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ECONOMIC IMPACTS OF AQUATIC WEEDS – A THIRD WORLD APPROACH

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Abstract: Aquatic plants are plants that normally grow in water, in soil covered by water, or in soil that is normally saturated with water. In nature, these plants perform many important functions in maintaining a balanced aquatic environment. But at the same time, their uncontrolled growth has manifold impacts on the water bodies. Their growth has been explosive in many parts of the world, especially, Asia, Africa and Latin America because of favourable climatic conditions and suitable habitats for its unchecked growth. In India, it has been estimated that more than two lakh hectares of water bodies are infested by aquatic weeds such as water hyacinth. While the approach of the developed nations is mainly focused on *control* and *eradication*, the third world countries have approached this problem in a different manner. They have been able to derive many positive benefits from these weeds by their innovative approaches. Thus the perceived negative economic impacts of the aquatic weeds have been transformed into positive income - generating enterprises. Some of the alternative approaches such as making of furniture, handicrafts, paper and packing material, mulching and composting, biogas production, organic manure, animal feed, bio-active compounds etc, by researchers in these countries are discussed in this paper. The author's own innovations in making value added products from the troublesome aquatic weeds of Kerala, India are also discussed.

Key words: *Eichhornia, Salvinia*, aquatic weeds, value addition, eradication, utilization

INTRODUCTION

Aquatic plants are defined as plants that normally grow in water, in soil covered by water, or in soil that is normally saturated with water. They can be classified into several broad groupings namely, free-floating, emergent and submerged aquatic. In nature, these plants perform many important functions in maintaining a balanced aquatic environment (Cook, 1996). But at the same time, the uncontrolled growth of these plants has manifold impacts on the water bodies. Their growth has been explosive in many parts of the world, especially, Asia, Africa and Latin America because of favourable climatic conditions and appropriate habitats for its unlimited growth (Brij Gopal and Sharma, 1981).

In India, it has been estimated that more than two lakh hectors of water bodies are infested with aquatic weeds, especially water hyacinth (Brij Gopal, 1987). Kerala, God's own country is blessed with multitudes of water bodies like lakes, rivers, canals, irrigation channels, paddy fields, ponds etc, both natural and man-made. They are a part of the day-to-day life of majority of Keralites, either directly or indirectly and play an important role in the social, cultural and economic aspects of the people. Now their beauty is being marketed through tourism and related activities, but at the same time, our callous attitude is slowly and steadily damaging them beyond repair. A cursory glance is enough for everyone to see that all these waters are infested with one kind of aquatic weed or the other. The major one is *E. crassipes*, commonly known as Water Hyacinth. It is an exotic weed which has colonized many parts of the world. Other major weeds include *Salvinia molesta* and *Pistia stratiotes*. India, being a subtropical country, is a fertile ground for the aquatic weeds and Kerala with its abundant sunshine, rains and water bodies, offers them an excellent habitat for explosive growth.

Impact of Aquatic Weeds

Gallardo *et al*. (2016) demonstrated that invasive species trigger strong and relatively consistent ecological impacts on aquatic ecosystems. Under favorable growth conditions, these weeds may double within about a week's time and cover the entire surface of the water which degrades natural habitats in many ways. They reproduce by both vegetative (by sprouting of new plants from existing ones) and also by producing seeds which sink to the bottom and wait till conditions are favourable for germination. Mats of floating plants prevent atmospheric oxygen from entering the water. Further, the decaying plants drop to the bottom, greatly consuming dissolved oxygen needed by fish and other aquatic life. They also prevent the entry of sunlight to the bottom layers, and slowly kills the natural, endemic flora & fauna. Thus it causes serious damage to biodiversity of the aquatic ecosystems (William, 2003). Their growth prevents the natural flow of water in irrigation channels, obstructs smooth navigation & interferes with hydroelectric power generation. Disease spreading vector species of mosquitoes breed freely in the static waters. The decomposition of the dead plants results in obnoxious smell, decreases clarity of water and depletes the dissolved oxygen content of the water, making it unsuitable for human use. Local fishermen have found it impossible to cast their nets into water covered with dense mats of these weeds. In Kerala, these weeds adversely affect water transport, agricultural activities, inland fisheries, and promotion of lake tourism, on which the people of Kerala depend on for their livelihood.

Aquatic weed infestation is a national and global problem and many approaches have been tried to eradicate them. Physical removal, chemical control, biological control etc have been tried unsuccessfully not only in India but also elsewhere in the world. Scientists have reached a conclusion that it is not possible to eradicate these weeds from our water bodies. The only possible approach is the concept of "eradication through utilization" and considering them as "opportunities" rather than "threat".

The Third World Approach on Aquatic Weeds

While the developed nations have tried to eliminate the weeds from their waters, the people in the "Third World" have approached this problem in a different way. The people have realized that the only hope lies in the economic utilization of these plentiful "natural resources" by simple and economically viable techniques - the concept of eradication through utilization or use to reduce (NSA Report, 1974). Many researchers have been striving to make use of these aquatic weeds for creative purposes. Some suggested uses include, manufacture of paper, packing material, fodder for cattle, manure, feed for fishes and ducks, mulching & composting, biogas production, waste water treatment, mushroom production and manufacture of mats, handicrafts, furniture etc. There are many reports on the possible use of these weeds for economic benefits from around the world. In Nigeria, water hyacinth is used for making handicrafts like hand woven baskets which earn them valuable foreign exchange. Similarly, in Thailand, the furniture manufactured from *E. crassipes* is of much benefit for the local communities. Researchers from Egypt have separated and identified nine active fractions from water hyacinth and showed their promising therapeutic activities. Several compounds such as alkaloid, phthalate derivatives, propanoid and phenyl derivatives were identified in the extract of water hyacinth (Ahmed *et al.,* 2011). A Japanese research group has isolated novel acylated delphinidin glycoside from the blue-purple flowers of *Eichhornia crassipes* as a major pigment and was identified as [6"' -O- (delphinidin 3-O- (6"-O- (beta-D-glucopyranosyl) -beta- D-glucopyranosyl) (6"-O- (apigenin 7-O- (beta-D-glucopyranosyl) malonate] by spectral methods (Toki *et al.,* 1994). A report from Portugal deals with the production of protein concentrate from water hyacinth. The protein in water hyacinth concentration was of better quality compared to other vegetable protein products, such as alfalfa and soybean flour. The amino acid composition was favorable, especially the presence of tryptophan is valuable since it is commonly low in plant protein products. The presence of all essential amino acids in the concentration suggests its possible use in the production of animal feeds and food supplements for humans (Medeiros *et al.,* 1999). Similarly, the roots of water hyacinth are known to remove heavy metals and radioac-

tive molecules from the aquatic environments. Heaton *et al.* (1987) have reported lead uptake by the water hyacinth. Rui *et al.* (2015) have reported polar and lipophilic extracts of roots, stalks, leaves and flowers of water hyacinth and suggested methods of value addition.

A convenient and economical process for extraction and separation of â-carotene from water hyacinth has been developed by researchers from India and a US Patent obtained for this process (Vinita *et al.,* 2005). National Environmental Engineering Research Institute, Nagpur had reported that the slurry obtained from aquatic weeds like water hyacinth could be used as a source of cellulose for microbial growth and enzyme production. In Kerala, some efforts have been made in the past for using these weeds for beneficial purposes, but no coordinated actions have been taken and no solutions have been identified to solve this infestation. Our own work at the Centre for Research on Aquatic Resources, S.D. College for the last 18 years have shown that all parts of the plant can be used in one way or the other – similar to the coconut palm. It is possible to use the plant as a raw material for the production of industrial enzyme like cellulase, bio-ethanol, for the preparation of beds for mushroom cultivation, vermi-composting, biogas, feed for fish, ducks and pigs, as pulping material for paper and a variety of pulp based products, briquettes for fuel and pigments from their flowers (Suresh Chandra *et al.*, 2005, Snishamol *et al.*, 2011, Nagendra Prabhu and Suresh Chandra, 2012, Anoop *et al.*, 2014,). Our lab has also developed many such innovative technologies for validation and adoption by unskilled labourers. Floating agriculture or modified hydroponics is another exciting area which can easily be adopted by us. Pictures of some of the innovative products made of water hyacinth pulp in our laboratory are given below as figures 1 to 9.

Fig. 1 a. Handicraft

Fig. 1 b. Handicraft

Fig. 2. Fruit Tray

Fig. 3. Disposable Plates

Fig. 4. Models of cartoon characters

Fig. 6. Ready to plant biodegradable nursery pots

Fig. 7. 3-D Model of Dr. A. P. J. Abdul Kalam made of water hyacinth pulp

Fig. 5. Mural painting on special canvas made of water hyacinth pulp

Fig. 8. X'Mas Crib made of water hyacinth pulp

Fig. 9. Fridge magnets

Fig. 11. Aquatic weed based biomass briquettes

Pictures of mushroom cultivation and briquette manufacturing using aquatic weeds in our laboratory are provided as figures 10-11.

Fig. 10. Mushroom Cultivation using aquatic weeds

Advantages for Kerala

Any proposal for using these weeds has the advantage that the raw materials are available almost free of cost and throughout the year. In fact, Kerala has lot of beneficial factors that can effectively by used to tap these "resources". Some of them include:

•High literacy and science awareness, even among farmers.

•Interest and involvement of media (TV, Radio and Newspapers) in agriculture and related areas. Farmers' meets are organised by newspaper groups and the various Government Departments every year and awards presented to the best farmers.

•Availability of skilled and unskilled labour.

•Geographical peculiarities & fairly good network of road/rail and waterways. This facilitates the transportation of raw materials and products to and from any corner within a few hours.

•Experience in successful implementation of Group Farming, People's Planning & Co-operatives. Strong influence and machinery of Farmer's Co-operatives, Kerala Sasthra Sahithya Parishad, (KSSP), Agency for Non-conventional Energy and Rural Technology (ANERT) etc.

This means that any technology can easily be dispersed to the common man and applied to the field in a relatively short span of time, when compared to other States in India.

Impacts on Society

The development and use of simple rural technologies will lead to economic utilization of weeds resulting in their removal from the aquatic environments. This can generate local level employment and value added products. Ultimately, this will increase the States' revenue through lake tour-

ism, water transportation, fisheries, production of goods for tourism industry, etc. besides reducing the occurrences of mosquito-borne diseases and water contamination. Such technologies are simple to be used and can be performed by unskilled labourers and women, thereby supplementing women empowerment programmes.

CONCLUSIONS

It is clear from the history that it is nearly impossible for mankind to completely eradicate the aquatic weeds that grow and cause problems to our water bodies. The only solution is to popularize the concept of "*eradication through utilization*". As already mentioned, all parts of the plants have manifold uses. Hence they are the new Wonder Plants or "*Kalpa Sasyas*", mythical plants that fulfill wishes. Research into appropriate technologies, suited for local level needs, should be encouraged at Universities and Research Laboratories. The development of economically viable, eco-friendly and simple technologies that can be operated by unskilled labourers will generate employment opportunities besides producing useful range of consumables and products. Many of the technologies are women friendly thus promoting gender equity. Disadvantaged sections of the society and differently-abled persons can also carryout many of the methods of using these weeds. Another advantage is that the negative impact of these weeds on our aquatic systems will be greatly reduced, if they are removed from these environments regularly. The recommendations of the International Conference on Aquatic Exotics should include a section on 'utilization of these "resources" along with other strategies on 'Control' and 'Eradication'. With coordinated action, it is possible and feasible to implement such schemes in areas infested with these weeds, as evidenced by the approach of the third world countries.

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