INTEGRATED FISH FARMING PRACTICES WITH SPECIAL REFERENCE TO COMBINATION RATES, PRODUCTION FIGURES AND ECONOMIC EVALUATION

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ABSTRACT

The study reviewed the various integrated fish farming practices that exist all over the world and groups them under four distinct systems. The combination rates of the items in such systems and the quantities of each item produced are also presented depending on availability of such information. Cost-benefit analyses of some systems are done to determine profitability. Special attention is given to integrated fish farming experiments done in Nigeria.

INTRODUCTION

Integrated fish farming (IFF), also called Agropisciculture or Integrated agriculture-aquaculture, has a long history in Asia dating back to more than 1500 years in India (Coche 1967) and more than 2400 years in China (Willman *et al,* 1998). In China it started as a complex system combining poultry, livestock and crop farming with fish polyculture. It also involved the use of crops, grass and manure as feed and fertiliser, all in a complex, mutually beneficial system. This long practice of integrated fish farming (IFF) in China partly accounts for the fact that China produces more than 60% of the world's total aquaculture production (Rana *et al* 1998). Indeed 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 for integrated rice-fish farming.

In Africa, integrated fish farming have been reported in countries like Nigeria, Benin, Madagascar, Zambia, Cameroon and Malawi but mainly at subsistence level.

Brown (1983), reported the use of large areas of land in Hungary, Czech republic and Slovakia for predominantly, animal-fish farming. Rice-fish farming is also being given attention in Spain and Italy. In the American continent, rice-fish farming is carried out at a low level in United states, Argentina, Brazil, Haiti, Panama and Peru (William *et al*, 1998).

According to Asala (1994), the idea behind integrated fish farming is to create a mutually beneficial system, which will lead to maximisation of productivity through optimum resource use. FAO (1979), listed the benefits of integrated fish farming in a community in China to include: providing cheap feedstuffs and organic manure for pond fertilisation and thus reduction of cost of inorganic fertilisers and commercial feed; 30-40% increase in profit; self sufficiency and self reliance for community due to production of grains, vegetables, fish and livestock from IFF and use of silt from fish ponds to fertilise crops leading to reduction of cost of chemical fertilisers.

1. INTEGRATED FISH FARMING SYSTEMS

Integrated fish farming systems can be divided into four broad groups, viz

A) **Integrated plant-fish farming** -- This involves integrating land plants (eg. vegetables, fruit trees, sugar cane, maize, sorghum, mangrove forest etc.) and aquatic plants (eg. water spinach and water chestnuts and aquatic weeds like pistia, duckweed, elephant grass, water hyacinth, azolla etc.) with fish farming. While the fish may feed on such plants and also use their roots for spawning (aquatic plant roots), the fish pond provides water and nutrients for the plants. Herbivorous fishes like grass carp, are usually cultured in such ponds.

Rice-fish farming (RFF). -Rice-fish farming involves making ditches and dykes around or in-between rice fields, flooding the ditches and culturing fish in them.

The total world rice farming area is about 148 million ha, (Halwatt, 1998); About 90% of the world's rice farming area is in Asia which accounts for the fact that Asia is the world's foremost continent in terms of rice- fish farming. India is the world's largest rice growing nation (42.3 million ha) followed by China with 33 million ha. In China 1.2 million ha of rice area is used for rice-fish farming. The major species cultured in Asian rice farms are the carps (common carp, grass carp, black carp etc.); Tilapia species (especially *O. niloticus*); silver barb and catfishes.

Table 1. Shows combination rates and production from rice-fish farming

b) **Integrated animal-fish farming.** Barash *et. al.* (1982) divided this into

Semi-integration (raising livestock on land and transporting the manure to the fish pond) and Complete or Vertical integration (raising livestock directly above the fish pond so that animal manure can drop directly into the fish pond).

Poultry-fish farming is the integration of poultry animals like chicken, duck and geese with fish farming. Other forms of animal-fish farming include cattle-fish, pig-fish, rabbit-fish and buffalo-fish farming.

Table 1. shows production from such systems. Table 2 shows optimal manure loadings for some of the systems to prevent over fertilisation

Table 2.

Animals	Animals/ha of fish pond.	Fresh manure (kg/adult/day)	Maximum manure loading (kg/ha/day)
Pigs	30 – 300	5 for 100kg pig	150
Meat chickens	1000 – 4000	0.15 for 1.5kg bird	150 – 600
Meat ducks	750 - 3000	0.2 for 2kg bird	150 – 600

Source: STOAS 1993.

Conversion ratios of animal manure to fish (ie. Kg of Fresh manure/kg increase in fish weight are as follows: Cattle, 35 45; Pig, 20 30; Chicken, 15 25 and Duck 15 25. Chicken and duck have better conversion ratios than pig and cattle. Table 3 shows the economic analysis of chicken-fish farming done at the integrated fish farming section of the National Institute For Freshwater Fisheries Research (NIFFR), New Bussa in 1999/2000.

C) **Integrated animal-plant-fish farming**. This is the most complex of all and consists of raising animal and plants on or near fish ponds. Each component of the system receives something and gives something to other components.

The feasibility of this system has already been determined in NIFFR by Otubusin (1986). In a study on the 515,000 ha Dogon Gari bay, he proposed a system with integration of fish and rice farming and raising of livestock (chicken and cattle). An enclosure of size 5 ha with poultry house ($75m^2$), had 2 ha for rice farming. A cattle shed (can contain cattle, sheep and goats) was also to be sited near the enclosure. The proposed system was estimated to loose about N40,000 in the first year due to sunk costs and then make profit from the second year onwards. Table 1 shows production from this system.

d) **Integrated wastewater-fish farming** This involves using wastewater from human and animal activity to fill fish ponds. Fish utilise the nutrients in the wastewater while the microbial load in the wastewater is reduced by this interaction with fish .Waste water refers to effluents from industrial, agricultural and domestic activities.

In NIFFR, Okoye *et al* (1986), carried out an experiment with a polyculture of *sarotherodon Galilaeus* and *Cyprinius Capio* in the $400m^2$ wastewater reservoir of National Electric Power Authority, (NEPA) quarters in New Bussa. After a ten month culture period, 1580 kg of *S. Galilaeus* with a mean weigth of 51.3g (initial mean wt. was 36.1g) was harvested along with 825g of *Cyprinius Carpio* of mean wt. 50.3g (initial mean wt. was 7.9g). The experiment found that physico-chem ical parameters in the NEPA wastewater reservoir was favourable for the growth fish food organisms.

2. PUBLIC HEALTH IMPLICATIONS OF INTEGRATED FISH FARMING.

This is of prime importance and it is natural for some people to be averse to eating fish from say a latrine-pond system. One way of checkmating this is the raising of Duckweed in such systems and then using the duckweed to feed the fish in a different pond. The world health organisation (WHO), standard is that wastewater used for aquaculture should contain less than 10^3 faecal coliforms per

CONCLUSION

The foregoing shows that IFF is practised world-wide. It is a way of life and a lucrative endeavour in Asia while in the advanced world (Europe and North America), it is practised at a low level even though it was introduced long ago. In Africa, Integrated fish farming is carried out mainly at subsistence level. Ibiwoye (1995), in a study on IFF in Nigeria found that out of 254 fish farmers sampled, only 46% did any form of integrated fish farming.

Combination rates and production figures from integrated fish farming varies from one region/country to another, however the profitability of the venture is not in question and in many cases it is more profitable than aquaculture alone. All the systems shown on table 1 were all profitable ventures.

In some cases, clear cut combination rates are available while in other cases especially, plant-fish systems, little literature exist.

Table 1. Combination rates and production from IFF systems.

Type of integration	Combination rates	Fish production	Production of other items	Source
Integrated plant-fish	1000-6000 Tilapia/ha of rice	100-250kg/ha/yr		Yaro (1996)
Integrated animal-fish	600chickens/30,000*O. andersonai*/ha of pond 544 chickens/10,000 fingerlings of*O. niloticus, C. gariepinus, C. catla* and *Rohu.* 0.3 ducks/m^2 6 fish/m^2 (Tilapia) 70pigs/23,438 Fingerlings Tilapia etc.	6,522kg/ha/yr 1536kg/15 months 9.6 tons/ha/yr. 3,956kg/ha	24,930 egg/yr 8,400kg of pig meat	Gopalakrishnan (1991) Ibiwoye *et al* (1996) Nguyen *et al* (1995) Tokrishna (1995)
Integrated animal-plant-fish	400 ducks/ha; 10,000 fingerlings of Tilapia/ha	Mean fish yield, 618kg/ha/yr	Mean rice yield, 4343kg/ha/yr	Cagauan et al (2000)
Wastewater-fish	5,670 fingerlings *S. galilieus* and 2500 C. carpio/ha of pond	4,385kg of *S. galileus* and 205 kg *C. carpio.*		Okoye et al (1986)

Table 3. Economic analysis of Chicken-fish farming at NIFFR, Oct '99-Nov 2000.

		₦
A.	**FIXED CAPITAL INPUTS**	
	Development of 1.5ha pond	9,000
	Building of Poultry house	11,800
	4 battery cages @ ₦1,000 each	4,000
	Farm house and store	3,000
	Beach siene net	10,000
	Sub-Total	37,800
B.	**RECURRENT INPUTS**	
	100 Layers @ ₦450 each	45,000
	Layer,s mash @ ₦540 each x 200 bags	108,000
	Medication	8,000
	Transportation of layers, feed etc.	14,000
	Fingerlings: i) Tilapia 8000 @₦1 each	8,000
	ii) Clarias 1800 @ ₦5 each	9,000
	iii) Heterotis 200 @ ₦5 each	1,000
	Night guard @ ₦1500/month	18,000
	Miscellaneous	10,000
	Sub -Total	221,000
	Total expenditure	258,800

C. **REVENUE FROM SALES**

Eggs (total of 16,151 eggs were laid but 15,870 were put in crates i.e. 529 crates) @ N250 each	132,250
Spent layers (out of 100 layers bought, 7 died, 93 were left)	30,000
Fish : (a) Table size	
i) Tilapia, 845kg @ N80/kg	67,600
ii) Clarias, 610kg @ N100/kg	61,000
iii) Heterotis 251.4kg @ N100/kg	25,140
Total revenue	315,990

Net Revenue from the project N315, 990 – N258, 800 = N57,190.

NB. The poultry house was meant for 576 birds while more the 1.5ha reservoir can take 20,000 to 30,000 fish and so higher revenue is expected from the project if the installed capacity is used.

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