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Performance Test of Hybrid Corn Seed Sorting Machine Using Vibrating Mechanism

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ABSTRACT

A corn seed sorter enhances the quality of seeds used in corn production. The corn seed sorting process aims to separate corn seeds based on size and dirt. With the existence of this corn seed sorting tool, it can greatly assist corn farmers in producing high-quality seeds. This research aims to determine the performance of the seed sorting tool in sorting corn seeds using a vibration mechanism. In this research method, the variation of machine rotation speed is carried out at three levels, 1065 rpm, 1300 rpm, and 1400 rpm. Each speed level is tested with different inclination levels, 10°, 12.5°, and 15°. The results of this study indicate that the work capacity is directly proportional to the machine's rotational speed and the inclination angle of the sieve. The best performance in the sorting process is achieved at a machine rotational speed of 1400 rpm and an inclination angle of 15°, resulting in a sorting rate of 99%. Meanwhile, sorting effectiveness can be achieved at a machine rotational speed of 1300 rpm°.

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1. INTRODUCTION

The agricultural sector constitutes a vital component of the primary sector, contributing significantly to societal well-being due to its direct influence on economic growth. The expansive cultivation of cereal crops, such as maize (corn), is a noteworthy facet of this sector. In Indonesia, the palawija crops occupy approximately 7.9 million hectares, with maize cultivation encompassing around 5.7 million hectares. The province of South Sulawesi holds substantial potential for maize cultivation on arid lands, boasting an estimated 1.8 million hectares. National maize production stands at 30 million tons, and South Sulawesi alone can yield 1.53 million tons of dried maize kernels, with the highest production recorded in Bone Regency at 290 thousand [1].

One avenue to augment maize crop production is through the adoption of new and high-quality superior varieties. Quality seed categories encompass attributes such as clear variety purity, uniform shape and size, germination rates exceeding 80%, and freedom from extraneous seeds and impurities. The uniformity of seed size and shape is a paramount requirement for quality seeds and is particularly essential for farmers. Techniques such as manual hand sorting or mechanical sorting aided by machines [2] can be employed to attain uniform seeds.

The sorting process, based on seed size, not only in packaging and post-harvest handling but also mitigates risks during transportation, consequently impacting agricultural production costs [3]. Several sorting machines employ horizontal sorting mechanisms (vibration screens) powered by mechanical sources that drive the vibrating motion. In response to technological advancements in the agricultural industry and heightened market demands, agricultural stakeholders continually innovate to create tools and machines that expedite and streamline post-harvest management. Factors such as machine efficiency, vibration levels, operational noise, power consumption, and the quality of sorted maize seeds play pivotal roles in efforts to enhance product quality [4]

The Indonesian Cereals Research Institute (Balai Penelitian Tanaman Serelia, Balitsereal) has developed a maize seed sorting device propelled by an electric motor. The primary function of this device is to sort maize seeds based on size. However, the performance of this maize seed sorting equipment has not undergone formal testing.

As stipulated by the Minister of Agriculture Regulation No. 5 of 2007, Section 5, regarding the requirements and procedures for testing agricultural tools, domestically-produced or imported agricultural machinery must undergo testing before commercial production or importation. In light of the aforementioned context, this study aims to assess the Performance Test of Maize Seed Sorting Device Using Vibrational Mechanism based on the degree of screen inclination and eccentric shaft rotation speed, evaluating the sorting efficiency of the device developed by Balitsereal for maize seed sorting.

2. MATERIALS AND METHODS

2.1 Time and Place

This research was conducted from September to December 2022 at the seed processing room of the Research Institute for Cereal Crops, Maros Regency, South Sulawesi.

2.2 Tools

The tools used in this research are scales, tachometer, grain moisture tester PM-410, plastic containers, buckets, stopwatches, vectors, protractors, sacks, and stationery.

2.3 Material

The materials used were maize seeds of the JH 37 variety with a seed moisture content of 10-11%.

2.4 Research Procedure

This research procedure includes the preparation of tools and materials then testing the performance of the tool through measurements and calculations, by varying the rotation speed of the eccentric shaft and the angle of inclination of the sieve, in order to find out the maximum results. The treatment of rotation speed on the eccentric shaft used is (1065 rpm, 1300 rpm, and 1400 rpm) with a tilt angle (10°, 12.5°, and 15°). The following is the tool testing procedure:

1. Adjusting the rotational speed by replacing the pulley on the shaft with a 2. inch, 3 inch, and 4 inch pulley,
2. Installing a 6 mm diameter sieve and a 7 mm diameter sieve on top,
3. Set the angle of inclination of the sieve / sieve compartment with an angle of 10°,
4. Putting the maize seed material of variety JH 37 into the hopper,
5. Switching on the machine and pressing the start button on the stopwatch when the material starts sorting,
6. Calculating the length of the seed sorting process,
7. Turning off the machine and then weighing the number of corn seeds that have come out at each outlet,
8. Repeating procedures 3 to 7 for the 1300 rpm, 1400 rpm, and 1400 rpm rotary speed treatments.
9. Repeating procedures 1 to 8 for the inclination angle treatments of 12.5° and 15°.

2.4.1 Research Flow Chart

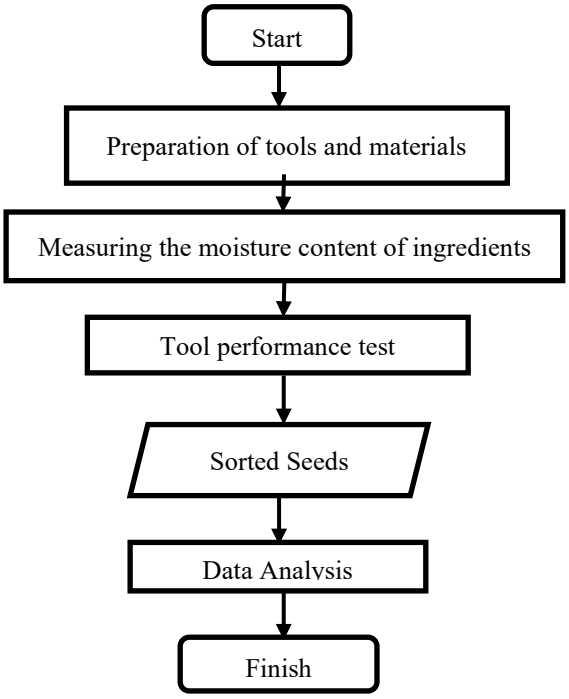

Figure 1. Research flow chart

3. RESULTS AND DISCUSSION

3.1 Working Capacity of Maize Seed Sorting Equipment

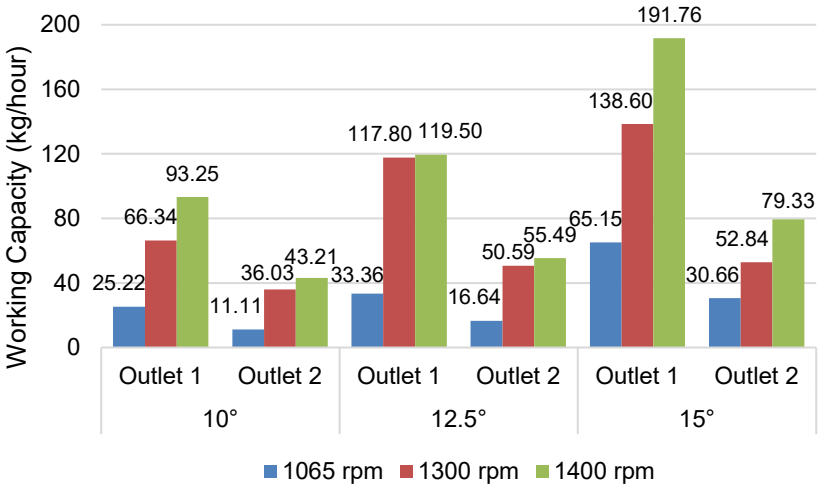

Figure 2. Working capacity of maize seed sorting equipment.

The results in the figure above show that the higher the engine rotational speed and the slope of the sieve angle will be directly proportional to the working capacity of the corn seed sorting machine due to the increased speed allows the machine to handle a larger volume of seeds within the same timeframe, leading to higher working capacity.This is indicated by the ability of the tool to sort corn seeds at a sieve inclination angle of 10° will increase along with the engine rotation speed of 1065 rpm at outlet 1 working capacity of 25.22 kg/ hour, 1300 rpm as much as 66.34 kg/ hour and 1400 rpm as much as 93.25 kg/ hour. The same thing also happens at the angle of inclination of the sieve 12.5° and 15° which is able to sort corn seeds as much as 119.50 kg/ hour and 191.76 kg/ hour at engine speed 1400 rpm, as well as for the working capacity of outlet 2. This is in line with the results of research by [5] that the working capacity of the sorting machine will be influenced by the slope of the sieve compartment and the rotation speed of the engine driving force. The greater angle of inclination of the sieve compartment causes a higher seed sliding force than a low angle of inclination.

3.2 Sorted Seeds

Seed sorting is an effort to obtain quality seeds by selecting seeds based on seed weight and size.

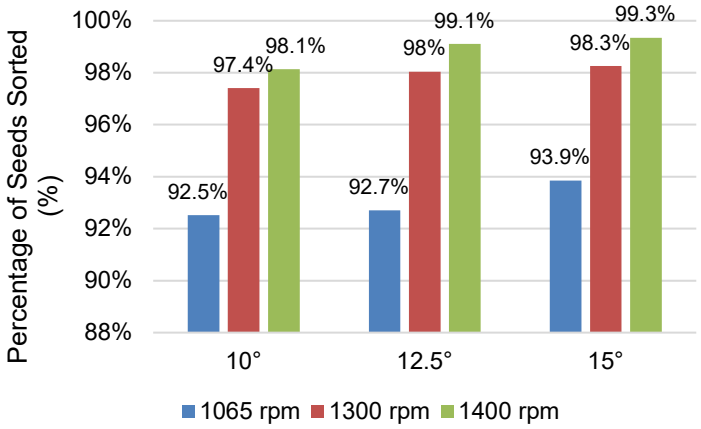

Figure 3. Percentage of sorted maize seeds.

The engine speed of 1065 rpm at an inclination angle of 10° shows a fairly low percentage of sorted seeds at 92.5% while the engine speed of 1400 rpm at an inclination angle of 15° shows a high percentage of sorted seeds reaching 99.3%. Most of the results show that at the same angle of inclination with higher engine speed, the corn seeds will fall more easily into the sieve hole to be sorted. This is in accordance with the results of research [6] that the success of sorting can be interpreted as a parameter that shows whether or not the percentage of sorted fruit of the whole sorted fruit is high.

3.3 Amount of seed impurities

Maize seeds are small in size and are often mixed with dirt, which causes low seed viability.

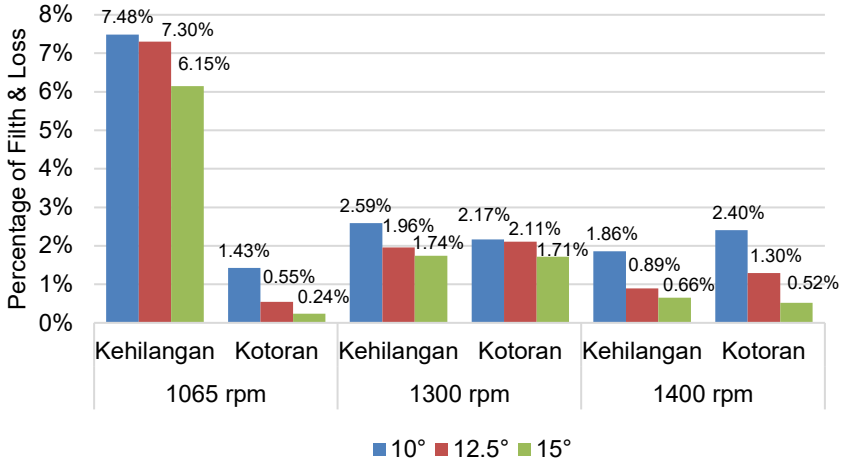

Figure 4. Percentage of maize seed filth and loss.

The results showed that the highest percentage of corn debris was found at a tilt angle of 10° with a rotational speed of 1400 rpm reaching 2.4% while the lowest percentage of seed debris at a tilt angle of 15° with a rotational speed of 1065 rpm was 0.24%. At engine rotation speed, the higher the angle of inclination will reduce the amount of sorted seed impurities, as well as the percentage of maize seed loss. This is in accordance with the opinion of [7] which states that seed sorting is carried out to separate pure seeds, seeds of other plants, and seed impurities so that the seeds are better maintained in quality so that the resulting production will be on target.

3.4 Sorting Effectiveness

Sorting effectiveness refers to the level of good and proper seed selection in the seed sorting machine. It is expressed as a percentage and indicates how well the seeds are selected according to the sieve hole size.

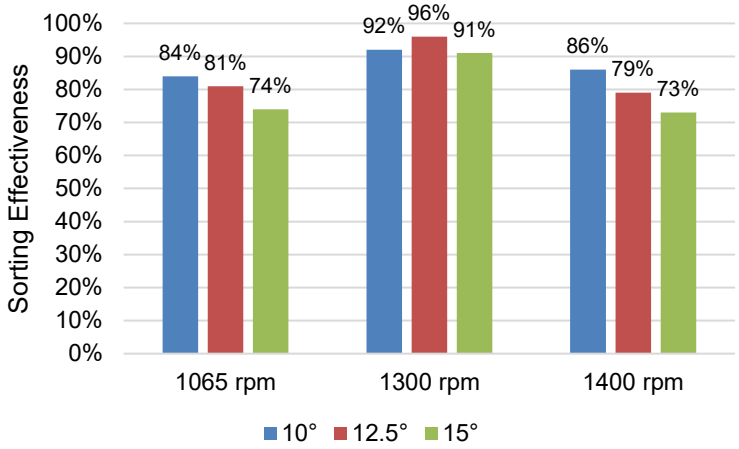

Figure 5. Effectiveness of maize seed sorting equipment.

Diagram above shows that at a speed of 1065 rpm, the sorting effectiveness decreases as the inclination angle increases, with 84% at an angle of 10°, 81% at an angle of 12.5°, and 74% at an angle of 15°. Similarly, at 1400 rpm, the sorting effectiveness decreased as the inclination angle increased, with 86% at 10°, 79% at 12.5°, and 73% at 15°. However, at a speed of 1300 rpm, the sorting effectiveness increases as the inclination angle increases, with the highest effectiveness of 96% at an inclination angle of 12.5°. Based on these data, it can be concluded that speed and inclination angle play an important role in the effectiveness of sorting. A lower inclination angle with the same machine rotation speed can increase the sorting effectiveness. However, if using a high inclination angle of 15° results in a decrease in sorting effectiveness. This can be overcome using an inclination level of 12.5°. The use of a 12.5° tilt angle can increase sorting effectiveness at a speed of 1300 rpm. This is in accordance with the results of research [2] that high work capacity does not guarantee that it will provide the best sorting products.

4. CONCLUSION

Based on the results of the study, the following conclusions were obtained:

1. The maize seed sorting tool has a level of work capacity that is directly proportional to the engine rotation speed and the level of inclination of the sieve angle. The highest working capacity is at a rotation speed of 1400 rpm with a sieve inclination angle of 15°.
2. The maize seed sorting tool has the best performance to get the highest capacity, which is at an engine rotation speed of 1400 rpm and a sieve tilt angle of 15 ° with a sorting success rate of 99.34% and seed loss of 0.66%.
3. The level of effectiveness produced based on the size of the seed dimensions shows the use of 1300 rpm rotation speed is better than the rotation speed of 1065 rpm and 1400 rpm.

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