

Peter Edwards writes on

Rural Aquaculture

Changes in traditional inland aquaculture in West Java, Indonesia

West Java in Indonesia, which dominates inland production in the country, has a long history of various types of traditional small-scale aquaculture involving the integration of fish culture with various types of on-farm and locally available off-farm organic matter inputs. I witnessed this diversity on a study tour of the area in 1981, almost 30 years ago. I retraced my steps on a 10 day trip in late June and early July this year to see the changes that have taken place in aquaculture over the past three decades in West Java. I visited numerous farms and government facilities on a circuitous route in the Bogor, Sukabumi, Cianjur, Cirata, Bandung, Subang and Sukamandi areas. The trip was arranged and guided in part by two AIT

alumni: Dr Agus Somamihardja and Mr Widyatmoko, both employees of the Aquaculture Division of JAPFA, one of the largest agri-food companies in the country with a nation-wide network of aqua-feed salesmen, several of whom facilitated the visits to local farms. I was also guided to farms by Mr Reza Samsudin of the Department of Marine Affairs and Fisheries, Bogor, and Mr Jaka Trenggana of the Main Center for Freshwater Aquaculture Development, Sukabumi.

There has been a massive increase in national inland aquaculture production over the last three decades from about 120,000 tonnes in 1981, according to FAO statistics, to almost 750,000 tonnes in 2007, a six-fold increase.



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While the number of farmed species has increased from 10 to 16 (excluding the category 'freshwater fishes nei' for miscellaneous species), common carp (*Cyprinus carpio*) remains the major species with 36 % of the inland aquaculture total, closely followed by



Supplementary feeding a wastewater-fed nursing pond, Sukabumi.



Fish ponds are an integral part of villages in West Java, Sukabumi.



Feeding African catfish with dried marine trash fish, Bogor.

Nile tilapia (*Oreochromis niloticus*) at 28 %. These two species therefore comprise almost three quarters of national inland aquaculture production.

Because of the tremendous diversity of inland aquaculture practices and lessons learned for possible application elsewhere, I cover traditional aquaculture in this column. 'Modern' aquaculture which I'm defining here as

using agro-industrial pelleted feed rather than natural food produced by organic fertilisers and supplementary feeds as nutritional inputs, will be covered in my column in the next issue.

Traditional aquaculture overview

Traditional aquaculture as described in the earlier literature and as I witnessed three decades ago mainly comprised a polyculture with various combinations of common carp and tilapia (but Mozambique tilapia, *O. mossambicus* rather than Nile tilapia today), and kissing gourami (*Helostoma temmincki*), nilem carp (*Osteochilus hasseltii*), silver barb (*Barbodes gonionotus*) and giant gourami (*Osphronemus gouramy*). The typically small ponds were integrated with wastes or by-products from agriculture, local agro-industry such as soybean and rice processing, and sanitation (overhung latrines on ponds, diversion of fecally polluted water from rivers and streams into ponds as a fertiliser, and small wooden and bamboo cages sitting on the bottom of polluted rivers and streams stocked with common carp in monoculture which fed on benthic invertebrates). Traditional cage culture had already been reduced by 1981 as it had been banned by the government because the cages impeded water flow and contributed to flooding of urban areas. Significant nursing of fish was carried out in rice fields as well as in small ponds.

Most traditional practices continue to at least some extent today but they have either declined or have been modified and are now mostly overshadowed by 'modern' aquaculture.

Changing balance of species

Nile tilapia is increasing in popularity as a farmed species as it lacks bones in the muscle and koi herpes virus has been adversely affecting the farming of common carp since the early 90's. Production of the other traditional species remains relatively low and static by comparison. National production figures were in 1981 and 2007, respectively, for kissing gourami (4,000 and 6,000 tonnes), nilem carp (17,000 and 15,000 tonnes) and silver barb (17,000 and 15,000 tonnes). Nilem and silver barb were not reported to be cultured anymore in the areas I visited as they have too many bones although they are still popular in the eastern part of West Java, in the Ciamis and Tasikmalaya areas. However,



Fish ponds interspersed with rice fields, Sukabumi.

giant gourami remains popular with a major increase in production of 4,000 in 1981 to 36,000 tonnes in 2007, a nine-fold increase. This species is more expensive than common carp and tilapia as it is relatively slow growing even when fed mainly with pelleted feed and thus is a restaurant fish rather than contributing towards national food security.

Integration of crops and fish

I visited a small-scale farm in the Bogor area stocked with a polyculture of giant gourami, common carp and tilapia. The herbivorous giant gourami was being fed with leaves of banana, cassava and sweet potato grown on the pond dikes and in adjacent plots but pelleted feed was also being fed to the fish.

There are two systems of rice/fish nursing in West Java: nursing fry and growing rice together at the same time i.e. concurrently; and but nursing fry for one month between rice crops. The first system is now rarer than the second. A third type of integration with rice in which a crop of rice was rotated with a crop of grow-out fish never occurred in West Java and was reported to have ceased also in East Java where it used to be practiced.

Rice fields used to be a major source of fingerlings but the practice of rice field nursing has declined significantly. It is estimated that less than 10 % of fingerlings are now nursed in rice fields in Cianjur, a major nursing area. Thus, I was fortunate to be able to interview a farmer in Maleber, Cianjur, who is the only one still nursing in rice fields in the area. He was nursing fry concurrently with rice with trenches dug around and across the rice fields. He had stocked one liter of common carp fry (20,000

individuals) in a 2,000m² rice field and expected to harvest 40-50 kg of 14-15 g fingerlings in 40 days. This farmer was also nursing in ponds converted from rice fields which he reported is better, as the same amount of fry stocked in a nursery pond would produce double the harvest of fingerlings, 100kg, in the same 40 day period than in a rice field nursery.

Integration of livestock and fish

I saw far fewer examples of integration of livestock with fish than previously. Indonesia has developed a large-scale broiler chicken industry for domestic consumption as well as for export. Small-scale poultry production was said not to be profitable anymore. The government is also discouraging livestock/fish integration because of public health concerns of using manure and a desire to maintain a good image of aquaculture for exporting fish.



A common carp breeding system in a wastewater-fed pond, Sukabumi.

I saw a few relatively small broiler chicken houses over fish ponds. The chicken farmers rent the space above the ponds from fish farmers. The chicken bedding, manure and spilled feed are not allowed to fall into the pond but are collected for sale to fish farmers. I also visited a large-scale integrated system with 15 chicken coups each with 5,000 birds over a 20 ha lake stocked with airbreathing striped catfish (*Pangasianodon hypophthalmus*) for live export to Sumatra in plastic drums by truck and boat as the people in Java do not like to eat this species.

Raising goats in pens is a traditional practice in West Java and I saw both a small-scale and a relatively large-scale operation integrated with fish ponds. In both cases the manure was collected from beneath the goat pens constructed on the pond dikes. The larger-scale system had 110 goats, with manure placed in a hapa suspended in the pond to decompose, with release only of soluble nutrients into the pond to avoid deoxygenating the water from too high an organic matter loading rate.

Wastewater-fed seed production

Although the various types of traditional grow-out systems for wastewater-fed aquaculture have almost disappeared from West Java, wastewater is still used as a pond fertiliser but for seed production rather than grow-out of common carp and tilapia as I observed in Cianjur, Bandung and Sukabumi. Water from polluted streams and canals flowing from urban areas by gravity is diverted into fish ponds in peri-urban areas. Seed from these three areas comprises the major source of fingerlings to various grow-out systems,



Large-scale broiler chickens integrated with fish, Bogor.



Trench across the field in concurrent integrated rice fish culture, Cianjur.



Small-scale goat raising integrated with fish, Subang.



Close-up of goat fish integration, Cianjur.



On-farm crops provide feed for herbivorous giant gourami, Bogor.



Relatively small-scale broiler chickens integrated with fish, Sukabumi.



Harvesting common carp fingerlings from a wastewater-fed pond, Bandung.

and especially pellet-fed cage culture of common carp and tilapia in reservoirs which is reported to supply about 80 % of domestic fish supply in West Java.

Tilapia and common carp are bred and nursed in Cisaat, the fish farming area of Cianjur. Until the 1980s the tilapia species was *O. mossambicus* but the Chitralada strain of Nile tilapia was introduced from Thailand followed by the 3rd and 6th generations of GIFT from the Philippines, which were distributed to the farmers by the Main Center for Freshwater Aquaculture Development in Sukabumi.

Almost every house in Cisaat has 1-2 ponds and some have up to 5 ponds. Fish seed provides the main year-round household income. Good cash flow because of the short duration of nursing is no doubt an additional attractive aspect of seed production, as well as the free source of nutrients in the wastewater for these relatively small farming households. As Cisaat is a suburb of the city of Sukabumi, some families have additional livelihoods, including involvement in the seed transport business.

There are four groups of farmers involved in the various stages of tilapia seed production in Cisaat:

1. Male and female Nile tilapia broodstock are stocked at a ratio of 1:4 in small shallow ponds and fry are harvested every 15 days using nets to scoop them up from a harvesting pit after the water has been drained from the pond.
2. First stage nursers stock the fry at 200-250/m² and rear them to 2-3 cm fingerlings in 21 days with a mortality rate of less than 10 %.
3. Second stage nursers stock the 2-3 cm fingerlings at 150-200/m² and rear them to 3-5 cm in 21 days with a similar mortality rate.
4. Third stage nursers stock the 3-5 cm fingerlings at 75-100/m² and rear them for another 21 days with a mortality rate of about 20 % to 5-8 cm after which they are mostly transported from the area to be stocked in cages in reservoirs. A 1,000 m² pond of this type that I specifically enquired about had a depth of about 0.7-1.0 m when filled with water and produced about harvested about 250 kg of fingerlings.

Ponds are drained between cycles and limed. If the water is not fertile then chicken manure will be used to fertilise the pond. Rice bran and chicken broiler bedding (rice husks,

spilled chicken feed and manure) are used as supplementary feeds in the wastewater-fed ponds at a rate of about 300 kg/ha/day.

Common carp are bred in a similar ponds but the broodstock are placed in a hapa in the small shallow pond. The broodstock lay eggs overnight on 'kakabans', branches also placed in the hapas. About 24-36 hours after hatching, the fry swim into the pond through the mesh of the hapa and reach a size of 2-3 cm in 25 days. A few large broodstock are also stocked in the nursery pond to stir up the sediments which prevents the growth of emergent aquatic macrophytes.

During my earlier visit to Bandung, the major wastewater-fed aquaculture area was in Bojongloa but this former rural area is now well within the urban area of the city of Bandung. The former major wastewater-fed aquaculture suburb of Bogor, Muara, has similarly been swallowed up by urban development. However, wastewater-fed seed production still takes place in some of the more distant suburbs of Bandung. I visited Bojongsoang, the largest wastewater-fed seed production area in Bandung with more than 100 ha of ponds which started in 1983, presumably because of the demise of Bojongloa.



The rice field eel is cannibalistic, Bandung.

The wastewater-fed nursery ponds are large and shallow with a 60cm depth and are owned by well-to-do families, several families ponds being overseen by one manager. The farm I visited was 13 ha in size and at the time of my visit a 5 ha pond was being harvested, producing 1.8 tonnes (about 0.3-0.4 tonne/ha) of fingerlings of 10-12.5 g which were being placed in oxygen filled plastic bags for transportation by truck to Cirata reservoir. One week old common carp fry are stocked at a rate of 30 l of fry/ha and are harvested after 40 days. The fish consume natural food such as tubifex worms and no artificial feed is given. Up until about 5 years ago fish were nursed year round but now nursing alternates with rice cultivation as the soil quality, but not that of wastewater, was said to have declined. Fish nursing now runs from November until June with five harvests of fingerlings.

As the demand for fingerlings to stock cages in Cirata reservoir is large, there are also fish seed nurseries in Bandung using only artificial feed. The fry to stock the wastewater-fed ponds I visited in Bandung also come from a hatchery in Majalaya which does not use wastewater.

Recently developed systems

African catfish (*Clarias gariepinus*) is a relatively newly introduced species which the government is promoting as a third species for national food security alongside common carp and tilapia. As it is an air breathing species it can be raised at high density and marketed at a small size of 150-200 g, the preferred size for local consumption. The national production of African catfish has risen rapidly and in 2007 was over 90,000 tonnes. I visited a large-scale farm that was feeding dried marine trash fish, cooked chicken offal from a nearby slaughter house (a major by-product of industrial chicken farming that the farmer gets free but must remove it from the factory daily and provide the transportation) as well as pelleted feed.

I also witnessed harvesting the rice field eel (*Monopterus albus*), a relatively high-value species, in a farmer-managed trial using a technology developed by a local farmer and supported by the local government as an initiative to increase farmer income. Thirty kg of wild eel broodstock had been stocked in a 144m² rice field and fed with earthworms raised separately in a mixture of chopped rice straw, banana stems and other organic matter and composted goat and cattle manure. Large numbers of eels were observed being dug out of the rice field but production would be reduced by the cannibalistic nature of the species.



Common carp fingerlings are transported in oxygen filled plastic bags from Bandung to Cirata reservoir.



Harvesting sump in a newly constructed nursing pond in a former rice field, Cianjur.



Farm-based trial with rice field eel, Bandung.



A harvesting sump in a wastewater-fed tilapia nursing pond, Sukabumi.



Manure decomposes in a net to reduce the organic loading on the pond, Cianjur.