International Journal of Agriculture and Forestry 2015, 5(5): 281-286
DOI: 10.5923/j.ijaf.20150505.03

Integrated Fish-Pig and Fish-Poultry Farming in East Kalcho, Saiha District of Mizoram, North-East India: An Economic Analysis

U. K. Sahoo*, S. L. Singh

Department of Forestry, Mizoram University, Aizawl, Mizoram, India

Abstract An experiment was conducted to evaluate fish production and income generation with integration of pig and poultry during August 2010 to July 2011. Six rain-fed, rectangular farmers' fish ponds (each approximately 250 m^2, 1.6 m deep) were selected to integrate the fish varieties, *viz*. Rohu (*Labeo rohita*), Silver carp (*Hypophthalmichthys molitrix*) and Grass carp (*Ctenopharyngodon idella*) along with piglets (Hampshire variety) and poultry (Broilers). The results showed that fish productivity was better in ponds integrated with pigs than with poultry. A stocking density of 10000 number of fingerlings/ha water body within six months gave rise to 9840 kg ha^{-1} yr^{-1} in fish-pig system while the fish-poultry system could produce only 8240 kg ha^{-1} yr^{-1}. A water body of 0.025 ha area provides good revenue from fish, besides earning a handsome amount from meat production. Amongst the fish varieties tested, Silver carp exhibited highest growth followed by Grass carp and Rohu. The economic analysis and benefit-cost ratio of practising integrated fish–livestock farming revealed that integrated fish-pig farming could generate maximum profit of Rs. 48023.19 per 0.025 ha yr^{-1} with B:C value of 2.04 which was higher than integrated fish-poultry farming system (Rs. 33664.06 per 0.025 ha yr^{-1} with B:C value of 1.09).

Keywords Fish polyculture, Economic viability, Livestock farming

1. Introduction

Integrated livestock-fish farming is a practice which links together two normally separate farming systems, whereby the livestock and fish become sub-systems of a whole farming system. Integrated farming is based on the concept that "there is no waste", and "waste is only a misplaced resource which can become a valuable material for another product" [1, 2]. Fish production figures reported in various published literature ranged from 1.5 ton ha^{-1} yr^{-1} to 18 ton.ha^{-1} yr^{-1}. The higher fish production is attainable through intensive management inputs, involving high stocking densities of complementary-feeding fish species, addition of energy-rich supplementary feed to a significant component of natural feed, and aeration of fish pond water. The rising cost of high protein fish feed and inorganic fertilizer, as well as the general concern for energy conservation, have brought about increased interest in the utilization of animal manures in aquaculture and in the traditional systems which integrate animal husbandry with aquaculture [3, 4]. The integration of livestock with fisheries aquaculture has received considerable attention lately with emphasis on the incorporation of animal manures as fertilizer and nutrient for promotion of natural feed in fish ponds [5, 6]. The rationale behind integrating fish with livestock is the large amount of nutrients (N-P-K) present in the animal feed being recovered in the manure, with possible proportions of 72–79% nitrogen, 61–87% phosphorus, and 82–92% potassium. These act as fertilisers in fish ponds to produce plankton which comprise high-protein natural food for certain species of fish. Recent experiments have demonstrated that considerable fish production can be obtained when animal manures are properly applied to fish polyculture systems [7]. Polyculture of carps, channel catfish and largemouth bass with manure wastes from 66 pigs per ha as the only source of nutrients yielded 4 ton ha^{-1} yr^{-1} [8]. Supplementary addition of chicken droppings under conditions of intensive fish culture increased fish yield by 21% and decreased the feed conversion rate by 0.4 units [9].

Integrated animal-fish farming could be an appropriate means for increasing returns from a limited land area and reducing risk by diversifying crops [10, 11, 12]. However, before mounting a development effort to popularize animal-fish farming, available production methods need to be adapted with the prevailing local climate and locally marketable fish species, and the economic viability of the system be ascertained. The present study is focused to evaluate fish-livestock polyculture systems that would provide the highest economic return, giving manure as the

* Corresponding author:
uksahoo_2003@rediffmail.com (U. K. Sahoo)
Published online at http://journal.sapub.org/ijaf

only nutrient source and clarify the economics of the developed production system. The goal of these research studies is the well-being of farmers that adopt improved technologies, and the ultimate test of research value is if farmers themselves demonstrate the economic benefit by incorporating new technologies to their farming systems. Therefore, economic analysis of the cost and benefits to the farmers of the various integrated fish-pig and fish-poultry farming systems will provide insight into the value and benefits of these technologies to farmers.

2. Materials and Methods

Experimental site and pond facilities

Six rain-fed, rectangular farmers' fish ponds (each approximately 250 m^2, 1.6 m deep), situated in NAIP cluster area of East Kalcho village (Lat. 22°24'05.0"N, Long. 92°57'23.0"E, 177 m asl) in Saiha district of Mizoram, North-East India were selected to carry out experiment from August, 2010 to July, 2011.

Experimental design and feeding

The experiment was carried out with two treatments, each with three replications. The first treatment consisted of directly integrating fish with one piglet (Hampshire variety), and the second treatment consisted of directly integrating fish with poultry birds (Broilers). The pig and poultry units were maintained with commercial feed and local available materials. However, no commercial fish feed was applied in each of the treatments, but locally available vegetative feeds were being given. All the treatments were stocked with fish component consisting of fingerlings, viz. Rohu (*Labeo rohita*), Silver carp (*Hypophthalmichthys molitrix*) and Grass carp (*Ctenopharyngodon idella*) in the ratio of 2:2:1 respectively with a stocking density of 10000 fingerlings ha^{-1}.

Fish pond renovation

Each of the experimental ponds was applied 2 kg of commercially available bleaching powder as fish toxicant to remove weed fishes, insects and unwanted organisms. Since total dewatering is not possible, so depending on the feasibility some percentage of pond water was pumped out and the same was refilled with new water. About 10 kg of quick lime is applied to maintain the requisite water pH for fish farming.

Construction of pig sty and poultry house

The pig sties were constructed on the pond embankments and the pig excreta were washed away directly to the fish pond. A diversion channel was provided to divert the excreta away from the pond in case if algal bloom or any other abnormality develops. The poultry houses were also constructed on the pond embankment, and below the cage some pots were placed to collect the poultry droppings which were then applied to the fish ponds.

Rearing of pig and poultry

The piglets were reared intensively that they were not allowed to go out of the pig sties. The pigs were fed balanced feed (pig mash) @ 1.4-1.5 kg per pig day^{-1}, divided into 3 equal instalments per day. Along with these balanced feed, they were also fed green grass and locally available vegetative materials, kitchen waste, spoiled vegetables, etc. These pigs were ready for slaughter in 6 months, hence 2 lots of pig was being raised in a year. In the fish-poultry farming, the poultry birds were also intensively raised, not allowed to go outside of their houses. Poultry birds were fed with balanced poultry feed @ 70-80 gm per bird day^{-1} in about 4-5 times a day upto the age of 6-7 weeks of birds. In this system, 6 lots of poultry birds were raised in a year.

Fish stocking and harvesting management

In all the experimental treatment ponds, fingerlings of Rohu, Silver carp and Grass carp with initial weight of 4-6 gm were procured from a local fry trader. These fingerlings were stocked 15-20 days after bringing the piglets and the poultry birds to their houses. Fingerlings stocking was done in the morning hours through proper conditioning to adjust with the new environment. The treatment ponds were applied lime (about 2 kg per month) for the remaining 11 months. Pig excreta and poultry droppings acts as the feed for the fishes under experiment, however locally available vegetative materials like, grass, maize leaves, banana leaves, chopped green fodder, etc. were also fed, especially for the herbivorous fishes. The fishes were completely harvested from the ponds after about a year old through netting.

Estimation of operational cost, Income generation and B:C ratio

An economic analysis was conducted to estimate the operational cost involved with the integrated fish-livestock farming systems and the net profit from different treatments. The analysis was based on local market prices for harvested fish and all other items. The net return was measured by deducting the gross cost from the gross return per hectare. The benefit cost (B:C) ratio was also measured as a ratio of net benefit to gross cost.

3. Results and Discussion

The cost of operations involved with integrated fish farming with pig and poultry in 0.025 ha pond is presented in Table 1 and Table 2. Comparatively, total inputs are higher in fish-poultry system than the fish-pig system. Monetary inputs with respect to fish rearing in both the systems are same. The average growth performances of fish and associated livestock in both the systems are presented in Table 3 and Table 4. It is observed that in each of the systems, despite of no commercial fish feed application, the fingerlings exhibited considerable weight gain. The results reveal that pond fertilization from the pig excreta and poultry droppings encourages the growth of tiny plants like

algae and other phytoplankton and tiny animals (zooplankton), providing food for the fishes. Amongst the fish varieties tested, Silver carp exhibited highest growth followed by Grass carp and Rohu. This may be attributed to the feeding potential and genetic characteristics of the fishes. However, the fish productivity is greater in the fish-pig system than the fish- poultry system. This result indicates the greater ability of pig excreta in fertilizing ponds than chicken droppings, towards production of phytoplankton and zooplankton. The algae also turn the water green, which makes it harder for predators, such as birds and snakes to see and catch the fish. Comparative effectiveness of the manure on the development of organisms in the food web is also noted by other worker [13] and thus promotion of biological activity in fish ponds is in the order as duck manure > pig manure > raw chicken manure > cattle manure > sheep manure. The pig attained slaughter maturity size (137.12 kg) within a six months time. A stocking density of 10000 number of fingerlings ha^{-1} water body within six months gave rise to 9840 kg ha^{-1} yr^{-1} in fish-pig system while the corresponding value for fish-poultry system was only 8240 kg ha^{-1} yr^{-1}. With the domestic markets for fish expanding the supply of fishes from capture sources cannot meet the demand for fish therefore there is growing opportunities for aquaculture production and this can be achieved faster through integrated fish farming to reduce the gap between supply and demand [14, 15, 16].

Table 1. Annual cost of operation for integrated fish-pig farming in 0.025 ha pond in Saiha district of Mizoram, North-East India

Operation details		Cost (INR*)
Fish culture		
Partial water replenishment	1(one) portable disel engine pump set hired @ Rs.500 per day	500
Bleaching	2 kg applied @ Rs. 15 per kg	30
Fingerlings	Rohu: 100 fingerlings @ Rs. 5 per unit Silver carp: 100 fingerlings @ Rs. 3 per unit Grass carp: 100 fingerlings @ Rs. 4 per unit	1000
Transportation	2 persons @ Rs. 250 per trip	500
Liming	30 kg of lime @ Rs. 10 per kg	300
Local available vegetative feeds	Grass, Maize leaves, Banana leaves, Chopped green fodder, etc.	500
Fish farming equipments	Digging tools for earthwork, Cutting tools for uprooting and destumping, containers, nets, etc.	500
Labour for fish harvesting	3 persons @ Rs. 500 per day	1500
Pond Rental	Rent @ Rs. 300 per year under agreement	300
	Total	5130
Pig rearing		
Pig sty construction (3x3 m^2 slatted floor area)	Poles and planks for Rs. 700 5 tin roof sheets @ Rs. 150 per sheet Nails, rope, screws, etc. for Rs. 50 1 carpenter @ Rs. 500	2000
Weaned piglet (2 lots @1pig/lot of 6months)	2 nos. @ Rs. 700 per piglet	1400
Transportation/handling	2 person @ Rs. 500 per trip	1000
Commercial pig feed	8 sacks @ Rs. 750 per 50 kg sack	6000
Locally available feeds	Green grass, Local vegetative materials, Kitchen waste, Spoiled vegetables, etc.	1000
Utensils and Energy	Cooking Utensil @ Rs 600 Feeding Tub @ Rs. 200 Firewood @ Rs. 1200	2000
Medicine	Water soluble antibiotics and in-feed inclusions	200
Labor	1 farmer @ Rs. 200 per month	2400
	Total	16000
	Total cost	21130
	Interest on working capital @ 10%	2113
	Total operational cost	23243

* Local existing market price in rupees

Table 2. Annual cost of operation for integrated fish-poultry farming in 0.025 ha pond in Saiha district of Mizoram, North-East India

Operations details		Costs (INR*)
Fish culture		
Partial water replenishment	1(one) portable disel engine pump set hired @ Rs.500 per day	500
Bleaching	2 kg applied @ Rs. 15 per kg	30
Fingerlings	Rohu: 100 fingerlings @ Rs. 5.5 per unit Silver carp: 100 fingerlings @ Rs. 4 per unit Grass carp: 100 fingerlings @ Rs. 4 per unit	1250
Transportation	2 persons @ Rs. 250 per trip	500
Liming	30 kg of lime @ Rs. 10 per kg	300
Local available vegetative feeds	Grass, Maize leaves, Banana leaves, Chopped green fodder, etc.	500
Fish farming equipments	Digging tools for earthwork, Cutting tools for uprooting and destumping, containers, nets, etc.	500
Labour for fish harvesting	3 persons @ Rs. 500 per day	1500
Pond Rental	Rent @ Rs. 300 per year under agreement	300
	Total	5380
Poultry rearing		
Poultry shed construction (2x3 m^2 slatted floor area)	Poles and bamboos for Rs. 250 4 tin roof sheets @ Rs. 150 per sheet Nails, screws, polythene sheets etc. for Rs. 150 1 carpenter @ Rs. 500	1500
Broiler chick (6 lots @25 chicks/lot of 2 months)	150 nos. @ Rs. 15 per chick	2250
Transportation/handling	12 person @ Rs. 500 per trip	3000
Commercial chicken feed	20 sacks @ Rs. 500 per 50 kg sack	10000
Equipments and Energy	1 brooder @ Rs. 300 2 feeder @ Rs. 150 3 waterer @ Rs. 80 Electric bill @ Rs.100 per month 1 kerosene lamp @ Rs 200 6 litres of kerosene @ Rs. 60 per litre	2400
Medicine	Antibiotics, chlorine, disinfectants, etc.	600
Labour	1 farmer @ Rs. 250 per month	3000
	Total	22750
	Total cost	28130
	Interest on working capital @ 10%	2813
	Total operational cost	30943

* Local existing market price in rupees

Table 3. Annual Stocking density, productivity and income generation under fish-pig farming system in 0.025 ha pond at East Kalcho in Saiha district of Mizoram, North-East India

Variety	Stocking density (units)	Final weight (g/unit)	Productivity (Kg)	Market price/kg (INR*)	Monetary value (INR*)
Rohu	100	872.68	69.81	130	9075.87
Silver Carp	100	1345.76	127.66	100	12766.08
Grass Carp	50	962.32	48.49	120	5818.80
Total income from fish sales					27660.75
Hampshire	2	137126.37	274.25	160	43880.44
Total Gross Income					71541.19

* Local existing market price in rupees

Table 4. Stocking density, productivity and income generation under fish-poultry farming system in 0.025 ha pond at East Kalcho in Saiha district of Mizoram, North-East India

Variety	Stocking density (units)	Final weight (g/unit)	Productivity (Kg)	Market price/kg (INR*)	Monetary value (INR*)
Rohu	100	809.36	64.75	130	8417.34
Silver Carp	100	1168.42	93.47	100	9347.36
Grass Carp	50	947.15	37.89	120	4546.32
Total income from fish sales					22311.02
Broiler	150	2349.78	281.97	160	42296.04
Total Gross Income					64607.06

* Local existing market price in rupees

Table 5. Comparative Benefit-Cost (B:C) ratio of integrated fish-livestock farming system in 0.025 ha pond at East Kalcho in Saiha district of Mizoram, North-East India

Farming System	Fish productivity (kg)	Total Operational Cost (INR*)	Total Gross Returns (INR*)	Net Returns (INR*)	B:C ratio
Fish only	268.81	14730	30275.20	15545.20	1.06
Fish-pig	245.96	23518	71541.19	48023.19	2.04
Fish-poultry	196.11	30943	64607.06	33664.06	1.09

* Local existing market price in rupees

The study revealed that the pig excreta act as excellent manure for the fish types tried in the experiment. A famer having a water body of 0.025 ha area generates good revenue from fish, besides earning handsome amount from meat production. The nutrient rich pond water can also benefit the vegetables grown on the pond dike and adjoining area [17], thus the system was found to improve the nutritional security and socio-economic condition of the rural famers of East Kolcho village in Saiha district of Mizoram, North-East India. So, it is suggested that the government should promote livestock-fish aquaculture and remove all bottlenecks so as to improve sustainable rural livelihood and food security [18] in the state.

The economic analysis and benefit-cost (B:C) ratio of practising integrated fish – livestock farming in 0.025 ha pond is presented in Table 5. It revealed that integrated fish-pig farming could generate maximum profit of Rs. 48023.19 per 0.025 ha.yr^{-1} with B:C value of 2.04 which was higher than integrated fish-poultry farming system (Rs 33664.06 per 0.025 ha.yr^{-1} with B:C value of 1.09).

4. Conclusions

From the findings of the present study, it may be concluded that integrated fish-pig farming is profitable for getting higher growth of fish, net income and optimum utilization of the given resources. The production yields from integrated fish farming vary depending on the livestock (either pig or poultry) and the management system practiced. Nevertheless, it has proved to be more profitable than unitary system of farming and ensures the spread of financial risk, reduced wastes and thus is ecologically more sustainable.

ACKNOWLEDGEMENTS

This study was part of the interventions carried out under National Agricultural Innovation Project (NAIP), Component-III (SRLS) funded by World Bank through Indian Council of Agricultural Research, New Delhi.

REFERENCES

[1] Edwards, P., Kaewpaitoon, K., McCoy, E.W. and Chantachaeng, C. 1986. Pilot small-scale crop/livestock/fish integrated farm. AIT Research Report No. 184, Asian Institute of Technology, Bangkok, Thailand, pp. 131.

[2] Vincke, M.M.J. 1992. Integrated Farming of Fish and Livestock: Present Status and Future Development. FAO. Rome.

[3] Chen, F.Y. 1989. Chicken Farming in integrated fish farming Regional Aquaculture Center, Wuxi, China. *NACA Technical Manual*, 11: 4-30.

[4] Edwards, P., Kaewpaitoon, K., McCoy, E.W. and Chantachaeng, C. 1986. Pilot small scale crop livestock-fish integrated farm. AIT. Research Report, 184 AIT, Bangkok, Thailand, 131 pp.

[5] Delmendo, M.N. 1980. A review of integrated livestock-fowl-fish farming systems, p. 59–71. In: Pullin, R.S.V. and Shehadeh, Z.H. (Editors). Integrated agriculture-aquaculture farming systems. ICLARM Conference Proceedings 4. International Centre for Living Aquatic Resource Management, Manila and the Southeast Asian Centre for Graduate Study and Research in Agriculture, College, Los Banos, Laguna, Philippines.

[6] Wohlfarth, G.W. and Schroeder, G.L. 1979. Use of manure in fish farming- a review. *Agricultural Wastes,* 1: 279-299.

[7] Shoko, A.P., Getabu, A., Mwayuli, G. and Mgaya, Y.D. 2011. Growth Performance, Yields and Economic Benefits of Nile Tilapia *Oreochromis niloticus* and Kales *Brassica oleracea* cultured Under Vegetable-Fish Culture Integration. *Tanzanian Journal of Science*, 37: 37-48.

[8] Buck, D.H., Baur, R.J. and Rose, C.R. 1978. Utilization of swine manure in a polyculture of Asian and North American fishes, *Trans. Amer. Fish. Soc*. 107(1):216-222.

[9] Rappaport, U. and Sarig, S. 1978. The result of manuring on intensive growth fish farming at the Ginosar Station ponds in 1977. *Bamidgeh,* 30(2):27-36.

[10] Jhingran, A.G. 1986. Integrated fish-livestock-crop farming and its role in developing rural economy. Bull. Cent. Inland Fish. Res. Inst., Barrackpore, (48):4.

[11] Williams, M.J. 1997. Aquaculture and Sustainable Food Security in the Developing World. In: John E. Bardach (Ed.). Sustainable Aquaculture. John Wiley & Sons, Inc., New York, 15-51 pp.

[12] Korikantimath, V.S. and Manjunath, B.L. 2008. Integrated farming systems for sustainability in agricultural production. Proceedings of national symposium on new paradigms in agronomic research. Indian Society of agronomy. Navsari Agriculture University. *Gujarat*, 279 - 281pp.

[13] Prinsloo J. F. and Schoonbee H. J. 1987. Investigations into the feasibility of a duck-fish-vegetable integrated agriculture aquaculture system for developing areas in South Africa. *Water SA,* 13: 109-118.

[14] Jayanthi, C. and Vennila, C. 2008. Integrated farming systems and sustainability for livelihood security. National symposium on new paradigms in agronomic research. 281 -283 Pp.

[15] Jhingran, A.G. 1986. Integrated fish-livestock-crop farming and its role in developing rural economy. Bull. Cent. Inland Fish. Res. Inst., Barrackpore, 48:1.1- 4.

[16] Mathias, J. 1998. Integrated fish farming in the context of world food security. In: Mathias, J.A; Anthony T. Charles; Hu Baotong (Eds.) Proceedings of a Workshop on Integrated Fish Farming held in Wuxi, Jiangsu Province, People's Republic of China. October 11-15, 1994. CRC Press. Boca Raton, New York, 3 - 18 pp.

[17] Dhawen, A. and Kaur, S. 2002. Pig dung as pond manure effect on water quality, pond productivity and growth of crops in polyculture systems. ICLARM (25:11): 11-14.

[18] Ogello, E.O., Mlingi, F.T., Nyonje, B.M., Charo-Karisa, H. and Munguti, J.M. 2013. Can integrated livestock-fish culture be a solution to East Africa's food insecurity? A review. African Journal of Food, Agriculture, Nutrition and Development, 13(4):8058-8076.