POLICY BRIEF

Sustainable Technologies and Aquaculture Field Schools to increase Indonesian's Shrimp and Milkfish Production

Main Conclusions

- ✓ Training farmers of *tambak* or brackish water ponds in low external input aquaculture (LEISA) using Field Schools is very cost-effective to (1) reduce rural poverty, (2) support communal coastal defence, and (3) increase Indonesia's yield of shrimp and milkfish.
- ✓ Liquid compost from wasted vegetables has more positive effect on shrimp growth, than that of wasted fruit, or their mixture.
- ✓ An IMTA of shrimp with seaweed, mussels and tilapia reduces diseases in shrimp, stabilises water quality and increases the total output of the ponds.
- ✓ In ponds, feeding fish and shrimp with less protein and more fibrous carbohydrates, reduces cost, and improves the farmer's yields and profit margins.
- ✓ Blue Swimming Crab juveniles can best be raised in ponds with sandy/muddy soils at less than 3 per m^2, and fed small amounts of large-sized shrimp pellets.
- ✓ Using LEISA and IMTA, the about 10,000 *tambak* farm households of Demak can quadruple the revenue from their ponds, and the seafood output of regency can increase from 11 to more than 20 thousand tons.

Background

The Project designing Aquaculture to Support Mangrove restoration in Indonesia (PASMI) was related to the program Building with Nature Indonesia (BwNI). BwNI supports the Demak regency to improve (1) coastal protection and (2) farmer's skills on sustainable aquaculture by using the farmer field school approach[1,2].

The PASMI team monitored these field schools, and, to further support BwNI, made an inventory of constraints to innovations and tested:

- Integrated multi-trophic aquaculture (IMTA) for shrimp and milkfish;
- Grow-out of small-sized Blue swimming crab.

PASMI is a project by Universitas Diponegoro (UNDIP), Indonesia, and Wageningen University & Research (WUR), Netherlands.

Context

Traditional farmers of milkfish and shrimp occupy 80% of Indonesian brackish aquaculture area, but produce only 10% of its shrimp. In 2015, in Demak regency, Central Java, the yields at harvest of shrimp and milkfish were about 40 and 240 kg ha^{-1} yr^{-1}, respectively. In other countries such shrimp farmers produce about 10-fold, and companies reach at least 100-fold.

Those *tambak* farmers, do not apply good aquaculture practices due to lack of proper training. Their gross margin from aquaculture is slightly more than 600 USD ha^{-1} yr^{-1} only for a variable cost of 300 USD ha^{-1} yr^{-1}. With such margins, farmers are tempted to open more ponds by cutting mangrove, and can't contribute to mangrove recovery for coastal defense. The latter is urgent considering the on-going sea level-rise and the subsidence in the area due to groundwater use. Several tidal lakes have emerged in Sayung where 1500 years ago was sea, later mangrove, then ricefields and *tambak*, and now fisheries, after destroying the mangrove.

For farmers to cope with these changes, BwNI trained them, while PASMI developed new aquaculture practices.

Efficient Transfer of Technology by Coastal- Aquaculture Field Schools

Between 2016 and 2018, BwNI, the NGO Blue Forest, together with KKP-Demak, trained 277 *tambak* farmers in LEISA[3]. Sixteen sessions of the Coastal-Aquaculture Field School (CAFS) cost about 1000 USD per farmer. Farmers were trained, among others, to manage pond bottom and water by using a cheap liquid compost (MOL).

LEISA was adopted by 85% of the alumni. Compared to the baseline, the LEISA adopters **tripled** their shrimp yields (Figure 3). Within a sample of 17 alumni, the yields of the adopters for milkfish and shrimp became 3 and 5 times higher, respectively.

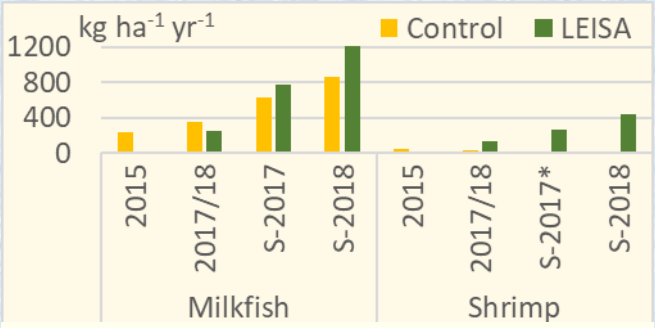


Figure 3: The yields of milkfish and shrimp of the non-LEISA farmers and LEISA adopters among all trained (2017/18) and the sample (S-2017 and S-2018), both compared to the baseline collected in 2015[4]. *Only one among non-LEISA stocked shrimp.

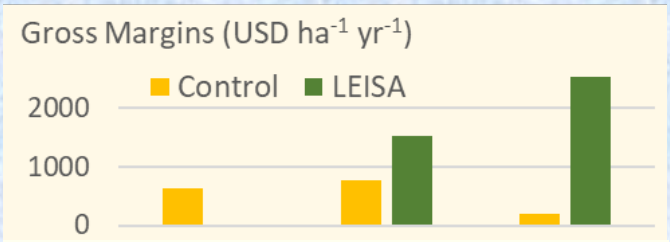


Figure 4: Operational cost, revenue and gross margins of the non-LEISA farmers and LEISA adopters in 2017 and 2018 of a sample of the farmers trained in 2016[4].

In the 2nd year, yields and margins of the sample's adopters improved further, indicating that the feedback sessions by the team were effective. A follow-up of the CFS in e.g. Alumni Innovation Platforms (AIPs) might reach the same effect.

The gross margin of the adopters within the sample increased with over 1,400 USD ha^{-1} yr^{-1} (Figure 4). For the mentioned 85% adopters, the estimated increase is close to 600 USD ha^{-1}. On average these farmers have 1.9 ha of ponds and thus the gross margin of their farms increased with more than 1,100 USD yr^{-1}. Thus, the field-school's rate-of-return was about 1.1 for the 277 alumni, and 3.6 for the sample. **These numbers indicate a pay-back-time of less than one year!**

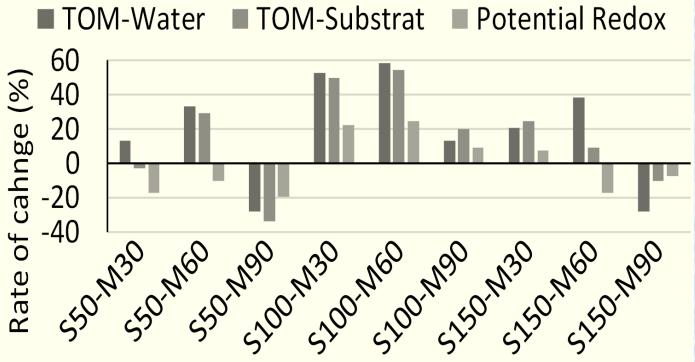
Integrated shrimp aquaculture: IMTA

The low yields of shrimp and milkfish from ponds are mainly due to bad practices. Monoculture and excessive use of feed and chemicals destroy the pond soil and creates unbalances in the water, which favor diseases and low yields in shrimp.

PASMI's cascade of studies in tanks and ponds, showed that:

1. Combining 100 gr m^{-2} seaweed (*Gracilaria verucosa*) with 60-90 gr m^{-2} green mussel (*Perna viridis*) improves water quality (see Figure at the right) and shrimp performance.
2. Tilapia reduces *Vibrio* bacteria, a disease agent for shrimp, by about 45%, slightly more than does milkfish.
3. Growth rate of shrimp in combination with tilapia is higher than without: 7.4% and 5.6%, respectively.

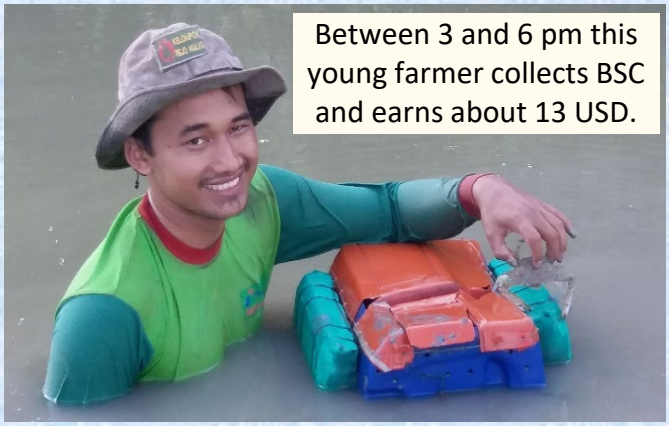
Pilot farmers using only seaweed next to shrimp and milkfish enhances shrimp growth and farmer's income significantly. Results from Thailand confirm the positive results of combining seaweed and tilapia. While using less of the ponds for shrimp, the output stabilized at a higher level and cost less.



Changes in Total Organic Matter in water and soil, and in substrate's redox potential due to nine combinations of seaweed (S) and green mussels (M).

Grow-out of Blue Swimming Crab

Blue swimming crab (BSC) delivers good incomes because of its high export value. There is overfishing with small mesh sizes that catch even the juveniles which have little value (<1,000 rupiah per piece). Producing juveniles in hatcheries is neither efficient nor effective as the survival rates are very low due to cannibalism.



Between 3 and 6 pm this young farmer collects BSC and earns about 13 USD.

Studies in tanks, nets and ponds with BSC juveniles showed that:

1. Densities higher than 2 per m^2 threaten the benefits due to cannibalism during molting;
2. Feeding moderate amounts of large-sized shrimp or crab pellets is more efficient than feeding small shrimp, mussels, or fish processing waste;
3. During the dry season, the grow-out of juveniles is successful in ponds with sandy or muddy soils in which crab can hide while molting. In 12-16 weeks during the dry season the BSC can grow from less than 20gr to more than 80gr, at low cost. This size fetches the prime market price.

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Next Steps for Feeding Shrimp in IMTA

The nutritious pond project[7] of WUR and WorldFish showed that in ponds without lining:

- ✓ The primary production in ponds improves by feeds with more carbohydrate (C) and less protein (N). Feed protein content gets below 25% but the C:N balance improves.
- ✓ When the balance between C and N is better, fish and shrimp consume more natural feed with healthy N components.
- ✓ The cost for feed and others decreased while farmer's benefits improved, also because the fish and shrimp suffered less from diseases.

Liquid compost (MOL) from waste.

A study by the PASMI team showed that liquid compost (MOL) made from wasted vegetables has more positive effect on shrimp growth, than that of fruit, or their mixture. Adding 0.125 g L^{-1} leaves of *Avicennia marina* had a positive effect. Other local mangrove species have negative effects.

Building with Nature Indonesia (BwNI) is a program by Ecoshape, Wetlands International and the Indonesian Ministries of Marine Affairs & Fisheries (KKP) and Public Works and Housing (PU). PASMI was funded by the Dutch Science Foundation (NWO), Ecoshape and Wetlands International.

Intensive Monitoring turned out to be an Aquaculture Innovation Platform: Farmers' yields and margins continued to increase.

Main references:

1/ Braun & Duveskog, 2008. IFAD, Rome.
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4/ Bosma et al, 2020. Aquacul. Econ. & Management.
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This brief was produced by PASMI for Indonesian policymakers, and extension agents.