Components of aquaponics

1)Water Quality: Water quality is important and optimum range of certain parameters required for successful fish culture in an Aquaponics System are as follows:

Sl. No.	Water Parameter	Optimum Range
1	Temperature	26 - 30 ^{o}C
2	Dissolved Oxygen	4 - 6 ppm
3	pH	7 - 8
4	Alkalinity	120 - 150 ppm
5	Ammonia	<0.05 ppm
6	Nitrite	<0.5 ppm
7	Nitrate	<5 ppm

2)Targeted Fish Species: Monosex Tilapia (Oreochromis niloticus), Pangasius (Pangasiandon hypophthalmus) or any species that can tolerate high density stocking are suitable for Aquaponic System.

	
GIFT Tilapia (Oreochromis niloticus)	Pangasius (Pangasiandon hypophthalmus)

A wide variety of commercially important fish species are grown in the Aquaponic Systems in different parts of the world. They include different Tilapia species and their strains/ hybrids, Common Carp, Silver Carp, Grass Carp, Channel Catfish, Rainbow Trout, Arctic Char, Striped Bass, Largemouth Bass, Yellow Perch, and the Giant Freshwater Prawn (Macrobrachium rosenbergii). Enough stocks of fish seed (fry/ fingerlings/ yearlings) are to be kept ready to stock the tanks after harvesting the grownup fish, so as to keep the Biological Filter stable and the Hydroponic sub-system running.

Aquaponics Fish Tanks (RAS)

Ornamental fish are good candidate species to be raised in an Aquaponic setup. Gold Fish (Carassius auratus) or Koi Carp (Cyprinus carpio) is especially suitable for this purpose. A variety of plants could be raised by incorporating a Hydroponic sub-system into an existing freshwater ornamental fish farm or even by latching it up with a good- sized aquarium indoors.

In India, usually Tilapia (Oreochromis mossambicus) is grown in Aquaponic systems as it is hardy and accepts a variety of feeds. Major and minor carps are also being attempted.

3)Fish Feed and Plant Nutrients

One of the most important starting inputs in an Aquaculture System is fish feed which has to be of high-quality. Commercially available pellet feed or floating extruded feeds are commonly used for raising high-value fish. Low-value or omnivorous fish could be fed low-cost mash/artisanal feeds. Alternate feeds include duckweed (grown within the Aquaponic System) for herbivorous fish, and worms from Vermicultue or Black Soldier Fly Larvae (BSFL) (Hermetia illucens Linnaeus) grown using kitchen leftovers, for feeding carnivorous fish.

The waste products excreted by the fish get converted into nutrients (nitrates) which the plants utilize. Plants require several macro- and micro-nutrients such as phosphorous, potassium, calcium, magnesium, sulfur, iron, etc., which may not be available in a newly set up Aquaponic System. The question from where other nutrients come from is the factor that basically defines the Aquaponic process. It has been shown that plants can be grown with nothing but fish waste and that in a mature Aquaponics System many plants grow better than in Hydroponics. The key to this success lies in high-quality fish feed, a mature

biological filter and optimum pH range. As the pH tends to drift downwards (7.0 to 6.8) there is a need to adjust it upwards (7.0 to 8.0) by adding some calcium/potassium carbonate/hydroxide as required. For plants to establish in a newly setup Aquaponic System, the Hydroponic medium or grow-beds media-beds may be periodically supplemented with Potassium, Calcium, Iron, etc. In a simple Flood & Drain Hydroponic sub-system where plants grow in solid media- beds, worms establish themselves, consume the fine solids and release plant nutrients.

4) Energy Requirements

Aquaponic Systems require electrical energy for operating pumps and motors to re-circulate water through the various sub-systems and to run the gadgets such as mechanical drum-filter, aerator, etc. However, the layout design is such that energy is conserved by letting the water flow down by gravity to the extent possible. Power failure may lead to loss of fish stock. Therefore, power back-up is a must for continuous running of pumps/motors, etc.; renewable energy sources such as solar and wind power could be integrated to reduce energy costs.

5) Plants

A wide variety of plants are being grown in Aquaponic Systems. Their choice and number primarily depend on the stocking density of fish in the Aquaponics and the nutrients that thereby become available to the plants. Crop duration and nutrients requirement are most important factors. Most often, vegetable plants are grown, and among them leafy vegetables such as lettuce, spinach, coriander, basil, mint, mustard, broccoli, cabbage, cauliflower, etc. are the primary choice because of their lower nutrient requirement, compared to

fruiting plants such as tomatoes, cucumbers, chilies, capsicum, peas, strawberries, melons, or even onions, ginger, beets, sweet potato, roses, etc.

7) Aquaponics grow beds

The leafy vegetables (herbs) are grown in a Deep-water Raft/ Nutrient-film Technique (NFT) Hydroponic sub- system, while the fruiting/ bulbous/ rhizome/ medicinal/ flower plants are grown in Solid-media/ Grow-bed type Hydroponic sub-system. Generally, fruiting plants are grown separately in mature Aquaponic Systems that provide adequate nutrients.

To ensure staggered planting and harvesting, a constant supply of saplings of the plants to be grown in Aquaponic Systems is necessary. Therefore, it is necessary to maintain seeds and a nursery of the required plants close by.

7)Diseases

Like in any other food production system, fish as well as plants in the Aquaponic System are susceptible to diseases. However, in a well designed system, disease incidence is much less than in field-grown crops. Further, drugs/ antibiotics/ chemical/ pesticides/ insecticides should not be used as they would cause harm to either the fish or bacteria in the biological filter or the plants. Therefore, preventive measures, biological methods and non-conventional approaches are adopted. In addition, the diversity of plant species grown mitigates disease problem.

8)Production & Harvesting

Generally, grow-out period of fish is much longer than that of the plants raised. However, the duration of fish culture could be short (45 to 60 days) if the RAS is used for production of fry or fingerlings of food fish or if ornamental fish are grown. If fish are to be grown to pan size/ table purpose the culture duration could

be 6 to 9 months or even more. Fish harvesting could be either staggered, so as to market them at regular interval, or all at a time. For continuous production and marketing of fish, the RAS fish- tank units have to be proportionately increased in number. Plant production could also be either staggered-type or batch-type. Most leafy vegetables reach market size in 3 or 4 weeks. Therefore, 3 or 4 growth stages of the plants are maintained and 1/3 or 1/4 of the crop is harvested and marketed weekly. In case of fruiting vegetable plants, the crop duration could be 3 months or more, in which case batch harvesting is done. A key factor in the design of an Aquaponic System is the ratio between the fish-rearing RAS unit and the plant- growing Hydroponic unit. Again, the volume of RAS unit depends on the intensity at which fish are raised; the quantity of feed added determines the amount of metabolic waste products produced and ultimately the plant nutrients generated. The fish to plant sub-systems ratio according to some is 1:2 by surface area or volume while according to some it is 1:7 by volume.

9)Marketing

Fish, vegetables, fruits and flowers grown in a commercial Aquaponic Enterprise have to compete with field-grown crops. Generally, Aquaponic Units are supposed to produce organically grown, chemical-/ pesticide-free products, and cater to niche markets (health-food stores, restaurants, homes) at a premium price. The perishable nature of the produce, harvest, post-harvest handling, shelf-life and marketing aspects have to be kept in mind while formulating the business plan.