HIGH YIELDS BUT STILL QUESTIONS: THREE YEARS OF ANIMAL-FISH FARMING

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THE CLSU/ICLARM Integrated Animal-Fish Farming Project at Central Luzon State University, Nueva Ecija, Philippines, is approaching the end of its third year. During this time, ponds and animal houses have been constructed and experiments conducted with pig-fish, duck-fish and chicken-fish systems. The project's objectives are to develop economically viable animal-fish systems suitable for the Philippines and to identify and quantify the system dynamics. We are well on our way towards the first objective. The second will require further research.

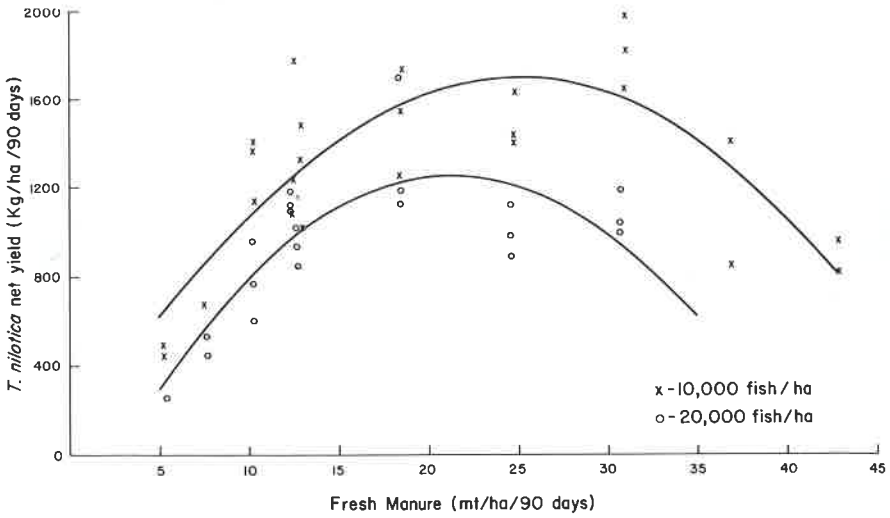
Pig-Fish Experiments[a]

The pig-fish facilities consist of twelve 0.1-ha ponds with pig houses constructed on the dikes. Each pond receives the wastes from one pigpen.

Weanling pigs of 10-15 kg each are purchased and grown for 180 days. The pigs are raised according to recommended Philippine practices and fed a commercial ration at the rate of 3-5% body weight/day. The pens are washed daily with water pumped from the ponds. The untreated manure flows into the ponds. Pigs are harvested at a weight of 90-100 kg each.

There are two fish production cycles in each pig-growing cycle because tilapia reach market size (> 60 g) in 90 days. Two fish stocking levels, 10,000 and 20,000 fish/ha, have been used. Tilapia *(Sarotherodon niloticus)* is the primary species and comprises 85% of the fish stocked. Common carp *(Cyprinus carpio)* make up another 14%; they are used to uproot aquatic macrophytes and disturb the pond bottom. *Ophicephalus striatus* (the snakehead or mudfish), a predator, comprises the remainder. All fish are harvested by seining and then draining the ponds.

[a]Based on a paper by Hopkins, K.D., E.M. Cruz, M.L. Hopkins and K-C. Chong, *Optimum manure loading in tropical freshwater fishponds receiving untreated piggery wastes,* presented at the International Symposium on Biogas, Microalgae and Livestock Wastes, 1980, Taipei, Taiwan, 15-17 September 1980.



Above: Fig. 1. Net yield of *S. niloticus* in 90 days in ponds receiving untreated pig manure. Right: upper, harrowing work in the ponds between fish production cycles; lower, Perlina Inocencio weighing samples prior to analysis.

We tested pig numbers of 40, 60, 80, 100, 120 and 140 pigs/ha of pond. The average fresh manure output per pig is 134 kg for the first 90-day period and 307 kg for the second 90-day period (average moisture content = 71%). The response of *S. niloticus* to manure input is illustrated in Figure 1. The curves are fitted by multiple regression and have correlation coefficients of 0.8049 for 10,000 fish/ha and 0.8060 for 20,000 fish/ha. The highest tilapia yield of approximately 1700 kg/ha/90 days is attained with 20,000 fish/ha and 25 t of fresh manure (equivalent to 83 pigs for the second 90-day period). The carp data are more difficult to analyze because stocking numbers and size varied due to fingerling shortages. The equation $\log_e Y = 3.8209 + 0.4736 \log_e M + 0.1771 \log_e B$ where Y = net carp yield (kg/ha/90 days), M = fresh manure (t/ha/90 days), and B = carp biomass at stocking (kg/ha), produces acceptable yield estimates.

In addition to examining the relationship of manure input to fish yield, the manure levels (expressed as pigs/ha) which will maximize profit and internal rate of return into perpetuity (IRR) were determined for four types of pond systems in the Philippines: levee-type ponds with gravity or pumped water systems and excavated ponds with gravity or pumped water systems.

To make economic forecasts more realistic, 2 mo were added to the production cycle for harvesting, repairs and preparation for the next cycle. To estimate yield for the whole cycle, the yields for both first and second 90-day periods must be computed using the appropriate manure input levels. The maximum attainable yield for the 180-d cycle is 3549 kg/ha using 103

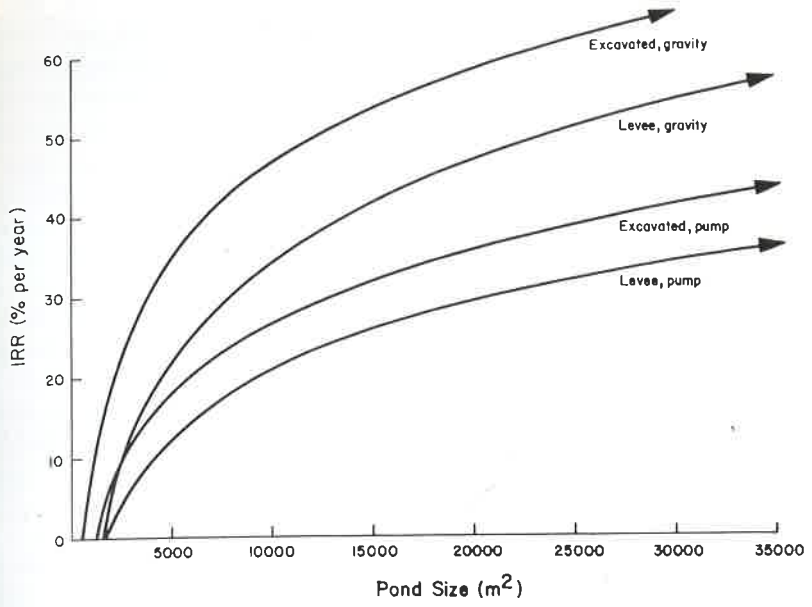


Fig. 2. Internal rate of return into perpetuity as a function of pond size for four pond type/water system combinations receiving manure from 80 pigs/ha of pond.

pigs/ha. Tilapia is higher priced than carp and maximum revenue is in fact attained by using 100 pigs/ha with this species combination.

Most persons who have expressed interest in establishing pig-fish systems are either pig raisers who have large numbers of pigs but only a limited area suitable for fishponds, or farmers who have adequate land but a limited number of pigs. In the first case, profit and IRR will be maximized when yield/ha is maximized, i.e., at 100 pigs/ha.

With a limited number of pigs, a different situation occurs. Maximum profit is attained with 53 pigs/ha for ponds with gravity water systems and 67 pigs/ha for ponds with pumped water systems. IRR is maximized at 80 ± 10 pigs/ha with the actual rate being highly dependent on pond size (Figure 2).

These pig-fish systems incorporate two 90-day fish culture cycles. In some cases, a single 180-day fish culture period would be preferable because 1) the fish would be harvested at a larger size, 2) the water requirements would be less and 3) harvest labor requirements would be lowered. We conducted a 180-day experiment using 100 pigs/ha. At a stocking level of 20,000 fish/ha the yields of marketable fish averaged 3,450 kg/ha/180 days which is not significantly different from the yield attained with two 90-day periods. However, over 2,000 kg/ha of small tilapia recruits were also harvested during the 180-day cycle because the predator-prey system, which worked well during the 90-day cycles, failed during the latter part of the 180-day cycle. If the recruits can be utilized or an effective recruitment control method perfected, then 180-day cycles appear to be preferable to separate the 90-day cycles.

Poultry-Fish[b]

The poultry-fish facilities consist of twelve 0.04-ha ponds with poultry houses constructed on the dikes.

Peking ducks were grown for 180 days (two 90-day fish cycles). They were kept in pens but allowed access to the ponds during the day. Two duck levels, 750 and 1,250 ducks/ha, were used. The highest yield (1,690 kg/ha) was obtained for the second 90-day period with 750 ducks and 20,000 fish/ha. The duck experiments were discontinued because of duckling supply problems and the limited domestic market for Peking ducks.

Chicken-fish trials have been started only recently. Broiler chickens were raised in cages to give manure loadings of 1,000, 3,000 and 5,000 chickens/ha of pond water. Mixed-size flocks were used with the largest 1/3 of the flock harvested and replaced by chicks every 2-3 wk. Fish were raised for one 90-day period at 20,000 fish/ha. The combined net yields of tilapia, carp and mudfish were 1,758 kg/ha/90 days with 1,000 chicken/ha, 1,814 kg/ha with 3,000 chickens/ha and 1,845 kg/ha with 5,000 chickens/ha. From these initial experiments, it appears that the response of this fish species combination to increasing chicken manure loading differs from that with the pig-fish system. Further experiments are in progress to investigate this.

Unanswered Questions

There are several aspects of these systems for which we still need answers. Primarily, we need to know if the fish are safe for human consumption. Animal-fish-systems have been in use for centuries with few apparent problems and in examinations of our fish, no parasites transmittable to man were found. But parasite problems may arise if different animal management practices are used. And we haven't yet looked for potential microbial pathogens (we expect to start in the near future).

What causes the decline in fish production when the manure loading increases to that of 120 and 140 pigs/ha? Dissolved oxygen (DO) at dawn is usually below 1 ppm for all of the treatments but there are indications that the length of time for which DO is low, increases with increasing manure manure load. Would supplementary aeration raise yields and allow higher manure loading? Can plankton biomass be reduced by adding a filter-feeding fish, such as milkfish, and thereby improve oxygen levels? These questions and many others, are now being addressed. Hopefully we will later be able to predict animal-fish system responses to differing environments.

[b]Based, in part, on Cruz, E.M. and Z.H. Shehadeh. 1980. *Preliminary results of integrated pig-fish and duck-fish production tests,* in R.S.V. Pullin and Z.H. Shehadeh (eds.) Integrated agriculture-aquaculture farming systems. ICLARM Conference Proceedings No. 4.