



The purpose of this quarterly digest brought out by the Centre for Ganga River Basin Management and Studies (cGanga) led by the Indian Institute of Technology Kanpur is to disseminate valuable traditional and scientific knowledge assimilated from national and international sources on various aspects of management of water and river restoration and conservation among concerned institutions and citizens.

## COMPETENT RIVERS, ADVANCED AGRICULTURE

Rivers are central to our lives and agriculture is the foundation of our economy. There is a close relationship between rivers and agriculture, their being complementary for each other's health and resources. However, for some years now, agriculture and rivers are being seen as competitive instead of as complementary. In current reckoning worldwide, agriculture is one of the main reasons for increasing river pollution.

In the previous issue of Pragyambu, we examined this opinion in the context of India and found that agriculture is not the main reason affecting the health of rivers. There are many other factors affecting the "nirmalta" (cleanliness) and health of rivers, relative to which the effects of agriculture are almost negligible. Taking the discussion forward in this issue, we will consider possible solutions for such river problems – solutions that are based on the principle of "Sarve Santu Niraamayaa" ("May everyone be healthy"), balancing aquatic and soil ecosystems. By implementing these solutions both rivers and agriculture can remain healthy and productive

Before discussing solutions, we must examine the different dimensions of the problem. The entry of hazardous chemicals in our daily lives has created new challenges not only for rivers but

for the entire environment. Through some research publications, it has come to light that the pollution level in waterbodies has increased considerably due to the chemical composition of the outer layers of tea and coffee cups that are considered eco-friendly. And similarly with chemicals in the outer surface of nonstick utensils: tiny quantities of these chemicals end up in the wastewater discharged every time the dishes are washed. When such utensils are washed daily in millions of houses, it can be well imagined how these dangerous chemicals escalate in the wastewaters.

The management of wastewater is still a challenge for our many small and big cities. This wastewater is becoming increasingly harmful day by day due to changes in our lifestyle. Many products like soaps, shampoos, hair conditioners, hair dyes, dishwashing chemicals, and detergents contain compounds of phosphorus. Substantial quantities of phosphorus thus enter the drains and streams with urban and rural wastewaters, and eventually they reach the big rivers. A comparative analysis of all these factors will show that the impact on rivers or waterbodies due to agriculture is much less in comparison to other factors. According to widely publicized beliefs, however, a significant part of fertilizers used in agriculture reach the rivers or waterbodies, which increases

the nutrient levels in the water, whereby the growth of aquatic weeds, especially water hyacinths, in rivers is boosted.

Our lakes, ponds and rivers are often beset by hyacinths, but this cannot be due to agriculture or fertilizers alone. The encroachment of waterbodies by hyacinths had started before the Green Revolution, which encouraged the use of chemical fertilizers and pesticides in agriculture. But water hyacinth entered India through Bengal during the British rule, and even before independence – many years before the Green Revolution – it created problems for our waterbodies.

Many small and big rivers of our cities are now turning into dirty wastewater drains flowing through the hearts of the cities. The Nag river of Nagpur, the Mutha-Mula river of Pune and the Yamuna river of Delhi are vivid examples of this phenomenon. The reason for the high pollution levels of these rivers is the discharge of untreated urban and industrial wastes into rivers. The foam enveloping the Yamuna river is also due to the abundance of phosphorus compounds in the river waters.

The increase in aquatic weeds in rivers and other waterbodies may be attributed to three reasons: The first reason is the basic tendency of weeds to grow rapidly; the second reason is the abundant sunlight in our country; and the third reason is nutritional enrichment. Now

nutrient enrichment can have many causes, such as through household wastes. According to an international agency, domestic wastewaters from metropolitan cities contain up to 20 mg per liter of phosphorus and 20 to 100 mg per liter of nitrogen. From this it can be estimated that when domestic wastewaters reach our rivers or waterbodies in untreated forms, how rapidly will nutritional enrichment occur! Today, from Kashmir to Kerala, from Punjab to Gujarat, the waterbodies of every province are struggling with problems like water hyacinths, crocodile weeds, alligator weeds, or water moss.

Now let's examine the problems of agriculture. On the one hand, the agriculture sector is grappling with water scarcity and, on the other hand, the health of the soil is deteriorating. Agricultural experts have often expressed concern about the lack of essential soil nutrients and the degradation of the microbial ecosystem of soils. And their third concern is the progressive loss of soil fertility and its gradual conversion into barren lands.

## MAY ALL BEINGS LIVE HAPPILY

We need a permanent solution to the problem of aquatic weeds invading our waterbodies in such a way that soil health is also preserved. Efforts to eradicate aquatic weeds have been going on for the last hundred years, but till now there is no effective control either in India or abroad. Chemical methods to eradicate aquatic weeds in waterbodies have been tried many a time, but such chemicals also destroy the essential flora of aquatic ecosystems. The same result accrues when mechanical means are employed for the removal of weeds.

## MULCHING THE FIELDS

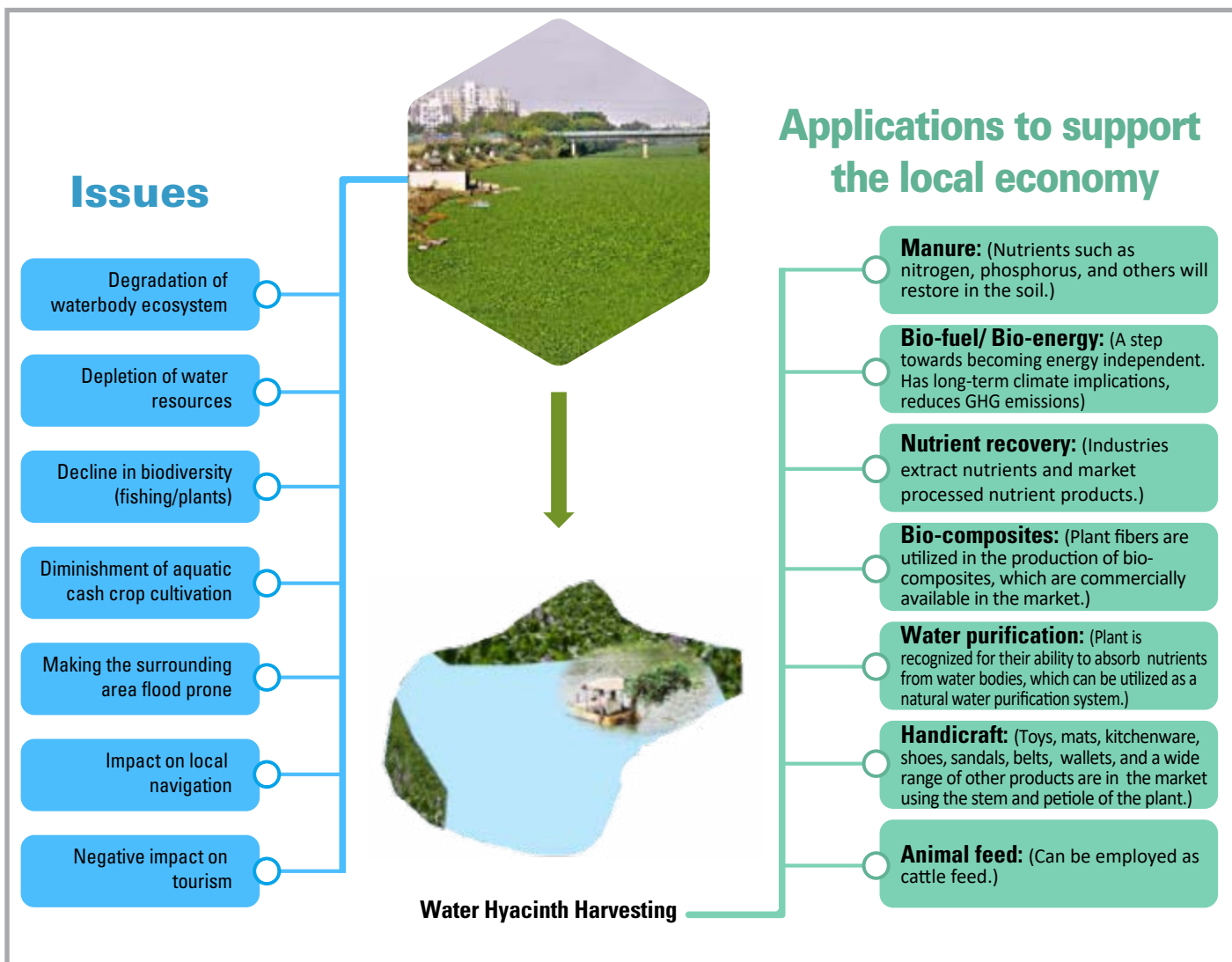
Mulching means covering soils with a layer of straw. Removing water hyacinths from waterbodies, cutting their leaves finely, and spreading the mulch on the field is easier than making organic manure or fertilizers. By laying this type of mulch, the soil evaporation rates reduce and, hence, moisture content

and water retention capacity of the soil increases. Thus, much less water is required for irrigation. Simultaneously, soil moisture also increases. Thus soil microbial activity and the number of earthworms also increase, due to which both the quality of crops and the fertility of soils improve. The use of hyacinth leaf mulch in rice cultivation in the north-eastern states of India has shown positive results. Hyacinth leaf mulch has been used in turmeric cultivation and in tea gardens around Thrissur city in Kerala, with very good results. Likewise, the use of hyacinth leaf mulches in Bangladesh have shown qualitative and quantitative increase in the yields of potato and tomato.

To preserve the nirmalta of rivers, if creative solutions like the above are adopted, they can solve local environmental problems and meet local employment needs. Then nature also bestows other rewards. Such solutions also fulfil the basic spirit of Vasudhaiva Kutumbakam according to

# NOT ELIMINATION BUT UTILIZATION

Over the years, efforts to control aquatic weeds by chemical and mechanical means have failed. Hence the focus should now be on their management and utilization. Such efforts are now going on in various places across the world. Scientists at the Indian Institute of Chemical Technology have developed a method to convert the roots and stems of water hyacinths into organic manure through anaerobic fermentation, which they claim to be the best option for water hyacinth management. By making fertilizers from water hyacinths, various nutrients including nitrogen and phosphorus can be returned to the soil, which will maintain the fertility of soils while the waterbodies get freed from being overrun by water hyacinth. Similarly, the International Crop Research Institute converted the biomass from water hyacinth into manure by using aerobic bacteria in rural Orissa. The ratio of nitrogen and carbon in the fertilizer prepared by this method is very good. Significantly, while carbon is continuously decreasing from our soils, both carbon (in the form of carbon dioxide) and temperature (heat) are increasing in the environment. To control rising temperatures, scientists have suggested sequestering carbon in soils (i.e. temporarily storing carbon in soils). Many studies have shown the presence of nitrogen, phosphorus or their compounds in soil to increase the rate of carbon sequestration. The biggest advantage of this process is that the abundance of carbon increases the fertility of the land. Another advantage of carbon sequestration in soil is that, as the percentage of carbon in soils increase, soil microbial activity also tends to increase. And when microbes proliferate, they catalyze plant growth by storing nitrogen in the root nodules of plants. In this way both soil fertility and the quality of crops increase, and there is reduced need for other soil additives to enhance crop quality. Just as rivers and waterbodies have their ecosystems, similarly soil too has a microbial ecosystem. This ecosystem is affected by the lack of carbon in soils, which affects soil invertebrates such as earthworms and other insects and moths. All these organisms contribute in maintaining soil fertility, and, in their absence, the soil gradually becomes barren. Organic fertilizers and manures are a better option to prevent soil barrenness.



which the entire World is One Family. In such a situation, the microorganisms living in the soil are also a part of our family, whom we cannot neglect.

### THERE ARE OTHER WAYS TOO: ETHANOL FROM WATER HYACINTH

Water hyacinth can be an accessible and cheap resource for organic ethanol which can be produced by treating it with sulphuric acid and subsequent fermentation. Many researches including that by the Department of Chemical Engineering, IIT Kharagpur has made this concept a reality. The ethanol thus produced can be used as bio-fuel for automobiles, cooking, and other needs. If such a project is

implemented on a large scale, then a cheap organic fuel can be made available to the public.

### FLOATING TREATMENT WETLANDS

In this method commercial plants like marigold, ashwagandha (*Withania somnifera*), and hibiscus are cultivated by hydroponics in artificially created islands in lakes and ponds, wherein nutrients are used in addition to water. Aquatic weeds remain controlled in this method and commercial benefits are also available. Such experiments have been successful in Andhra Pradesh, Kerala and Delhi. Likewise, in Bangladesh, vegetables are being cultivated by making solid platforms from hyacinth stems. These platforms

float on the water surface, due to which they are named Floating Vegetable Gardens called "dhaps" in the local language. This type of soilless farming is prevalent in other parts of the world as well, such as in the Dal Lake in Kashmir and the Inle Lake in Myanmar. It is noteworthy that in the year 2015, the Food and Agriculture Organization of the United Nations declared these methods as global agricultural heritages. In fact, to meet the food demand of the growing world population, it will become imperative in future to adopt such alternative methods along with the traditional methods of agriculture.

### OTHER OPTIONS

Organic bricks can be made from water hyacinth and used

in mushroom cultivation. This project is underway on a small scale in parts of South India. Scientists have also developed a method to make cellulase enzyme from water hyacinth, which is used in food processing, medicine, paper and cosmetics industries.

Many other products are also being made from water hyacinth in different states of India, such as decorative items, paper, canvas, toys, mats, and boards. In the north-eastern states, many decorative and daily use items are being made from the stems of water hyacinth for which the Northeast Financial Development Corporation gives financial assistance. With this kind of experiment, green employment is being made available to women in rural areas.

Although these initiatives are commendable, but with these methods the waste material is actually being converted from one form to another, and after some time it again reaches the soil or aquatic ecosystems as solid or liquid wastes. Aquatic weeds and agricultural waste control is a global problem, for which it is not appropriate to rely on limited local solutions. We need to invest in projects that can be implemented globally and make full use of the waste, such as bio-fuels and organic fertilizers, instead of converting it into another form of waste.

## THE BIG CHALLENGE

While promoting different uses of water hyacinth, we must bear in mind that the main reason for promoting these applications is to free waterbodies from hyacinths. Therefore, water hyacinth has to be linked with the local economy in such a

way that the river and water body – and not the aquatic weeds – remain at the centre of people's daily routines, needs, culture and business. Because, if the weeds take centre stage, then the health of waterbodies becomes secondary to human greed. Our first priority should be to minimize or control the production of water hyacinth by biological, chemical and physical methods. In rivers, especially, water hyacinth affects the depth of the river over time, which gradually becomes shallow and hence flood-prone. In the control and management of water hyacinth, special care must be taken that we do not invite a different problem somewhere else while searching for a solution to the problem at hand.

## AND FINALLY

Efforts are ongoing at many levels to free rivers from nutritional enrichment and their encroachment by aquatic weeds. For example, the use of organic fertilizers is being encouraged in place of chemical fertilizers throughout the country. Many scientists in India and United Kingdom are doing independent and joint researches for balanced use of nitrogen in agriculture and prevent excess nitrogen from entering waterbodies. The growth of aquatic weeds can also be curbed by restoring the continuity of the rivers. Efforts are going on in this direction as well. With the combination of modern science and traditional knowledge, we should be able to hand over the gift of safe water sources and food security to future generations.

## THE LESSON FROM THIS PROBLEM

It is said that every problem offers us a lesson. Hyacinths and other aquatic weeds also deliver an important lesson. Hyacinth was introduced in India as an ornamental plant during British rule, but it soon became a problem. Similarly, a plant known as alligator weed, which has become a menace for ponds and lakes in many states, was first noticed in the country in 1964. According to one theory, this weed reached India along with some goods imported from America. Today, this amphibious plant has become a problem for many of our waterbodies from Kashmir to Chhattisgarh. Like hyacinth, the basic instinct of alligator weed is rapid growth and reproduction. This species, which comes from Europe, proliferates very fast in our country on receiving abundant sunlight, and it has become a threat to aquatic ecosystems. In fact, this weed became a challenge because we considered waterbodies as resources but did not understand the biological ecosystem. Our rivers, ponds, lakes, lands, plains, and mountains are all living ecosystems. If any non-native plant or animal is introduced in these ecosystems, then the whole chain changes. Some organisms easily become a part of any ecosystem without harming its basic nature, while other organisms like water hyacinth disrupt the entire ecosystem. And this may happen not only with new plants, even the introduction of certain species of fish into waterbodies for commercial purposes has caused imbalance in those ecosystems. We cannot change history, but we can definitely learn from our mistakes. In this case the important lesson is that, before the introduction of any new flora, microorganism or any aquatic or amphibian animal that is different from the existing species in a waterbody, expert opinion must be taken. And, only after authentic research and consent should it be allowed to enter the system. A systematic procedure should be developed to monitor the biodiversity of waterbodies.

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