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Developed Integrated Multitrophic Aquaculture Systems: Culture Water in Layers for Higher

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At present aquaculture is popular sector for its fastest growing food production in the world. Due to its popularity creates pressure on captive production and initiate to produce aquatic organisms the same pond, tank or cage by minimizing feed, water and labour. Monoculture based farming normally utilize resources inefficiently such as uneaten feed, fish excreta and dissolved nutrients simply accumulate as waste material. The waste material produce from monoculture always remains untreated into the environment. The developed integrated multitrophic aquaculture system solves this problem by utilizing different trophic levels of water for producing multiple crops from same unit. So, the waste of one crops become inputs of another crops. What began as a traditional composite fish culture thought has, with biofloc technology, recirculating systems, aquaponics, sensors and automation, motivate farmers to adopt science based farming model for reach to their target.

Definition of Integrated Multitrophic Aquaculture System

An integrated multitrophic aquaculture system defines the system where two or more crops are cultivated within one operational unit so that the outputs of one crops become potential input for another. When the integration merges only pure aquatic organisms and they occupying different feeding niches, scientists specify it an integrated multitrophic aquaculture system. Generally land based enterprises namely poultry, dairy or vegetable farming near side or along with fish pond known as an integrated fish farming. Advanced versions of both type of integrated models now applied in biofloc tanks, recirculatory aquaculture systems, aeration and water quality measurement sensors to make nutrient cycling faster, more predictable and easier to monitor.

The Trophic Logic: Fed, Extractive and Filter Species

A well-designed integrated multitrophic aquaculture systems represent three functional groups mimic a natural food web:

Fed Species: In fish based integrated system, high value carnivorous or omnivorous fish and shrimp namely Catla, Pangasius, Tilapia or Vannamei shrimp that are given formulated feed when they cultured in captive condition. So they can generate most of the uneaten feed and excreta.

Extractive Filter –Feeders: Various shell fishes namely mussels, oysters and clams, or filter feeding fishes including silver carp and catla releasing suspended organic particles and phytoplankton developing water quality.

Extractive Plant/ Algae Component: Several aquatic plants such as duckweed, azolla, aquatic macrophytes or seaweeds are capable to absorb dissolve nitrogen and phosphorous efficiently and function as a living biofilters while themselves becoming a harvestable crop-feed, biofilters or human food.

Above of these living organisms occupies a different feeding niche, competition for food is minimised while nutrient recovery is maximise which confirms the basic principles of Integrated multitrophic aquaculture system and its benefits over monoculture.

General Integration models practiced by Farmers

- **Composite fish farming:** It's a kind of intensive farming where fishes are stocked according their feeding habits in the same pond to utilize the entire water column effectively.
- **Paddy cum fish farming:** In this culture system, fish or prawns are raising in flooded paddy fields with several aquatic plants which fixes nitrogen for the crop while fish control weeds and insect larvae, cutting cost of pesticide and fertilizes also.
- **Poultry cum fish farming:** Poultry droppings or cattle dung mainly used in this system as fertilize the pond to produced natural fish food organisms, it's a closed nutrient loop long practiced in eastem and southern India.
- **Aquaponics:** This system combines soilless vegetables or herb cultivation with fish farming in recirculating aquaculture system where waste material from fishes utilized as liquid nutrient for plant roots and the plant here act as natural biofilters for fish which lower the nitrate level of the systems.
- **Biofloc integrated Culture:** This system is usually design for culture high densities fish or shrimp in a tank maintained with a controlled carbon to nitrogen ratio where beneficial bacteria convert ammonia into protein rich floc. Generally this system lower the supplementary feed cost.
- **Coastal and Cage Culture:** Rearing various finfish or shrimp in cages or coastal water bodies by utilizing each and every single column of water, it's called a coastal based integrated multitrophic aquaculture.

Advantages of Integrated Multitrophic Aquaculture System

Increment of total productivity per unit area: In integrated farming system, multiple harvestable outputs- fish, shrimp, shellfish, aquatic plants, sea weeds, vegetables can achieve from the one single culture unit.

Reduced feed and input cost: Some innovative approach namely biofloc and filter feeder components recycling in a way that a portion of uneaten feed and waste material back into usable biomass.

Better water- quality management and lower pollution: In integrated farming, extractive species absorb nutrients that would otherwise accumulate or be discharged, deducting the risk of disease outbreaks and eutrophication.

Income Diversification: These types of farming systems create an opportunity to getting income from several crop productions even if the price or health of one component falters in a given season then other crop components cushions the loss.

Environmental Sustainability: Closed nutrient loops and deduction of effluent discharge align with responsible aquaculture guidelines being promoted globally.

Conclusion

Advanced integrated multitrophic aquaculture systems follow the concept of age old wisdom of composite fish culture and sharpen it with developed water quality monitoring, biofloc technology and recirculating aquaculture systems. Accurate species selection with manageable stocking density can bring success to adopt this type of farming system. Because farmers transform the uses of pond waste into an additional harvest, allow to cut input costs of farming and build more reliable environmental friendly farm business. Integrated multitrophic aquaculture system offers a proven, scalable way forward- provided it is adopted step by step, with sound technical guidance and careful monitoring.

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