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DESIGNING AND MANUFACTURING HARVESTING MACHINE FOR *CENTELLA ASIATICA*

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Abstract: This paper presents the designing, manufacturing and piloting process of a havesting machine for *Centella asiatica*. This model is designed and manufactured on the basis of the survey taken on the characteristics of *Centella asiatica* in Quang Tho district, Thua Thien Hue Province. Within the project, the experiments of the machine's moving speed, cutting speed and optimal speed are carried out. The results meet the authors' expectance in terms of efficiency.

Keywords: havesting machine, *Centella asiatica*, efficiency

1 Introduction

Applying automation in agriculure is a significant means to minimize labour and enhance crop and production value. In this attempt, scientific research aligned with practical agricultural situation has become the main concern of today's society with a view to change the traditional mindset of the farmer, modernize farming methods as well as to meet the development requirements of modern manufacturing in agriculture.

A harvesting machine for *Centella* reduces the labour of farmer, enhances crop, and reduces expenses in the *Centella asiatica* production process. These days, *Centella asiatica* has been widely used as a healthy kind of food and drink, such as *Centella* tea [1]

However, cutting and collecting *Centella* are mainly carried out manually. This traditional method not only results in low harvesting productivity (50–70 kg/person/day) but also affects farmers' health because they work outdoor for long hours. In addition, according to 2015 report [2], the expense for harvesting *Centella asiatica* accounted for nearly 20 % of the total income. Therefore, it is necessary to study and design a specialized harvesting system to enhance the *Centella* productivity, quality and avoid damaging the product during harvesting.

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Fig. 1. A farmer in Quang Tho District cuting *Centella asiatica* by hand

2 Material and research method

2.1 Research material

Research material in this project is *Centella asiatica* grown in Quang Tho 2 Agricultural Commune. The detailed botanical characteristics of *Centella asiatica* are described in Table 1.

Table 1. Botanical characteristics of Quang Tho *Centella asiatica*

Unit: cm

Lenth of main root	Diameter of main root	Trunk diameter	Leave diameter	Petiole diameter	Petiole length
6.84	0.18	0.12	4.43	0.22	13.93

Based on the report of Quang Tho 2 agricultural commune, the harvesting machine should cut the *Centella asiatica* about 5–6 cm in length. In addition, according to the farmers' requirements, the machine should move slowly to avoid the damange of *Centella*.

Fig. 2. The height of *Centella asiatica* grown in Quang Tho commune

2.2 Research method

Based on the botanical characteristics of *Centella asiatica* and soil characteristics in Quang Tho 2 Agricultural Commune, machine designing process is shown in **Error! Reference source not found.** in the following:

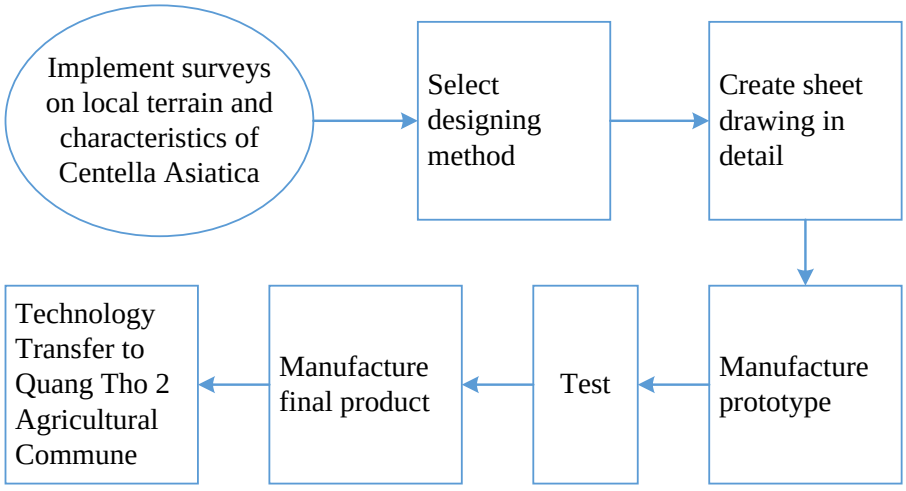

Fig. 3. Designing process diagram

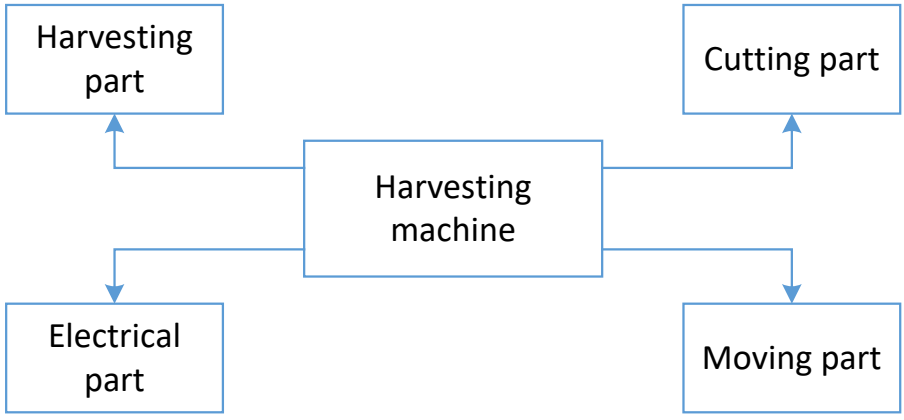

Fig. 4. Diagram of the cutting machine

After surveys, authors suggest designing the machine that is suitable for user as lawn mower does [3]. Therefore, the machine including 4 parts is designed as shown in Figure 4, in detail:

- Electricity part: Battery providing electricity for the electric motor
- Harvesting part: include conveyor and container

- Cutting part: include cutting blaze, rulo, conveyor
- Moving part: include two wheelers controlling machine under human force

2.3 Calculation of Harvesting machine

According to [4], the knife speed of the harvesting machine is calculated as follows:

$$V_k = \frac{W \bullet n}{30} \quad (1)$$

where:

V_k: speed of the cutting blaze (m/s)

W: length of the cutting blaze (m)

n: speed of the cutting electric motor (rpm)

Moving speed of the machine is calculated according to the following formula [4]:

$$V_f = \frac{3.6\mathrm{D}}{T} \quad (2)$$

where:

V_f: moving speed (km/h)

D: harvesting distance (m)

T: harvesting duration (s)

Cutting capacity of the circuit is calculated accoding to the following formula [4]:

$$F_c = 0.1 \cdot V_f \cdot \mathrm{W} \cdot f_e \quad (3)$$

Therein:

F_c: machine capacity (hectare/h)

V_f: machine's moving speed (km/h)

f_e: cutting efficiency. It is the ratio between operating duration and total duration that the machine is on the field.

3 Research results and discussion

3.1 Design the harvesting machine

After surveys and calculations, the harvesting machine is designed as shown in Figure 5. Due to the small entrance to move the harvesting machine, authors have proposed a harvesting machine that the farmer can easily bring to the *Centella* field. The machine elements are designed based on Vietnamese standards [5]. The important of the harvesting machine is the cutting blaze. The principle of cutting blaze is designed as shown in Figure 6 [6, 7].

According to the report [1], the *Centella* often gathers between 2 and 5 leaves in a group. Based on the diameter of trunk, the authors select a saw blade where the distance of two teeth is about 3 cm as shown in **Error! Reference source not found.**. Moreover, in order to reduce the uneven surface of the soil, the length of blade is B = 622 mm is chosen. The software used for drawing is Solidwork [8]. The 3D machine design are described in **Error! Reference source not found.**. The technical properties of harvesting machine are shown in Table 1.

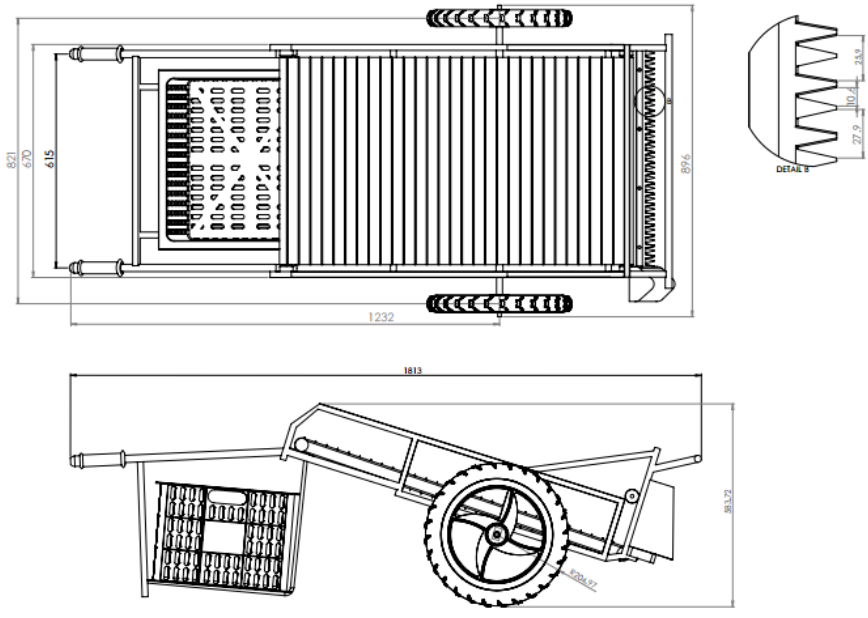

Fig. 5. *Centella asiatica* harvesting machine

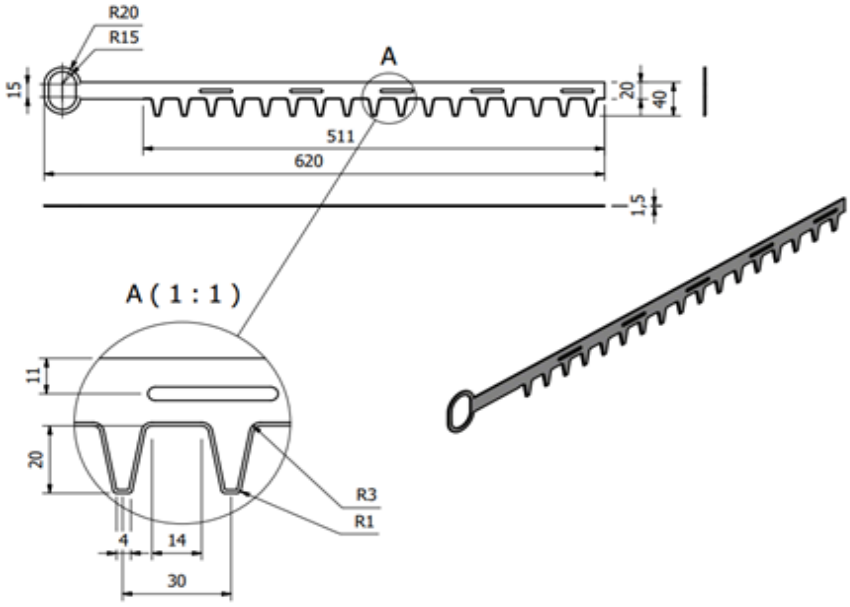

Fig. 6. Drawing of the blade

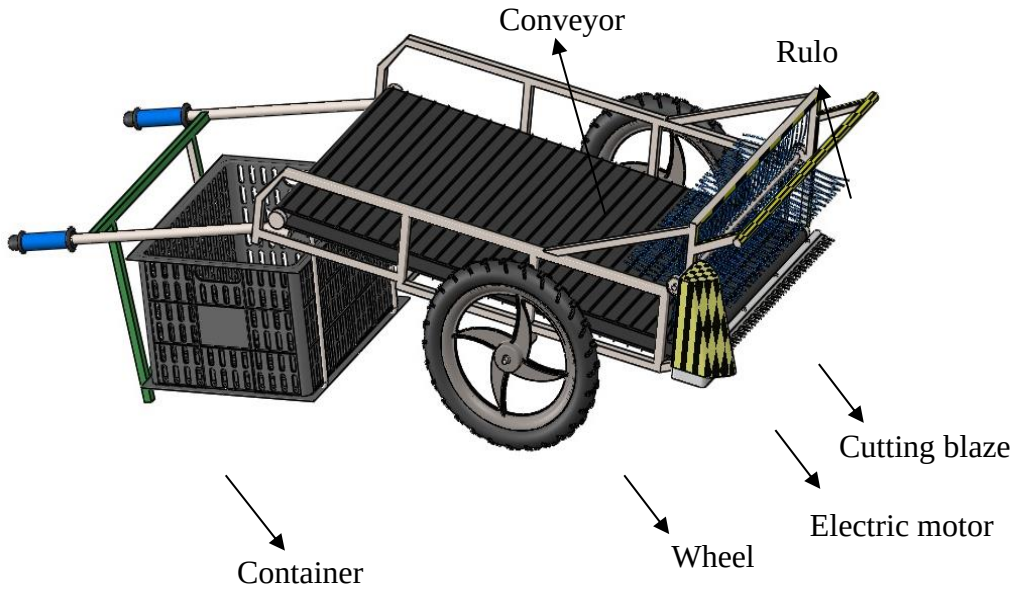

Fig. 7. 3D drawing of *Centella asiatica* harvesting machine

Table 2. Technical parameters of *Centella asiatica* harvesting machine

Specification of harvesting machine	**Unit**	**Value**
Height	mm	580
Width	mm	890
Length	mm	1800
Width of the cutting blaze	mm	620
Speed of the cutting blaze	m/s	2
Conveyor width	mm	580
Conveyor speed	rpm	100
Rulo speed	rpm	100
Machine capacity	kg/h	60
Machine's moving speed	km/h	1–5
Battery capacity	Ah	20
Number of electric motor	motor	2
Capacity of the electric motor	W	80
Operating duration of machine	h	3
Machine's weight	kg	50
LxWxH (Length x Width x Height)	mm	1800x890x580

3.2 Manufacturing the harvesting machine

After creating drawing sheet for manufacturing, a harvesting machine for *Centella asiatica* is manufactured as shown in **Error! Reference source not found.**. Havesting machine parameters are shown in Table 2. Its size and weight are suitable for using in household units. A farmer tries to operate the machine as shown in **Error! Reference source not found.**.

Fig. 8. Manufacturing of Harvesting machine for *Centella* Aisatica

Fig. 9. Farmer harvests *Centella asiatica* by using proposed machine

Operating parameters of harvesting machine are described in Table 3. Different cutting speeds are tested to investigate machine's efficiency.

3.3 Experimental results

Experimental parameters are described in **Error! Reference source not found.**. When the operating speed is over 2 km/h, machine's cutting speed fails to catch up with user's moving speed. Consequenly, machine's capacity reduces due to accumulated *Centella asiatica*. On the basis of experiment results, the machine will reach its best efficiency at the speed of 2 km/h.

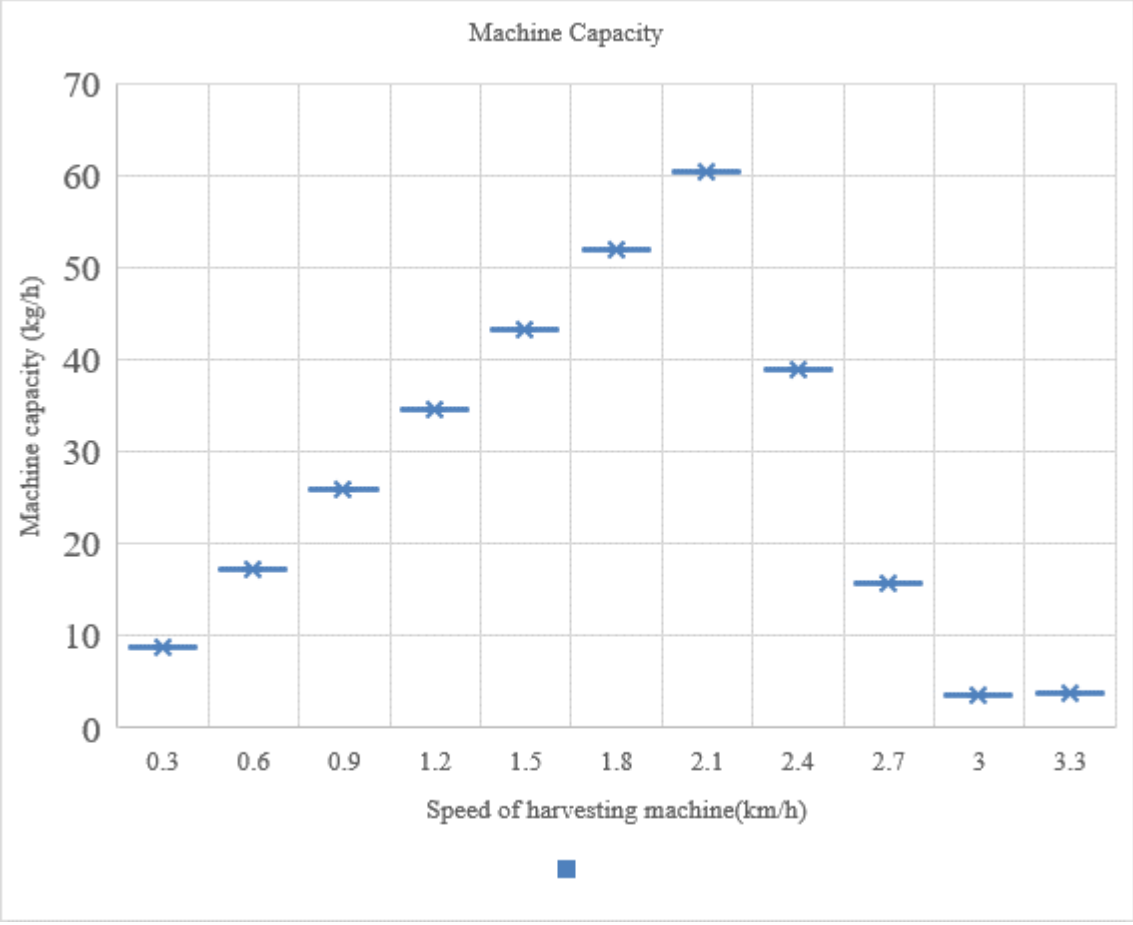

Fig. 10. Experimental parameters of *Centella asiatica* havesting machine

4 Conclusion

In this paper, the harvesting machine for *Centella asiatica* is designed and manufactured to confirm the feasibility of the proposed machine. Through the experimental results, the machine has harved Centell successfully. The optimal speed for the proposed machine is about 2 km/h. The harvesting machine has solved the manual cutting of farmer and verified the advantage of har-

vesting machine for *Centella*. Although this harvesting machine has innitially helped increase farmer's economy, crop productivity and reduced muscle labour, more improvements still should be done to increase its working efficiency and machine capacity. For example, improving cutting part, designing a functional part which helps separate yellow leaves. Therefore, authors suggest having more time to cary out research, site pilot to fully complete the project.

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