Peter Edwards writes on

Rural Aquaculture

Comments on possible improvements to carp culture in Andhra Pradesh

Dr Edwards is a consultant and Emeritus Professor at the Asian Institute of Technology in Thailand where he founded the aquaculture program. He has over 30 years experience in aquaculture education, research and development in the Asian region. Email: pedwards@inet.co.th.

Introduction

In February I took up the kind invitation of Dr Ravi RamaKrishna, Senior Scientist at the Fisheries Research Station in the West Godavari district of Andhra Pradesh, to visit the 'fish bowl' of India in the Kolleru Lake area of the State. The local carp production system has become well known within India as well as abroad. See previous articles in this magazine: Nandeesha, M.C. (2001). Andhra Pradesh farmers go in to revolutionary carp research. Aquaculture Asia 4(4):29-32; and RamaKrishna, R. 2007. Kolleru carp culture in India: an aquaplosion and an explosion. Aquaculture Asia Magazine 12 (4): 12-18.

Our intensive four day study tour involved visits to fish farms and formal meetings with individual farmers in Mallavaram village in West Godavari district and Bhujabalapatnam village in Krishna district, cooperative fish farmers in Prathikollanka village, in West Godavari district, all by Kolleru Lake; to carp hatcheries and nurseries in the Kaikaluru area of Krishna district; and to fish farms and informal meetings with individual farmers towards Gudivada in Krishna district where a second phase of carp culture development has taken place. At the end of the tour I was only too pleased when asked to comment to a group of about a dozen farmers belonging to the Delta Fish Farmers Association. And I repeat here what I said to the farmers at the start of our final meeting, that four days was hardly sufficient time to fully appreciate the most impressive but complex aquaculture system I had been shown but that at the very least my comments should stimulate further debate about how to resolve some of the problems and how the system might evolve in the future.

Farmer checking the amount of natural food in fish pond water.

Feedlot chicken manure en route to the farm.

Overview of the system

The technology of the current system of Indian major carp culture in Andhra Pradesh has been mainly developed by local farmers as described in the article by Dr. Nandeesha. It is a simplified two-species system in which rohu is dominant with 80-90% of the fish biomass and with catla a very profitable 10-20%. Production may be described as semi-intensive and indirectly integrated. It is a 'green water' system with mainly local off-farm inputs: chicken manure (and chemical fertilizers); supplemented with farm-mixed de-oiled rice bran and oil cake.

A well fertilized 'green water' pond.

Delivery of de-oiled rice bran to the farm.

Sustainable annual production is 3-4 tonnes/acre (7.5-10 tonnes/ha) although 5-6 tonnes/acre (12.5-15 tonnes/ha) have been achieved but at increased risk of fish mass mortality. Last year 5,000-6,000 farmers produced a total of 450,000 tonnes of fish from 60,000ha of ponds.

Farmers reported that they are experiencing problems, especially increasing cost of production, mainly due to rising cost of fertilizers and supplementary feed; and weather related fish mass mortality. The main problem is the fall in dissolved oxygen (DO) in the rainy season in particular but also during cloudy weather in general and during cool season fog. Water quality problems also occur during the hot season from April to June when there is limited water availability, especially with high density culture, which may cause disease. The farmers also recognized the need for change, especially to farm new species for domestic and possibly export markets.

Comments on the system

The following account is based on a final oral presentation to the Delta Fish Farmers Association and the written comments subsequently sent to them.

1. Water quality

The main cause of adverse water quality in the ponds is a decline in night-time DO due to excessive growth of phytoplankton. This can be addressed in part by a lower intensity of culture, already recognized by the farmers who now aim for a more sustainable maximum annual production of 10 rather than 15 tonnes/ha; and/or use of pond aeration as practiced by some farmers. Water quality can also be improved by more efficient use of fertilizers and supplementary feeds as discussed below.

A farm worker suspending supplementary feed-filled sacs from a rope in the pond.

2. Fertilizers

A major factor in profitable carp culture is use of fertilizers to produce natural food as is well appreciated by the farmers. However, pond fertilization

Sacs perforated with small holes are used to hold supplementary feed.

research carried out elsewhere could improve local practice. Both organic and chemical fertilizers can be used effectively to fertilize fish ponds. It is not true that both organic and chemical fertilizers are required for phytoplankton production as believed by some farmers. To be most effective, fertilizers need to be used frequently, preferably weekly in small doses. The reason that some farmers believe that chemical fertilizers cannot be used alone is their usual 1-2 monthly frequency of application is too long to sustain adequate phytoplankton growth.

It is also not true that organic is cheaper than chemical fertilizer based on the weight of the major nutrients of nitrogen and phosphorus contained in the fertilizers. Inorganic fertilizers also require less labour and lead to less build up of pond sediment which can also adversely affect water quality.

A farmer was concerned that use of only chemical fertilizers may lead to mineral deficiency but there are adequate micronutrients in fertilized and supplementary-fed ponds.

Another farmer reported that he preferred cattle manure to poultry manure as the former produces only methane and not ammonia. Poultry manure is a much better fertilizer than cattle manure as the former has a higher nutrient and lower organic matter content. Thus poultry manure would produce more phytoplankton and less pond sediment than cattle manure on a unit weight basis.

Farmers asked about toxic levels of ammonia but there is no need for concern in fertilized fish ponds as phytoplankton use ammonia as a source of nitrogen; DO will become critical before ammonia. Reported total ammonia levels in local ponds of 2-3 mg/l are not excessively high; although the toxic form of ammonia, un-ionized

Farm workers mixing de-oiled rice bran with oil cake as a supplementary feed.

ammonia, increases relative to ionized ammonia with rises in pH and water temperature during the day, ammonia levels fall to low levels in productive fish ponds as they tend to be removed from the water by phytoplankton during intensive photosynthesis.

Farmers believed that less fertilizer is required in West Godavi than in Krishna district as the former has richer soil than the latter. While this might have been true when fish culture began, it is unlikely to be so today as the fertilizer effect of the two dimensional pond sediment is minor compared to that of the three dimensional water column which requires a relatively high level of intentional fertilization for productive fish culture.

3. Liming

Farmers traditionally lime ponds to reduce CO_2 in the water which they believe would otherwise be toxic to the fish. However, highly productive alkaline fish ponds have carbon in the form of bicarbonate rather than toxic CO_2 in the water. Furthermore, lime will precipitate phosphorus and thus make fertilization less effective so it should not be used other than in pond preparation. Lime is used to increase the pH of acidic soil as well as to disinfect the soil between crops of fish.

Farm workers with rohu.

4. Supplementary feed

The greatest impact on current practice would be made by improving supplementary feeding. The two main feeds are de-oiled rice bran (12% protein) and groundnut cake (40% protein), mixed together and placed in the pond in suspended sacks with holes through which the fish feed. Cotton seed cake is also widely used and if both are used they are usually mixed at a ratio of 1:1. However, the high average food conversion ratio (FCR) of 3:1 (range 2.5-3.5:1) indicates a low supplementary food conversion efficiency. Observation revealed considerable physical loss of feed through the sack holes to which may be added loss of feed nutrients due to leaching as well as handling losses. This is confirmed by comparison of the FCRs for floating pellets of about 1.5 and sinking pellets of about 2.0 in clear water systems, and 1.0 in experimental fertilized ponds with a commercial pellet used as supplementary feed (see section 6).

Trials should be carried out to compare the present bag feeding method with minced moist feed, broadcast or placed on feeding platforms. Farmers said it would not be possible to produce dry feed on-farm in the quantities required. However, ways to reduce feed wastage do need to be explored.

Farm workers preparing quicklime for spreading on the pond surface.

Supplementary feed may be readily lost through the holes when the fish are feeding on the feed mix as suggested by lifting the sac.

Only rice bran is fed until the fish reach 300-350 g after which oil cake is added to give a feed mix of 80-90% rice bran and 10-20% oil cake with an approximate mash protein content of 18%. However, some farmers use oil cake from the start of the grow-out cycle.

Eight to ten 25 kg sacks are used per acre giving a feeding rate of 40-100 kg/acre/day as each sac is filled with 5-10 kg of mash according to one farmer. Farmers never give feed by estimating the fish biomass in the ponds as they believe that fish increase in size by the same weight increment each day irrespective of fish size. Another farmer reported that for the first month fish are fed 20-30 kg/acre/day and then from the second month until harvest at month 12 are fed 50-60 kg/acre/day which corresponds to the rate reported by the first farmer interviewed.

There was a need to explain to the farmers that:

- Fish only grow quickly on phytoplankton alone when they are small. As they increase in size they need more food to maintain their growth rate as the surface area of their gut declines relative to their total body volume as they increase in weight. This means that current farmer practice of only feeding rice bran initially is probably wise.
- However, as the fish grow larger they need increasing amounts of supplementary feed so the current practice of maintaining only two feeding rates is inefficient. The bigger a fish, the faster it grows; but to maintain growth as close as

Close up of rohu.

Close up of catla.

A recently introduced species, silver striped catfish.

Feral Mozambique tilapia.

practical to its genetically maximum rate requires increasing amounts of feed.

- The fish also need to be fed a diet with more protein as they get larger. One farmer reported that he used more oil cake, at a ratio of rice bran to oil cake of 2:1 i.e., 33% oil cake rather than the usual 10-20% oil cake in the feed mash, and got improved production. Another farmer stated that carp do not require a diet with a protein content beyond 16-18% protein but giving larger fish a supplementary diet with this relatively low protein content will slow down their growth. It is not the protein content of the feed that is critical but the total amount of protein in the diet – and as the fish grow larger they require a correspondingly larger amount of protein. Thus, the proportion of oil cake in the diet should be increased with time as the fish grow, possibly up to about 30% protein in the mash. Feeding a mash with a lower protein content means that either the fish get insufficient protein or that they need to eat much more feed with a lower protein content, even if they were able to do so, which would have a greater adverse impact on water quality through increased production of faeces.

Fish nutrition specialist colleagues advised me that it is better to feed a fish twice than once/day in terms of fish feeding efficiency. However, as the difference in growth rate may only be small, it may not be economic to feed fish more than once a day due to increased labour costs.

Fish should be fed when the DO in the pond water has risen due to phytoplankton photosynthesis. Thus, fish should not be fed soon after dawn but commencing at 8-9 am at the earliest.

5. Pelleted feed as supplementary feed

According to a farmer, the traditional method of feeding costs R20-22/kg of fish production compared to R28/kg with commercial pelleted feed so he asked why spend more? With a farm gate price of carp of R40/kg, the profit with commercial pellets would be only R12/kg compared to R18-20/kg with traditional feed he explained. However, use of pellets would require less labour, would improve the water quality as feed conversion would be more efficient, and fish growth and production would be increased. While the capital invested in fish culture would be higher and the profit margin per kg of fish produced possibly lower with use of pelleted feed, the profit per farm would be higher due to increased fish production per unit area of fish pond. Thus, it is not true that increased use of feed will lead to loss of money if feeding efficiency, water quality, fish growth and production are all increased. This is supported by the experience of a farmer in Prathikollanka Cooperative who reported that use of pellets at 1.5% fish body weight/day was very profitable in a poultry manured pond. However, he stocked large 400 g fingerlings and rohu attained 1.3 kg and catla 2.4 kg in only 4 months. It is recommended that use of pellets be investigated, at least for fattening fish in the latter half of the grow-out phase.

Considerable expense is involved through installation of nylon string to protect small fish from bird predation.

6. Chemical fertilizers and commercial pellets as supplementary feed

It may be possible to increase sustainable production by use of commercial pellets as supplementary feed in chemically fertilized ponds. Experiments with monoculture of tilapia in Thailand produced about 20 tonnes/ha with a FCR of only 1.0 in the 'green water' ponds. Ponds were fertilized weekly. Feeding at 50% feed satiation with pellets of 30% protein content began when fish reached 50-100 g and continued daily until harvestable size of 500-600 g. This experiment showed the effectiveness of proper supplementary feeding in a fertilized pond.

7. New species

Farmers expressed interest in improved and new species. Seed quality of carps was reported to be low due to inbreeding but an improved strain of rohu has been developed by a Norwegian funded project. About 250-300 local farmers were already using the improved rohu, available from Farm Pallewda, Krishna district, a Multiplier Centre, which grows 30% faster and therefore shortens the culture period by 2 months.

An estimated 10-15% of local farmers stock silver striped catfish (Pangasianodon hypophthalmus) in either polyculture or monoculture with production in monoculture of 20-25 tonnes/ha. Market accessibility and price are low at R35/kg compared to R45/kg for rohu and catla. It is unlikely that local farmers will be able to compete with Vietnam in export of this catfish as it currently produces over 1 million tonnes and has established markets but they should be able to compete with Bangladesh and Burma where catfish production is increasing and may already be being exported to Kolkata.

Although tilapia is considered as a "weed fish" at present, selling at only R5/kg, it has potential if a market can be developed. As one farmer stated,

"tilapia is more delicious than rohu and catla" so it is highly likely that tilapia will be increasingly accepted in Indian markets. Nile tilapia, in contrast to the feral Mozambique tilapia present in the area, has potential to become a major commodity for national Indian markets as well as for export from the country.

Local farmers need to develop Nile tilapia culture if they are to compete on the Kolkata market as Bangladesh and Burma have already imported quality tilapia seed and hatchery technology from Thailand. Quality seed of various Nile tilapia strains may be obtained from Nam Sai Farms, Thailand. I recommended that a delegation of local farmers visit Nam Sai Farms, website www.tilapiathai.com, and later confirmed that the farm is willing to host a small delegation from Kolleru and to also take them to visit local farms and markets for tilapia and other species, including silver striped catfish.

Other possible culturable species are seabass, walking catfish and snake-head, all traditionally fed on high-protein trash fish diets. Snakehead has been bred in Thailand and successfully fed on dry commercial feed.

Visiting a large cooperative fish pond with the farmers. The writer (centre left), Dr. RamaKrishna (centre right).

Dr. RamaKrishna introducing the writer to a final meeting at the Delta Fish Farmers Association.

Dr. RamaKrishna introducing the writer to the members of a fish farming commune.

8. Pond size

According to the farmers, "bigger is better" for pond size, with average grow-out pond size of about 20 acres (8 ha) and optimum size considered to be at least 25-50 acres (10-20 ha). Some ponds exceeded 100 acres (40 ha). While Indian major carps may grow best in large ponds, Chinese farmers reported to me in the early 1980s that ponds of 0.2-0.3 ha were best for highly productive Chinese fertilized and supplementary fed polyculture, an order of magnitude smaller than a similar semi-intensive system.

Local farmers reported better unit area production, more water surface area per farm and need for fewer watchman with larger than smaller ponds. However, large ponds must be more difficult to manage, especially with intensified production. It is recommended that optimum size of ponds be reconsidered.

9. Stunted yearlings

The system as developed by the farmers consists of two stages of 10-12 months each: production of 100-250 g yearlings in which 2.5 cm fingerlings are stocked at 4-5/m^2; and

grow-out in which yearlings are stocked at about 0.4/m^2 until rohu reaches marketable size of 1.5 kg and catla 2.3 kg. A partial harvest may take place after 8 months.

Most farmers believe that, irrespective of stocking density and feeding, carps grow slowly in their first year and only grow quickly in their second year. The two-year cycle with the area of grow-out to nursery ponds of about 4-5:1 on most farms has evolved based on a belief for the need to stunt carps in their first year.

While compensatory growth of stunted fish has been reported in the scientific literature, it may be more profitable to redesign the system around optimizing fish growth at all times within the carrying capacities of well fertilized and fed ponds, as there would be better use of pond space and a shorter time to produce marketable size fish,. This is supported by the experience of a farmer who said that it is possible to grow rohu to marketable size in 1 year with food of adequate amount and quality. Research on growth rates of carps of different sizes and ages, with bio-economic modeling is recommended. Farmers expressed concern that reducing the length of the fish culture by providing more growing space for smaller fish would lead to more bird predation. Currently stunted fish are protected from bird predation by nylon string mesh.

10. Pond additives

Farmers commonly use commercial mineral supplements, especially when fish are stressed; these are unlikely to be needed in fertilized 'green water' ponds with abundant natural food.

The need for bromine as a "water sanitizer" to reduce bacteria is probably also unnecessary.

11. Pond effluents

Farmers reported no adverse impact of discharged pond effluents on Kolleru Lake, a Ramsar site. Effluent quality could be improved by reduced use of manures and improved supplementary feeding practices. Furthermore, discharge of sediment-rich effluent could be reduced by simple pond draining procedures and by being treated by sedimentation in on-farm drainage canals before being discharged to the lake.

12. Farmer seminar

I also recommended that current farmer experience be documented through questionnaires and subsequently discussed at a seminar. Several farmers are continuing to experiment so it would be invaluable to benefit from their experience over the past three decades. It appears that several of my suggestions for possible improvement of the system have already been tested by small numbers of farmers. Dissemination of improved farmer practice could lead to major benefits for other farmers who continue to farm fish in the local traditional way.