# SUSTAINABLE AQUACULTURE MANAGEMENT FOR SUSTAINABLE ECOSYSTEM

*Can we really make it happen?*

*Tiger prawns, sized 22 pieces/kilogram, were cultivated for 2.5 months.*

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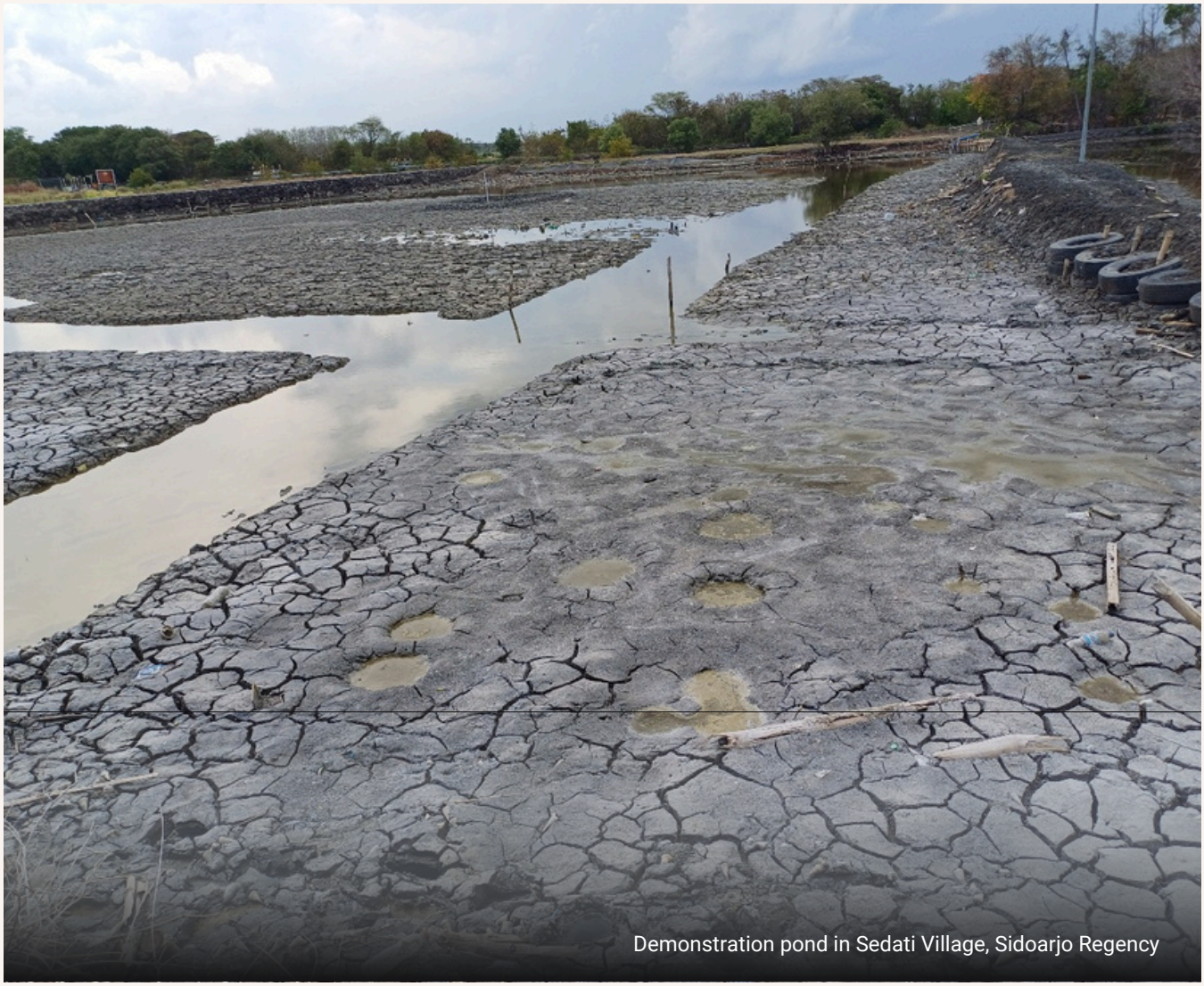


Demonstration pond in Sedati Village, Sidoarjo Regency

**Restoring tides, Reviving livelihoods**

Sidoarjo, a coastal city located in East Java Province, Indonesia, is known for its high-value milkfish (ikan bandeng) and tiger shrimp (udang windu), both regional specialties with geographical indication status. However, declining brackish water quality caused by sedimentation, blocked tidal flows, and upstream factors like land subsidence and the mud volcano has led to reduced aquaculture productivity. In response, a 2022 scoping study by EcoShape explored the potential of applying Building with Nature (BwN) approaches to address the challenges. The study resulted in several recommendations: wetland restoration, mangrove replanting, and improved tidal flows, alongside better pond design, polyculture, and fish farmer field schools approach.

To follow up on these recommendations, the Sidoarjo Fish Farmers Field School (FFFS) was initiated as a first step in improving aquaculture sustainability in the region. The program equips fish farmers with the knowledge and skills to improve pond soil and water management based on Low External Input Sustainable Agriculture (LEISA). Through a structured, learner-centered, and participatory learning approaches, it promotes sustainable practices, strengthens farmers understanding of ecological factors, and builds their capacity for informed decision-making and innovation. In turn, it encourages behavioral change and supports collective efforts to enhance aquaculture in Sidoarjo.

Fish farmers control algae to be utilized as raw material for composting to increase nutrients in fishponds

Since the 1980s, Indonesia's coastal ecosystems have been slowly but surely heading into crisis. This includes the fishpond areas in Sidoarjo, East Java, which today face a harsh reality: drastically declining productivity, rising operational costs, increasing risk of crop failure, water flow into the pond is blocked due to sedimentation and unstable market prices. The mangrove vegetation that once served as a natural barrier against abrasion and waves has been severely degraded, coupled with the continuous use of chemical pesticides that have further disrupted the ecological balance of the ponds.

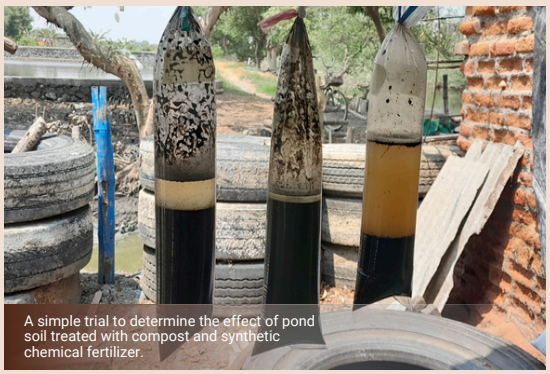
For decades, this region was known as one of East Java's key aquaculture centers. But what's happening in Sidoarjo is, in fact, a reflection of the broader condition across Indonesia's coastal zones. Intensive aquaculture practices that sacrificed mangroves for short-term gains have backfired. Pond soil has hardened, microorganisms have vanished, natural food chains are disrupted, nutrient cycles are broken, and tidal flooding (rob) occurs more frequently each year.

**This is where the big question arises: Is it really possible to manage productive fishponds without destroying mangroves?**

## Fish Farmers Field School Approach

The Fish Farmer Field School, seeking common ground. Hope emerged through the initiative of the Fish Farmer Field School, developed in Banjar Kemuning and Kedung Peluk Villages, Sidoarjo Regency.

The FFFS approach is a series of interconnected activities, starting from identifying participants and selecting the learning demonstration sites, to facilitator training, and curriculum materials tailored to local challenges and participants' needs. Following this, a Training of Trainers (ToT) is conducted in the Fish Farmer Field School involving five representatives from each village, extensionists, DKP, ATINA, and KOIN. The ToT is essentially a process to prepare prospective facilitators to accompany fish farmers in collective learning in the field. The main principle is not merely delivering material, but facilitating a participatory learning process where participants can discover knowledge through experience, experimentation, and discussion.



A simple trial to determine the effect of pond soil treated with compost and synthetic chemical fertilizer.

Field school participants learn together about pond soil ecology

There are three key pillars in the FFFS ToT, which also form the core spirit of the FFFS:

1. Learning by doing facilitators engage participants in hands-on practice, not just listening to theory.
2. Participatory & contextual the materials are always linked to local experiences, real problems, and the existing potential in the village.
3. Reflection & action every session concludes with a joint reflection: what was learned today and how it can be applied in daily life.

Regular meetings Sidoarjo field school

Facilitators trained in the ToT are also instilled with attitudes such as patience in listening, the ability to ask key questions, openness to local knowledge, and creativity in designing activities and games to keep the learning atmosphere alive. With these principles, FFFS does not merely transfer knowledge but fosters critical awareness and participants' self-confidence.

FFFS is designed over 16 regular sessions, equivalent to one aquaculture cycle, with a frequency of one meeting per week. Each session follows a consistent structure: opening with agroecosystem analysis, followed by a specific topic, presentations, reflection, and closing. This consistent flow helps participants become familiar with the rhythm of learning, while observations can be compared and analyzed over time.


Regular meetings Sidoarjo field school

The topics are arranged sequentially, from the most basic to more advanced applications:

1. Introduction to the Organic Pond Program
2. Understanding and Mapping the Village Ecosystem
3. Trend Analysis
4. Site Selection and Pond Preparation
5. Soil Ecology
6. Making Local Microorganisms (MOL) and Compost Fertilizer
7. Seed Management
8. Seed Nursery (Penggelondongan)
9. Water Quality Management and Measurement
10. Identification of Pests and Diseases in Black Tiger Shrimp
11. Mangrove–Pond Integration
12. Natural Feed
13. Financial Management in Aquaculture Enterprises
14. Tidal Flood Adaptation in Relation to Ponds
15. Harvest and Post-Harvest
16. Final Reflection and Follow-up Action Plan

Through the 16-session format, participants not only learn technical aspects of aquaculture and management but also develop habits of recording, observing, collaborating, and making collective decisions. The ultimate goal is not merely increased knowledge, but the emergence of farmer analysts who are able to manage ponds more wisely, productively, and sustainably.

The Field Day in FFFS is the culmination of field learning, where fish farmers take center stage to present their observations, experiments, and discussions to fellow farmers, the community, government, academia, and development partners. This moment affirms the capacity of farmers as analysts and pond managers, while also serving as a multi-stakeholder platform to directly observe pond conditions, listen to farmers' voices, and witness locally driven innovations.

This, Field Day is not only a space for sharing experiences, but also a medium for building equal dialogue and strengthening partnerships towards more sustainable pond management.

This FFFS has become a collective learning space for fish farmers to explore more environmentally friendly and ecosystem-based aquaculture approaches.

**The main principle applied in this FFFS is Low External Input Sustainable Agriculture (LEISA).**

The approach is simple, yet has a significant impact. It involves the use of local microorganisms (MOL), compost made from agricultural waste and mangrove leaves, as well as natural feed sourced from around the pond. All of this is designed to be easily adopted and replicated by other fish farmers. Fish farmers are encouraged to rediscover that soil is not just something to stand on, but a living medium whose fertility must be maintained. Soil is not merely the pond's base it is the “engine of the ecosystem,” quietly working to filter, store, and supply nutrients so that life within the pond can thrive in a healthy and sustainable way.

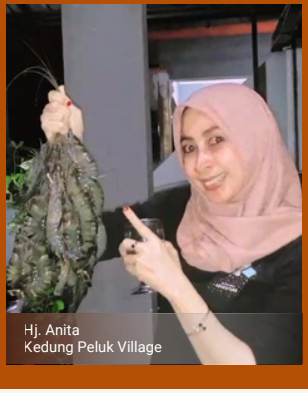
# Mangroves Return, Hope Restored

It’s not just the fishponds that are improving, awareness of the importance of mangroves is also growing. Together with the local government, fish farmers have agreed to support mangrove rehabilitation along the sides of the demonstration ponds, aiming to restore their ecological function as protectors of the ponds and vital sources of life

Mangroves are not merely coastal forests, but the natural foundation that determines the sustainability and productivity of aquaculture ponds. Mangroves support pond water quality by filtering pollutants, while mangrove litter provides organic nutrients that maintain water fertility. Their roots help retain sediments, reduce water turbidity, and improve the environmental quality essential for the health of shrimp, milkfish, and crabs. Mangroves also serve as a green belt that protects ponds from abrasion, strong waves, and seawater intrusion. With mangroves surrounding aquaculture ponds, the risks of physical damage and production failures caused by tidal floods and storms can be significantly reduced. This means that mangroves are not only guardians of the ecosystem, but also a form of “natural insurance” for fish farmers.

Mr. Suriyanto
Segoro Tambak Village

I’ve been working in fishponds since 1981, but it’s only this year that I’ve truly realized the importance of mangroves. Back then, the coastline was still lush the mangroves even stretched out into the sea. Now they are gone, and that loss has affected our pond yields too.”



Hj. Anita
Kedung Peluk Village

All this time, I only knew of two types of mangroves and can produce mol and compost for pond

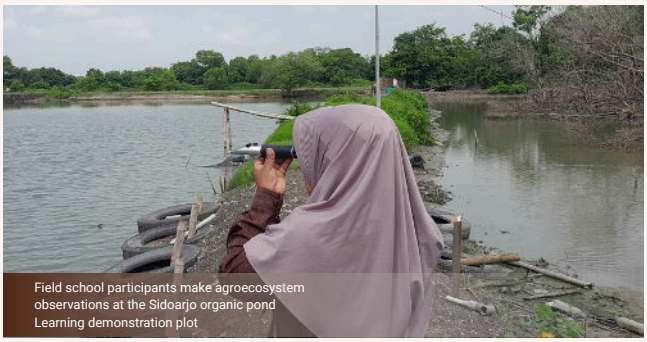
Hj. Anita and Mr. Suriyanto have now even become agents in the village, teaching other farmers in Sidoarjo how to make local microorganisms (MOL) from rice washing water and rotten fruit.

# LEARNING FROM NATURE AND OUR OWN PONDS

Through hands-on practice at the demonstration ponds, FFFS participants not only learn aquaculture techniques, but also gain a renewed understanding of the vital role mangrove ecosystems play from providing nutrients and regulating pond salinity, to supporting the growth of natural plankton and serving as protection against tidal flooding and coastal erosion.

Fish farmers are introduced to the use of simple tools to monitor water quality: pH, salinity, dissolved oxygen, and soil color. They are also trained to regularly monitor shrimp growth, including measuring length, weight, and overall health condition.

In FFFS, farmers also gained a better understanding that sedimentation at the estuary affects the tides and impacts water exchange in the ponds. This is exacerbated when rainfall coincides with the highest tides, which affects the productivity of shrimp and milkfish.



Field school participants make agroecosystem observations at the Sidoarjo organic pond Learning demonstration plot

Routine monitoring is conducted to determine the growth rate of tiger shrimp.

Field school participants displaying harvested shrimps at the Sidoarjo organic pond learning demonstration plot.

## ASTONISHING RESULTS FROM A SINGLE CYCLE

The fish farmer field school ran for 16 sessions, covering one full shrimp cultivation cycle.
The results were highly promising: the shrimp grew faster, showed greater resistance to disease, water quality improved, and production costs dropped due to the elimination of chemical fertilizers and antibiotics. Even harvest yields increased, with healthier shrimp quality.

Beyond highlighting the successes, it is also important to remain realistic. Not everything went smoothly. Farmers continue to face persistent system pressures such as floods, which make aquaculture highly challenging by causing production losses and frequent disease outbreaks. The FFFS on its own cannot fully resolve the issue of declining productivity. It would be more effective if this approach is complemented with additional strategies that can strengthen the resilience and sustainability of farming practices under such uncertain conditions.

At the end of the program, farmers were guided to analyze their production costs by comparing the conventional system with the organic system. The outcome, cultivation using local microorganisms (MOL) and compost proved to offer significantly greater economic benefits.

# Fishpond Financial Management

Managing organic ponds is not just a matter of how we spread seeds and feed the fish, but also how we understand whether or not our business is viable.

At FFFS, pond business analysis helps farmers not only rely on experience and old habits, but also think critically and based on data. With analysis, participants can compare conventional and organic farming methods, calculate the difference in input costs, and assess the long-term benefits, which are often greater because organic ponds reduce dependence on chemical fertilizers and pesticides.

**ANALYSIS OF POND CULTURE (Before SL) 6 months**

**Cultivation Type: Windu-Bandeng (polyculture)**

| | |
|---|---|
| **Date** | 18 Jul 2025 |
| **Name of Farmer / Age / Phone** | H. Sugianto / Sudarmo / 0812-3117-0227 |
| **Address** | Kedungpeluk Village-Candi-Sidoarjo |
| **Land Area** | 2.4 Hectares (Owned) |

**Labor**

| Activity | Who Performs | Time | Day |
|---|---|---|---|
| Land Processing | 4 people x 7 days | 07.00 - 11.30 | 28 |
| Fertilization | 1 person x 7 days | 07.00 - 11.30 | 7 |
| Pesticide application | 1 person x 2 days | 07.00 - 11.30 | 2 |
| Algae Processing | 2 people x 7 days | 07.00 - 11.30 | 14 |
| Water Management | 1 person | 07.00 - 00.00 | 15 |
| Harvesting | 5 people x 1 day | 18.00 - 12.00 | 5 |
| Produce Processing | - | - | - |
| Sales | - | 3 hours | 1 |
| Transportation | - | idem | - |
| Total | | | 72 |

**Probiotics & Chemical fertilizers**

| Fertilizer Type/Brand | Type | Quantity (/ha) | Price (Rp/ha) |
|---|---|---|---|
| EM4 | Liquid | 6 Bottles / Ha | 432.000 |
| Urea | Solid | 1 Zak/ Ha | 1.080.000 |
| SP 26 | Solid | 2 Zak/Ha | 912.000 |
| Total | | | 2.424.000 |

**Pesticides**

| Pesticide Type/Brand | Type | Amount (kg/ha) | Price (Rp/ha) |
|---|---|---|---|
| Saponin | Solid | 25 Kg | 250.000 |
| Potassium | Solid | 1 Ons/ha | 50.000 |
| | | | |
| Total | | | 300.000 |

**Feed**

| Type of Feed/Mrek | Type | Amount (kg/ha) | Price (Rp/ha) |
|---|---|---|---|
| - | | | |
| - | | | |
| Total | | | |

**Equipment**

| Type of Equipment | Status (owned/rented) | Quantity (unit) | Price (Rp/ha) |
|---|---|---|---|
| Bendo, pacul, rake, saw | owned | 1 set | 300.000 |
| Plastic drum | owned | 1 | 160.000 |
| Timba | owned | 1 | 25.000 |
| Total | | | 485.000 |

**Other**

| Cost Item | Status (owned/rented) | Amount (liters) | Price (Rp/ha) |
|---|---|---|---|
| Solar fuel | buy | 50 | 425.000 |
| | | | |
| Total | | | 425.000 |

**Seed**

| Seed Type | @price/seed | |
|---|---|---|
| Windu Shrimp (20 rean) | 180000 | 3800000 |
| Milkfish (1Rean) | 3000000 | 3000000 |
| **Total** | | 6800000 |

**Labor**

| | |
|---|---|
| Total working days (days/ha) | 72 |
| Cost (Rp/day) | 100.000 |
| Total labor cost | 7.200.000 |

**Operational Costs (Rp/ha)**

| | |
|---|---|
| Seed | 6.800.000 |
| Fertilizer | 2.424.000 |
| Pesticides | 300.000 |
| Feed | - |
| Equipment | 485.000 |
| Other | 425.000 |
| Total Operation | 10.434.000 |

| **Selling Price (Rp/kg)** | **Windu & milkfish** |
|---|---|
| Min Windu Price | 75.000 |
| Max Windu Price | 110.000 |
| Average Price | 92.500 |
| Min Milkfish Price | 12.000 |
| Max Price of milkfish | 17.000 |
| Average Price | 14.500 |

**Revenue**

| | |
|---|---|
| Average Price (Rp/kg) | 92.500 |
| Yield (kg) | 50 |
| Windu Income (Rp/ha) | 4.625.000 |
| Average Price (Rp/kg) | 18.000 |
| Yield (kg) | 600 |
| Milkfish Income (Rp/ha) | 10.800.000 |
| Gross Income | 15.425.000 |

**Net Income (Rp)**

| | |
|---|---|
| **Total Income (Gross)** | **Rp15.425.000,00** |
| **Labor** | **Rp7.200.000,00** |
| **Cost / Operational** | **Rp10.434.000,00** |
| **Revenue (Net)** | **-Rp2.209.000,00** |

Managing fishpond finances plays a key role in maintaining sustainability and improving the operational efficiency of fish farmers.

**Before CFS**

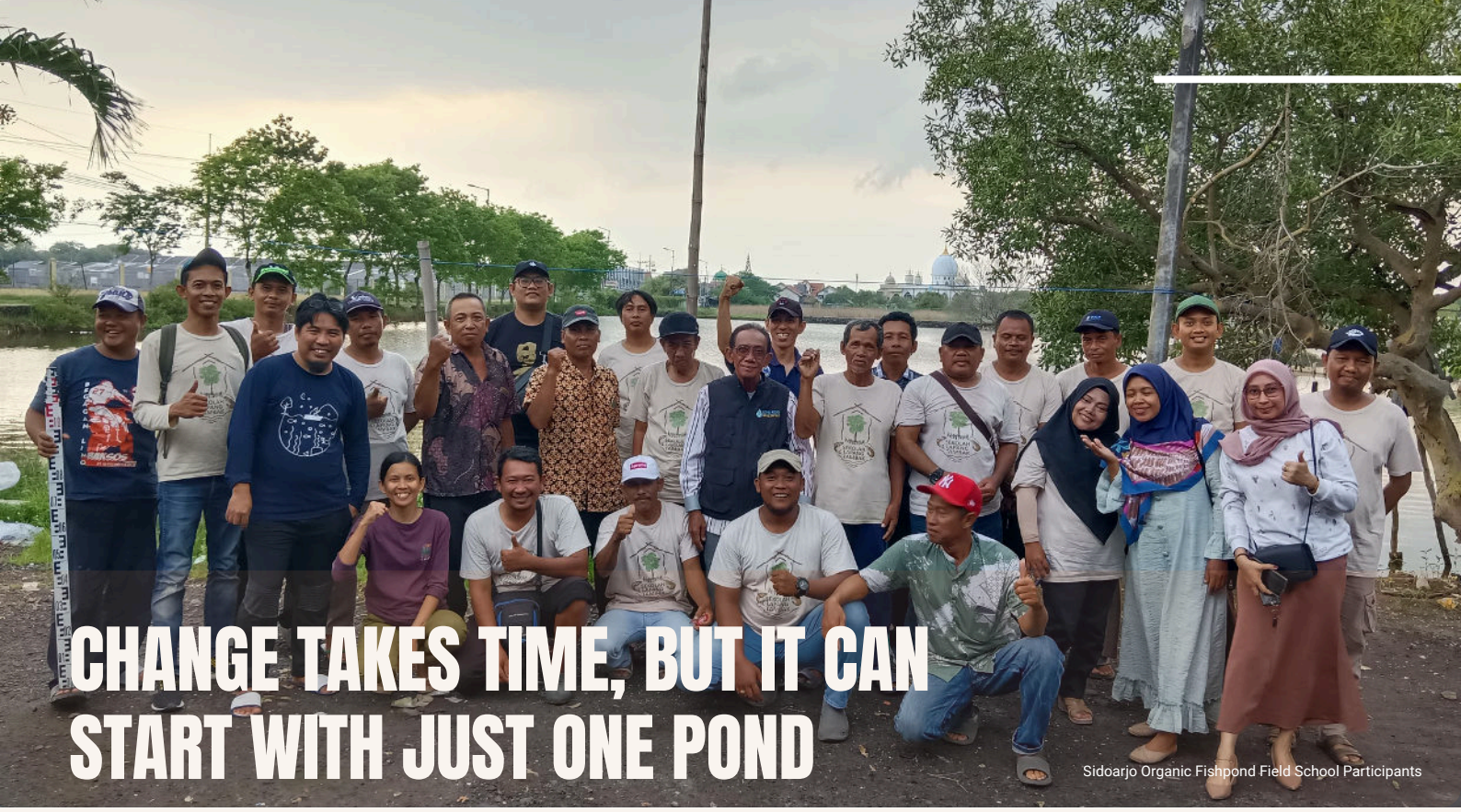
| Source of Income | Income Value | Cultivation Period (month) | Net Income/month |
|---|---|---|---|
| Cultivation | - 2.209.000 | 6 | - 368.167 |
| Daily (Posongan) | 400.000 | 6 | 66.667 |
| | *Total Income per 1 Month* | | **- 301.500** |

**After CFS**

| Source of Income | Income Value | Cultivation Period (month) | Net Income/month |
|---|---|---|---|
| Cultivation | 5.567.500 | 4 | 1.391.875 |
| Daily (Posongan) | 750.000 | 4 | 187.500 |
| | *Total Income per 1 Month* | | **1.579.375** |

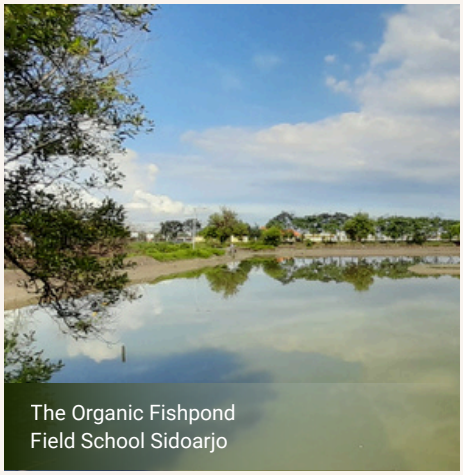
Furthermore, business analysis makes farmers more confident in making decisions: whether to expand their farms, add new commodities, or improve feed management and water quality. The results of the analysis can also be used as a basis when farmers deal with external parties, such as cooperatives, buyers, or financial institutions, because they can show clear and transparent business calculations.

Organic pond business analysis is not just an exercise in numbers, but a tool for planning a healthier, more sustainable, and profitable future for the business. Through this activity, we learn to see ponds not only as places of cultivation, but also as business systems that must be managed wisely.



# CHANGE TAKES TIME, BUT IT CAN START WITH JUST ONE POND

Sidoarjo Organic Fishpond Field School Participants



The Organic Fishpond Field School Sidoarjo

The Fish Farmer Field School has demonstrated that sustainable and productive aquaculture without harming mangroves is not only possible, but already a reality.

Of course, change doesn't come without challenges. Some farmers still have doubts, feeling that the organic system is too slow. Changing long-standing habits is never easy especially when the use of chemicals is seen as a "shortcut."

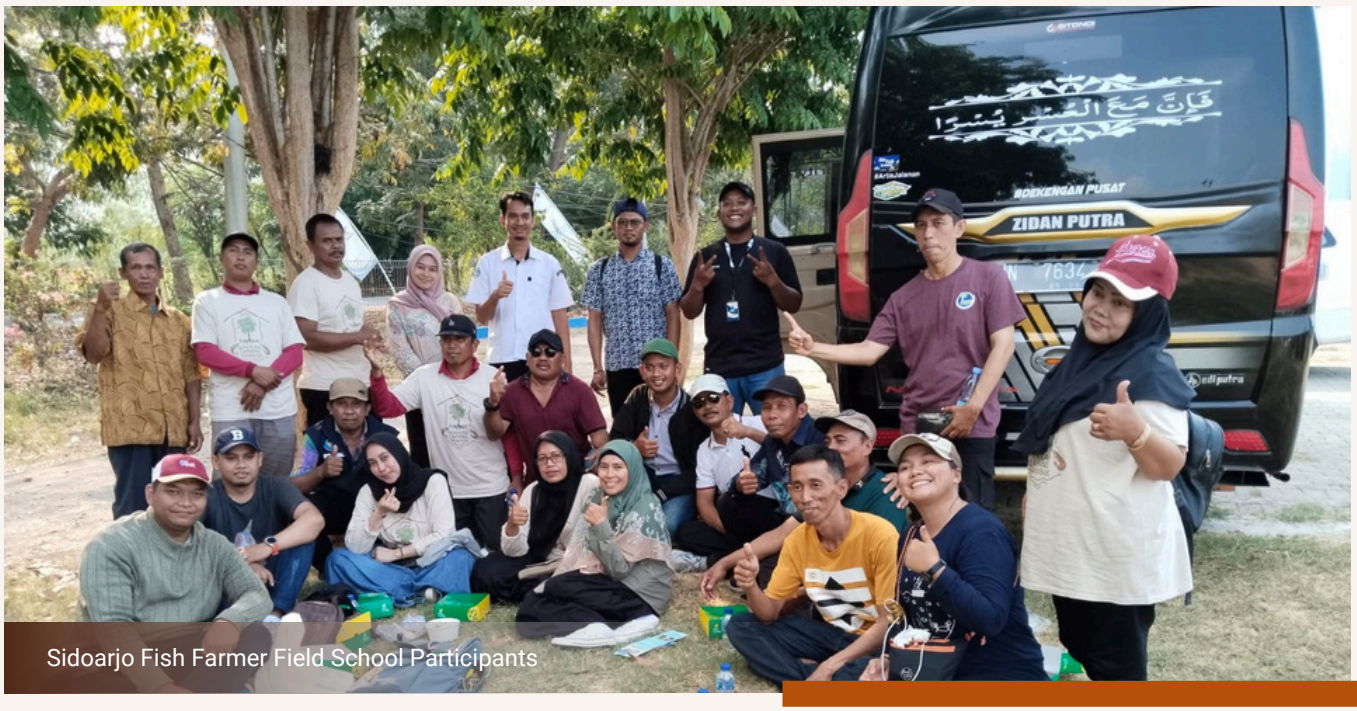
The Field School in Sidoarjo has become a crucial space for fish farmers to strengthen their adaptive capacity in facing increasing environmental pressures such as tidal flooding (rob) and the more frequent occurrence of white spot disease.

However, technical adaptive capacity alone is not sufficient. Adaptation also requires resources, policies, and integrated systemic support.

A systemic approach is key to linking individual capacities with institutional dynamics and policies that can address cross-scale challenges. The collaborative efforts facilitated by Regional Development Planning Agency (BAPPEDA) Sidoarjo together with the Fisheries Office, East Java Water Resources Agency (PUSDA), Brackish Water Aquaculture Development Center Jepara, and private sector partners such as PT. Atina serve as an early example of cross-sectoral work that brings solutions closer to the real needs of fish farmers. Driven by a system thinking mindset, this process goes beyond program design, it builds shared awareness through dialogue, reflection, and collaborative action. The path to sustainable aquaculture is not only about increasing production it is about building a socio-ecological-economic ecosystem that reinforces itself. That is where true growth begins

Sidoarjo Pond Field School Meeting

Field trip to Situbondo

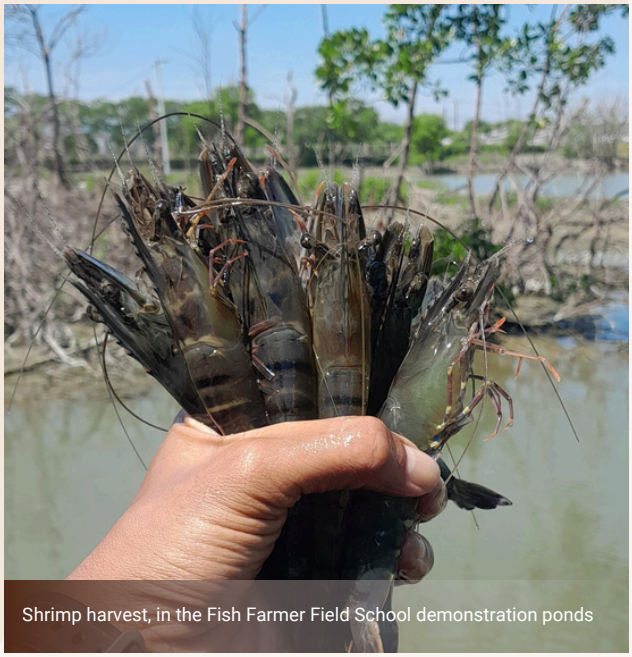


Sidoarjo Fish Farmer Field School Participants

The implementation of the Fish Farmer Field School has provided valuable lessons for participants, facilitators, and local stakeholders alike. Its participatory approach, hands-on field practice, and context specific learning materials have proven effective in enhancing community knowledge and skills for more sustainable pond resource management.

However, several challenges remain. These include the diverse backgrounds of participants, inconsistent attendance due to daily economic pressures, and the lack of local policy support for sustainable pond management.
A single cultivation cycle has proven insufficient to deepen understanding and promote lasting adoption of improved practices. Therefore, sustained learning efforts must be encouraged through repetition and integration into village development agendas.

Going forward, strengthening the capacity of local facilitators, fostering cross-sectoral support, and institutionalizing the outcomes of the field school into village policies and programs will be key to scaling up impact and ensuring the sustainability of environmentally friendly pond management efforts.


Shrimp harvest, in the Fish Farmer Field School demonstration ponds

**The origin of funding:**




**The implementing partner:**


**The supporting organisations:**