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CHAPTER 8

Design Considerations for Sustainable Engineering Practices in Freshwater Fish Farms in Konkan Region

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Abstract

The increasing trend of fish consumption in the local market has led aquafarmers to prioritize supplying a large quantity of fish for their growing population. Freshwater fish farming ponds in the Konkan region were studied, dividing them into small (less than 2.0 ha), medium (2.0 to 5.0 ha) and large size ponds (above 5 ha). These ponds are located near rivers, reservoirs, lakes, streams, and tube wells, which provide water during the summer season. The ponds are rectangular to square, with some irregular shapes. The main sluice gates are made of wooden and reinforced cement concrete structures, while the ponds are constructed using 300–500-micron tarpaulin to prevent excess water drainage. The soil texture of the ponds is sandy clay loam, sandy loam, and loamy sand. To prevent viral diseases from spreading, animal and bird fences are used in fish farms.

Keywords: Freshwater fish farms, Layout, Design, Engineering aspects, Konkan region

Introduction

Aquaculture engineering encompasses the application of engineering principles and procedures to fisheries and aquatic organism culture. Vast arrays of engineering technologies have been developed specifically for aquaculture. This article addresses the crucial topic of modernizing or improving aquaculture in order to increase production. Appropriate site selection, surveying, designing aquaculture farms, water intake systems, building and maintaining fish farms, choosing major equipment (such as pumps, aerators, feeder canals, feed plants, effluent treatment plants, and other mechanical and electrical equipment) and updating current techniques that are applicable or available in the field of aquaculture and aquaculture engineering are all included (MPEDA, 1997).

Aquaculture has become much more in demand in the last few years. Creating efficient systems for the culture of freshwater and marine fish is the focus of aquaculture engineering. One of the technical subjects that are most crucial for creating functional fish pond designs is aquaculture engineering. Ponds are now used for aquaponics, fish culture, crab, shrimp and fish hatcheries to boost fish production and improve the fishing industry, among other uses. Aquaculture is the practice of reproducing and raising aquatic organisms entirely under human supervision. As a result of new fish farm designs and the expected expansion of activities due to the further improvement and diversification of practices, aquaculture production is currently rising globally. The industry producing animal-based food that is expanding the fastest is aquafarming, especially in India. The fact that the fish farming industry in aquaculture engineering is still in its infancy on the continent indicates that its enormous potential for fish farming has not been fully realized. It keeps expanding quickly and understanding of the engineering underlying aquatic production facilities is becoming more and more crucial for everyone involved in the sector. It calls for familiarity with a wide range of general engineering topics, including mechanical, environmental and building design and construction as well as material technology.

The use of engineering in aquaculture begins with the first steps in choosing locations for aquaculture facilities, including design and construction, water management, facility maintenance and all

the way to the end of the industry's operations, i.e., harvesting, transportation and marketing including the postharvest technology. Aquaculture science must be integrated with engineering disciplines like civil, chemical, mechanical, agricultural and naval architecture in aquaculture engineering programs. The engineering principles of aquaculture, cost-effective layout and design, the utilization of contemporary equipment like high discharge pumps, aerators, water testing kits, blowers etc. have been worked out by the aquaculture engineering (Mukharjee, 2003).

A good aquafarm site must be chosen, as well as the layout and farm management techniques to be implemented, for the business to succeed. Around the world, a significant portion of fish culture production is dependent on the use of freshwater ponds, which are designed to hold and exchange water, receive feed or fertilizer and facilitate the holding, rearing and harvesting of fish. Achieving success in fish farming requires careful planning, building and maintenance of these ponds and the structures they support. Well-designed ponds should be affordable to build, simple to maintain and effective at managing the water and fish populations. An essential component of a healthy freshwater fish culture is the physical, chemical and favorable qualities of the soil. Soil required for building ponds, a water supply, canals, reservoirs, barrages, small dams and effective fish pond management.

Freshwater aquaculture surveys are necessary to ascertain the site's natural accessibility and the kinds of services that are offered, particularly power and water supply, as these aspects should also be taken into account when choosing locations that are suitable for the construction of aquaculture facilities. The general suitability of the site for fish production as well as the various engineering inputs made by the aquafarm is not the only factors that determine the success of fishpond operations. In addition to identifying desirable physical, chemical and biological characteristics, site selection is crucial for providing insightful data that helps prepare the facility's overall design and layout, any necessary engineering changes and the management strategies that are best suited for the particular location. The site's principal streams are the subject of hydrological studies to ascertain the volume of flows. The evaluation of water quality will require an understanding of hydrological phenomena and the consequences of both high and low flows.

The most crucial element in a fish farm's success is most likely careful site selection. In a pond, the quality of the soil affects the water and productivity. But it also needs to work well for building dikes (Carballo *et al.* 2008).

Site Selection

Farms in the Konkan Region are situated in plain, gently sloping, hilly terrain with high-quality water supplies from rivers, lakes, streams, reservoirs, tube wells, springs and rainfall. In the Konkan region, the average temperature ranged from approximately 26 to 32˚C and the rate of evaporation was approximately 2 to 7 cm per day. Most of the fresh water fish farms in Konkan region are located on the inner side from the main road and also some farms are adjacent to the road. The topography, freshwater source, rate of evaporation and temperature among other factors indicate the perfect location for freshwater fish culture.

Design and Engineering Aspects of Freshwater Fish Farms

The Konkan regions classified in to various type of ponds such as spring-water source ponds, seepage water source ponds, rain water source ponds, water fed directly from barge pond, pump-fed ponds, undrainable ponds, drainable ponds, earthen ponds, stone pitching ponds, lining ponds, excavated ponds, embankment ponds, spawning ponds, nursery ponds, grow-out pond, brood ponds, fattening ponds, square shaped ponds, rectangle shaped ponds and irregular shaped ponds.

The fish farms pond area from Konkan region for small, medium and large size farm was ranged from 0.01 to 0.84 ha, 0.001 to 1.74 ha, 0.02 to 6.84 ha; respectively while water spread area of cultured ponds was observed from 0.01 to 0.68 ha, 0.001 to 1.35 ha, 0.01 to 3.61 ha; respectively. The overall length of fish farms, classified as small, medium, and large, ranged from 13 to 118 m, 8 to 143 m and 16.16 to 68 m respectively. The width of the ponds was found to vary between 8 and 74 m, 4 to 91 m and 12.6 to 55.6 m. Water depth of ponds for small, medium and large size fish farms was ranged from 1 to 3 m, 1 to 2 m, 1 to 5 m; respectively. The dimensions of peripheral dike; top width was ranged from 1 to 5 m, 0.3 to 2 m and 1.5 to 5 m for small, medium and large size fish farms; respectively while side slope was observed from 2:1 to 8:1 m, 2.5:1 to 6:1 m, 2:0.6 to 10:5 m; respectively. The range of free board for small, medium and large size fish farms peripheral dike was from 0.3 to 1.2 m, 0.3 to 1 m, 0.3 to 1 m; respectively and total height of peripheral dike ranged from 1.3 to 4 m, 1.3 to 3 m and 1.4 to 6 m; respectively.

In Konkan region top width of partition dike was ranged from 1 to 5 m, 0.3 to 2 m and 0.4 to 2.75 m; side slope was observed from 2:1 to 8:1 m, 2.5:1 to 6:1 m and 2:0.6 to 10:5 m; free board was ranged from 0.3 to 1.2 m, 0.3 to 1 m and 0.3 to 1 m; total height ranged from 1.3 to 4 m, 1.3 to 3 m and 1.4 to 6 m for small, medium and large size fish farms; respectively. The drainage canal was constructed only for small size fish farms of Konkan region with top width, bottom width, depth, bottom slope, drainage canal dike top width and free board of drainage canal dike 1.5 to 2 m, 0.8 to 1.2 m, 0.9 to 1.5 m, 1000:1,1 to 1.3 m and 0.3 to 0.5 m; respectively. The drainage canals in the Konkan region were not adapted because most medium-sized and large fish farms were seasonal. HDPE lining was used in the Konkan region on small, medium and large fish farms, with thicknesses of 0.3 mm, 0 mm, and 0.5 mm, respectively. The ponds sluice gates for small and medium-sized fish farms in the Konkan region had respective widths of 1 and 1 m and heights of 3 and 1 m. small, medium, and large fish farms in the Konkan region used pumps with capacities ranging from 1.5 to 5 HP, 3 to 5 HP and 5 to 10 HP; respectively. Large fish farms in the Konkan region use aerators that can reach up to 2 hp.

Soil Quality Parameters of Freshwater Fish Farms

The soil type in the farm pond and its fertility status much good in Konkan region. However, the best soil for the fish pond for the fresh water fishes especially the carps is alluvial soil with neutral pH ranging between 6.5 to 7.5. Though the soil type cannot be changed except in the long-range plans, the pH has to be brought to neutral if the pond soil and water are saline, alkaline, sodic or acidic. Both productivity and pond water quality are impacted by the quality of the soil. It needs to be appropriate for building dikes, though. In assessing the suitability of a soil, soil texture and porosity or permeability are

the two most crucial characteristics to look at. The ideal soil for building a pond has a lot of clay because the bottom of the pond needs to be able to hold water and the soil should supplement the water's fertility by supplying nutrients. In the Konkan region small, medium and large size farm soil quality parameters of the soil such as moisture was ranged from 9 to 15 %, 11 to 16 %, 11 to 16 %; pH was ranged from 6.5 to 8, 6.9 to 7.5, 6.1 to 7.1; electric conductivity was ranged from 1.25 to 3.55 dS/m, 1.12 to 3.52 dS/m, 2.13 to 3.56 dS/m; water holding capacity was ranged from 50.53 to 72 %, 55.94 to 72.03 %, 54.85 to 61.57 %; bulk density was ranged from 1.2 to 1.29 g/cm^3 - 1.21 to 1.28 g/cm^3 - 1.24 to 1.27 g/cm^3; seepage rate was ranged from 2 to 7 cm/day, 2 to 5 cm/day, 3 to 4 cm/day; respectively. The small, medium and large size farm soil texture was sandy clay loam, sandy loam and loamy sand; respectively.

Water Quality Parameters of Freshwater Fish Farms

The role of water supply, soil composition and terrain are all vital, but water supply emerges as the most significant consideration in site selection. Fish have an unwavering dependence on water, requiring it for multiple purposes including respiration, nourishment, development and reproduction. In the Konkan region fresh water fish farms small, medium and large size farm water quality parameters such as salinity was ranged from 3 to 4 ppt, 6 ppt, 5 ppt; temperature was ranged from 27 to 30°C, 27 to 29°C, 28 to 29°C; pH was ranged from 7.4 to 8, 7.4 to 7.8, 7.5 to 7.7; dissolve oxygen was ranged from 4 to 5.6 mg/l, 4 to 5 mg/l, 4.5 to 4.9 mg/l; ammonia was ranged from 0 to 0.02 mg/l, 0 to 0.01 mg/l, 0 to 0.01 mg/l; total alkalinity was ranged from 100 to 140 mg/l, 110 to 140 mg/l, 110 to 130 mg/l; total hardness was ranged from 70 to 130 mg/l, 70 to 140 mg/l, 100 to 130 mg/l; transparency was ranged from 30 to 45 cm, 30 to 40 cm 30 to 40 cm; respectively.

Biosecurity

The ultimate goal of a proposed biosecurity plan should be to enhance the biological, operational and financial performance of your organization. Plans for biosecurity must be well-thought out and balance cost, practicality, and regulatory requirements. In order to get the intended results, good biosecurity practices should be as easy to implement as affordable. An effective biosecurity plan ultimately needs to be seen as insurance, requiring commitment, as well as an investment of time and money in terms of both knowledge and resources.

Summary

Freshwater fish farming ponds in Konkan are of a semi-improved type, as can be seen from the analysis above. In parallel, the site has undergone meticulous technical management and design. The soil and water in Konkan are suitable for aquaculture, according to findings from the analysis of freshwater fishponds. Future success for the farmers in this Konkan region and the potential to increase aquaculture production are both contingents upon sustainable aquaculture management that takes into account all relevant factors.

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