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DEVELOPMENT AND EVALUATION OF A MECHANICAL COLLECTING SYSTEM FOR SALVINIA WEED

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Salvinia molesta, locally known as *African Payal* is a noxious floating type aquatic weed which has infested the inland water surfaces of many countries of the world, causing hindrance to inland navigation as well as wet cultivation of crops. This floating weed can be controlled by several means employing manual, mechanical, chemical or biological methods. Widely spreading chemicals create problems of pollution and are detrimental to health of man, animal and certain plants. A complete control is often very difficult and biological control is a very slow process. Salvinia harvesting machine is a mechanical device for the physical removal of the weeds easily from the water ways.

Materials and Methods

The mechanical system consists of four major components schematically presented in Fig. 1 & 2. They are (1) a twin pontooned floating platform on which the harvester is mounted, (2) an engine-driven conventional high head centrifugal pumpset which serves as the prime-mover for the ejector system, (3) a high capacity jet device which multiplies the pump discharge by about four times and the secondary flow of the jet device sucks the salvinia from water and (4) a floating perforated container placed on the delivery side of the ejector system to collect the pumped out weed which can be loaded into a country boat or to the shore, manually or mechanically. The size of the equipment is 360 cm x 150 cm and weighs about 415 kg.

African Payal is dispersive in nature over the water surface. Even a slight disturbance of water by rapid current or wind shatters the plant body and displaces it easily and quickly. Hence, none of the conventional means of control such as conveyor belt system or fishing net could be effectively used for its collection. The material always finds it easier to flow around the obstruction than be caught on it. But in the newly designed salvinia harvesting machine an ejector system sucks and pumps out the weeds along with water as a fluidized medium.

In operation, the delivery of the prime-mover pumpset is connected to the jet of the ejector system. The water with high pressure from the pumpset is forced into the jet and the jet converts the pressure head into high velocity head. When the high velocity jet of water is passed through the venturi shaped throat of the ejector system, partial vacuum is created there. This causes a large volume of water to be drawn-in through the mouth of the ejector system and an artificial whirpool is created near the mouth. This in turn attracts surrounding wide spread salvinia weed into the whirpool and weed-water mixture is passed to the throat. The high

velocity water from the jet moves this fluidized mass of weed and pumps out through the delivery side of the ejector system. Here suction force is used to collect the weeds from the water. During this operation the weeds do not pass through any moving parts, hence do not clog the system. The pumped out weed water mixture is collected in a perforated floating fence from where water is drained off by gravity and the materials are retained. As the weeds get accumulated, the heap of weeds is removed to a boat or to the shore. Instead of using a floating fence, weeds can be pumped out directly to the shore, but heavy pumping-effect causes considerable erosion on the banks and hence is normally unacceptable. The equipment can also be operated as a self propelled unit. During the propulsion, the weed is collected in the floating fence from where it is emptied when it is filled with the weeds.

The field testing of the equipment was carried out at the kole lands of Trichur district and at the kayal lands of Kuttanad region, taking the Regional Agricultural Research Station, Kumarakom and the Rice Research Station, Moncompu of the Kerala Agricultural University as testing centres. The investigation was carried out during the period 1980-1981.

Results and Discussion

The harvesting capacity of the 10 HP prototype unit was found to be 1 6 to 18 t/h at almost zero head condition when the weed was pumped to a fermentation pond or pumped into a floating fence. The result of 18 t/h is acceptable for short duration pumping system. whereas the more conservative figure of 16 t/h may be taken as a representative value for the harvesting capacity of the 10 HP prototype machine for continuous working. The data relating to the results are presented in Table 1 and 2. At a static lift of 70cm, the capacity was found to be 9.2 t/h and this capacity was reduced again to 6.1 t/h at 1.4 m lift condition. The results are presented in Tables 3 and 4.

The test result shows that salvinia pumping capacity of the ejector system is very sensitive to the slight changes in the total head. Samual (1975) reported that the pumpset ejector combination system is sensitive to the changes in total head, when the system is used even for pgmping water alone for lift irrigation. Therefore, for best performance, the ejector system should be operated preferably at zero lift with no drastic changes on the direction of the weed mass flow. Further, the feeding rate and the positioning of the suction mouth should be optimal.

Table 5 shows that the quantum of salvinia weed harvested (wet weight) is 13.1 per cent of the total weight of the weed-water mixture. The proportion of weed obtainable is of the order of 15 per cent by weight when the weight of the weed is compared to the secondary flow of 1500 lpm when pumping water alone. Considering the fact that the salvinia is lighter than water having a relative bulk density of only 0.4, these results compare favourably with the proportion of 20 per cent of solids normally obtainable in dredging works (Cornik, 1960).

Economic Analysis The operating cost of the salvinia harvesting machine has been worked out on the basis of the assumption that the salvinia problem is prevalent for about six months during the year. Hence a very conservative figure of 500 hours of annual use of the equipment is taken for the cost analysis. The life of the equipment is taken as 10 years with a nil salvage value. One skilled labourer is engaged for operating the equipment and three unskilled women labourers are engaged for gathering and feeding the weeds. Sixty per cent operating hour field efficiency is expected. Harvesting rate is 0.1 ha/h and fuel diesel consumption is 3 l/h. The cost of collecting salvinia per hour using this harvesting machine is as follows:

Investment (Rs)		
Cost of the 10 HP high pressure pumpset and its starting accessories		10,200.00
Cost of fabrication of ejector system including cost of materials		600.00
Cost of floating platform		1,200.00
Cost of perforated floating fence		1,000.00
Cost of other accessories and other pipe fittings		1,400,00
Overhead charges for fabrication work		560.00
	Total	14,960.00
Fixed cost (Rs)		
Depreciation		1,500 00
Interest on investment at 10% on average cost		750.00
Maintenance and storage value at 5% of annual fixed cost		750.00
	Total	30,00.00
Hourly fixed cost: 3000/500		6.00
Variable cost (Rs)		
Cost of fuel per hour (3 l)		10.20
Cost of oil (10% cost of fuel)		1.00
Labour charges: (a) skilled (@ Rs 20 per day of 8 h)		4.20
(b) unskilled (@ Rs 10 per day of 8 h)		6.20
	Total	21.60
Operating cost (6.00 + 21.60)		27.60

The spread density of salvinia in the Kuttanad region of Kerala state is 160 t/ha. Hence the clearance time using this equipment is 10 h/ha. Therefore the expected cost for clearing one hectare of weed infested paddy field is Rs. 280. This value is more economical compared to the value of Rs. 750.00 to 1000.00 required for the manual collection and disposal of this weed from one hectare of rice field.

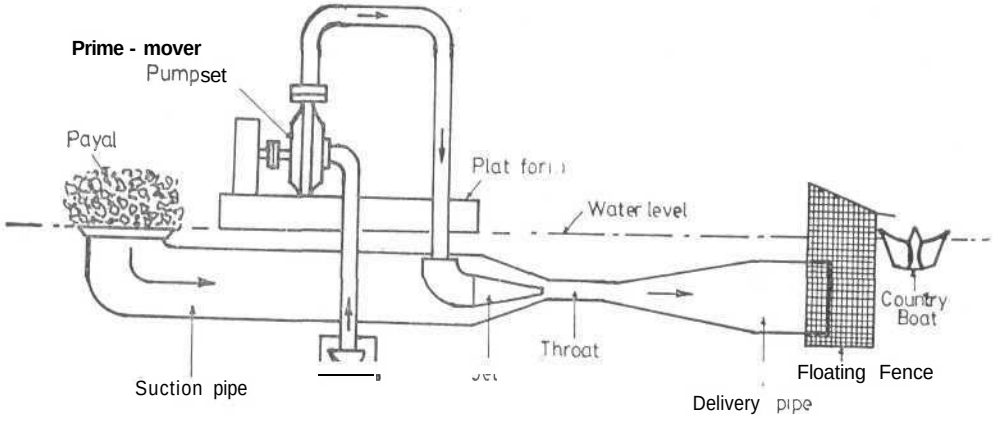

Fig. 1 Diagramatic representation of salvinia harvesting machine

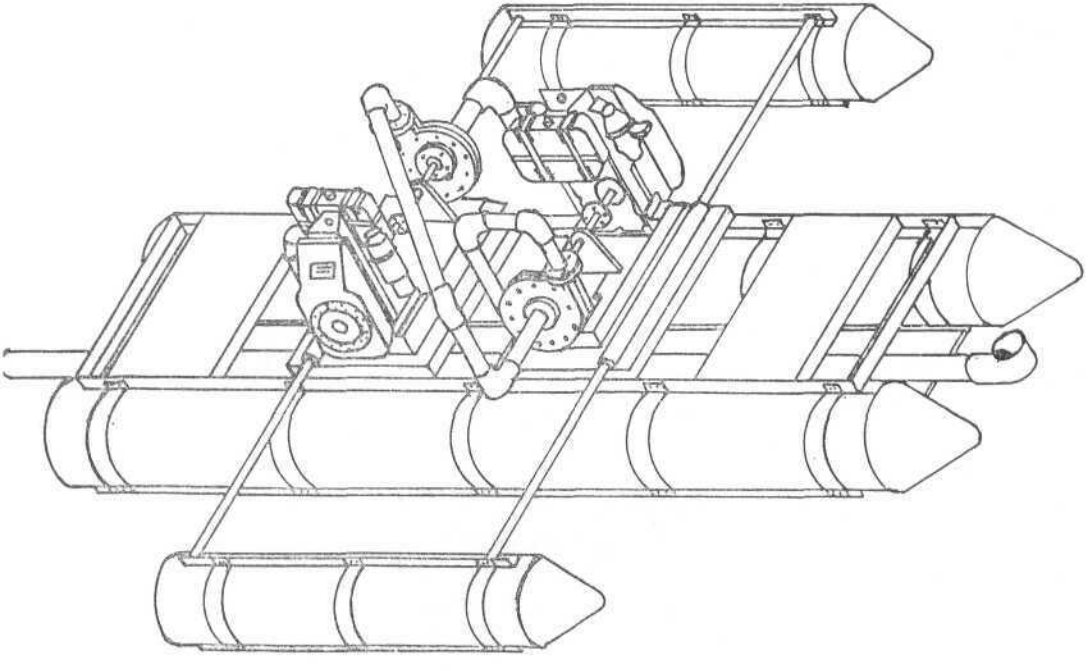

Fig. 2 Prototype salvinia harvesting machine—isometric view

Table 1

Salvinia harvesting capacity of the machine at almost zero lift condition when pumped to a fermentation pond

Trial No.	Speed of the engine (rpm)	Discharge pressure (kg/cm²)	Harvested area (m²)	Time taken (min)	Average spread density (kg/m²)	Harvesting capacity (t/h)
1	3600	4.50	725.21	62.50	20.16	14.27
2	3600	4.45	182.62	9.05	17.16	19.60
3	3600	4.45	614.25	23.95	11.60	17.81
4	3600	4.50	573.30	44.65	17.50	13.40
5	3600	4.50	578.00	29.50	13.16	15.29
6	3600	4.50	318.57	22.00	17.66	15.36
7	3600	4.50	245.00	16.50	16.66	16.27
Mean						16.00

Table 2

Rate of pumping of salvinia into floating fence at near zero lift condition

Trial No.	Speed of the engine (rpm)	Discharge pressure (kg/cm²)	Time (s)	Weed collected (kg)	Rate of collection (t/ha)
1	3600	4.45	60	264	15.8
2	3600	4.50	60	317	19.0
3	3600	4.50	60	320	19.2
Mean					18.0

Table 3

Rate of pumping of salvinia into floating fence at a static lift of 70 cm

Trial No.	Speed of the engine (rpm)	Discharge pressure (kg/cm²)	Time (s)	Weed collected (kg)	Rate of collection (t/h)
1	3600	4 50	60	148	8.9
2	3600	4.55	60	156	9.4
3	3600	4.45	60	153	9.2
Mean					9.2

Table 4

Rate of pumping of salvinia to the bank through filtering unit, at a static lift of 1.4m

Trial No.	Speed (rpm)	Discharge pressure (kg/cm²)	Time (s)	Weed collected (kg)	Rate of collection (t/h)
1	3600	4.50	60	102	6.1
2	3600	4.50	60	94	5.6
3	3600	4.45	60	110	6.6
Mean					6.1

Table 5

Proportion of weed in the fluidized weed water mixture, collected at zero lift condition

Trial No.	Time taken (s)	Weight of water in the mixture (kg)	Weight of weed in the mixture (kg)	% of weed in the mixture (by wt.)
1	30	780	98.0	11.2
2	30	672	112.0	14.3
3	30	702	113.5	13.9
Mean				13.1

Summary

Salvinia harvesting machine is a mechanical device suitable for removal of salvinia weed (locally known as *African Payal*) from the waterways. The harvesting capacity of the equipment is 16 t/h. The estimated cost of the machine is about Rs. 5000 besides the cost of the high head centrifugal pumpset. The operating cost of the equipment is calculated as Rs. 28 per hour and this amounts to a weed clearing cost of Rs. 280 from one hectare of weed infested rice field.

Acknowledgement

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