Selection of Sites For Aquaculture

Abstract

The history of aquaculture projects all over the world has led to the conclusion that the right selection of sites is probably the most important factor in determining the feasibility of viable operations. Even though, after many years of painful efforts and of new technology, some farms on poor sites have been turned into productive units, there are many that have been abandoned after considerable investment of money and effort. So there is no gainsaying the basic importance of selecting suitable sites for successful aquaculture. At the same time it has to be recognized that compromises have often to be made, as ideal sites may not always be available, and conflicts over land and water use will have to be resolved. In many situations good, irrigated agricultural land may be the best site for pond farms for fish culture, but national priorities in cereal food production may make it unavailable for aquaculture, irrespective of economic or other advantages. On the other hand many countries, particularly in Asia, are now giving higher priority to aquaculture and farmers are utilizing rice fields increasingly for fish and shrimp culture.

Although site selection will generally be based on the species to be cultured and the technology to be employed, under certain circumstances the order may have to be reversed. If it is decided to bring under culture certain sites, selection may be oriented towards determining the species that can best be cultured there and the most suitable technologies to be used for that purpose, if indeed the site is primarily suited for aquaculture. Limitations in any of the three factors, namely site characteristics, species and appropriate technology, obviously restrict choice of the others. However, as mentioned earlier, in the large majority of cases the species to be cultured would have been determined in advance, based on market requirements and consumer preferences.

4.1 General considerations

Although many of the factors to be investigated in the selection of suitable sites will depend on the culture system to be adopted, there are some which affect all systems, such as agro-climatic conditions, access to markets, suitable communications, protection from natural disasters, availability of skilled and unskilled labour, public utilities security, etc. (see Chapter 3). It may be possible to find solutions when these factors are unfavourable and present problems, but it would involve increased investment and operating costs and would affect profitability. In the case of small-scale aquaculture, it is necessary to determine that the selected site has easy access to materials that cannot be produced on the farm and that the necessary extension services are available.

All available meteorological and hydrological information about the area (generally available from meteorological and irrigation authorities) such as range and mean monthly air temperature, rainfall, evaporation, sunshine, speed and direction of winds, floods, water table, etc., have to be examined to assess their suitability.

In land-based aquaculture, the most commonly used installations are pond farms and hatcheries. Since most such farms have earthen ponds, soil characteristics, the quality and quantity of available water and the ease of filling and drainage, especially by gravity, are basic

considerations. For fresh-water pond farms, the land available consists mainly of swamps, unproductive agricultural land, valleys, stream and river beds exposed due to changes of water flow, etc. (figs 4.1–4.3). Land elevation and flood levels have to be ascertained. The maximum flood level in the last 10 years or the highest astronomical tide (in the case of brackish-water sites) should not be higher than the normal height of the dikes that will be constructed for the farm. It will be advantageous to select land with slopes not steeper than 2 per cent. The area should be sufficiently extensive to allow future expansion and preferably be of regular shape to facilitate farm design and construction.

The nature of the vegetation indicates the soil type and elevation of the water table. Obviously dense vegetation, particularly tall trees, makes clearing more difficult and expensive.

Fig. 4.1 A swampy area reclaimed into a fish farm in Indonesia.

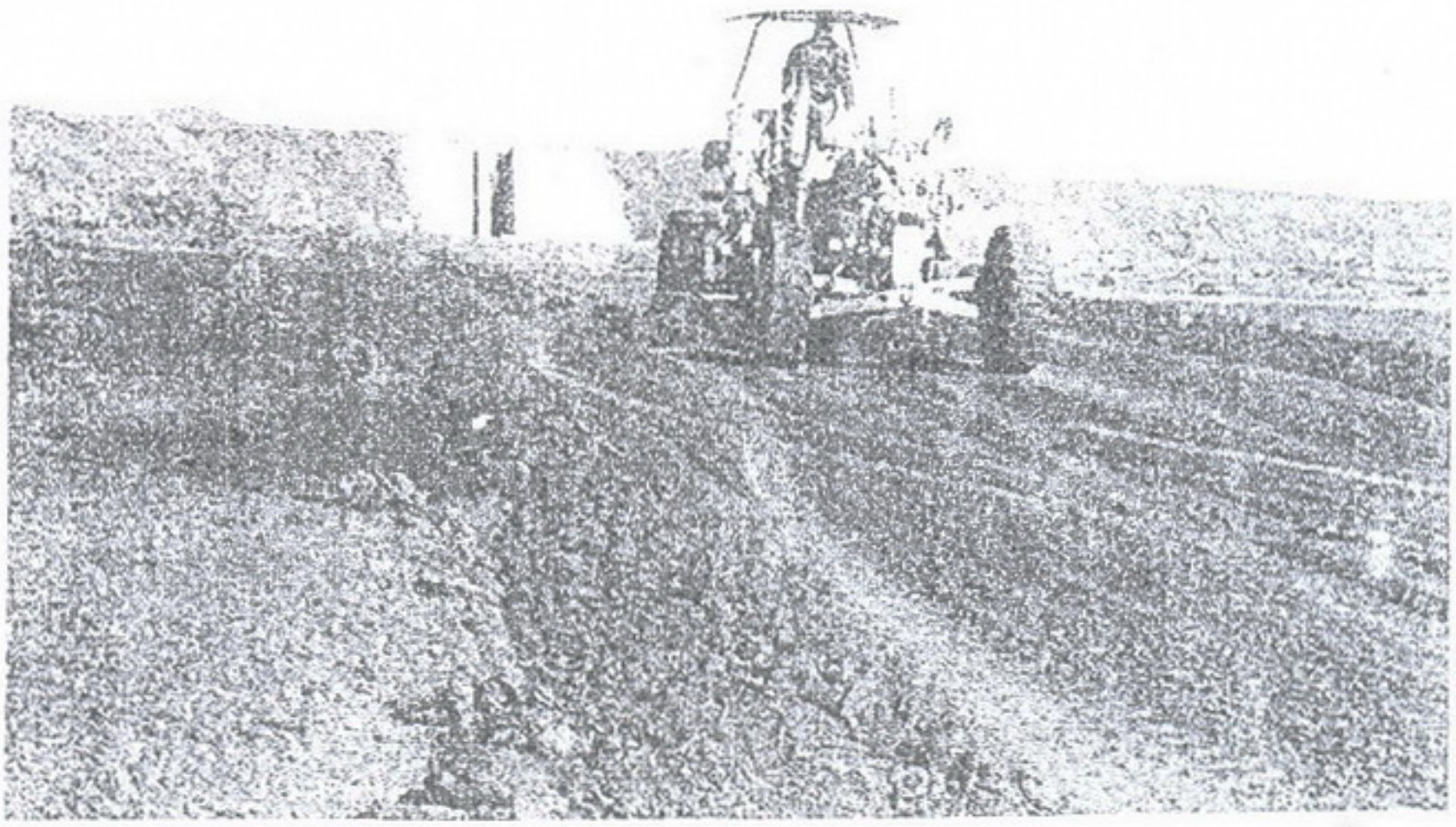

Fig. 4.2 A fish farm under construction in a saline soil area in Egypt.

Fig. 4.3 A fish farm in a valley in northern Cameroon.

Land under grass or low shrubs is much better suited in this respect. However, in areas exposed to strong winds and cyclonic or similar weather conditions, sufficiently tall vegetative cover around the farm can serve as an effective wind breaker. High ground-water level may create problems in farm operation, as drainage will become difficult and expensive. The use of mechanical equipment for pond construction will also become inconvenient.

Among the other important general factors to be considered are the existing and future sources of pollution and the nature of pollutants. In this connection, information on development plans for the neighbourhood areas will be necessary. It will be useful to ascertain the past use of the site, if any. Croplands that have been treated for long periods with pesticides may have residues that are harmful to fish and shellfish. If the site is located adjacent to croplands that are sprayed from air or land, there is the risk of contamination occurring directly or through run-off water. Similarly, the possible effects of discharges from the pond farms into the waterways and irrigation systems in the neighbouring area should be considered. This can greatly influence the attitudes of the neighbourhood communities to the proposed farming and hence their future cooperation.

– When a hatchery is planned in connection with a pond-rearing facility, the selection of its site depends on the location of the nursery and rearing ponds. The more important consideration is the unrestricted availability of good-quality water, such as from springs, tube wells, reservoirs, etc. If earthen nursery ponds are to be constructed alongside the hatcheries, it is necessary to ensure the quality of the soil for pond construction and pond management. In many modern hatcheries, fry rearing is mostly done in tanks and troughs, with as much control over ambient conditions as possible. So the main consideration is the availability of essential utilities such as electricity. The situation is very similar for the selection of sites for raceway farms. When the raceways are made of cement concrete the main consideration is the availability of adequate quantities of good-quality water and essential utilities.

The choice of sites for integrated aquaculture – such as fish culture combined with crop and livestock farming – is governed by factors other than their mere suitability for aquaculture. Land available for integrated aquaculture is

generally agricultural land, even if it is somewhat less productive. A satisfactory irrigation system is likely to have been developed for agriculture, in which case water and soil management can be expected to be easier. Since integrated farming is based on the recycling and utilization of farm wastes, problems of pollution can be expected to be minimal.

4.2 Land-based farms – conflicts

Sites generally available for coastal pond farms are tidal and intertidal mud flats in protected areas near river estuaries, bays, creeks, lagoons and salt marshes including mangrove swamps. The traditional and, in many cases, the most economical method of water management for a coastal farm is through tidal flow, and so one of the essential pieces of information is the tidal amplitude and its fluctuations at the site. The tidal range along the shore line may be more easily obtained from tide tables or other sources, but in estuaries and other water bodies away from the coast the figures will be different: the mean tidal level generally becomes higher, the duration of the ebb tide becomes longer and the flood tide shorter. The diurnal tidal range, that is the difference in height between the mean higher high and the mean lower low waters, becomes less. In order to determine the relation between tidal levels and ground elevation at the proposed coastal farm site, tide measurements will have to be made on the site with a tide gauge or tide staff over a period of time. The relationship of tides between the nearest port and the tide gauge placed at the site has to be determined first for this purpose. The tide curves and other necessary tidal data at the site can be calculated from the highest astronomical tide (HAT), mean high water springs (MHWS), mean high water neaps (MHWN), mean low water neaps (MLWN) and mean low water springs (MLWS).

The construction of ponds in areas reached only by the high spring tides would require excavation, leading to high construction costs and problems in disposal of the excess soil. If the dikes are made higher than necessary to deposit excess earth, the productive water area in the farm will be reduced. Excavation may also affect efficient drainage using tidal energy. Further, the removal of fertile top soil, which is important to induce the growth and maintenance of benthic food organisms in coastal ponds, will result in the loss of much time in reconditioning the pond bottom to stimulate such growths. However, in certain mangrove areas, particularly those under the red mangrove *Rhizophora*, the top layer may contain peat or a very dense mass consisting of rootlets of mangroves, which in any case will have to be excavated to make the pond bottom productive.

The selection of suitable sites, based on tidal fluctuations and elevation, is shown in fig. 4.4. A tidal fluctuation of around 3 m is considered ideal for coastal ponds. However, it has to be remembered that if the tidal energy can be replaced by other forms of energy for water management, the limitations indicated would not apply. As mentioned earlier, the main consideration then would be the cost involved and the economics of operation. Gedrey *et al.* (1984) estimate that the construction and operation of a farm with a pumped water supply system can be more economical than that of a tidal water farm.

4.2.1 Soil characteristics

The quality of soil is important in pond farms, not only because of its influence on productivity and the quality of the overlying water, but also because of its suitability for dike construction. The ability of the pond to retain the required water level is also greatly affected by the characteristics of the soil. It is therefore essential to carry out appropriate soil investigations when selecting sites for pond farms. Such investigations may vary from simple visual and tactile inspection to detailed subsurface exploration and laboratory tests. Because of the importance of soil qualities, detailed investigations are advisable, particularly when large-scale farms are proposed. Sandy clay to clayey loam soils are considered suitable for pond construction. To determine the nature of the soil, it is necessary to examine the soil profile, and either test pits will have to be dug or soil samples collected by a soil auger at regular distances on the site. To obtain samples, rectangular pits (1.0–2.0 m deep, 0.8 m wide and 1.5 m long) are recommended. If available, a standard core sampler or soil auger of known capacity (e.g. 100 cm^3) can be used for collecting samples of soil from each soil horizon.

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