Environment Conservation Journal 7 (1-2) 49-54, 2006
(ISSN 0972-3099)

Sustainable Integrated Fish-Cum-Live Stock And Poultry Farming

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Introduction

At the world scenario, China is the first country who had leaded this world for the use of night soils in the fish ponds for the first time, for fish production and thus became a pioneer in integrated fish farming system by using other livestock -wastes. This system in China was established in the early 19th century, estimated annual production of excreta of cow dung, 900 kg pig dung, 2200 kg chicken excreta 40-50 kg and the night soil of human beings 790 kg.The excessive use of natural resources exert pressure on the land and on the water body, therefore, it requires to maintain more productive yet sustainable aquaculture system. To maximize aqua cultural production from a single unit area, through optimum utilization of resources, it involves crop farming, livestock farming and fish culture to maximize production through recycling of organic wastes. In this system, practically, nothing is wasted and simultaneously, ecological balance is maintained and thus, varieties of products are received. But if the system is poorly managed, accumulation of these waste materials in the aquatic system would lead to health hazards. Therefore, availability of different resources in various agro-climatic conditions, following kind of integrated fish farming systems can be established. Increased production is being achieved by the expansion of areas of land and water under culture, and the use of more intensive and modern farming technologies that involve higher usage of inputs such as water, feeds, fertilizers and chemicals. FAO (1990) defined the sustainable development as the management and conservation of the natural resources base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in agriculture, forestry, and fisheries sectors) conserves land, water, plant and animal resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable.

Most village farmers have few numbers of cattle, goats, sheep, birds, land and water areas, which can be exploited for food production. These components offer great scope for uplifting their socioeconomic conditions by following diversified activities. It is well known that the pond bed provides enough humus for increasing soil productivity, crop production, consequently, helps in fish culture, animal husbandry thereby acting as an integrated web cycle in the farm making it an independent multi-structural unit. The most integrated systems of aquaculture are duck and pig farming and poultry production. In some places cattle and fish culture are also partly integrated. Smaller fragmentation of agriculture land and population pressure calls for the diversification and integration of these enterprises.

Characteristics of Integrated Farming

The concept of unitary culture either of fish, crop, or animal husbandry is gradually changing to the integrated culture system with the view of producing fish, meat, egg, milk, vegetables and other allied products within a farm itself on an economical scale. Accumulation of wastes/byproducts can generate pollution to the environment. Such wastes/byproducts can be recycled for food production through integrated system of fish culture. The characteristics of integration is the development of structural network in line with local conditions and utilization of wastes by various ways of recycling as manure, bio-gas, crop production, feed etc.

Importance of Manure

Animal wastes are used to fertilize fish pond and are considered superior to inorganic fertilizers in producing and maintaining desirable species of planktonic and benthic food organisms in fresh and brackish water ponds. Yields obtained with organic fertilizers are usually higher than those obtained with inorganic compounds. Moav *et al*. (1977) reported that fish fed on plankton produced in manured ponds have lipid contents (6.2 %) less than those fed pellets of high protein content (15 % lipids) or those fed cereals (20 % lipids). The cost of manure is lower than that of inorganic fertilizers.

Organic fertilizers contain nitrogen and phosphorus, but also decaying organic matter. Nutrients benefit phytoplankton (and phytobenthos), while the organic matter promotes the development of bacteria in suspension in the water and in the sediment. The heterotrophic production cycle is thus stimulated leading to an increase in zooplankton and zoobenthos. Manure also supplies organic colloids, which increase the sorption capacities of soil and seston. Phytoplankton supplies organic matter for decomposition thereby regenerate the nutrients to the benefit of phytoplankton and themselves are consumed by zooplankton and fish and zooplankton in turn are consumed by fish.

Comparative Value of Manure

Some fish especially tilapia, feed directly on fresh excrements. They can be observed, for instance, below pigsties or at the entrance of feeder canals bringing sewage from stables, feeding on excreta floating in the water. This has led to the idea of using dung directly in the preparation of artificial feed pellets. Analysis of cow dung and chicken manure indicated that this contains an amount of metabolizable energy, in the order of 2510 to 3347 kJ kg and 3766 to 5021 kJ kg and 10 to 15 % and up to 25 % gross N-proteins, respectively. The composition of excreta of common animals is presented in Table 1. Amount of excrement expressed in fresh weight and dry weight per day per 100 kg of live weight produced by common animals are presented in Table 2.

Table 1: Composition of excreta of common livestock animals (Little & Muir, 1987)

Animal	Faeces to urine ratio	Humidity	Nitrogen (%)	Phosphorus (%)	Potassium (% of K_2O)
Cattle	75:25	85	4.0	2.7	3.4
Pig	53:47	85	4.7	4.3	2.7
Sheep	67:33	70	3.9	2.4	3.5
Horse	75:25	75	2.3	1.3	1.4
Chicken	100	65	6.0	7.9	3.7

Table 2. Amount of excrements of common animals in fresh and dry weight basis per day (Little & Muir, 1987)

Animal	Fresh excreta/ Animal/ day (kg)	Dry weight/ animal/day (kg)	Fresh excreta/ 100 kg wt./ day (kg)	Dry wt. per 100 kg live wt/day (kg)
Cattle	30.0	4.50	6.0	0.90
Chicken	0.7	0.27	35.0	13.40
Ducks	1.0	0.38	33.3	12.70
Pigs	8.0	1.20	14.5	2.17
Sheep	2.1	0.71	7.0	2.40
Horse	24.0	8.20	6.3	2.15

Studies have indicated the superiority of chicken manure over cow dung for fish production. As compared to the control, chicken manure increases fish production by 21%, while this value was 11 % for cow dung. The feed conversion rate of pellets decreased by 12 and 6%, respectively, for chicken manure and cow dung, as compared to the control.

Types of Fish Cultured in Manured Ponds

Fertilization with manure can be applied to ponds where fish with various diets are cultured in polyculture, making use of different feed resources of the pond. Primary productivity is used by phytoplanktivorous fish, secondary productivity by zooplanktivorous fish, and detritus by detritivorous fish. Some fish especially tilapias have wide feeding regimes, capable of using a broad range of food items.

Disadvantage of the use of manure

1. Excess of organic fertilizer causes depletion in dissolved oxygen particularly during the hottest hours of the day because of high microbial activity.
2. There is release of ammonia especially when pH is alkaline which is toxic.
3. Risk of transmission of parasitic diseases to humans with fish as intermediate hosts, however, no such disease has yet been detected.

Precautions for use of manure

1. Spread manure in water in small amounts and several times a week.
2. Spreading should be homogenous over the whole surface.
3. Manure in an advanced stage of decomposition fertilizes better than less decomposed matter as the nutrients diffuse more easily to the water.
4. In dried ponds, spread dung/compost on the bottom of ponds before impoundment.
5. Ponds should be shallow, ideally with a mean depth of 1 m.
6. In stocked ponds, manuring is increased concurrently with fish growth @ 2 to 4 % (dry weight) of the standing fish biomass.
7. Application rates are 100 to 150 kg/ha/day (dry weight) in intensive production.

Number of livestock heads needed for integrated fish farming

In integrated livestock-cum-fish farming, the animals are raised near or on ponds so that the manure and other waste materials can be discharged directly into the ponds. The number of animals is regulated to ensure that the wastes discharged into the ponds do not exceed the desired quantities. This number varies with intensity of production, and with size and weight of the animals. For pigs, the numbers vary between 30 and 85 pigs/ha, and for ducks, between 1000 and 3500/ha. Pigsties and duck pens can be built directly over ponds, on stakes, or nearby. Pigs are raised for 5 to 6 months, until they reach a commercial weight (60 to 100 kg). Chicken and ducks are raised for 1 to 3 months, till they reach their market size.

Types of Fish-cum-Livestock Integrated Farming

A. Fish-cum-Duck Integration

1. Ducks are popularly known as "Living Manure Machine'.
2. Ducks use both land and water as habitat.
3. Ducks feed on the predators (tadpoles, dragonfly, weed fishes) thus help fingerlings to grow.
4. Duck raising in fishpond reduce the demand for protein on duck feed.

5. Duck droppings go directly in to water bodies providing C, N and P.
6. Daily waste of duck feed can be utilized as fish feed in pond.
7. Manuring by ducks is homogeneously distributed without any heaping of duck droppings.
8. Ducks oxygenates pond water by their frequent movements and dubbing habits in water.

B. Fish-cum-Chicken Integration

1. Fishmeal is used as a protein source in poultry feed.
2. Poultry droppings are rich source of N and P.
3. Chicken manure is a very efficient fertilizer for fish production.
4. Chickens can be housed over the ponds and the droppings can fall directly into them.
5. For one acre of fishpond about 250-300 birds are required.
6. Droppings can also be utilized as a component in fish feed pellets.

C. Fish-cum-Pig Integration

1. Left over, residues of kitchen, aquatic plants, and wastes are used as feed for pigs.
2. Pig dung contains 70-75% easily digestible nutrients for fish.
3. Feed cost for fishes can be reduced by 40-45%.
4. Pig manure is consumed by bottom feeders and is beneficial for the growth of plankton.
5. About 25-30 growing pigs can fertilize one acre of pond.
6. Pig's pens can be constructed over the bank of the pond.
7. Three tier system (poultry in upper stall, pigs in lower stall and below it the fish ponds) is more profitable as pigs consume poultry droppings and fish consume pig's dropping.
8. Duration of the culture of fish and pigs is about one year.

D. Fish-cum-Cattle Integration

1. Cattle dung and urine also have super manure value.
2. Waste fodder and washings are also utilized as a fish feed.
3. Cow manure is rich in N and P levels, which are congenial for plankton growth.
4. Cow manure is very fine due to repeated digestion in stomach of cow and it can suspend longer in the water.
5. Such suspensibility of dung enables fish to get more feeds, reduces oxygen consumption and avoids the formation of harmful gases.
6. For manuring an acre of fish pond, 4-5 cattle heads are sufficient.
7. BOD of cow manure is relatively lower than other livestock manure because the cow forage has already been decomposed by micro-organisms in cow's body.

E. Fish-cum-Sheep/Goat Integration

1. Sheep and goats are very prolific small ruminants.
2. Droppings can be used as a component of fish feed thus reducing the cost of artificial feed.
3. Pens having slotted floors are constructed on the banks of pond such that the faeces are dropped directly into the pond water.
4. A unit of 25-30 animals is sufficient to manure an acre of fish pond.

Mathematical Management of Farming Systems

In integrated system, there is need of integrated management. Some of the management considerations to be adopted are given below.

1. Feed demand
   M = YF
   M = Feed demand
   Y = Target yield of fish
   F = Food conversion rate.
2. Number of Individuals/Water Area
   N = (Y1 - nY2)C/m
   m = Amount of excreta per individual
   C = Conversion factor of manure
   Y1 = Net yield of filter feeder and omnivorous
   Y2 = Gross yield of fish
   N = Ratio of herbivorous fish fecal to filter feeder and omnivorous fish production (0.2 - 0.6).
3. Manure requirement
   M = (Y1 - nY2)C
4. Construction Area of Animal House
   S = N*s/C
   S = Standard area
   N = Number of animals raised in whole year.
   s = Average construction area per animal i.e.
   Cow - 7m^2, grazing area 15-20m^2/cow
   Duck - Dry run 45 individuals/m^2, wet run 3-4 individuals/m^2
   Pig - 2m^2/individual
5. Number of cycles per year for different species
   Cow and chick - One cycle/year
   Pig - Two cycles/year
   Ducks - Four cycles/year

References

Little, D. and Muir, S. 1987: A guide to integrated warm water aquaculture. Univ. of Sterling U.K.

Moav et al. 1977. ***Aquaculture*** 10: 25-43.

Financial Considerations of An Integrated Cattle-Poultry-Fish System

Assumptions: The owner has two hectare of land, i.e. one hectare for ponds, remaining land for livestock and poultry sheds, stores and fodder cultivation etc. There are five family members to support the system in addition to one more hired labour. Five buffaloes and 200 layer chicks are considered to run the unit.

Financial Details

A.	**Initial Capital Investment**		**Amount (Rs.)**
	i)	Layout and leveling charges for fish ponds (1 ha)	5000
	ii)	Cost of construction of 8 nursery ponds (40'x20'x5'), 4 rearing ponds (60'x40'x6'), 2 stocking ponds (200'x80'x8')	95000
	iii)	Cost of 5 buffaloes	100000
	iv)	Cost of buffaloe sheds (4 sq.m/head, @ Rs. 800/sq.m) and for open area of 8 sq.m/animal (@ Rs. 200/sq.m)	50000
	v)	Poultry sheds of 500 sq.ft area (@ Rs. 70/sq.ft)	35000
	vi)	Office-cum store (100 sq.m, @ Rs. 1500/sq.m)	150000
	vii)	Construction of tubewell/guard shed etc.	100000
	viii)	Cost of dairy equipment, fish nets and other farm accessories	80000
	ix)	Miscellaneous expenses	70000
		Total Capital Cost	6,85,000
B. Expenses			
	i)	Interest on bank loan @ 10%/annum on 80% of capital	54800
	ii)	Depreciation ponds, building @ 5%/annum	16750
	iii)	Depreciation on equipment @ 10%/annum	18000
	iv)	Insurance premium of buffaloes @ 4%/annum	4000
	v)	Cost of 10000 fish seed @ Rs. 200/1000	2500
	vi)	Cost of 30 qtl. Fish feed (@ Rs. 1000/qtl)	30000
	vii)	Pond monitoring, liming charges etc.	3000
	viii)	Cost of 547.5 qtl green fodder (30kg/animal/day @ Rs. 55/qtl)	30112
	ix)	Cost of 73 qtl dry fodder (4kg/animal/day @ Rs. 150/qtl)	10950
	x)	Cost of 55 qtl. Concentrates (3 kg/animal/day @ RS. 700/qtl)	38500
	xi)	Labour charges @ Rs. 3000/month	36000
	xii)	Cost of 200 chicks @ Rs. 14/chick	2800
	xiii)	Cost of feeding chicks (@ 6.5 kg/chick/day up to 18 weeks	71974
	xiv)	Miscellaneous charges etc	55000
		Total expenses	374386
C. Total Receipts			
	i)	Sale of milk 10/lt/animal for 300 days (@ Rs. 14/lt)	210000
	ii)	Appreciation of heifers (@ Rs. 2500/head/annum)	12500
	iii)	Sale of 4500 kg fish (@ Rs. 40/kg)	180000
	iv)	Sale of eggs of 190 hens with 280 eggs/year @ Rs. 1.65/egg	87780
	v)	Sale of 170 spent hens @ Rs. 45/hen	7650
		Total Receipts	486310
		Net Income per annum	123544
		Net income/month	**10295**