

## Aquatic weed removal with a rake to optimize water delivery

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### ABSTRACT

Aquatic weed infestations are caused by various types of weed in irrigation channels, such as floating weeds, emergent weeds and submerged weeds. Other causes of the infestations include land-use change, excessive fertilization, or even global warming. There are many ways to weed depending on suitability, such as the use of large machines, chemicals, and manpower regularly. Likewise, the Royal Irrigation Department (RID) usually eliminates weeds in irrigation channels. In 2020, the budget was allocated to weeding in irrigation channels in the amount of 141.38 million baht, equivalent to 2,749,774 tons of weeds eliminated. (RID 2020).

The objective of this research is to study, design, and develop a tool to eliminate the submerged weeds. The tool was designed by taking into account materials that are applicable, easily found, at the proper weight, convenient to move, and able to work efficiently. The tool was tested in the irrigation canal area, at the Water Transmission and Maintenance Department 3, Water Delivery and Maintenance Project, Kamphaeng Saen, Nakhon Pathom Province, Irrigation Office 13. The testing eliminated submerged weeds, such as *Potamogeton nodosus* Poir, *Hydrilla verticillata*, and *Ottelia alismoides*. In order to suit the width of the canal, the researchers developed a submerged weed control tool in two types: Cart rake set and Wheelbarrow rake set. The cart rake type is used at the bottom of the canal with a width size from 0.5 - 1.0 meters, while the wheelbarrow rake type is used at the bottom of the canal, with a width size from 1.0 - 2.0 meters. As a result of testing the tools in a canal with a width of 1.0 - 2.0 meters, the tools were able to weed 5.52 - 9.69 tons per day (approximately 1.1 - 1.7 kilometers canal length), using six workers and two pickup trucks. The weed rake is an innovation in weeding, in order to support the irrigation water delivery in being more efficient and effective.

**Keywords**— Weed Rake, Aquatic Weed, Submerge Weed, Efficiency of water management

### INTRODUCTION

According to the policy of the Director-General of the Royal Irrigation Department in the removal of weeds obstructing irrigation water, the weeds in irrigation channels are obviously considered as a direct obstacle to currents, causing the speed of the current to decrease, the change in flow direction not in corresponding to the design principle, and eventually leading the current to resist the regular flow in the channels resulting in a calm look. These causes directly impact the water management by not allowing some water to be delivered to the target area and increasing the amount of wasted water. This results in an allocation of excessive water meeting the needs of the plants.

There are many suitable ways to weed, such as the regular use of large machines, chemicals and manpower. Likewise, the Royal Irrigation Department (RID) has regularly eliminated weeds in

irrigation channels. There is a budget allocation to weed limitation in irrigation channels, along with the likelihood for more budget for continuously resolving weed infestation.

### 1. BACKGROUND AND SIGNIFICANCE OF THE RESEARCH

The Water Transmission and Maintenance Department 3, Kamphaeng Saen Water Delivery and Maintenance Project, Irrigation Office 13 surveyed the canal area and found 3 types of submerged weeds; *Potamogeton nodosus* Poir, *Hydrilla verticillata*, and *Ottelia alismoides*, which currently present problems in delivering water. Therefore, an innovative idea was formulated to design a submerged weed removal tool (weed rake) for the project operation.



Fig. 1. Irrigation weed problems

### 2. OBJECTIVES

2.1 To research and develop submerged weed removal tools in irrigation canals

2.2 To innovate submerged weed removal tools including (their) usability testing

2.3 To disseminate the inventions used for the duties of the Royal Irrigation Department and other departments within the Ministry of Agriculture and Cooperatives.

### 3. RESEARCH METHODOLOGY

3.1 Relevant research data exploration.

3.2 Conducting a survey of the area and discovering the irrigation canals with submerged weeds ; *Potamogeton nodosus* Poir, *Hydrilla verticillata*, and *Ottelia alismoides*, etc., which root firmly in the ground underwater.

3.3 Innovating a submerged wood removal tool, "Weed rake", suitable for the size of the canal with a bottom width of 1.0-2.0 meters and a depth of about 1.5-2.0 meters. There is no complexity in the production of a weed rake tool; on the contrary, its materials, which are known for their low cost, compactness, lightness, portability, and simple maintenance, are generally available on the market. The weed rake tool can be illustrated in two types below.



Fig. 1. - Cart rake set. For canals with a bottom width of 0.5 to 1.0 m.



Fig. 2. Wheelbarrow rake set. For canals with a bottom width of 1.0 to 2.0 meters.

3.4 Testing the performance and efficiency of the submerged weed removal tool in the irrigation canal area at the Water Transmission and Maintenance Department 3, Kamphaeng Saen Water Delivery and Maintenance Project, Nakhon Pathom Province, Irrigation Office 13, which has the following weed removal tools:

3.4.1. Basic submerged weed removal tools; 1 set of weed rakes.

3.4.2 Two wire rope slings with two loop ends of 6 millimeters in diameter, and 25 meters in length each, and hook kits for hauling tool carts, etc.

3.4.3 One - two small trucks or tractors for hauling weed rake tools.

3.4.4. This tool is designed to be used by four operational staff. That is, one person is in the water to support the tool, one to two people to drive and two people to scoop up weeds from the water onto the bank.

TABLE 1 FIELD TESTS

No.	Canals	Distance (kms)	Amount of weeds (tons)	Remarks
1	2R-1R-1L-5L	1.60	9.28	Laem Bua Subdistrict, Nakhon Chai Si District, Nakhon Pathom Province
2	2R-1R-1L-5L	1.00	5.63	Huai Phra Subdistrict, Don Tum District, Nakhon Pathom Province
3	2L-5L	1.50	8.45	Nong Ngu Luam Subdistrict, Mueang District, Nakhon Pathom Province
4	2R-1R-1L-5L	1.70	9.69	Huai Khwang Subdistrict, Kamphaeng Saen District, Nakhon Pathom Province
5	2L-5L	0.98	5.52	Thap Luang Subdistrict, Mueang District, Nakhon Pathom Province
6	2L-5L	1.20	7.08	Huai Duan Subdistrict, Don Tum, District, Nakhon Pathom Province
7	2R-1R-1L-5L	1.10	6.60	Huai Khwang Subdistrict, Kamphaeng Saen District, Nakhon Pathom Province
8	2L-5L	1.10	6.19	Nong Ngu Luam Subdistrict, Mueang District, Nakhon Pathom Province
9	2L-5L	0.70	4.20	Nong Ngu Luam Subdistrict, Mueang District, Nakhon Pathom Province
10	2L-5L	1.10	6.44	Nong Ngu Luam Subdistrict, Mueang District, Nakhon Pathom Province
11	2L-5L	1.30	7.93	Takong Subdistrict, Mueang District, Nakhon Pathom Province
Total		13.28	76.99	

Note: Tested in the area of the Water Transmission and Maintenance Department 3, Kamphaeng Saen Water Delivery and Maintenance Project, Nakhon Pathom Province, Irrigation Office 13





Fig. 4. Removing weeds from the water onto the bank with weed rakes.



Fig. 5. Wheelbarrow rake set. For canals with a bottom width of 1.0 to 2.0 meters.

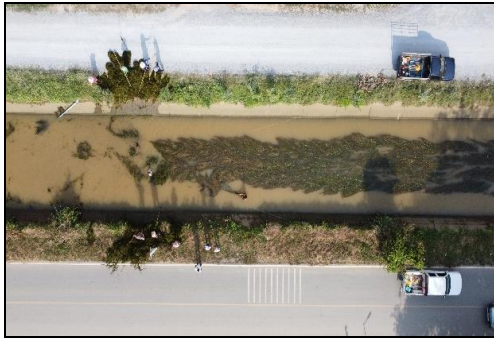


Fig. 6. Removing weeds with weed rakes and two pickup trucks (Aerial view)



Fig. 7. Data collection of size, length and weight of weeds to calculate the density of weeds per square meter

#### 4. DISCUSSION AND CONCLUSION

4.1 According to the 10 test results of the canal with medium to high density of *Potamogeton nodosus* Poir, using the weed rake tools in one day (3-7 hours) **could remove weeds of 1.10 -1.70 kilometers**, with an average of 1.21 kilometers. The weight of *Potamogeton nodosus* Poir was approximately 5.52 - 9.69 tons/day, averaging 7.0 tons/day or 1.0-2.33 tons/hour, at the hauling speed of 5-9 km/hour, with 6 operational workers. However, the removal distance and the amount of submerged weeds removed depend on the density of weed infestation.

#### 4.2 Tool Prices

The price of tools, consisting of the rake set and wheelbarrow, is about 5,000 baht.

The price of tools, consisting of the rake set and trolley, is about 3,000 baht

\*\*\* These prices exclude other tools, such as wire rope slings and steel rakes.



Fig. 8. Before and after weeding

TABLE 2 COST COMPARISON AND THE AMOUNT OF WEED REMOVAL

Weed method	Number of operational workers	Cost/Day (Baht)	Weeding distance (km/day)	Amount of weeds (tons/day)	Amount of money per ton
Manpower	6	2,264	0.4-0.5	2.25-2.80	896
Weed rake tools and manpower	6	2,568	1.1-1.7	5.52-9.69	337
Backhoe machine	1	8,000	0.7-0.8	3.90-4.50	1,904

Note: All tests had similar weed densities. (The weed density per square meter was already surveyed.)

Table 2 illustrates the comparison between costs and the amount of weed removed as follows:

**Method 1 – removing weeds with manpower**

**Method 2 - removing submerged weeds with weed rake and manpower.**

**Method 3 - using a backhoe machine**

As can be seen, removing weeds with only manpower has the lowest cost per day, which is approximately 1.13 times lower than the removal method with the Weed Rake tools, and 3.53 times lower than the use of a backhoe. This indicates that using a backhoe to remove weeds per day is the costliest, while using the weed rake tools cost nearly the same as only manpower.

## 5. RECOMENDATION

There should be an extension of further research and experiment at the Irrigation Office 13 and irrigation canals facing similar problems for a year, for data collection and planning, as well as establishing the annual weeding period.

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