## Weed problems in aquaculture farms

Weed infestation of aquaculture farms is a problem of varying intensity in almost all systems of aquaculture all over the world. But it assumes very severe proportions in tropical and semi-tropical pond farms, especially in 'undrainable' ponds, such as those in use in South Asia. Limited growth of aquatic plants may be useful in maintaining water quality and may serve as shelter and substrates for food organisms in ponds, but profuse and uncontrolled growth affects aquaculture operations in several ways. Besides restricting the movements of fish and other aquaculture species, dense growths of vegetation, particularly floating plants, prevent adequate light penetration into the water and thus affect their productivity. Photosynthesis and oxygen production will be reduced when pond surfaces are covered by vegetation and this may cause oxygen depletion and consequently anoxia of the cultured species. Considerable amounts of nutrients from the water and those introduced into ponds through fertilization will be used up by the weeds and consequently the growth of food organisms will be reduced, resulting in low yields of the cultured species. Blooms of algae in ponds and enclosures often lead to oxygen depletion as a result of dead and decaying algal mass. Mass mortality of fish can occur under these conditions. Dense growths of aquatic weeds will make fishing with nets extremely difficult in ponds. Weed-infested stagnant ponds provide favourable conditions for mosquito breeding and thus become a public health hazard. In cage culture, in both fresh- and seawater, thick growths of algae on the net cages reduce water exchange and thus affect the water quality within the cages.

Control of weed growth is not so difficult in small farms, when labour is not too expensive. In countries like China aquatic weeds are effectively used as feed or fertilizer in fish ponds. However, in large farms in most tropical countries weed control is a formidable problem. It adds substantially to the operational cost as control measures have to be adopted at frequent intervals to prevent reinfestation. Seeds or spores may be brought in through water intake, blown in by wind or carried by birds or other animals or inadvertently by workers. If the control measures employed do not include removal and disposal of dead weeds from the pond area, the weeds decay and add to the fertility of the soil and water and thereby promote further growth of dense weeds. This problem is not unique to aquaculture farms: shallow lakes, reservoirs and irrigation channels can also be choked by dense growths of weeds, which are very difficult to control.

Several factors, individually or jointly, influence the growth of particular species of weeds. Besides the geographical and climatic conditions, topography, depth of water, extent of bottom sediments, clarity and fertility of the water, access to sources of infestation, and occurrence of floods are some of the factors that are of importance. Aquaculture farms to store nutrients for use when they are not available or to produce and liberate certain metabolites which help in the exclusion of other algae.

## Common aquatic weeds

Aquatic weeds belong to various families of dicots, monocots and single-celled and filamentous algae. From the point of view of aquaculture and weed control, the macrophytic and algal weeds can be best classified according to their habits and habitat.

(1) floating weeds, which are unattached and float with their leaves above the water surface and roots under water (e.g. Eichhornia, Pistia, Azolla);

(2) emergent weeds, which are rooted in the bottom soil but have all or some of their leaves, leaf laminae or shoots above the water surface (e.g. Nymphaea, Trapa, Myriophyllum);

(3) submerged weeds, which are completely submersed under water, but may be rooted in the bottom soil (e.g. Hydrilla, Najas) or free-floating (e.g. Ceratophyllum, Utricularia);

(4) marginal weeds, which fringe the shore line of the water body and are mostly rooted in waterlogged soil (e.g. Typha, Phragmites);

(5) filamentous algae, which form 'mats' in the marginal area or 'scums' in the main body of water (e.g. Spirogyra, Pithophora); and

(6) algal blooms, occurring dispersed in the water body (e.g. Microcystis, Anabaena).

Submerged weeds are generally more difficult to control and are therefore considered more noxious than all the others. Hydrilla, Najas, Nitella,Vallisneria, Potamogeton, Ceratophyllum, Urticularia and Chara are some of the persistent submerged weeds which it requires considerable efforts to eradicate. While many algae are the food of fish and other aquaculture species, it is the excessive growth of filamentous algae like Spirogyra and Pithophora and persistent blooms of planktonic algae such as Microcystis and Anabaena that account for their sometimes being considered as weeds in aquaculture farms.

## Methods of weed control

Prevention of infestations and utilization of weeds

It will be logical to consider first the possibility of preventing infestation of weeds in aquaculture farms.When constructing pond farms, care could be taken to avoid very shallow marginal areas and to maintain a depth of about 0.75–0.9m around the shoreline, to discourage growth of marginal weeds. Accumulation of silt can be reduced by preventing drainage of runoff from fertile land areas and by regular desilting of ponds. Erecting barriers or mesh filters to prevent entry of noxious weeds and their spores or seeds can be of some help. The use of netting, treated with antifouling chemicals, to make cages may reduce to some extent the growth of algal weeds in cage farms. But none of these preventive measures goes far enough to eliminate entirely the weed problem in aquaculture farms. So, it is often necessary to resort to one of the four other common control methods: manual, mechanical, chemical or biological. It will often be necessary to combine two or more of these methods to obtain satisfactory results.

The selection of the method of control has naturally to be based on the type and density of the infestation, the nature of the farm and the species that is cultured. Similarly, it is necessary to select the most appropriate time for treatment to get best results. Control measures are more effective if applied at the most vulnerable period in the life history of the weed, which is often the period of intensive production of reproductory units. For example, the best time to treat water hyacinth is during its active vegetative growth, when it is very susceptible.

Plants with well-marked seasons of flowering or turion formation can best be cleared before the fruits, seeds or turions are fully formed and shed. Cutting of plants like water lilies (Nelumbium), Typha and Phragmites should be done when they are flowering. Another major consideration in the selection of a method of weed control is the cost and naturally this varies very considerably between countries and locations. While estimating costs, the costs of not only the first major treatment, but also subsequent treatments have to be taken into account. By a combination of methods, such as manual and chemical, it may sometimes be possible to bring down the costs.

The cost of weed control can be reduced if some of the weeds can be put to productive use. Several efforts have been made to convert aquatic weeds to food, fertilizer, paper, fibre and energy (biogas). For comprehensive reviews of experience in this aspect Another option is to compost the weeds and use them as fertilizer for the ponds or for terrestrial plants grown in association with the fish farm.

**Manual and mechanical methods**

In small farms it is often possible to remove floating weeds and uproot marginal and emergent weeds manually, with the help of simple tools like hand scythes, wire mesh, coir nets, etc.

Water hyacinth, arrow head (Sagittaria), water lettuce, salvinia, duck weed, Azolla, Spirodella and Hygrorhiza are examples of floating weeds which can thus be removed from aquaculture waters. It is often difficult to eradicate the weeds completely, and the few that remain may be enough for the water body to be recolonized.

Repeated removal, combined where possible with biological or chemical methods, may be required to keep their growth under control.

Several types of mechanical equipment have been devised for weed control, but since these are generally meant for large bodies of water such as lakes, most of them can be used only in very extensive pond farms There are several models of mechanical weed cutters; many of them consist of flat-bottomed boats fitted with cutting beams or other cutting devices which can be adjusted to cut at different depths. Many of the cutting devices consist of two cutting beams: one horizontal and the other vertical. Motor-propelled boats fitted in front with a series of circular saws (one vertical and the others horizontal) have also been used. Floating weed cutters are generally driven by paddle wheels fitted with weed-cutting devices are especially convenient for use in shallow ponds and enclosures.

**Chemical methods**

Treatment with herbicide chemicals shows relatively more rapid results in weed control. However, most herbicides are also lethal to cultured animals at the levels of concentration required to kill aquatic weeds, in which case they can be used in aquaculture farms only after harvests and during renovation. Another problem is the accumulation of dead weeds after herbicide application. *Unless they are removed manually or by mechanical means, the weeds will decay and create oxygen depletion in the water.*

Further, the nutrients released by disintegrated weeds will add to the fertility of the farm and lead to further growth of weeds. It is also likely that herbicides will affect the development of blooms of desirable phytoplankton in the farm. The use of inorganic fertilizers to develop a thick growth of phytoplankton that will cover the water surface and prevent the penetration of sunlight, and consequently the establishment of weeds, has been recommended in some areas. But this method has not received wide acceptance, especially in the tropics where introduction of additional fertilizers in already fertile waters often results in more luxuriant growth of macrovegetation rather than plankton. However, shading of nursery and fry ponds with dyes, and even cowdung, has been tried to control noxious algal blooms with some success.

The herbicides used show a wide range of chemical structure and their action is either by direct contact that results in the destruction of the protoplasm or by translocation to unexposed parts of the weed. They are applied on the foliage or in the water in which the weed grows. In the case of rooted vegetation, the herbicide is applied on the soil where the roots penetrate. Some of them show selective action against particular weeds, whereas others are non-selective. The effectiveness of herbicide treatment depends on a number of factors, including the weed growth, the time and method of treatment that chemical treatment has to be combined with manual or mechanical removal, as well as

effective farm management, to prevent reinfestation.
The economics of treatment vary considerably according to country and location.
More importantly, many countries prohibit the use of some of the chemicals in aquaculture waters.
Among the herbicides, 2,4–D (2, 4-dichlorophenoxyacetate) has been widely used in controlling floating and emergent weeds by foliage application. It is commercially available as an acid, sodium salts, amine salts or as esters. The amines and esters have been widely used in the control of water hyacinth.

**Biological control**

The limitations, costs and possible side-effects of the methods of weed control have naturally led to searches for acceptable biological control measures that can be adopted in aquaculture farms. The use of several herbivorous fish and other aquatic animals has been considered and some experimental work carried out. The most well-known herbivorous fish is *grass carp to control aquatic weeds.*
*Though in theory any aquatic herbivore would be useful in reducing the growth of aquatic plants, their selective feeding at different stages of life, the population density needed to exert an effective control on the plant growth and the current aquaculture techniques that also use artificial feeds make it much more difficult to use biological control methods in aquaculture farms.*
The situation will, of course, be different in open bodies of water, including irrigation channels, small reservoirs, lakes and swamps. Biological control measures may involve the use of exotic species. In such cases, it will be advisable to use sterile hybrids to avoid their multiplication in aquaculture farms.