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Effectiveness of Cassava Harvesting by Applying Harvesting Implement

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Abstract*. Cassava is one of Indonesia's leading food commodities, especially in Lampung Province. However, cassava harvesting is still predominantly done manually, which is time-consuming, labor-intensive, and prone to crop damage. This study aims to evaluate the effectiveness of cassava harvesting using a Kubota mechanical harvesting implement compared to traditional manual methods. The research was conducted in Bandar Mataram District, Central Lampung Regency, over an area of 0.75 hectares and observed parameters including harvest time, tuber damage, losses, and labor efficiency. Results showed that the harvesting implement significantly improved efficiency, allowing one machine to harvest up to 1.07 hectares per day, compared to only 0.045 hectares per day per person using manual labor. Tuber damage and losses were also reduced from 7% in manual harvesting to 1.59% with the implement. Furthermore, the implement created soil ridges suitable for direct replanting without further tillage. Despite its advantages, some operational weaknesses were identified, such as the need for stem cutting and transportation improvements. Overall, the use of mechanized harvesting tools enhances cassava farming efficiency and has the potential to reduce labor dependency and improve farmer productivity.*

Keywords: *Cassava, harvesting implement, effectiveness, tractor.*

1. Introduction

Indonesia is one of the world's largest cassava producers. Cassava production in Indonesia reached 22.7 million tons, ranking fourth after Nigeria, Congo, and Thailand. Lampung Province is the largest contributor to cassava production in Indonesia. In 2023, Lampung Province produced 7.3 million tons of cassava, equivalent to 32.2% of total national production. The district with the highest cassava production in Lampung is Central Lampung Regency with production reaching 2.5 million tons, followed by Tulang Bawang Regency (778 thousand tons), East Lampung Regency (1 million tons), West Tulang Bawang Regency (732 thousand tons), and North Lampung Regency (1.1 million tons).

Mechanization in the cassava harvesting process is crucial for increasing farmer efficiency and productivity. Currently, many farmers still use manual methods to remove cassava from the ground, which require significant physical effort and a long time. Furthermore, manual methods often lead to fatigue and injury. The application of appropriate technology, such as mechanical cassava harvesting tools, can be an effective solution to these problems. This tool makes the cassava harvesting process easier and faster, thereby increasing farmer efficiency (Sundari, et al., 2022).

Technological innovations in the harvesting process, such as the implementation of the double-row system, have been shown to increase cassava productivity. This system allows for more efficient planting spacing, thereby increasing yields per hectare (Beja and and Apelabi, 2022). The implementation of modern harvesting technology in Lampung could be a strategic step in addressing production challenges and increasing the competitiveness of the regional agricultural sector.

Furthermore, mechanization can also reduce reliance on manual labor, which is often in short supply, especially during harvest season. Thus, mechanization not only improves productivity but also the overall welfare of farmers (Wijayanto and Puspitojati, 2024).

Before widespread technology adoption, testing the effectiveness of harvesting equipment on farming productivity and efficiency is crucial. This evaluation includes analysis of operational costs, yield increases, and impacts on product quality. Studies on the technical and economic efficiency of cassava farming in several regions indicate that optimizing production factors can increase output and farmer income (Prasmatiwi, et.at., 2022). Therefore, thorough testing and evaluation of innovative harvesting technology will provide a strong basis for decision-making to improve the efficiency and welfare of cassava farmers in Lampung. The objective of this study was to assess the effectiveness of the Kubota cassava harvesting equipment compared to manual methods.

2. Methods

2.1. Location and Time of Activity

A cassava cultivation trial, conducted through full mechanization, was conducted in Bandar Mataram District, Central Lampung Regency. The trial site was 3/4 hectare of land owned by Mr. Widodo, an antenna farmer for Kubota. This land was then divided into four plots for each treatment. Each treatment area measured 35 x 50 meters. The trial lasted eight months, from May 2024 to January 2025. The duration of the trial followed the local cassava cultivation practices of farmers.

2.2. Tools and Materials

The tools used in this study were: planting equipment such as hoes, measuring tape, raffia rope, and stakes to mark planting rows. Planting and harvesting equipment included a tractor with additional equipment from Kubota, measuring tape, scales, calipers, writing instruments, a timer, and a camera.

The materials used in this study included cassava cuttings of the Celeng Hitam variety, 200 kg/ha of urea fertilizer, 200 kg/ha of Phonska NPK fertilizer, 250 kg/ha of potassium chloride (KCl), 3 tons/ha of dolomite, and 10 tons/ha of manure.

2.3. Effectiveness of Harvesting Tools

Evaluation of harvesting equipment effectiveness is conducted to determine its efficiency and impact on crop yields. Several parameters observed include:

a) Harvest Time per Hectare: Measurement of the time required for the harvesting process to determine labor and equipment productivity.
b) Tuber Damage Rate: The percentage of tubers damaged during the harvesting process will be analyzed to identify the most effective harvesting method.
c) Losses: The percentage of tubers lost during the harvesting process due to being left in the soil or damaged during uprooting.
d) Labor Requirement: The number of laborers used in each harvesting method will be compared to determine labor cost efficiency.

3. Results and Discussion

3.1. Comparison of Harvest Time, Tubers Damage, and Labor Efficiency between Kubota Implementation and Manual Methods.

Cassava harvesting using machinery is carried out using a 4-wheel tractor and a harvesting implement (Figure 1). The cassava harvesting implement consists of a horizontally mounted disc blade that is sunk into the soil to a depth of approximately 30-40 cm, following the depth of the cassava tubers. This disc blade is attached to a frame or frame attached to the 4-wheel tractor with 3 tree-point mounted attachments so that it can be raised and lowered or sunk into the soil to the desired depth, usually according to the depth of the cassava tubers. The harvesting implement is sunk into the soil and pulled forward by the 4-wheel tractor so that the cassava tubers are upside down and ready to be separated from the stems (Figure 2).

Figure 1. Cassava Harvesting Implement

Figure 2. Cassava tubers harvested using a harvesting implement

Cassava harvest time is the time required to harvest or remove the cassava stems until the tubers are ready to be separated from the stems. Harvesting using machinery is faster than manually. Therefore, using harvesting implements provides a shorter harvest time and allows for faster soil preparation for subsequent planting. Cassava planting based on the season or rainfall allows for greater flexibility. The average time required for harvesting with implements is 1.07 ha/day.

Harvesting using a cassava harvester or implement minimizes losses due to damage or retention of tubers in the soil compared to manual harvesting. Tubers harvested with implements can be completely turned to the surface of the soil, eliminating any tubers remaining in the soil. Furthermore, harvesting with implements significantly minimizes damage from being cut or crushed by implements or tractor wheels. Table 1 shows that the average loss (loss due to cassava tubers remaining in the soil or being damaged/deleted by implements) is very small, at around 1.59%. These losses are very small compared to manual harvesting, where losses reach 7% (Sagala and Suwarto, 2017).

Table 1. Harvest damage (losses)

	Damaged samples (kg)	Sample weight (kg)	Percentage of damage (losses) (%)
Test 1	0,35	72,75	0,4811
Test 2	0,8	60,35	1,325601
Test 3	2,05	67,35e	3,043801
Average	1,07	66,81	1,596408

The harvesting process using a harvesting implement takes less time than manual harvesting. Harvesting using an implement with one operator can harvest 0.935 hectares of cassava per day, while manually harvesting with one person can only harvest 0.045 hectares. In other words, one harvesting machine can harvest 1 hectare in one day, while harvesting 1 hectare in one day with manual labor requires approximately 23 people. Therefore, harvesting cassava using an implement is much faster than manually harvesting.

3.2. Impact of Implement Use on the Quality of Harvested Tubers.

The harvesting process using an implement completely inverts the cassava tubers. Observations showed that harvesting using an implement did not result in any cassava tubers remaining in the soil. Many of the inverted tubers were also not broken. According to Table 3.4, only about 1.59% of the tubers were damaged or broken. These fractures were clearly visible and could be removed and combined with the collected cassava tubers, thus not reducing the harvest yield. The resulting tubers were also not peeled or damaged, thus concluding that the cassava tubers harvested using an implement were of excellent quality (Figure 3).

Another advantage of harvesting with this implement is that the resulting mounds or ridges form the soil, allowing cassava seedlings or stems to be planted directly into these mounds without requiring any special tillage. This direct harvesting and planting method reduces tillage costs by eliminating the need for further tillage.

Figure 3. Harvesting Process with Tractor-Pulled Implements.

3.3. Weaknesses in Implementing Cassava Planters and Harvesters

Besides the advantages of using a planting implement, there are several drawbacks to this machine: the cassava seed storage box or hopper lacks grooves for storing the cassava seeds. The cassava seeds are placed on a flat surface, which often causes the seeds to become ragged and their orientation to become irregular. Therefore, it is necessary to design an adequate cassava stem seed box to maintain the orientation of the cassava seeds. Misaligned seed orientation makes it difficult for the operator to plant properly and can lead to incorrect orientation of the cassava seed planter. Incorrect seed orientation can lead to low cassava yields. Furthermore, the soil cultivation process also produces angular ridges, making it difficult for the operator to plant the cassava seeds, and some seedlings fail to plant. Therefore, the application of ridge levelers is necessary.

Harvesting cassava using a harvesting implement still requires labor to cut the cassava tree before harvesting with the implement. Harvesting with the implement creates new ridges that can be directly planted in the next planting season. On the other hand, this makes it difficult for trucks transporting the harvested cassava to enter the cassava harvest area, requiring labor to transport the harvested cassava out of the harvest area (Figure 4). To overcome this condition, it is necessary to design a cassava stem cutter placed in front of the tractor so that it can cut the cassava stems during harvesting. Meanwhile, to transport the harvest, it is necessary to design a harvest container at the rear of the harvesting implement that can be harvested and unloaded when the tractor maneuvers at the end of the harvesting area or when turning around at the side of the harvesting area.

Figure 4. Bunches of Harvested Crops Using Implements and Crops that Need to be Transported Out of the Harvest Area.

4. Conclusion and Suggestions

The use of cassava harvesting tools has proven to be more efficient than manual methods, because it only requires one machine to harvest 1.07 ha per day (compared to 23 people manually for 1 ha per day), reduces the level of tuber damage from 7% to 1.59%, and produces ridges that allow replanting without the need for plowing the land.

It is recommended to use a ridge leveler on a tillage implement or planting tray. This tool will level the surface of the ridge after tillage, creating a flatter and more stable surface for planting seedlings. This makes planting easier for the operator and minimizes planting failures. It is recommended to design and install a cassava stem cutter that is mounted on the front of the tractor or integrated with the harvesting implement. This allows for automatic cutting of the cassava stems simultaneously with the harvesting process, eliminating the need for manual labor and speeding up the overall process. It is recommended to design and add a harvesting container to the rear of the harvesting implement. This container should have sufficient capacity to accommodate the cassava harvest and be designed for easy unloading. Unloading can be done while the tractor is maneuvering at the end of the harvesting area or when turning around at the side of the harvesting area, allowing the harvest to be immediately moved to a location more accessible to the transport truck.

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