07	2.39	6.44

** Mean in the same column follow by a common letter are not significantly different at the 5% level by DMRT.

Table 3: Comparison seed quality of Lopburi 84-1 soybean after harvest by different harvesting method.

As for the germination of soybean seeds after each month of storage for 6 months, it was found that the percentage of seed germination from the three harvesting methods was not statistically different after 6 months of storage, methods 1, 2, and 3 had average germination of 83.6, 80.0, and 81.2%, respectively (Table 4), which still has standard quality for commercial varieties (ISTA, 2020).

Treatment	*Months after storage*					
	1	*2*	*3*	*4*	*5*	*6*
1. Labour + threshing machine	85.2	87.4	90.0	90.0	85.0	83.6
2. combine harvester (395 rpm)	84.8	83.2	85.6	87.2	82.0	80.0
3. combine harvester (330 rpm)	84.2	86.6	90.2	87.2	85.0	81.2
CV (%)	0.59	2.60	2.93	1.83	2.06	2.25

Table 4: Percent seed germination of Lopburi 84-1 soybean after 6 months storage.

Summary of experimental results

The results of the test of 3 harvesting methods on the yield and quality of soybean seeds, Lopburi 84-1, found that the manual harvesting method using a threshing machine with a thresher speed of 400 rpm was able to harvest at a lower distance than the combine harvester (8.12 centimeters from the ground) and had lower seed moisture after harvest, which was 9.80% because after harvest soybean plants are dried in the sun and then threshed to get seeds which uses 2-level are 395 rpm and 330 rpm soybean seeds have a loss of 14.64 and 16.98%, respectively, and the process uses labor and is kneaded with a massager the seed purity was as high as 84%, while the seeds were only 67 and 68% pure in both combine harvester methods in addition seeds are harvested using manual labor and threshing machines seeds are harvested using manual labor and threshing machines seeds had 83.6% germination after 6 months of storage, which is a germination rate within the standard for commercial varieties, which is not less than 65%.

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