Pig-Duck-Fish-Azolla Integration in La Union, Philippines

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Introduction

La Union is one of the four provinces that comprise Region I of the Philippines. It has an area of 147,900 ha, two-thirds of which are hilly to mountainous. Natural springs abound in the area and skyponds have been established: rainfed, drainable upland ponds.

The aim of this research project, which was funded by the International Foundation for Science, was to evaluate an integrated farming system comprising livestock, azolla and fish. Pigs and ducks are raised adjacent to ponds. Their feed is supplemented by the nitrogen-rich aquatic fern azolla (*Azolla pinnata*) grown in the fishpond. Manure from the livestock fertilizes the fishpond. This farming system is expected to generate a higher income per unit area than existing systems.

The objectives of this study were:

1. to evaluate the growth performance of pigs and ducks as affected by different levels of azolla meal in their feed;
2. to determine the yield of Nile tilapia (*Oreochromis niloticus*) affected by manure inputs and different stocking densities; and
3. to determine the profitability of pig-duck-fish-azolla integration.

Materials and Methods

Three studies were conducted simultaneously. The first study evaluated the performance of pigs fed with different levels of dried azolla as supplementary diet. The second study was on the performance of ducks supplemented with fresh azolla, and the third study investigated the growth of *O. niloticus* under different stocking rates. Feeding studies on pigs and ducks were conducted for a period of six and four months, respectively.

Pig Growth Trials

Nine five-week old piglets (Hypor breed) were used and were randomly distributed into three treatments which were replicated three times following the Completely Randomized Design (CRD). The treatments were as follows: PA = control (commercial feed alone); PB = 20% dried azolla + 80% commercial feed; and PC = 40% dried azolla + 60% commercial feed.

One week prior to study, the pens were disinfected and were ventilated to allow the odor and the disinfectant to evaporate. Fresh azolla was gathered from the production pond and was dried for about two to three hours before it was thoroughly mixed by hand with the commercial feeds to insure proper mixing.

In all the treatments, feeding was given *ad libitum*. Strict standards of hygiene and sanitation were observed throughout the duration of the study.

Duck Growth Trials

In contrast to the pig trials which were conducted in a pen about 50 m from the pond, the housing for the ducks (native, for meat production) were located on the dikes of the pond. Thirty-six six-week-old native ducks were used in this study and were randomly distributed into three treatments which were replicated three times following the CRD. The treatments were as follows: DA = control (chicken grower mash alone); DB = fresh azolla + 60% chicken grower mash; and DC = fresh azolla + 40% chicken grower mash.

The ducks in all treatments except the control were allowed to move freely around the pond. Duck manure was regularly collected from the pen and evenly applied to the ponds. These ponds were seeded with azolla at a rate of 200 g/m/week as feed supplement for the ducks.

The following data were gathered for the feeding studies of pigs and ducks: gain in weight (kg); final weight (kg); feed consumption (kg); and feed conversion efficiency (kg).

Fish Growth Trials

Three fishponds were cleared from wild fishes and weeds, and flushed to remove toxic materials before Nile tilapia were stocked. Thereafter, the ponds were filled with water to a uniform depth of 50 cm and a mixture of dry pig and duck manure was spread at the rate of 500 kg/ha. After initial manure application, the water level was increased to 80 cm in all three experimental ponds. The sizes of ponds for each treatment were: I = (54 m^2), II = (43 m^2) and III = (60 m^2). Each pond had three earthen subdivisions. These were then stocked two weeks after initial flooding following the three treatments. The fish in all treatments were given a mixed manure (pigs and ducks) load of 100 kg fresh matter/ha/day and supplemented with fresh azolla of 200 g/m^2/week. The experiments were conducted in a CRD and replicated three times with the following stocking rates: FA = 10,000 fingerlings/ha; FB = 20,000 fingerlings/ha; and FC = 30,000 fingerlings/ha.

Manure loading was stopped two weeks before harvest. The experiment was conducted for a period of three months. The following data were gathered: mean net yield (kg/ha/day) and average weight of fish (g).

The chemical analysis of the feeds used is presented in Tables 1 and 2.

Table 1. Guaranteed analysis of pig feeds from bag labels.

Component[1]	Per cent composition[2]		
	Starter ration	Grower ration	Finisher ration
Crude protein	>21	>16	>18
Crude fat	> 4	> 4	> 4
Crude fiber	< 8	<10	< 7
Moisture	<13	<13	<10

[1]Feeds are also supplemented with vitamins and minerals.
[2]Per cent of dry matter (except for % moisture).

Table 2. Laboratory analysis of azolla (*Azolla pinnata*).

	% Composition of dry weight
Moisture	5.06
Ash	22.21
Crude protein	20.98
Crude fat	5.17
Crude fiber	19.30
Calcium	1.08
Phosphorus	0.21
NFE	27.28

Results

Pig Growth Trials

Pigs fed with either commercial feed alone, 20% azolla + 80% commercial feed or 40% azolla + 60% commercial feed did not significantly differ in terms of the average final weight, average feed consumption and average feed conversion efficiency (Table 3). PA pigs fed with commercial feed alone were significantly heavier than PC pigs, but were statistically comparable to PB pigs in terms of their average gain in weight.

The average azolla consumption per pig for each treatment was: PA = none; PB = 71 kg; and PC = 142 kg.

Duck Growth Trials

On the other hand, ducks fed with either commercial feed alone, 60% commercial feed or 40% commercial feed were statistically comparable in terms of average gain in weight, average feed consumption and average feed conversion efficiency (Table 4). DB and DC ducks were not significantly different in terms of their final weight, but were significantly lighter than the DA controls.

Fish Growth Trials

A Nile tilapia stocking rate of 20,000/ha gave a statistically higher mean net yield (kg/ha/day). On the other hand, the fish produced under this stocking rate had a significantly lower average weight than those grown under a stocking rate of 10,000/ha (Table 5).

Consumption of azolla by fish and ducks was not monitored. However, it was observed that the fresh azolla seeded at a rate of 200 g/m^2/week or 10 kg/50 m^2 were cleared after the 6th or 7th day of the week.

It was found that azolla could be a viable source of supplementary feed considering the high cost of commercial feeds.

Results of this research project suggest that it is possible to increase production with lesser input through the utilization of azolla as supplementary feed for pigs and ducks. Further, the manures of these animals fuel the natural foodchain in the pond and enhance tilapia and azolla production.

Table 3. Growth performance of pigs fed with different levels of dried azolla (*Azolla pinnata*) as a supplementary feed in six-month trials.*

Parameters	Treatment		
	Control (PA)	20% dried azolla + 80% commercial feed (PB)	40% dried azolla + 60% commercial feed (PC)
No. of pigs	3	3	3
Average initial weight (kg)	11.00[a]	10.45[a]	9.99[a]
Average final weight (kg)	74.75[a]	69.20[a]	64.24[a]
Average gain in weight (kg)	63.75[a]	58.75[a]	54.25[a]
Average feed consumption (kg)	359.62[a]	355.62[a]	355.65[a]
Average feed conversion efficiency (kg)	5.65[a]	6.05[a]	6.55[a]

*Means with the same suffix letter are not significantly different at the 5% level, DMRT (Duncan's Multiple Range Test).

Table 4. Growth of ducks supplemented with fresh azolla (*Azolla pinnata*) in four-month trials.*

Parameters	Treatment		
	Control (DA)	Fresh azolla + 60% commercial feed (DB)	Fresh azolla + 40% commercial feed (PC)
No. of ducks	12	12	12
Average initial weight (kg)	0.68[a]	0.67[a]	0.75[a]
Average final weight (kg)	1.98[a]	1.75[b]	1.70[bc]
Average gain in weight (kg)	1.30[a]	1.08[b]	0.97[b]
Average feed consumption (kg)	7.20[a]	6.92[a]	6.28[a]
Average feed conversion efficiency (kg)	5.54[a]	6.47[a]	6.67[a]

*Means with the same suffix letter are not significantly different at the 5% level, DMRT.

Table 5. Growth performance of *Oreochromis niloticus* under varying stocking rates.*

Treatments	Stocking density (no./ha)	Mean net yield (kg/ha/day)	Average weight (g)
FA	10,000	8.22[a]	58.15[a]
FB	20,000	10.97[b]	43.67[b]
FC	30,000	9.54[c]	37.41[c]

*Means with the same suffix letter are not significantly different at the 5% level, DMRT.

Optimum Size of the Practical Integrated Model

The average output per day of pig excreta (including urine), depending on feeding, was recorded to determine the optimum size of the integrated model: 1) starter rations (10-20 kg live weight (LW) of livestock in first two months) = 1.43 kg; 2) grower rations (20-55 kg LW on 5th month) = 3.2 kg; 3) finisher rations (56 kg LW on 6th month) = 4 kg; and 4) average pig manure output per day from starter to finisher ration = 2 kg.

Since the manure load used was 100 kg fresh manure/ha/day or 10 g/m²/day in a period of three months (fish culture period duration), the total manure load is 45 kg/50 m² pond (average size of pond). It was difficult to measure the manure output of ducks. However, the data from Woynarovich (1979) was adopted wherein an output of 6 kg manure/duck was observed over a seven-week period of study, which was equivalent to 11.7% of LW of ducks.

The optimum size based on the 100 kg/ha/day manure load is two pigs per 400 m² or 53 heads per hectare which is comparable to the integrated pig-fish system by the Central Luzon State University in Muñoz, Nueva Ecija, Philippines of 50 heads per hectare. Furthermore, the optimum size of two pigs per 400 m² should be supplemented with 10 ducks based on the total manure output of pigs and ducks.

Reference

Woynarovich, E. 1979. The feasibility of combining animal husbandry with fish farming with special reference to duck and feed production, p. 203-208. *In* T.V.R. Pillay and W.A. Dill (eds.) Advances in aquaculture. Fishing News Books, Farnham, Surrey, England.

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Improvement of Traditional Shrimp Culture in the Mekong Delta

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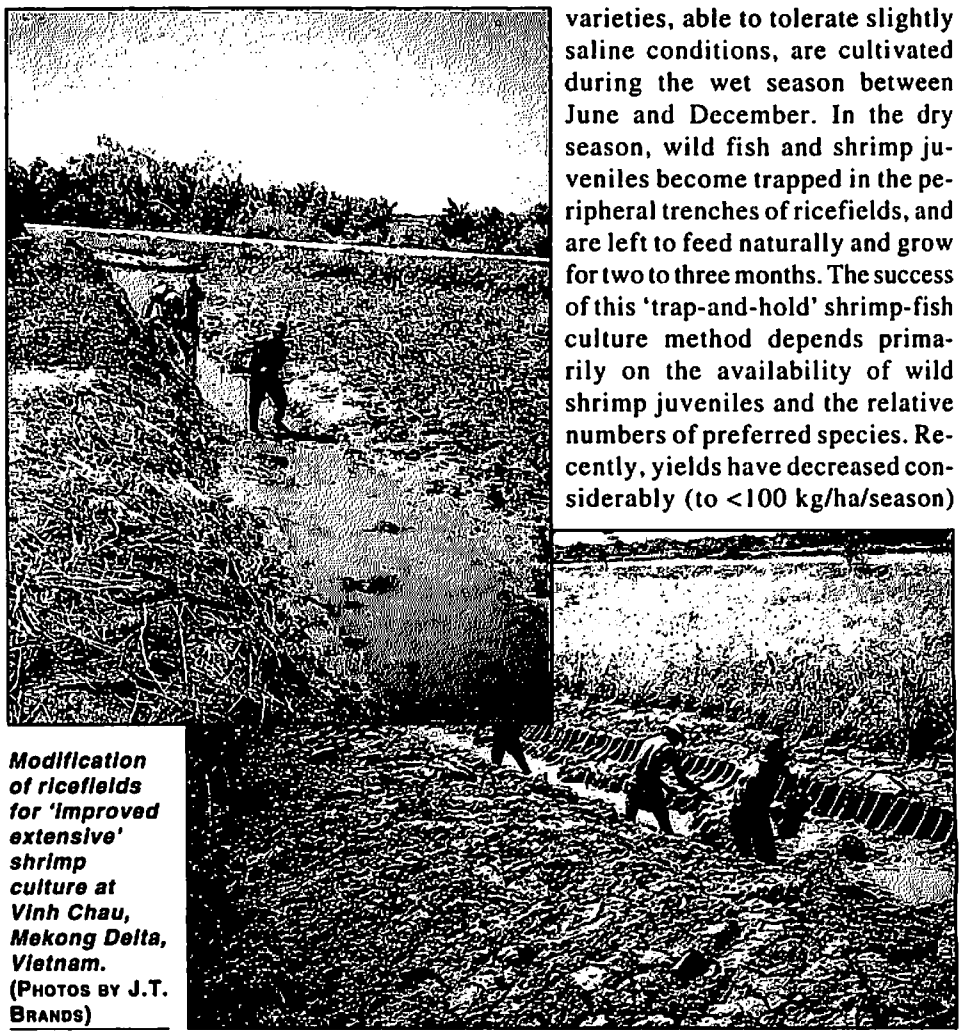
Introduction

In Vietnam, most shrimp farms are 'extensive' and are run by resident small-scale farmers. Yields are about 100-150 kg/ha/crop. Shrimp culture provides employment and income, contributes to improved living conditions for the coastal population and generates foreign exchange - very important for the national economy. The environmental conditions in the Mekong Delta are good for shrimp farming. Most production takes place in two agroecological zones: permanently saline coastal marshland, mangroves and salt works; and seasonally brackishwater areas. Promotion of shrimp farming in the permanent saline area has accelerated mangrove clearance, with expected negative effects on other forms of coastal aquaculture and on capture fisheries. This short paper discusses improvements to traditional brackishwater shrimp culture.

Traditional Shrimp Farming

Traditional shrimp farming in seasonal brackishwaters is based on rotation of rice and shrimp.* Local rice varieties, able to tolerate slightly saline conditions, are cultivated during the wet season between June and December. In the dry season, wild fish and shrimp juveniles become trapped in the peripheral trenches of ricefields, and are left to feed naturally and grow for two to three months. The success of this 'trap-and-hold' shrimp-fish culture method depends primarily on the availability of wild shrimp juveniles and the relative numbers of preferred species. Recently, yields have decreased considerably (to <100 kg/ha/season)



Modification of ricefields for 'improved extensive' shrimp culture at Vinh Chau, Mekong Delta, Vietnam. (PHOTOS BY J.T. BRANDS)

*(See also Naga 15(2):24-29; 16(4):18-21. *Ed.*)