# Large-scale sandfish production from pond culture in Vietnam

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**Abstract**

In recent years the farming of sandfish (*Holothuria scabra*) has been adopted by a number of farmers in south-central Vietnam. Hundreds of thousands of hatchery-produced juvenile sandfish have been stocked into ponds in the region. Broodstock were collected from the wild in Khanh Hoa province and from commercial culture ponds at 40–500 g weight. The broodstock were stored in a holding pond at a low density without adding feed. Animals of average weight (~350 g) were then transferred to conditioning tanks about 1 month prior to spawning. Indoor conditioning tanks were prepared with a sandy substrate and sand-filtered water supply. The animals were fed with fine shrimp feed. Simplified hatchery methods using cheap and basic equipment have been refined over the past decade, and consistent batches of juveniles can now be produced at will, with around 50,000 competent juveniles produced from batches of 2 million eggs.

Sandfish were cultivated in ponds with muddy-sand or coral-sand substrates using simplified techniques and locally developed management methods. The results of model sandfish culture ponds in three provinces proved that these methods can be profitable for farmers in these coastal areas. The constraints to commercial sandfish pond culture in Vietnam are no longer pond management or the price paid by the dealers, but density limits and culture duration.

## Introduction

High demand for sea cucumber (e.g. sandfish (*Holothuria scabra*)) in China has resulted in overfishing in many countries in the Asia–Pacific region (Lovatelli et al. 2004). While restocking offers a plausible fast-track recovery of sandfish fisheries (Bell et al. 2007), pond culture provides livelihood options and a source of income for coastal communities engaged with faltering shrimp-farming enterprises (Mills et al. 2008).

Hatchery and juvenile production techniques have been developed, documented and carried out with a minimum of advanced infrastructure (Battaglene 1999; Pitt and Duy 2004; Duy 2005, 2010; Agudo 2006). Over the past decade, many studies on breeding and rearing sandfish have been conducted by the Vietnamese Research Institute for Aquaculture No. 3 (RIA3) sandfish hatchery in Van Ninh district, Khanh Hoa province, and the WorldFish Center (WorldFish). Other sandfish projects in Vietnam have been supported by the Australian Centre for International Agricultural Research (ACIAR), the Danish International Development Agency, the Vietnamese Government, the South East Asian Fisheries Development Center (SEAFDEC) and so on. The hatchery and juvenile production techniques developed to date have been disseminated to the project partners and other private sector operators in the Asia–Pacific region.

The large-scale production of sandfish for pond culture has been conducted in Vietnam based on knowledge developed from research collaborations between RIA3 and ACIAR–WorldFish (Pitt and Duy 2004; Bell et al. 2007; Mills et al. 2008). This paper describes the simplified techniques used in this research for seed production of sandfish and large-scale sandfish production for pond culture in

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Vietnam. The progress of research on seed production and grow-out of sandfish will support the industry's expansion in Vietnam and elsewhere in the region.

## Simplified techniques for seed production of sandfish

### Sandfish broodstock management

A few years ago, sandfish broodstock were collected from the wild or holding ponds and pens, and immediately induced to spawn. Various methods of spawning stimulation were trialled but proved unreliable. In recent years, however, the broodstock have been conditioned in tanks in the hatchery for a period of about 1 month to allow gonads to reach full maturity.

In the simplified techniques, concrete or fibreglass tanks placed indoors for shade were prepared with a 10–15-cm layer of cleaned dried sand, and supplied with sand-filtered sea water to a depth of 0.5 m. Adult sandfish weighing more than 350 g were transferred from holding ponds to conditioning tanks. The seawater temperature in the conditioning tanks was stable, maintained below 30 °C. The density of broodstock should be less than 2 animals/$m^2$. Water exchange was carried out in the morning to avoid broodstock being induced to spawn from thermal shock. Fine shrimp starter feed at 1 g/$m^3$ was fed twice a day. In addition, broodstock were co-cultured with the carnivorous Babylon snail (*Babylonia areolata*), providing extra protein-rich feed that contributed to sandfish growth and condition. Even when kept in good health, broodstock might lose weight in 1 month of conditioning; weight loss of less than 20% is acceptable.

After conditioning in tanks, broodstock were reliably induced to spawn, being more sensitive to thermal shock stimulation (Agudo 2006; Duy 2010). This allowed the year-round production of sandfish juveniles. Pond-held broodstock are maintained close to the hatchery for convenience of transfer to conditioning tanks. There should be sufficient animals in holding ponds to substitute a group of 50 animals after each breeding cycle in the hatchery.

### Larval rearing

Optimal larval density and feed were the two main factors in maximising growth and survival. The micro-algae *Chaetoceros muelleri* was used for the swimming and settled stages in the hatchery. Using a single species of algae represented a significant simplification of the technical and infrastructure requirements for larval production, and meant that techniques could be more easily adopted by small-scale hatcheries such as former shrimp hatcheries.

The feeding rate was increased gradually during larval rearing. The optimal rearing density was at 200–300 larvae/L. At high densities of larval rearing, growth rates can decrease and high malformation rates are observed. As a result, it is better to get 10% survival (to 2–5-mm juveniles) from a starting point of 200 larvae/L in 4 weeks than 1% survival from 1,000 larvae/L in 6 weeks. In addition, faster growth of juveniles can prevent predator disasters, such as copepod infestation. Loss from copepods was also minimised by preparing settlement plates by coating them in a slurry made from *Spirulina* paste (Figure 1) rather than natural conditioning through immersion in sea water (Duy 2010).

### Juvenile production

Simplified hatchery methods using cheap and basic equipment were refined, and consistent batches of juveniles can now be produced at will, with around 50,000 competent juveniles produced from batches of 2 million eggs. Hapa nets were used effectively for a low-cost nursery in ponds (Figure 2), removing the need for large raceways at hatchery facilities for juvenile rearing.

## Testing economic return from large-scale production in model ponds

### Design of model ponds

We used two ponds in each of three provinces (Khanh Hoa, Phu Yen and Ninh Thuan) in central Vietnam. The ponds had a coral-sand or muddy-sand substrate. The ponds in Phu Yen and Ninh Thuan were used previously to rear shrimp and swimming crab. There was a collaborating agreement between RIA3 and farmers to operate model ponds in Phu Yen and Ninh Thuan provinces. The two ponds in Khanh Hoa province were sediment settlement ponds at the National Center for Seed Production, belonging to RIA3, and were operated by project staff.

### Pond preparation

All chosen ponds were located in the intertidal zone for convenient seawater exchange. The steps of pond preparation were as follows:

**Figure 1.** Preparation of *Spirulina*-coated settlement plates

**Figure 2.** Hapa nets used for a first-stage nursery of sandfish in ponds

- Dry the pond by draining through sluice-gates and pumping.
- Remove predators and unwanted seaweed.
- Till the sediment to disturb and wash the mud layer, ensuring that there is a burying layer of about 5 cm.
- Build a net pen at the sluice-gates to exclude predators, and prevent escape or massing of sandfish in this area.
- Apply lime (agriculture or hydrated) at 0.5–1.0 t/ha.
- Fill the pond with sea water 1 week prior to stocking with juvenile sandfish.

## Transportation of juveniles

The 2–20-g juveniles were produced at the RIA3 sandfish hatchery from a single spawning in May 2008. They were nursed to a size of 2 g in ponds using the hapa systems described by Pitt and Duy (2004), and then grown at high density in earthen ponds to a larger size (advanced nursery) before stocking in the model ponds in Phu Yen and Ninh Thuan. They were selected and placed in bare tanks to defecate for 1–2 days prior to transferring them to the ponds. An open transportation method of juveniles in foam boxes was used effectively, with survival rates of up to 100%.

## Water quality management

The biggest causes of sandfish mortality in ponds are known to be predators and the stratification of pond water in the wet season. Despite this, we did not use paddle wheels to reduce stratification in the six model ponds; it was found to be unnecessary due to the efficiency of mixing during tidal water changes and wind mixing. During culture, pond water depths were kept at 0.8–1.5 m, and the water was changed by opening and closing the sluice-gates. Water quality parameters (temperature, salinity) were monitored daily (Table 1). We found that the two model ponds in Khanh Hoa province experienced less water exchange than other ponds, which we believe was due to neap tides and hot weather. This resulted in high temperatures (up to 36 °C) and salinities (up to 41‰) in these two ponds in the dry season. Ponds in Ninh Thuan and Phu Yen provinces had daily water changes, resulting in better conditions.

## Harvest

We found that sandfish in all ponds reached commercial size (>300 g) in average weight in November 2009, after 9–14 months in ponds (Table 2). The harvest was brought forward due to a significant flood event. Ponds in Khanh Hoa had endured the last wet season in 2008 without any losses. Final yields were in the range 2.61–2.80 t/ha (Table 2). Survival rates were higher for juveniles stocked at larger sizes (80%, 85% and 87% for 2-g, 10-g and 20-g juveniles, respectively). The sandfish were sold to local dealers and buyers in Ho Chi Minh City. Most of the production of this harvest was processed by a Singaporean processor using his preferred techniques to ensure higher quality. Local buyers also bought some sandfish and degutted them at the pond, then processed them using traditional methods. The dried, cultured sandfish were later seen at the market in Ho Chi Minh City, Vietnam.

## Financial return from pond culture

At the harvest in November 2009, cultured sandfish were sold to processors at the ponds (Figure 3) for 35–40,000 Vietnamese dong (VND)/kg (US$2.00–2.20) whole wet weight. The profit fluctuated between 49.5% and 80.1%, and the profit margin was estimated at 33.1–45%. This is equivalent to about 30–40 million VND (US$1,700–2,200)/ha/crop.

**Table 1.** Mean (± SD) temperatures and salinities in model ponds in Khanh Hoa (KH), Phu Yen (PY) and Ninh Thuan (NT) provinces

| Pond | Temperature (°C) | Salinity (‰) |
|---|---|---|
| KH1 | 27.4 ± 4.8 | 24.5 ± 8.5 |
| KH2 | 27.4 ± 5.0 | 24.5 ± 8.4 |
| PY1 | 28.2 ± 2.8 | 25.6 ± 6.5 |
| PY2 | 28.2 ± 2.7 | 25.6 ± 6.6 |
| NT1 | 29.5 ± 3.4 | 30.0 ± 2.7 |
| NT2 | 29.5 ± 3.4 | 30.1 ± 2.7 |

**Table 2.** Results of sandfish model pond culture in three provinces, 2008–09

| Province | Total area ($m^2$) | Mean stocking size (g) | Density (juv./$m^2$) | Mean weight at harvest (g) | Mean survival rate (%) | Duration (days) | Yield (t/ha) |
|---|---|---|---|---|---|---|---|
| Khanh Hoa | 14,000 | 2 | 1 | 350 | 80 | 420 | 2.80 |
| Phu Yen | 10,000 | 10 | 1 | 310 | 85 | 305 | 2.63 |
| Ninh Thuan | 10,000 | 20 | 1 | 300 | 87 | 274 | 2.61 |

**Figure 3.** Processing of pond-cultured sandfish at Research Institute for Aquaculture No. 3

## Discussion

The results from model ponds in Phu Yen, Khanh Hoa and Ninh Thuan provinces showed that monoculture of sandfish in ponds can be profitable to farmers in coastal areas. It was clear that the bigger the sandfish are when released, the higher the survival rates obtained. However, there was a slower growth rate at around 1.0 g/day in these ponds compared with sandfish growth rates previously reported from other pond studies. In Van Ninh, Khanh Hoa province, growth rates were 1–3 g/day or 1.0–1.8 g/day, respectively (Pitt and Duy 2004; Mills et al. 2008). In the hatchery, density affects sandfish growth at biomass levels greater than 225 g/$m^2$ (Battaglene et al. 1999). There may have been limited natural food and benthic organic matter in the substrates, thus affecting the growth in our model ponds when this threshold density was exceeded due to high survival rates. This led to a long culture period to attain commercial size for sandfish in the model ponds in Khanh Hoa province, while sandfish in the ponds in the two other provinces were at commercial size because of the bigger size of release. In fact, the growth of sandfish appears to depend on many factors including substrate, pond site and supply of natural feed through water exchange.

During culture, water management in the sandfish ponds requires attention by the farmers. Mass mortalities are likely if ponds are not adequately attended in the wet season; this has resulted in high mortality rates in the past. All the evidence gathered so far suggests that these problems can be cheaply and effectively overcome, even in uncharacteristically heavy and prolonged periods of rain (Mills et al. 2008). However, the relatively long duration of culture increases the expense of renting ponds and labour costs due to the high risk over the wet season. The prices paid for sandfish are increasing over the years, which will support a higher profit for the farmers in the future.

The results of the model pond trials have been encouraging for industry expansion in the region and sandfish farming is contributing to viable livelihoods for the farmers in coastal central Vietnam.

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