AQUATIC WEEDS: PROBLEMS, CONTROL AND MANAGEMENT TO BOOST LAKE ENVIRONMENT

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ABSTRACT

Aquatic plants have created havoc all over the world. Natural aquatic plants population to some extent is healthy for any aquatic ecosystem as it serves as fish feed, plays an important role in nutrient cycling, purify the water, control unwanted algal growth and support fauna including birds. Unwanted growth of aquatic plants especially some seriously invasive species like water hyacinth and Salvinia has caused a loss of billions of US$ all over the world. It affects the supply of drinking water and water hyacinth (Eichhornia crassipes) has proved to be a persistent and expensive aquatic weed problem costing millions of dollars to control and unaccounted millions of dollars more to the damage to the environment, irrigation systems and crops. Water hyacinth has posed ecological and economical problems in several countries. This weed pose problem especially in tropical and subtropical countries where environmental conditions provide a year round growing period. The natural loss of water from the water surface by evaporation is thought to increase through transpiration from the leaves of water hyacinth by at least 40 to 50 percent. The dense growth of aquatic weeds obstructs water flow in irrigation channels, interferes with navigation and hydroelectric power generation. The flow of water is reduced by 40 to 95 percent and roughness coefficient increases from 0.024 to 0.055 in irrigation channel. Free floating aquatic weeds interferes with the seed germination and seedling establishment in paddy, resulting in heavy economic losses. Over the years, various control methods have been studied and tried including chemical, biological and mechanical means but with no lasting success. The simplest way to management of aquatic weeds is to harvest it and utilize it for useful products. In order to reduce the cost of transportation a mechanical system has been developed at CTAE, Udaipur which reduces the bulk of freshly harvested water hyacinth up to 73%.

INTRODUCTION

Water, one of the most abundant compounds on Earth, is special because all life-forms on Earth are totally water dependent. Water amounts to up to 80% of our bodies and plays diverse chemical roles in humans as well as in flora, fauna, soil, and air. A huge portion of the world's population does not have access to a reliable supply of drinking water and pollution of water resources is a global problem. Aquatic weeds are those unabated plants which grow and complete their life cycle in water and cause harm to aquatic environment directly and to related eco-environment relatively. The presence of excessive aquatic vegetation influences the management of water in natural waterways, canals and reservoirs. The area under small tanks and ponds is equally important because of the establishment of many small irrigation schemes and watershed management projects all over the world. India has 1.9 m ha under water in

reservoirs and 1.2 m ha under irrigation canals. The area under village ponds and tanks is nearly 2.2 m ha. The total global supply of water is astronomical. "But from the consumer's point of view, it is a pity that more than 97% of this is found in the oceans and can, therefore, not be directly used for drinking. Of the remaining amount, approximately one-eighth is suitable for drinking. Unlike other natural resources, such as coal and oil, water is infinitely renewable. But in spite of efficient natural recycling, we are facing a global water problem, mainly because the world's population has been growing at an exponential rate for decades. In 1920, there were 1 billion people; in 1960, some 3 billion; and today, there are over 6 billion of us. As a result, the average amount of drinking water available per person has been and is still decreasing.

Occurrence of weeds in water bodies has become a common problem nowadays and it is necessary to have weed free situation so as to keep the normal recreational activities and other economic oriented activities running. Indian Subcontinent ranks second to South America in the number of endemic aquatic plant species (Lavania et al, 1990). These plants are thought as aquatic weeds due to their negative impact on the beneficial uses of the water resources in which they grow. Accordingly all efforts so far, have been directed towards their eradication measures (Gopal, 1990). But complete eradication of noxious species has never been possible. Mechanical removal generates a large amount of plant biomass which, if not removed adds to the same problem. Therefore scientific interests have been directed towards the management and utilization aspects of these plants. Water hyacinth, one of the fasted growing aquatic plant was first introduced as an ornamental plant in India in 1896 from Brazil.

Need for Water hyacinth Chopper cum Crusher

Capacities of mechanical management systems for aquatic plants are usually limited by the volume of the plant material that must be handled, transported and stored. Water hyacinth plants are harvested and transferred in their natural state to the hauling unit which, in turn, delivers the plants to a disposal site which may be at a considerable distance from the harvesting site. As fresh water hyacinth has around 92% moisture content with the bulk density of around 96 kg m^{-3}, it necessitates handling a plant volume of 130 m^3 and disposing of 9.2 tonnes of water for every tonne of dry matter removed from the site . Water hyacinth removed in large quantities from the harvest location can be transported easily when chopped. Packaging to higher density than the conventional bale reduces the problem of transportation, storage space and provides better flow characteristics during material handling. Chopping and compressing or compacting has been proposed as means of reducing volume and weight or increasing density. Cutting with a counter cutting edge is accompanied by crushing, resulting in removal of surface and free cell water from the fresh water hyacinth plants. Three types of choppers flywheel type, flail type and cylindrical types are used for forage chopping and it is suggested that the power loss due to the water resistance and mechanical losses were high in flail type of cutters and also the accuracy of cutting was worse. Therefore a cylindrical type chopper cum crusher was developed for chopping and crushing of water hyacinth simultaneously for volume and weight reduction.

PROBLEMS CREATED BY AQUATIC WEEDS

The presence of excessive aquatic vegetation influences the management of water in natural waterways, man made canals and reservoirs. The area under small tanks and ponds is equally

important due to the establishment of many small irrigation schemes and watershed management projects all over the world. Aquatic weeds often reduce the effectiveness of water bodies for fish production. Aquatic weeds can assimilate large quantities of nutrients from the water reducing their availability for aquatic life. They may also cause reduction in oxygen levels and present gaseous exchange with water resulting in adverse fish production. Excessive weed growths interfere with fish harvesting. Dense growth and heap of aquatic weeds provide ideal habitat for the development of mosquitoes causing malaria, encephality filarasis. These weeds may also serve as vectors for disease causing organisms and can greatly reduce the aesthetic value of water bodies from a recreational point of view. Aquatic weeds have been found to severely reduce the flow of irrigation water thereby reducing the availability of water to the farmer's field. Aquatic weeds may also damage pumps and turbines in super thermal power stations and hydroelectric power stations influencing electric production and increasing the cost of maintenance of power stations. Some of the harmful effects of aquatic weeds are listed below:

Harmful Effects of Weeds

- Reduces water storage capacity in reservoirs, tanks, ponds
- Impedes flow and amount of water in canals & drainage systems
- Reduces fish production
- Interfere with navigation and aesthetic value
- Promote habitat for mosquitoes

They cause tremendous loss of water from water bodies like lakes and dams through evapo-transpiration. India has the largest canal network in the world where the velocity of flowing water is reduced by about 30 - 40 percent due to the presence of aquatic weeds. Floating and deep rooted submerged weeds interfere with navigation. Aquatic weeds also affect quality of water. These weeds cause taste and odour problems and also increases biological oxygen demand because of organic loading. Aquatic weeds impede the free flow of water which may contribute to increased seepage and may cause rises in water-tables in the adjoining areas. It may lead to water logging. This may also create saline or alkaline conditions in the soil and also give rise to many other land weeds. Submerged and floating weeds propagate at a tremendous rate. The surface floating weeds get interwoven and form dense mats that move downstream. Often these moving mats pack up against bridges and structures creating enormous pressure that sometimes results in serious damage being caused. An example of this sort of damage was observed on Kasur Nala near Taran-Taaran in India. Over time if left unchecked the weed mats become so dense that people and animals can walk on them.
Quantification of the problem is often extremely difficult. The real effect on fish stocks and flora is unknown. It is hard to calculate the effect on fishing communities. Satellite methods are the only accurate way of determining the spread of the weed. Success is hard to measure when the exact scale of the problem is not clearly defined and is anyway growing rapidly. In many areas of the world few studies have been carried out to quantify the basic effects of the growth of the weed on the surrounding communities and environment. This causes problems when trying to evaluate the scale of the problem, possible ways of combating its proliferation and the impact that any control or management programme may have.

MANAGEMENT OF AQUATIC WEEDS

The management of aquatic weeds is a very important task to ensure the availability of water from the source to its end users. It also improves the conveyance efficiency. Water storage systems often get choked with the weeds and cause environmental pollution specially in low lying areas, adjoining irrigation and drainage channels. Management of aquatic weeds consists of two approaches viz. preventive and control of existing infestation (Aquatic Weeds Report, 2002). Type of aquatic weeds flora and their intensity influence the damage caused by them. Weed "control" means keeping the weeds at a level where they do not cause economic damage. Aquatic weed can be brought under control to manageable limits by various methods. Broadly, these methods can be grouped under four groups such as (1)Physical or Mechanical methods (2) Biological methods (3) Chemical methods, and (4) Cultural and physiological

CONTROL METHODS

Physical or Mechanical Control Methods

Mechanical Control of aquatic weeds Physical control, using mechanical mowers, dredgers or manual extraction methods, is used widely but is costly. It involves physical power which may directly or indirectly inhibit the growth and development of aquatic weeds. This could be done by hand, using hand tools or machine power. The advantages of mechanical management are it is environmental friendly. The large removed biomass can be used for making various useful products like, green manure, fertilizer, soil additives, animal feed, rope craft and furniture etc (Lindsey and Hirt, 1999). Furthermore, in India water hyacinth is also used as a medicinal plant (Oudhia, 2001). The limitations include limited effectiveness as in some cases aquatic weed re-grow up from their rootstocks, rhizomes and the like; physical removal especially with machines may help spreading weeds to new areas; and sometimes removal of aquatic weeds may deplete water bodies of their nutrients limiting growth of plantation. The best way of the mechanical management is to harvest the weed and chop and crush it by means of a chopper cum crusher (Mathur and Singh, 2004) so that it can not be allowed to re-grow. In areas sparsely infested, weeds can be removed by hand. This could apply to the removal of floating weeds like water hyacinth. Generally, this method is applied to emergent weeds eg. *Typha spp., Phragmites spp., Justicia spp.* (Willow), where men cut the vegetative growth with heavy knives and hooks. In shallow water the prop gules, rhizomes and other underground reproductive organs can be removed.

Biological control: Biological control is the use of host specific natural enemies to reduce the population density of a pest. Several insects and fungi have been identified as control agents for different aquatic weeds. These include a variety of weevils, moth and fungi. Biological control of water hyacinth is said to be environmentally benign as the control agents tend to be self-regulating. One major drawback is that it can take a long time to initiate such projects because it can take several years for the insect population to reach a population density sufficient to tackle the pest problem. Biological management of aquatic weeds is a broad term for the exploitation of living organisms or their products to reduce or prevent the growth and reproduction of weeds. The organisms that are used for biological control are diverse e.g. insects, pathogens, nematodes, parasitic and competing plants. Biological control is more complex than chemical control because it requires (a) long term planning (b)multiple tactics and (c) manipulation of cropping system to interact with the environment.

Chemical control: The applications of herbicides for controlling aquatic weeds have been carried out for many years. The time and method of herbicide application varies with the type of weed flora and the habitat in which the weeds are to be controlled. It has been found that there is a good success rate when dealing with small infestations but less success with larger areas. Application can be from the ground or from the air and requires skilled operators. Control of aquatic weeds by herbicides is generally easier, quick and usually cheaper, when compared to mechanical methods. The use of herbicides has the disadvantage of being in water as residue specially in fresh water lakes. An herbicide should have certain specifications for its use in different types of aquatic environments such as

- It should have high degree of phytotoxicity to kill weeds fast.
- The chemical should degrade or dissipate from water immediately after the action on weeds.
- Technology should be available for their use in static or flow water systems.
- It should be environmentally safe for humans, fish and other aquatic life.

Many herbicides are harmless to fish at concentrations required for control of weeds. There are many aquatic situations where herbicides can be of help in controlling aquatic weeds without coming in contact with water. Many of the herbicides at recommended levels of application are harmless to fish and other beneficial aquatic fauna. Selective herbicides are also being used in managing weeds in the aquatic environment which will not hurt other flora and fauna which is necessary to maintain the birds and other aquatic species which generally thrive in these situations. Some of the advantages of using herbicides are:

1. Herbicides are economical and fair in action thus save time.
2. The dead weed biomass sinks to the bottom of the water body avoiding loss of
3. Herbicides kill even the roots and other deep rooted reproductive organs which generally can not be removed by mechanical means.
4. One or two applications of herbicides are sufficient while mechanical methods may need to be applied a number of times. The common herbicides are 2, 4-D, Diquat and Glysophate.

SOLUTION

The above study shows that the only alternative to solve and management of the problem of aquatic weeds in natural drinking water lakes is mechanical harvesting and utilization of it for various useful products so that the cost of harvesting can be reduced. In order to solve this problem College of Technology and Engineering has developed a mechanical system which reduces the bulk of freshly harvested water hyacinth. The system has the following salient features

- Ease in handling and saving of labour in transportation
- Environmental friendly and no need of application of any chemical in fresh water lakes.
- The average no load power to run the machine was 1.1 kW. The power required in chopping and crushing increased with the increase in feed rate and speeds of cutting cylinder and crushing roller.

- Specific chopping and crushing energy and total energy requirement did not change with change in no. of blades.
- The developed chopper cum crusher reduced the specific volume of water hyacinth by 73 per cent and weight by 45 per cent at recommended feed rate of 2t/h.
- 66 % reduction in cost of transportation can be achieved with the introduction of mechanical system.

Figure 1 shows the developed mechanical system

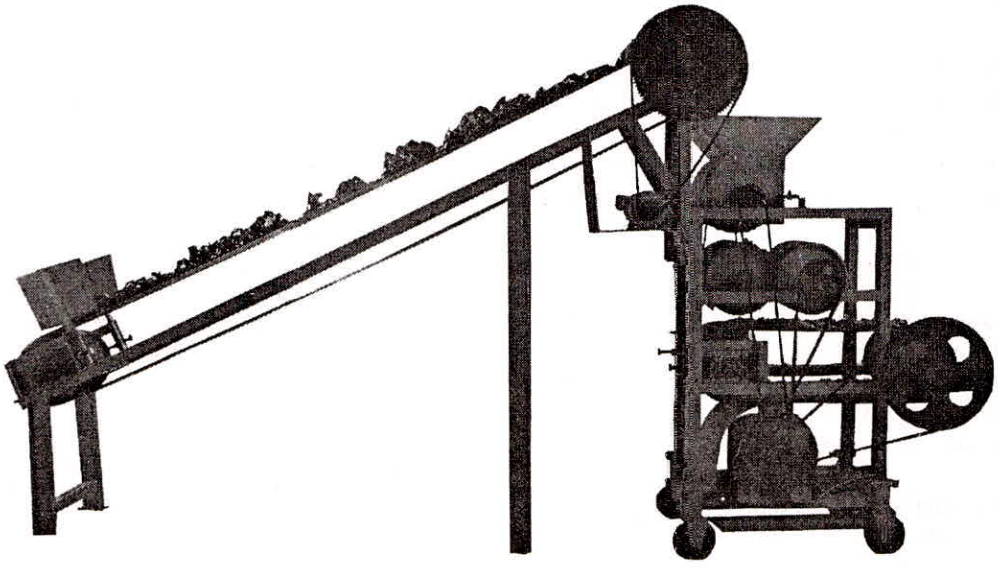

Fig.1: Developed Mechanical System for Chopping and Crushing of Aquatic Weeds

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