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Review of fish farming integrated with cattle farming

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Abstract
With increase in population in India, Integrated fish farming remained a key player in agricultural enterprises due its sustainability and focuses on diversified agricultural production with emphasis on fish. In present study we focused on the fish farming integrated with the cattle farming. Integrated fish farming is the farming of fishes with livestock and Agriculture that is, rising of fishes with agriculture and animals. Integrated fish farming is also called Agro-Pisci culture. The integration of aquaculture, fisheries, agriculture and other productive or ecosystem management activities has an integral role to play in the future of the aquaculture industry. Principle behind this study includes that Cattles provide organic manure to fish ponds. Cattle dung is nutritionally rich, very fine due to repeated digestion in the cattle and it can suspend longer in fish pond. The suspend ability of dung not only enables fish to get more feed, but also reduces oxygen consumption caused by manures, this also avoids the formation of harmful gases. Effort is required to standardize the fish size, stocking rate, feeding, species combination and feeding, type of animal, number of animal and their size; age and diet, quality of seasonal factors will also have to be considered. As the success of integrated system depends on low production cost and high returns, the management techniques for animals will have to be improved. Feeding technology for reducing feed cost, faster growth and higher yield of animals should be adopted. Liquid manure of effluent from bio-gas digester can be matched with this production technology.

Keywords: Fish farming, cattle farming, livestock, aquaculture, integrated

Introduction
Integrated fish farming is the farming of fishes with livestock and Agriculture that is rising of fishes with agriculture and animals. Integrated fish farming is also called Agro-Pisci culture. It is beneficial for farmers to reduce feed and fertilizers cost used in fish farming and enhances profit as well as social economic status of fish farmers. Fish farming integrated with cattle means fishes are raised on the output of cattle farming in point of manures. Integrated farming is the use of waste from one system as an input for another system [1]. India having was same land resources and having 302.3 million of cattle's and buffaloes and ranks first in milk production so waste that is cow dung and buffalo dung used as input for fish farming. The waste generated from cattle rearing is reclaimed, recycled, reused that is animal waste as fish feed manure for crops that is fish. Dung droppings contain 1.85 percent nitrogen 1.46 percent phosphorus and contributed calcium into pond. Cattle graze on pond banks and grassy areas in the vicinity and manure is either collected directly from cattle shed into fish pond. Cow dung is efficient in promoting production of zooplanktons and phytoplankton. Cow dung increases the nutrient status in a fish pond and acts as feed for fishes or enhancing the food availability fishes. One cow excretes 400 kg of dung and 300-liter urine per annum [2].

Present Status in India and in world states that, India is organic-based and derives inputs from agriculture and animal husbandry. India stands first in the milk production with 187.7 MT of milk production in 2018-19. The per capita availability is 394grm/day. The Fish cum cattle farming is practiced in north eastern states of India, the major activity observed in Assam and Tripura states. The Aratani's, a form integrated culture practiced in north eastern states. Asia is the world's foremost continent in terms of IFF. Vast areas of land (especially rice fields) in China, India, Japan, Indonesia, Thailand, Vietnam, Philippines and Bangladesh are used. In Africa, integrated fish farming has been reported in countries like Nigeria, Bcnin, Madagascar, Zambia, Carneroon and Malawi but mainly at subsistence level. The use of large areas of land in Hungary.

Czech Republic and Slovakia for predominantly, animal-fish farming [3, 4].

Material and Methodology

Farming Methods: fish cum cattle farming having two methods that is semi-integration means raising livestock on land and transporting the manure to fish pond and another method is complete or vertical integration that is raising livestock directly above the fish pond and animal manure drop directly into fish pond. The complete method is less used due to control of ammonia level in fish pond is hardy. Semi integration is more popularly used because of manure is given as per requirement a fish pond to avoid forming of algal bloom.

Cattle Farm: The location of farm should be isolated from human population but the road connectivity should be good. The workers hygiene and farm hygiene should be maintained by considering clean milk and meat production and genetic diseases Anthrax full stop ventilation of the farm should be well maintained so that there will not be respiratory problem in livestock and human workers. Minimum space requirement for cattle is 2.5 feet x 6 feet water requirement for animal is approximately 110 litter per day including watering washing of animal cleaning of farm. The space requirement should be maintained such that there will not be overpopulation. The field required for animal can be grown near the farm if sufficient space is available and soil and water quality is good that is dikes of pond maybe used for growing fodder. The general fodders required for feeding are subdivided into cereal fodders and legumes fodders based on crude protein content of fodders.

Manures and Animal Waste Management: following methods of manure management: I) Composting ii) Biogas iii) Applying for other Spp- Fish. The animal waste includes faecal matter urinary waste discarded products of animals such as mastitis milk, clipped hair, feed residues etc.

Disease management: The factors which are important performance eating animal waste as a feed includes regular monitoring of animal for infectious and parasitic diseases management and preventive measures such as deworming sanitization ectoparasitic management. If any deviation from normal healthy animal Environment is observed then veterinarian should be called for necessary action.

Pond Management Practice- Pond Selection: Selection of suitable sites for fish farm construction is very important. The following three essential conditions guide the proper site selection: 1) Topography, 2) Source of water and its quality 3) Soil type.

1) Topography: It is economical and convenient to construct ponds in waterlogged areas, irrigation command areas or in marginal lands. In such areas construction cost is relatively low mainly due to limited earth cutting. For example, a pond of 100m × 40m (0.4ha) of water area requires only 3 234m3 of earth to construct around a dyke of 2 m high above ground level (GL) with side slope ratio of 2:1 and top width of 1.5m. This quantity of earth may be obtained only from 1.1m depth of cutting. This limited depth of cutting reduces the construction cost considerably. However, full consideration should also be given to the possible effects of flood. The surface features of the area proposed for the pond or the farm is also equally important. A saucer-shaped area may be an ideal site for a large dug-out pond, because it may hold appreciable quantity of water with a small amount of earthwork. For smaller and flat areas eye estimation is enough, but for a big area proposed for farm construction with a number of ponds for different purposes and of different sizes, it is essential to conduct contour survey for determining the topography and land configuration.

2) Source of water and its quality: The quality of the available water is also equally important for fish culture. Pond fish production is influenced by the physical and chemical properties of the water. Water should be clear as far as possible. Turbid waters which carry suspended solids cut the light penetration, thus reducing primary productivity of the pond. Excess of suspended solids also adhere closely to the gill filaments and cause breathing problems. Water temperature also significantly influences the feeding and growth of fish. Prevailing water temperature, ranging between 15 °C and 35 °C in tropical areas, is most suitable for carps. The chemical quality of water depends on its content of dissolved salts. Rain water does not carry any dissolved salts. However, it collects nutrient salts from the ground surface of the catchment area. The water should be neither too acid nor too alkaline; neutral or slightly alkaline waters are most suitable for fish culture and hence acid water should be limed to make it neutral. Waters with pH values below 5.5 or over 8.5 are not proper for fish culture. The farmer will need huge quantity of lime to neutralize it while highly alkaline water may cause the precipitation of both phosphate and iron, and if it remains continuously above pH 9, it may be harmful to fish.

3) Soil type: Pond soil must retain water. Soils with a low infiltration rate are most suitable for fish pond. Table 5 shows the filtration rate of different types of soils. The best soils for our purpose are thus the impermeable clay which can be easily compacted and made leak proof. Loamy soils can also be used, but they need well compacting, and may leak slightly in the early stages, although they tend to seal themselves with time. Sandy and gravelly soils should be avoided, but if they are the only ones available, they must be made impermeable with a thick coating of clay or with polythene sheeting. Soil permeability can also be achieved by soil compaction at the pond bottom and dyke with either a mixture of soil + 1–5% cement or soil + 10–20% cow dung. Treated areas should be kept moist for 2–3 days by gently sprinkling water to avoid cracking and finally the pond is filled with water. Peat soils have special problems, since they are usually very acidic in nature and need sufficient liming, while the organic matter decomposition may lead to dissolved oxygen deficiency. Soils rich in limestone also create special problems, since the excessive lime content tends to precipitate phosphate and iron. Such ponds would then have little plankton population and macrophytes and would be relatively sterile. This can be overcome by adding sufficient organic matter such as cow dung, poultry manure, etc.

Maintenance: Proper maintenance of the pond and pond structure is most essential. Most of the earthen structures, especially the dykes, are susceptible to weathering action

and hence they need periodical checks. Attending to minor damages regularly avoids the chances of more costly repairs later. Erosion from the top during heavy rains causes grooving out of small channels and it is an indication that the top has not been properly consolidated. The area should be levelled with more soil and thoroughly rammed and then grass should be planted to bind it. Side erosion at the dyke bottom may be due to a number of reasons. The worst damage is done by common carp. Erosion due to frequent wave action, particularly if the grass at the edge has been grazed by grass carp, can cause undercutting of banks and subsequent collapse of dykes. Some methods used to provide protection against such erosion are earth berms, stone or brick pitching, stakes/bamboo piling.

ii) Pre stocking Management: -

A. Drying of Pond: The pond should be dried until cracks occur in the pond bottom. The drying of pond is important to kill pathogens present in soil and removal harmful gases. The UV rays of Sunlight kills the pathogen present in soil.

B) Ploughing: Carried out for removal of harmful gases and mixing of soil layers.

C) Clearance of Aquatic Weeds: If perennial pond is used for fish farming, then there is a necessity to remove aquatic weed because aquatic weed give shelter to insect's predatory organisms and consumes dissolved oxygen and nutrients in water.

Manual and mechanical control: Manually by hand picking uprooting the emergent and marginal weeds dragging with log weeders. Fitted with spikes and barbed wires mechanical winches.

Biological Control: Submerged weeds hydrilla and Najas are controlled by grass carp. Stocking size of grass carp 200-250mm. *Puntius gonionotis* is also used to feed upon the aquatic weed. Ducks are also used.

Eradication of Predatory fishes and unwanted fishes: - Predatory fishes directly prey upon the stocked fish and weed fishes compete with stock fishes for feed and shelter and consumes oxygen in the pond and utilizes primary productivity. These unwanted fishes are removed by repeated netting draining and applying of fish toxicants the most commonly used toxicant of plant origin is Mahua oil cake which is applied@ 2500 kg per hectare of water. The toxicity of Mahua oil cake lasts for two weeks and also acts for Organic fertilizer. The dead fishes are removed by netting air dragging of hand net, these fishes are safe for human consumption. After treatment of toxicant stocking is done after 2 weeks.

Liming: Liming helps to raise the total alkalinity level and consequently the Reserve CO2 will increase the availability of carbon for photosynthesis by Rising the Bicarbonate concentration in water. Depending upon the pH of soil the dose of liming should be adjusted. Alkalinity can also be used as indicator of the need for LIME in fish ponds and total dose not given at one time it may be divided into 3 - 4 doses and the first dose may be applied about week prior to maturing of the pond. It helps in faster mineralization of organic matter in pond sediment and acts as prophylactic agent as well.

Water Filling: The pond filled with water after liming the water should be filtered through suitable net to avoid entry of unwanted organisms. Optimum level of water in pond it as follows: Nursery Pond 0.5-1.0m, Rearing Pond 1.5-2.0m, Grow out pond 2.0-3.0m. The water should fall from the water inlet into pond so that the water mixes with oxygen from air has it falls into the pond. The water should not go into the pond too quickly if water enters too fast the pond bottom will get stirred up, and thus the water becomes muddy. The water should be allowed to be free for few days after it has been filled. The quality of water in the pond should we check ready for the stocking is done.

Manuring: The organic and inorganic fertilizers are used for manuring of fish pond to enhance primary productivity. Fertilizers provide necessary elements and Minerals to fish for growth and maturation. The inorganic fertilizers are applied @ 140kg per hectare and triple superphosphate @ 60kg per hectare in 4-5 instalments. The total quantity of inorganic fertilizers to be applied is decided according to soil type and applied in equal monthly instalments. Nitrogenous fertilizers are selected on the basis of soil PH. A combination of organic fertilizers and inorganic fertilizers are considered more effective than using either of these alone.

Stocking Management: Considerations for selection: I). The selected species should be compatible with each other, II) The species and their combination ratio should be adjusted according to the amount of feed stuff and manure that are expected to be made available by the other sub-system, III). As far as possible the species should fast grow, IV). Selected fish should be hardy and resistant to common diseases and parasites, V) The species should be able to tolerate low oxygen levels and high organic content in the water.

Quality of available natural fish food in pond and capacity of farmer to provide supplementary feed are also matters for consideration. In composite fish culture rearing of six species of carps is considered to be ideal combination but 3 - 4 species combination can also be taken up. Stocking pond also should have a desired level of plankton population of about 13-50 ml per metre cube.

Nursery Pond 1.5-2.5 million/ha

Rearing pond 0.25-0.30 million/ha

Grow-out Pond 6000-8500 fingerling/ha

b) Fish species can be cultured: Rohu *(Labeo rohita*), Catla *(Catla catla*), Mrigal *(Cirrhinus mrigala),* Silver carp (*Hypophthalmichthys molitrix),* Common carp (*Cyprinus carpio*), Grass carp (*Ctenopharyngodon idella),* Tilapia *(Oreochromis mossambica*), Magur *(Clarias batrachus*), Java puthi *(Puntius javanicus)* Kurhi *(Labeo gonius*), Freshwater prawn, etc.

Post - Stocking Management: -

Supplementary Feeding: The high cost of feed is the major constraint to intensive fish production. The rising cost of fish feed has brought interest in the utilization of animal waste in pond culture. The cow dung and poultry dried droppings as a direct fish feed showed that manure are poor substitutes for the components normally included in fish

feed pellets. The maximum 30 percent dried manure may be included in the fish be feed to obtain equal growth with conventional fish feed pellets (Schroeder, 1980). The quality value of manure as a substrate for microbial growth is directly related to the feed the animal received. The concentrated feed gives the high value than the fibrous feed. Generally, the value of the manure, in increasing order is: cattle, sheep and goat, followed by pig, chicken and ducks. The provision direct supplementary feed with application of manure is alternative strategy. Application of 3 ton per hectare cow manure with supplementary feeding (0.5, 1.5, 3.5%) Rice bran: MOC 1:1 increased growth but above 1.5% should not be recommended.

Water quality management: - The success of fish culture largely depends upon the water quality of the stocking pond. Water quality is defined as suitability of water for the survival and optimum growth of cultured fish. In water quality management we regulate the environmental conditions so that are within the optimum range for the cultured stock. Some of the water quality problems encountered in fish farms are-

A. **Depth of water:** The depth of water in the fish cultured pond is important factor from the productivity point of view. The optimum depth of water in fish pond is 2- 2.5 m. If there is any change in the depth of water in the fish pond is seen then it should be corrected. The excess water from pond can be removed through pumping or through the use of outlet in the embankment. If the water depth is reduced then from a nearby source it should be filling up.
B. **Turbidity of pond water:** This is occurring when there is more clay content in the soil of fish pond or it may cause due to overgrowth of phytoplankton. This reduces the primary production in pond, causes oxygen depletion in the pond water, reduce growth of cultured fish and also cause mortality of cultured fishes due to asphyxiation. Normally small fish and eggs are suffered from this water quality problem. To control this water quality problem, apply aluminium (filter alum) sulphate that is Al2 (SO4)314 H2O at the rate of 10-40 mg/ lit of water. Actual quantity can be determined by putting alum in a glass of turbid water. After applying alum liming should be done as per the water PH as mentioned in the corrective measures of water PH.
C. **Dissolved oxygen (DO):** Dissolved oxygen range in the stocking pond should be in between 5- 8 ppm. Dissolved oxygen depletion normally occurs in the morning or in the late-night hours. If the depletion of DO occurs in the pond, then the fishes will come to the surface of water and try to gasp air from the atmosphere. In that case feeding and fertilization in the pond should immediately be stopped. Supply water from a nearby source. Turbulent the water with the help of a split bamboo. Harvest the table size fish and reduce the density of fish in the pond. If they DO concentration is increase than its normal range then "Gas Bubble Disease" may occur. Normally it is seen in the noon and afternoon hours. Fish fry and fingerlings are mostly affected due to entry of gas bubble in the arteries of fish and finally fish may die. Supply of water from a nearby source having less DO concentration, transferring the affected fish to a nearby pond, etc. are the remedial measures.
D. **Ammonia:** Ammonia occurs in pond water in 2 forms that is ionized and unionized. Unionized ammonia toxic to fish. Ammonium (NH4) is lethal to fishes only at a level above 16 ppm while ammonia (NH3) is lethal at a level above 0.02 ppm. If the unionized ammonia concentration is increased then the fish may die. Control the water temperature, PH and also the concentration of phytoplankton in the pond and for that purpose take the renovate measures given in case of changes of water PH & temperature.
E. **PH of water:** PH is defined as the negative logarithm of hydrogen ion concentration. PH value 7 is neutral, below 7 is acidic and above 7 is alkaline. For fish culture soil and water PH should be in the range of 7.5-8.5. Acidic PH is due to chemical nature of soil and water and it can be controlled through liming as mentioned above in liming. Alkaline PH is seen with alkaline soil and with phytoplankton bloom and this can be controlled by water replenishment and through the application of gypsum.
F. **Phytoplankton bloom:** The sudden increase of population of certain planktonic algal group as thick mass in water is called phytoplankton bloom. It is identified by the deep green or blue green or reddish green colour of the pond water. During the day time phytoplankton produces excess oxygen and during night and cloudy days they absorb dissolved oxygen from water for their respiration resulting dissolved oxygen depletion and fish mortality. The death and decay of algae also cause dissolved oxygen depletion. The reason for this algal bloom in pond water is the presence of excess nutrients in water. Therefore, if this problem encountered in the fish culture pond, then supply of cow dung to the pond should immediately be cut off and the remedial measures should be taken as mentioned in the case of algal bloom cited in the renovation measures of a pond which cannot be dried.

Harvesting: Harvesting is generally done at the end of 1st year, when the fishes attain average weight of 800 gm to 1.25kg. With Proper management a production of 4 to 5 tons/ha can be obtained in a year. Harvesting is done by partial dewatering and repeated netting. In some cases, complete dewatering of ponds is resorted to. Some farmers resort to partial harvesting also depending on the season and demand for fish.

Production: Fish productivity was recorded highest in fish cum cattle farming. Culture of Chinese carp in pond manure with 15 ton per hectare per year cow dung produced 5 tons per hectare per year. 5 - 8 cattle are sufficient to fertilize a hectare water area to get over 4000 kg fish without feed or any other application. According to Samra *et al*., fish production from integrated cattle farming is 5-7.5ton/ha/yr. One cow 3000 litre of urine and 400 kg of dung per year. The milk production from one cow per annum approximately 3000 litres. Energy Efficiency in cattle cum fish farming is 0.66 experiment taken at Calicut in 2006-2007 integrated fish farming evaluated the net return from livestock is 14.3%. Conversion ratios of animal manure to fish that is kg of fresh manure to per kg increase in fish weight in cattle is 35%. The survival rate is recorded in cattle farming is 80-95%.

Importance of cattle-fish integration

1. Minimizing wastes leading to improved environment quality of the area.
2. Reducing need for fertilizer but with increased fertility.
3. Improves soil nutrients and increased its fertility.
4. Increases fish production leading to improved nutrition and income of rural population.
5. Reduces dependence upon outside inputs leading to increase stability.
6. Increasing employment opportunities.
7. Catties are raised for milk and manure on pond banks and their washing are drained directly into the pond. Under this system cost of fish culture is reduced by 50%.

Conclusion:

The integration of aquaculture, fisheries, agriculture and other productive or ecosystem management activities has an integral role to play in the future of the aquaculture industry. Effort is required to standardize the fish size, stocking rate, feeding, species combination and feeding, type of animal, number of animal and their size; age and diet, quality of seasonal factors will also have to be considered. As the success of integrated system depends on low production cost and high returns, the management techniques for animals will have to be improved. Feeding technology for reducing feed cost, faster growth and higher yield of animals should be adopted. Liquid manure of effluent from bio-gas digester can be matched with this production technology.

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