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Development of the water hyacinth transport up from the canal

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Abstract

Water hyacinth has caused damage to the ecosystem and agricultural problems. The tools designed for water hyacinth eradication can be easily transported and have no environmental impact. The working principle of the water hyacinth transporter uses a gasoline engine as power, allowing it to be used in remote areas without electricity. It is suitable for use in small canal areas, capable of transporting 3,950 kg of water hyacinth per hour at a speed of 80 rpm. This speed depends on the size and density of the water hyacinth and the feedrate. The machine's performance is indicated by R^2 = 0.94 for its ability to work and R^2 = 0.99 for the appropriate use of fuel. It can be a powerful tool for water hyacinth eradication and help reduce labor.

Keywords: Water Hyacinth, Irrigation, Conveyor set

1. Introduction

Currently, water hyacinth is classified as an invasive species that spreads rapidly, causing damage to native plants and the ecosystem of Thailand. This leads to various problems in agriculture, irrigation, and public health. Controlling this weed is difficult because water hyacinth is resilient to environmental conditions and reproduces rapidly through seeds and runners. In just one month, one water hyacinth plant can produce up to 1,000 offspring, and its seeds can remain viable for up to 15 years even in dry conditions. when provided with sufficient water, they sprout new plants.

The main problems caused by water hyacinth include: 1) Hindering water drainage by reducing water flow by approximately 40%. 2) Blocking waterways, making navigation difficult for boats. And 3) Dense growth obstructing fish growth and fishing, leading to flooding and dense mats of water hyacinth on the water surface [1]. In the year 2023, the Department of Development and Maintenance of Waterways conducted the eradication of water convolvulus and weeds in collaboration with various agencies and under the supervision of the Committee for the Coordination of Development Efforts to Address Water Hyacinth Issues. This was done to alleviate the concerns of the public and enhance the efficiency of water drainage, aiming to prevent flooding during the rainy season. The Port Authority dispatched eight weed removal boats and one set of backhoe loaders to eradicate water hyacinth in the Chao Phraya River, totaling 658,000 tons [2]. As a result, each year, the Department of Irrigation incurs significant losses in controlling and eradicating water hyacinth. There are several methods used for controlling and eradicating water hyacinth, including manual labor, with an estimated cost of about 3,400 baht per acre, machinery such as large and small weed removal boats, chemical use, biological methods, and integrated approaches. Chemical use is a convenient, fast, cost-effective, and efficient method. However, chemical use has limitations due to its environmental impact, as it involves applying chemicals to water sources, raising concerns about environmental safety. This has led to difficulties in effectively controlling and eradicating water hyacinth in the past [3].

From research studies that have been conducted to develop tools for water hyacinth eradication, such as Nagassa & Belay [4] Current status of water hyacinth (Eichhornia crassipes) in Ethiopia: achievements, challenges and prospects. Schreyers et al. [5] Plastic Plants: The Role of Water Hyacinths in Plastic Transport in Tropical Rivers. Yan et al. [6]. Advances in management and utilization of invasive water hyacinth (Eichhornia crassipes) in aquatic ecosystems. Thongchai [7] studied and developed a water hyacinth harvesting machine with an installation-based conveyor system along the banks to control and utilize water hyacinth. The machine is powered by a 30 Hp electric motor, three-phase electrical system. It can harvest approximately 5-10 tons of fresh weight water hyacinth per hour, with just 2-3 workers controlling its operation. Thipphayarattan et al. [8]. designed a water hyacinth harvesting machine with characteristics similar to a backhoe. The design involved analyzing the machine's water weight-bearing capacity. Tantipitsankul [9] conducted a study and built a water hyacinth eradication boat. The boat's design is divided into four main parts: the boat body, propulsion system, cutting set, and conveyance system. The cost of operation averaged at approximately 16.98 baht/m^2.

Based on past studies, it was found that the equipment is large-sized and high-powered. If the equipment used for weed control can be easily transported, energy-efficient, and environmentally friendly, it can reduce labor, lower costs for water hyacinth eradication, and be eco-friendly. Therefore, this research investigates the working principles of a conveyor system using power from a gasoline engine. It aims to develop a water hyacinth transportation system from canals and test its ability to transport efficiently. This would be beneficial for use in small canal areas, serving as a powerful tool for water convolvulus eradication and reducing labor.

2. Materials and methods

2.1 Development of the machine

Cut four pieces of angle iron to a length of 450 cm and eight pieces of box iron to a length of 80 cm. Then, weld these components to assemble the machine frame. Next, cut six sheets of galvanized iron to a length of 90 cm and a width of 30 cm. Cut fifteen pieces of angle iron to a length of 44 cm to be used for the water convolvulus conveyor. After that, cut forty-five pieces of flat iron to a length of 8 cm. Then, assemble and install the conveyor belt onto the water convolvulus conveyor machine using a 5-horsepower gasoline engine as the power source, as shown in Figure 1.

Figure 1 Water hyacinth transport machine

2.2 Evaluation of performance of a water hyacinth transport machine

Before testing the machine's capabilities, measure the width, length, and height of the chayote squash with a STANLEY 5M / 16 in measuring tape and weigh it with a digital scale model ICS429-BC60 with a maximum weight of 60 kg and a reading accuracy of 2 g. Then, calculate the fuel consumption rate before testing. Next, install the chayote squash conveyor machine on the ground and lower the end of the machine to touch the water. Then, feed the chayote squash close to the machine. The conveyor system will transport the chayote squash upward. Test at three speed levels: 170, 120, and 80 rpm, and calculate the fuel consumption rate during the test as shown in Figure 2.

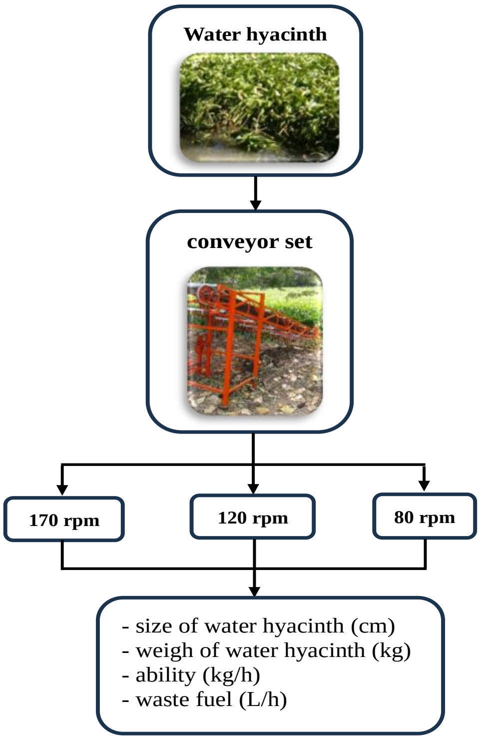


Figure 2 Flow chat for capabilities of the water hyacinth transport machine

2.3 Analysis of test results

The ability to work efficiently is crucial because agricultural machinery is primarily used for contract work, whether it's on a per unit area or per unit production basis. Therefore, contractors are keen on performance in this regard. The capability of the chayote squash conveyor machine can be determined by its material processing capability, which is the ratio of the total weight of material processed to the time taken for the operation, expressed by the equation $C_m = M/T$, where C_m represents the material processing capability, M is the total weight of material processed, and T is the time taken for the operation [10]. The chayote squash conveyor machine is powered by a 5-horsepower gasoline engine. Therefore, the machine's operating expenses consist of fuel costs, which can be calculated as the fuel consumption rate per unit of operation time. This can be determined by the amount of fuel used (in liters) divided by the duration of operation (in hours) [11].

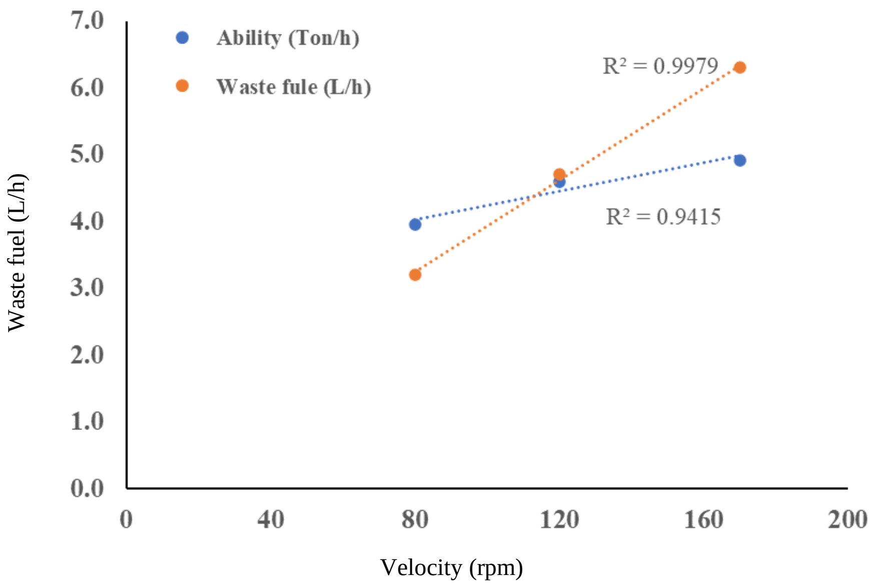
3. Results and Discussion

The operation process of the chayote squash conveyor machine begins with installing the conveyor along the bank, with the end part touching the water and sweeping the chayote squash towards the end where the machine makes contact with the water. Then, the conveyor system pulls the chayote squash upward, where it drops onto the bank. The results of the machine's operational capability and fuel consumption are shown in Table 1.

Table1 Results of water hyacinth transport up from the canal

Velocity (rpm)	Ability (kg/h)	Waste fuel (L/h)
170	4,920	6.3
120	4,588	4.7
80	3,950	3.2

When data from Table 1 is represented as a graph illustrating the relationship, it is observed that as the operating speed increases, it results in a linear increase in the machine's performance, with an R^2 of 0.94. Similarly, an increase in operating speed leads to a linear increase in fuel consumption, with an R^2 of 0.99, as shown in Figure 3.



The test results of the chayote squash conveyor machine reveal that at an operating speed of 80 rpm, it can transport chayote squash at a rate of 3,950 kg/h, consuming less fuel compared to operating speeds of 170 and 120 rpm, respectively. This is because lower operating speeds depend on the size and density of the chayote squash and the feeding rate. These findings align with the research by Thongchai Chuchamtipong [7], which studied a chayote squash cutting machine powered by an electric motor with a minimum size of 1/5 horsepower and an operating speed of approximately 1,000 rpm. This machine could harvest approximately 5-10 tons of fresh chayote squash per hour, depending on the density of the chayote squash and the speed of the water flow, with 2-3 workers controlling the operation.

4. Conclusions

The principle of operation of the water hyacinth conveyor machine utilizes a gasoline engine as the power source. This allows the machine to be used in remote areas without electricity. It is suitable for use in small canal areas, where it can transport water hyacinth at a rate of 3,950 kg/h. It can serve as a powerful tool for controlling water hyacinth and can help reduce manual labor. To further develop the water hyacinth conveyor machine, it should be lighter in weight and easier to transport. It should also be easy to install. It is advisable to switch from a single chain to a double chain for increased operational efficiency.

5. Acknowledgements

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