Chapter 12
Increasing production

Increasing the production from ponds
To increase the production of a pond, a fish farmer has a number of options available. These include combining different species of fish (polyculture) or growing fish along with other domestic animals (integrated aquaculture).

Monoculture
The most commonly farmed fish in Africa is tilapia. The most frequently used species is *Oreochromis niloticus* stocked at 1-2 fingerlings per m^2, with an average stocking size of 5-10 g each. The ponds are fertilized with manure or compost and the fish are fed irregularly using locally available ingredients. The production cycle lasts around 5-6 months and harvest yields 750-2000 kg of fish per hectare (15-50 kg/year in a 100-m^2 pond). This can be doubled for the year if the ponds are used twice.

Polyculture
Polyculture is culturing two different species at the same time. The two species use the same space but because they have different habits and diets, they do not negatively affect each other. In many cases the growth of the different fish is better than when they are grown alone in the same pond. This is because one species cannot completely use the nutrients in the pond, and thus two species make better use of them. For example, ponds with Nile tilapia on its own produced 35% less kg/ha/year than ponds stocked with Nile tilapia and catfish.

The most common polyculture species are:
- Common carp (omnivore) and *Oreochromis* species (planktivores)
- Common carp (omnivore) and grass carp (herbivore)
- Common carp (omnivore) and silver carp
- *Oreochromis* species (planktivores) and catfish (carnivore).

It is important that the size of the two species are similar when stocking the pond, otherwise the larger species could end up eating the other.

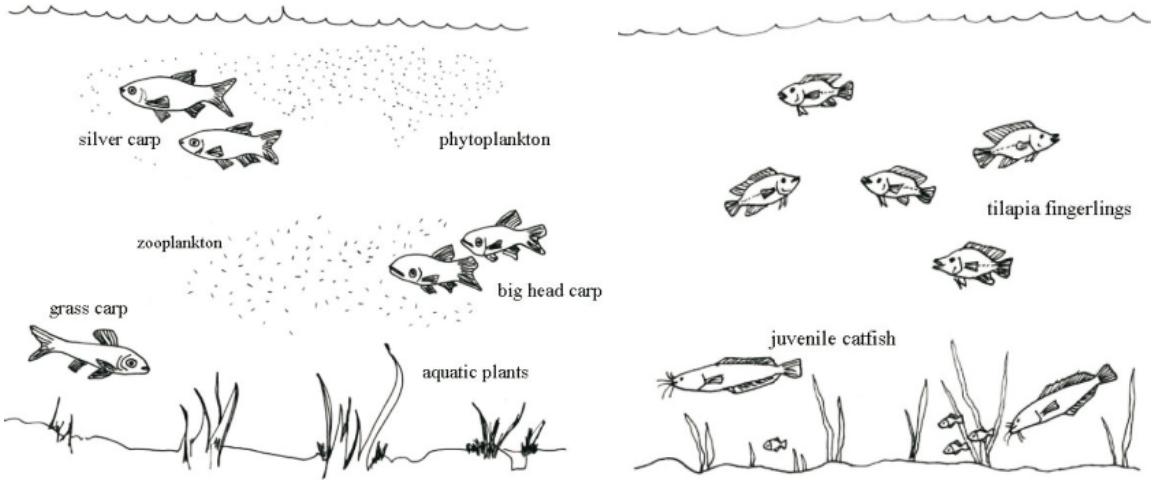
INFO BOX: POLYCULTURE

Polyculture (two or more species grown together) —
- In Israel, yields of up to 11 tons/ha/year achieved.
- World average is 3.4 tons/ha/year.
- In South Africa with just fertilization of ponds, can achieve 1.25-2.25 tons/ha/year
- In South Africa with supplementary feeding, can achieve 3-6 tons/ha/year.

Integrated aquaculture
In other parts of the world, polyculture aquaculture has become more important as it improves the recycling of organic wastes.

Irrigation of farmlands and fish farming
If the ponds are built so that the water level is higher than the crop fields, it is possible to drain the water to irrigate the farmlands. This has a number of benefits. First, the water is reused, which is important in southern Africa due to the limited supply of freshwater. Second, the water coming from the pond is likely to have a higher nutrient load due to excretion by the fish. This extra nutrient is beneficial to the plants and will save the farmer fertilizer and manure. Design and placement of the irrigation canals should be considered before building the pond as the relative position of the pond and fields is important.

Mixed-sex *Oreochromis mossambicus* production	**Single-sex (all-male) *O. mosssambicus* production**
•Stocked at 1-2 fish/m^2	•Stocked at 5-10 g fingerlings per 1-2 m^2
•Fingerlings of 5-10 g (5-8 cm length)	•Fingerlings of 5-10 g (5-8 cm length)
•Growing period 6 months	•Pond fertilized with organic manures
•Ponds fertilized with organic manures	•After 6 months fish grow to 350-400 g
•Harvest size 50-400 g, many juveniles	•Expect to harvest 5 tons/ha
•Harvest yield 0.75-2.0 tons/ha.	•With supplementary feeding expect up to 8 tons/ha.



Combinations of species used in polyculture: three carp species, and catfish with tilapia.

Integrated fish/pig farming

Pig sties are constructed on the pond embankment or near the pond to allow for easy runoff of waste directly into the pond. The recommended number of piglets is 100 per hectare of pond (1 piglet per 100 m^2). Two-month-old weaned piglets are fattened for six months until they attain market size (70 kg). The waste acts as pond fertilizer and encourages the growth of natural fish food organisms. The fish also feed directly on the pig waste and no other feed or fertilizer is required.

In this manner, after six months, monoculture ponds stocked with *Oreochromis niloticus* at 2 fingerlings per m^2 can yield 4000 kg/ha and 3000-4500 kg of live pig.

Integrated fish/duck farming

A duck hut is built on the pond embankment or on a floating platform. Erosion damage may be caused by the ducks pecking at the soil on the sides of the pond in search of insects. Therefore, a fence should be placed around the inside wall to prevent the walls from collapsing. Peking and Muscovy ducks are the most popular, with Peking ducks being preferable as they spend more time on the water. The ducks will feed on aquatic organisms such as insect larvae, tadpoles, snails and weeds, but they should also be provided with duck feed at 100 g/bird/day. As with pigs, the duck droppings act as fertilizer for the pond water. About 10-15 ducklings per 100 m^2 (2–3 months old) are suitable for starting with. Ponds can be stocked with tilapia, common carp or catfish, at 2-3 fingerlings per m^2. The fish require no additional feeding and the pond can produce 1250-2250 kg of fish/ha and 750 kg/ha of duck per six-month cycle. Additional food (or ducklings) can be obtained when the ducks start to lay eggs after 5-6 months.

Integrated fish/chicken farming

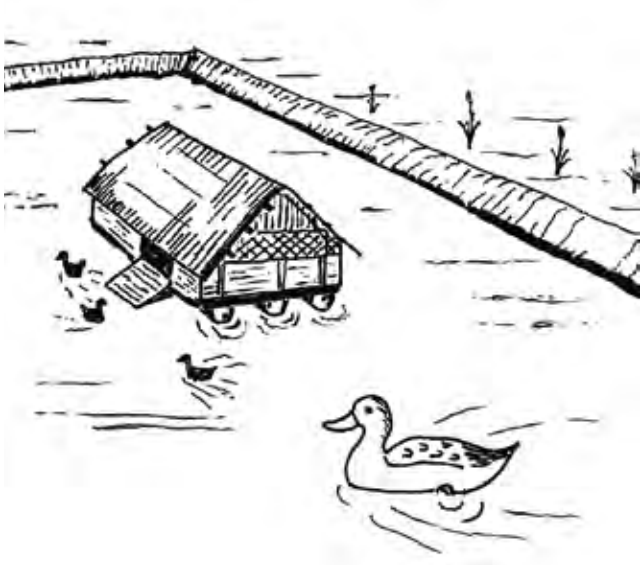
Like integrated duck farming, the chickens are raised in cages under a hut constructed over the pond, on the side of the pond or nearby. About 20-50 chickens can be used per 100 m^2. If the hut is not built over the pond, the chicken droppings fall on the floor, from where they are collected and applied to the pond. No extra feed or fertilizer is added to the pond. Polyculture of tilapia (2 fingerlings per m^2) and catfish (1 fingerling per m^2) or common carp will yield 1700-2500 kg/ha after six months. At each harvest, the live weight of the chickens will be between 40-60 kg per 100 m^2 of pond, depending on the number raised and breed

INFO BOX: INTEGRATED AQUACULTURE

- With irrigated crops, water is used twice and enriched by fish waste.
- With crops, vegetable farmers can feed vegetable waste to herbivorous fish species (lettuce, cabbage, spinach, beetroot leaves, carrot tops) can all be added directly or as compost.
- With livestock, chicken, cattle, sheep, goat or pig manures used to fertilize ponds.
- With fowls, ducks or geese can directly fertilize ponds, increasing productivity.

Annual production through integrated carp and livestock farming:

Animals	Fish production	Animal production (live weight)
Fish + pig farming	6–7 ton/ha	4 000–5 000 kg pig meat
Fish + duck farming	3–4 ton/ha	500 kg duck meat + 17 000–20 000 eggs
Fish + chicken farming	4–5 ton/ha	60 000–70 000 eggs + 1 500–2 000 kg meat

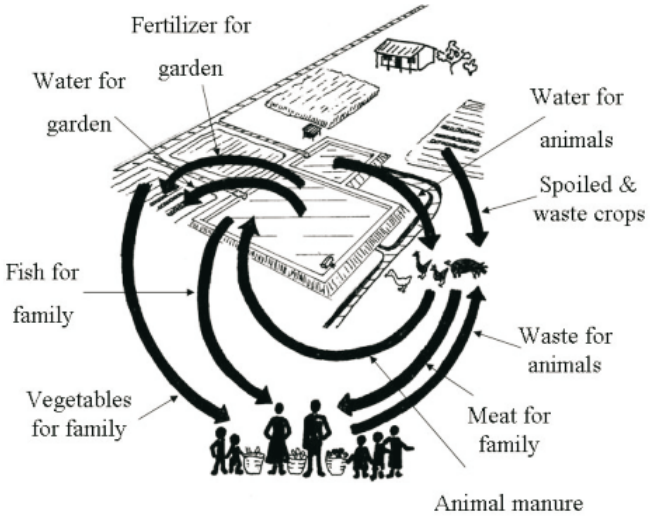


Integrated fish/duck farming. The duck hut can float on the pond or be built on the side of the pond embankment.

Integrated fish/chicken farming. The chicken hut can be built on poles over the pond or on the side of the pond embankment. In South Africa, where land is less at a premium than in China, for example, it is best to place the chicken houses adjacent to the pond to make netting the pond easier.2

used. Egg production can help provide additional income (and chicks), with approximately 120-200 eggs produced per chicken per year.

A successful pond can help the farmer by providing fish and water for his/her family, garden and livestock. In turn, the livestock and vegetable garden can provide the pond and fish with food (via feces and waste plant materials).



The benefits of integrated aquaculture: using a pond, livestock and vegetable garden can improve the farmer's livelihood.3