Selection criteria

In this lecture we are going to discuss the selection criteria of fish and fish farming techniques and the factors that might influence the decision of the farmer. Let us look at the major ones listed below in detail.

1. Climate.
2. Water resources.
3. Finance.
4. Scale of operation. (manpower, knowledge, support services, etc.)
5. Ecological considerations.
6. Risk Considerations.

1. Climate

Climate is the long-term average of weather, typically averaged over a period of some years. More rigorously, it is the mean and variability of meteorological variables over a time spanning from months to of years. Some of the meteorological variables that are commonly measured are temperature, humidity, atmospheric pressure, wind, and precipitation. In a broader sense, climate is the state of the components of the climate system, which includes the ocean and ice on Earth. The climate of a location is affected by its latitude, terrain, and altitude, as well as nearby water bodies and their currents.

Climates can be classified according to the average and the typical ranges of different variables, most commonly temperature and precipitation.

Climate change and impacts on aquaculture

Climate change is the variation in global or regional climates over time. It reflects changes in the variability or average state of the atmosphere over time scales ranging from decades to millions of years. These changes can be caused by processes internal to the Earth, external forces (e.g., variations in sunlight intensity) or, more recently, human activities. In recent usage, especially in the context of environmental policy, the term "climate change" often refers only to changes in modern climate, including the rise in average surface temperature known as global warming. Climate changes affecting aquaculture are reflected by temperature changes in both water and air, particularly surface temperatures in marine conditions and other alterations in oceanographic conditions, including currents, wind speed and waves. Extreme weather conditions – becoming more intense and more frequent – are important effects, either as storms causing material damage or flooding of freshwater farms. Fish and other aquatic animals are subject to different stresses and physiological effects, affecting growth and development, which may further increase their susceptibility to diseases and infections. Climate changes could also reduce the agricultural production of soy, corn and other ingredients that today's fish feeds rely upon, hence the industry has to search for new and sustainable resources to produce cultured fish, such as algae, in the future. The industry is in need of innovative solutions to solve this urgent challenge. Climate changes may affect production through differences in nutrition, frequency and intensity of harmful algal bloom events while ocean acidification may reduce growth through reduced calcification of mussels in general. Thus, the technology for closed systems, more robust systems, systems for new species and new operating conditions for offshore farms raise new challenges and risks, while knock-on effects will be reflected in assuring worker safety and insurance rates. New technologies for distance management (with new ICT solutions and satellite monitoring) of farms are anticipated. A core challenge to aquaculture in this regard, comes from understanding and anticipating the effects of gradual change as opposed to extreme events.

Climate models

Climate models use quantitative methods to simulate the interactions of the atmosphere, oceans, land surface and ice. They are used for a variety of purposes; from the study of the dynamics of the weather and climate system, to projections of future climate. All climate models balance, or very nearly balance, incoming energy as short wave (including visible) electromagnetic radiation to the earth with outgoing energy as long wave (infrared) electromagnetic radiation from the earth. Any imbalance results in a change in the average temperature of the earth. The most talked-about applications of these models in recent years have been their use to infer the consequences of increasing greenhouse gases in the atmosphere, primarily carbon dioxide. These models predict an upward trend in the global mean surface temperature, with the most rapid increase in temperature being projected for the higher latitudes of the Northern Hemisphere.

2. **Water resources.**

Water resources are natural resources of water that are potentially useful. 97% of the water on the Earth is salt water and only three percent is fresh water; slightly over two thirds of this is frozen in glaciers and polar ice caps. The remaining unfrozen freshwater is found mainly as groundwater, with only a small fraction present above ground or in the air. Natural sources of fresh water include surface water, under river flow, groundwater and frozen water. Uses of water include agricultural, industrial, household, recreational and environmental activities. All living things require water to grow and reproduce. Technologies used to provide fresh water (apart from naturally occurring fresh water) include the use of reclaimed water and desalination. Water resources are under threat from water scarcity, water pollution, water conflict and climate change. Fresh water is a renewable resource, yet the world's supply of groundwater is steadily decreasing, although it is still unclear how much natural renewal balances this usage, and whether ecosystems are threatened. The framework for allocating water resources to water users (where such a framework exists) is known as water rights.

Technologies used to provide fresh water

Reclaimed water

Water reclamation (also called wastewater reuse) is the process of converting wastewater into water that can be reused for other purposes. Reuse may include irrigation of gardens and agricultural fields or replenishing surface water and groundwater (i.e., groundwater recharge). Reused water may also be directed toward fulfilling certain needs in residences (e.g., toilet flushing), businesses, and industry, and could even be treated to reach drinking water standards. This last option is called either "direct potable reuse" or "indirect potable" reuse, depending on the approach used.

Reclaiming water for reuse applications instead of using freshwater supplies can be a water-saving measure. When used water is eventually discharged back into natural water sources, it can still have benefits to ecosystems, improving streamflow, nourishing plant life and recharging aquifers, as part of the natural water cycle.

Desalination

Desalination is a process that takes away mineral components from saline water. More generally, desalination refers to the removal of salts and minerals from a target substance, as in soil desalination, which is an issue for agriculture. Saltwater (especially sea water) is desalinated to produce water suitable for human consumption or irrigation. The by-product of the desalination process is brine. Desalination is used on many seagoing ships and submarines. Most of the modern interest in desalination is focused on cost-effective provision of fresh water for human use. Along with recycled wastewater, it is one of the few rainfall-independent water resources.

Due to its energy consumption, desalinating sea water is generally more costly than fresh water from surface water or groundwater, water recycling and water conservation. However, these alternatives are not always available and depletion of reserves is a critical problem worldwide. Desalination processes are usually driven by either thermal (in the case of distillation) or electrical (in the case of reverse osmosis) as the primary energy types.

Water uses

We will only list other water uses for the sake of the lectures purposes but will dwell on the importance it has on aqua farming.

1. Agriculture
2. Industries
3. Domestic use
4. Recreation
5. Environment
6. Aquafarming

Aquafarming

The supply of food and other products through aquaculture and fisheries constitutes one of the most direct and yet highly dependent goals in water resource management. From the local through to the global level, the continuity and interdependence of water resources, their subtle and intimate connections with harvested species, and the many levels of society and economy which depend on these, mean that almost any intervention must have consequences for human well-being. While aquatic ecosystems and the species they support may be tolerant of substantial external change, and may continue to be productive under even the most constrained of circumstances, we see increasing evidence of damage in the wake of the land-use and water resource effects of population growth, and economic and physical development. However, armed with the knowledge of the potential which could be realised, and given the opportunity to incorporate aquatic production goals into water resource management, there are clear prospects for improving the situation. This part of the lecture considers the relationships between aquaculture, fisheries and the water resources which support them, and outlines the practical implications for developers and managers.

The role and use of water

The availability and quality of water resources is clearly a key factor in determining where and how fisheries and aquaculture may be supported or developed. As a medium, water provides direct life support, nutrient exchange and food production, as well as providing environmental and behavioural context, and the conditions in which stocks can be controlled, protected or exploited. The relationships involved, although at times complex, depend particularly on the habitat involved, the species and life-cycle characteristics, and the nature of the production system.

A fishery or aquaculture system may be vulnerable at any life-cycle stage and to any of these processes, and the absence of satisfactory conditions in only one respect may jeopardise the entire production potential. Nevertheless, many systems can be surprisingly robust, and may respond to external influence by, for example, changing the relative importance or distribution of species mix, rather than an absolute fall in output. However, much quality and value may be lost in the process when simple measures may have permitted or even expanded the original potential. In some cases, aquaculture techniques can be used to circumvent or constraints in 'natural' systems, but the existence and mechanisms of these constraints must be recognised and defined before action can be considered.

Water resources and their potential

For the purpose of fisheries and aquaculture production, distinctions can be made between:

· inland water resources; streams, rivers, floodplains, lakes, reservoirs, ponds, groundwater, irrigation supplies

· coastal water resources; ponds, lagoons, estuaries, mangrove areas, inshore reef zones.

Surface freshwaters: Surface freshwaters include streams, rivers and temporary bodies such as floodplains and can be particularly vulnerable to human influence, including physical obstruction, impoundment, containment and pollution.

Static freshwaters: Static freshwaters include ponds, lakes, reservoirs and normally have more stable physical and chemical characteristics. Related to flushing time, controlled fertilisation allows highly fertile pond ecosystems, successfully used in many tropical and subtropical regions. These systems are also of considerable interest for cage culture, aquaculture-based fisheries, and water supply or storage. There can however be problems from waste accumulation from intensive cage aquaculture. Water bodies are characterised by factors such as overall shape, average and distributed depth, permanence of volume, their nutrient characteristics and trophic states, incident solar and wind energy, the degree and effects of mixing and turnover of water, seasonal effects, as well as their importance for other social or economic objectives.

Groundwater supplies: Groundwater supplies (artesian or other wells, springs and groundwater-fed ponds) are of interest for aquaculture, particularly for hatcheries, and usually have more stable chemical characteristics than surface waters, although they may contain undesirable levels of dissolved salts and metal ions, low levels of dissolved oxygen and high levels of toxic gases (carbon dioxide, hydrogen sulphide). There is increasing concern about contamination of groundwater supplies by persistent pollutants which may also prove detrimental to aquaculture.

Coastal water supplies: Coastal water supplies may be relatively stable, though estuarine coastal water, influenced by large and/or periodic freshwater effluxes is more variable, with a risk from pollution, salinity and temperature fluctuations. Additional problems of marine water include fouling organisms and blooms of toxic algae. Coastal areas may be critically important for intermediate life-cycle stages of marine species and often support extensive fisheries.

Industrial sources: Aquaculture has been successful in using water e.g., warm cooling water from nuclear power stations and municipal tap-water supplies. Heated effluents are frequently supersaturated with nitrogen and other gases and other industrial and municipal waters may be contaminated with various inorganic and organic compounds which may require pre-treatment or culture of appropriately tolerant organisms.

<u>Wastewaters</u>: Wastewaters hold considerable potential in the longer term, and approaches for wastewater use are being developed widely throughout the world, particularly in association with increased integration of municipal-level wastewater treatment and disposal. There is also more potential to use wastewaters in irrigation schemes with integration of fish culture in supply channels and/or intermediate storage ponds - subject to similar public health/ acceptability constraints. Wastewaters may be used to recharge reservoirs, e.g., for irrigation purposes, stock could be transferred to 'cleaning reservoirs' prior to harvest. Although technical means are available for carrying out these approaches, there remain problems of public perception and acceptability, even if wastewater is treated, let alone using it for direct production of food.

3. Finance

Finance is a term for matters regarding the creation, management and study of money and investments. Savers and investors have money available which could earn interest or dividends if put to productive use. Individuals, companies and governments must obtain money from some external source, such as loans or credit, when they lack sufficient funds to operate. Finance is the process of channelling money from savers and investors to entities that need them. Specifically, it deals with how and why an individual, company or government acquires the money needed – called capital in the company context – and how they spend or invest that money. Finance has also been defined as the study of how to determine the value of assets such as stocks, bonds, loans, commodities, and by extension entire companies. Accurately determining value is crucial to sound business decisions. In some cases, such as one company acquiring another or entering a new line of business, judgements about asset values can make or break the investor.

The rise of aquaculture may hold promise to mitigate the environmental pressures of overfishing wild populations, and the food scarcity issues resulting from the rising global consumption of fish. However, to achieve these benefits, the aquaculture industry growth must be coupled with an increase in sustainable practices. Investors have a vital role to play through their power to reallocate funds away from unsustainable forms of aquaculture. This means avoiding businesses who are using fishmeal from juvenile fish or illegal bycatch, making heavy use of antibiotics in their fish stocks or creating significant wastewater discharges that threaten biodiversity. To finance the sustainable aquaculture revolution, investors must be able to define sustainability in aquaculture, address current barriers to investment and identify impactful investment opportunities.

4. **Scale of operation.**

This includes the man power needed for the whole operation of aqua farming to be successful, institutions and bodies that implement laws and regulations for the fishing sector, entities such as marketing, sales and distribution. This also includes knowledge, support services, Market demand and access etc.

5. **Ecological considerations.**

Aquaculture is one of the fastest growing food-producing sectors, supplying approximately 40% of the world's fish food. Besides such benefit to the society, the industry does have its problems. There are occupational hazards and safety concerns in the aquaculture industry. Some practices have caused environmental degradation. Public perception to farmed fish is that they are “cleaner” than comparable wild fish. However, some farmed fish have much higher body burden of natural and man-made toxic substances, e.g., antibiotics, pesticides, and persistent organic pollutants, than wild fish. These contaminants in fish can pose health concerns to unsuspecting consumers, in particular pregnant or nursing women. Regulations and international oversight for the aquaculture industry are extremely complex, with several agencies regulating aquaculture practices, including site selection, pollution control, water quality, feed supply, and food safety. Since the toxicological, environmental, and health concerns of aquaculture have not been adequately reviewed, there is need to have researchers look into it further to help develop policies to ensure its management.

6. **Risk Considerations.**

Generally, risks associated with aquaculture are similar to those facing agricultural enterprises and relate to components that can affect the aquacultural crop itself, whether it is disease, equipment failures, or unexpected competition. Others include; Production associated risks and Marketing risks etc.

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