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## Fish: A vital ingredient for development in Bangladesh

### Executive summary

Funded by the United States Agency for International Development (USAID), the five-year Aquaculture for Income and Nutrition (AIN) project improved income and nutrition for thousands of Bangladeshis.

Initiatives undertaken by  
AIN reached almost

**1 million households**

Fish is the most important animal sourced food in Bangladesh. AIN research in 2015 indicated that 60% of rural poor eat fish every other day. However, in a country where undernutrition and poverty are major concerns, the average consumption of fish at 44 g a day is low enough to warrant attention. Fish is a powerful source of the micronutrients that are critical to the first 1000 days of life.

AIN aimed to increase aquaculture productivity by developing hatcheries and nurseries, disseminating improved fish and shrimp seed, enhancing farm management skills of smallholder farmers, promoting new technologies to expand commercial aquaculture, developing backward and forward market linkages, supporting policy reform and building capacity of the public and private sectors resulting in increased farmers' productivity and revenue. Increased productivity at the household level was anticipated to result in more food for consumption and more produce for sale. This would contribute to further adoption of these improved technologies and

management practices, and would result in an overall increase in rural households' income, thereby sustainably reducing poverty.

**130,000 farmers**  
received training  
from the AIN project

### AIN had four components:

1. Fish and shrimp seed: Increasing availability of high quality fish and shrimp seed.
2. Household aquaculture: Improving the nutrition and income status of farming households.
3. Commercial aquaculture: Increasing investment, employment and fish production through commercial aquaculture.
4. Institution and policy: Supporting policy and regulatory reform and institutional capacity building for sustainable aquaculture growth.

Between 1 October 2012 and 31 December 2016, AIN was implemented in 20 districts in Barisal, Dhaka and Khulna, focusing on poor communities and particularly women. More than 130,000 farmers, including small- and commercial-scale fish and shrimp farmers, received training on topics including aquaculture technology, nutrition and gender empowerment. Novel information and communications technologies were used during the project, such as a shrimp traceability program, a digital "yellow pages" of suppliers, and a "mobile



Freshly harvested tilapia.

money” program enabling farmers to pay suppliers using mobile phones.

A key focus of AIN was the supply of quality seed. Over a billion healthy shrimp postlarvae were distributed to farmers from 2012 to 2015, resulting in production increasing by an average of 26% (from 230 kg/ha in 2012 to 290 kg/ha in 2015).

AIN also worked on increasing the availability and access to quality feed at both the farm and national level. The project helped improve the institutional capacity of the Department of Fisheries (DoF) to implement the Quality Feed Act and enforce its regulation.

**Over 1 billion**  
healthy shrimp postlarvae  
were distributed

The genetic improvement program of rohu (*Labeo rohita*), a carp species that contributes 30% to national farmed fish production, developed a first-generation improved stock. The selective breeding program, which will continue until 2020 as a collaborative program between WorldFish and the DoF, may result in a 30% or more increase in growth rate, when the fish population reaches its third generation.

Hatcheries supported by AIN also distributed 4.12 million genetically improved farmed tilapia (GIFT) broodstock during the project period.

In rural Bangladesh, many fish farmers have limited access to information about aquaculture. To address this, AIN trained 1275 existing fish feed and seed suppliers to become private sector trainers and facilitators. Trained individuals provided advice and training to local fish farmers, in addition to their existing business services.

Mola (*Amblypharyngodon mola*) is a type of small fish that can be eaten whole and has been shown to have great potential in the reduction of micronutrient deficiencies. Traditionally caught in the wild, AIN promoted farm rearing of the species and distributed around 4700 kg of broodstock to over 9100 household farmers. In turn, household farmers developed and distributed a further 5600 kg of broodstock to an additional 37,500 farmers. Demand for mola increased and it became abundant in the local markets.

Increased fish consumption was a major objective of AIN. This was achieved not only by increasing the availability of fish in homesteads and in local markets, but also by increasing farmer awareness of the nutritional benefits of small-fish consumption and by assisting household members to harvest fish from their household ponds, particularly for home consumption.

**4 million**  
improved tilapia broodstock distributed



Rohu collected as part of the carp genetic improvement program.

Photo credit: Mohammed Wahabuddin Rahim in WorldFish

## Quality shrimp seed key to consistent production

In Bangladesh, the export of black tiger shrimp (*Penaeus monodon*) is the third-largest source of export earnings after garments and leather. About 90% of the 200,000 ha used for shrimp culture in the coastal zone is farmed using extensive traditional practices by smallholders who produce an average of less than 300 kg/ha of shrimp, which is very low compared to global averages.

To increase production in traditional small-scale shrimp farming systems, the AIN project provided technical assistance and training to around 50,000 small-scale shrimp farmers in Bangladesh.

A 2016 performance survey by the project found that the training helped increase shrimp production from 230 kg/ha in 2012 to 280 kg/ha in 2016. This resulted in an overall production increase of around 1700 metric tons of shrimp in 2016. Shrimp farmers, who traditionally produce shrimp alongside several species of fish, also increased their fish production from 245 kg/ha in 2012 to 553 kg/ha in 2016—equating to an average additional production of 11,622 metric tons in 2016.

Together, these production increases helped farmers to boost their income by 76% or USD 886 per hectare of ponds.

As part of the training, farmers learned the importance of using healthy and quality shrimp seed to reduce the risks of disease, especially White Spot Syndrome Disease (WSSD), which can kill a farmer's entire shrimp stock within days. Many farmers use wild caught broodstock, of which 40%–50% are naturally infected with the virus according to the project's observations,

making their farms—and neighboring farms—vulnerable to the risk of disease.

To make quality virus-free seed available to farmers, the AIN project assisted 24 shrimp hatcheries to produce WSSV-free postlarvae by testing them using the polymerase chain reaction (PCR) test.

This process enabled project-supported farmers to access over 1 billion WSSV-free shrimp postlarvae in 2012–2015. Over the four production seasons, use of WSSV-free seed led to an average production increase of 26% per year for 17,000 shrimp farmers—accounting for an estimated overall increase of 3160 metric tons, valued at USD 39.75 million.

Research by WorldFish, with support from AIN data from about 1000 ponds, found that small-scale farmers that stocked PCR-tested seed had

- a shrimp survival rate of 27% compared to 15% in ponds with non-tested seed;
- less disease at 29% compared to 48% with non-tested seed;
- 48% higher production and 81% higher profit per hectare compared with non-tested seed.

In 2014, the project worked with the DoF and the private sector to introduce a second type of seed: specific pathogen free (SPF) shrimp seed (domesticated black tiger shrimp tested regularly for eight specific viruses and two bacteria). The seed were shipped from a facility in Hawaii, US, to Bangladesh and raised in a hatchery licensed for SPF shrimp for about a year.



Photo credit: AWW, Anusuzama/WorldFish

Shrimp ready for sale at an auction center.

In 2016, the hatchery produced 150 million seed. Initial observations of an experiment comparing the results of 450 small-scale farmers that stocked seed produced from SPF shrimp with 150 control farmers are positive.

Some farmers claimed that use of SPF postlarvae, originating from SPF broodstock, performed better in ponds with about 40% improvement in growth rate. The number of PCR-tested postlarvae and postlarvae produced from SPF broodstock is still low relative to overall demand.

It is anticipated that in the coming years more farmers will gain access to PCR-tested seed and know how to use and benefit from it helping to further reduce disease risks and boost overall shrimp production in Bangladesh.



Freshly harvested shrimp from a gher.

## Improved strain of rohu to boost future carp production

Carp represent about 60% of the 1.85 million metric tons of fish per year produced through aquaculture in Bangladesh. Key to this sizeable production, which is mostly for domestic consumption, is the availability of seed. About 900 carp hatcheries in Bangladesh produce an estimated 500 metric tons of carp spawn every year. However, many of these hatcheries have a poor record for broodstock management. Without good management protocols, many hatcheries experience reduced performance of seed due to inbreeding and deterioration of genetic quality.

Instead of applying science-based protocols, hatcheries often try to reduce inbreeding by mixing their broodstock with fish raised from wild caught seed. However, this is not good practice and it does not provide significantly better results.

In order to combat this, in 2014 the AIN project started a genetic selection program for rohu, a type of carp that accounts for 30% of production. The initial focus of the rohu genetic improvement program (RGIP) is to improve growth performance, thereby increasing the profitability of carp aquaculture and the overall volume and value of total production.

Selective breeding is common in other species like poultry and livestock. For example, modern chicken breeds grow much faster than their wild ancestors. However, this type of genetic improvement has only been carried out so far in a few fish species, including salmon and tilapia. Developing an improved breed of rohu through selective breeding will require a minimum of three generations, at least six years.

To form the base population, the project collected wild fry from three rivers in Bangladesh and raised them separately in ponds. They were individually tagged using the passive integrated transponder (PIT) system, allowing WorldFish scientists to identify individual fish using a scanner and accurately perform single pair mating. Once the tagged fish reached spawning size, they were bred using the single pair mating method and the base population was produced.

From this base population, 210 families were selected and bred again in December 2016. The offspring, also known as the first filial generation (F1), were individually tagged in February 2017 and will be raised in ponds to produce the F2 generation.

It is estimated that each successive generation will have at least 10% improved growth performance, thus the F3 generation should have an improved growth performance of about 30%. The rohu carp breeding program will continue beyond the AIN project, under a joint program between WorldFish and the DoF. It is expected that the F3 generation of improved rohu stock will be available for mass reproduction and distribution after 2022.

The DoF, with support from AIN, had been working with hatcheries to implement the Hatchery Act (2010) and Rules (2011), which requires them to document the source of broodstock, thereby supporting the effective introduction of improved genetically selected stock. The project supported this by individually tagging broodfish to identify the source of broodstock.



Rohu broodstock from the carp genetic improvement program.

In parallel, and to encourage better traceability of fish seed, the project has established four quality seed groups (QSG) that consist of nurseries committed to jointly sourcing spawn from selected hatcheries. The nurseries will only sell to seed traders who are members of the group, which assures traceability.

In 2017, building on the work to produce an improved rohu strain, WorldFish started similar selection processes for production of base populations of two other popular carp species: catla and silver carp. These will further boost aquaculture production of carp in Bangladesh, an important source of food, income and nutrition for many rural households.



Photo credit: A. W. M. Islam / WorldFish

Staff working at a site of the carp genetic improvement program.



## Leveraging tilapia's potential

Tilapia has become increasingly popular in Bangladesh because it is cheap, tasty, nutritious and less bony than other species. It is a freshwater fish that can tolerate brackish water in coastal areas and can be grown under both extensive and intensive conditions by subsistence or commercial fish farmers.

More than 400 tilapia hatcheries produce over 4 billion mono-sex tilapia fry in Bangladesh every year. However, until 2005, when attempts were first made to improve broodstock performance, most hatcheries had poor broodstock management practices, resulting in deteriorating seed quality, poor fish growth and greater susceptibility to disease.

To help Bangladeshi fish farmers access better quality seed, in 2012 the AIN project imported GIFT, the genetically improved, faster-growing strain of Nile tilapia developed by WorldFish from their breeding center in Malaysia.

AIN technically assisted four specialized hatcheries, each known as a tilapia breeding nucleus (TBN), to establish breeding programs. Each hatchery received broodstock that came from 56 families separated into eight cohorts.

The broodstock was reared and mated in eight ponds (one per cohort), from which the required number of males and females were selected from each cohort for the next year's broodstock. Each year the males were rotated to create eight new combinations, a method known as rotational breeding, which maintains genetic diversity. This ensures that the next generation has at least the same quality as the parent

fish, enabling farmers to realize the full potential of the fast-growing GIFT strain.

To scale up production of GIFT the TBNs sold broodstock to four tilapia satellite hatcheries (TSH) specializing in the multiplication and sale of broodstock to regular hatcheries, which use the fish to produce mono-sex tilapia fry for grow-out farmers.

By December 2016, the four TBNs had produced about 5 million mixed-sex fry as brood and distributed to 93 multiplier hatcheries, including 51 in the project area. The 51 hatcheries, including four TBNs, produced 400 million mono-sex fry for grow out, representing an estimated 10%-15% of total tilapia fry demand within the project area.

Project monitoring suggests that the introduction of GIFT resulted in the production of an additional 80,000 metric tons of tilapia between 2012 and 2016 and that GIFT tilapia grew around 30% faster than other tilapia strains available in the AIN project area. In addition, AIN helped to establish three TBNs outside the project area.

Arif Ahmed Chowdhury, a commercial tilapia farmer from Gopalganj Sadar Upazila, said he had tried cultivating tilapia in four ponds with fry from different sources. "The GIFT fry performed best in commercial farming. This line grows better and looks better."



Photo credit: Babarun M. Hossain/WorldFish

Tilapia farmer.

Another commercial farmer, Mizanur Rahaman Mukul from Rajbari Upazila, said he got 15%–20% more yield from GIFT compared to other strains he had used.

To encourage hatcheries to follow good broodstock management, AIN supported the formation of the Avoyagar Matshya Hatchery Owners Co-operative Society in March 2013. Based in southwest Bangladesh, the association provides a link between its members and the DoF.

Under AIN, GIFT breeding work has been conducted with private partners. GIFT now being managed in private facilities are supported with technical assistance from WorldFish scientists. It is expected that the breeding program will continue without further financial assistance.

In the future, as demand from fish farmers increases for GIFT, more hatcheries will replace their existing broodstock with GIFT. As long as they also adopt good management practices, farmers can have confidence in the quality of the fry they are buying, which will ensure that all farmers, including the poor, can profit from the benefits offered by the GIFT strain.



Photo credit: Basimul Kabir/WorldFish

Freshly harvested tilapia from a pond.

## Training leads to higher carp production and better seed quality

Fish farming in household ponds is a common activity in the AIN project area.

But the yield from these small ponds—average size 1.25 ha—is often low and many farmers lack knowledge on farming and pond management.

To help household farmers increase production, AIN provided training on improved pond management, while hatcheries and seed value chain actors were trained in producing and maintaining high quality carp seed. Complementing these activities, the project also worked to improve the quality of tilapia seed and manufactured fish feed.

The training included sessions on aquaculture technologies, nutrition and gender awareness, and was delivered by AIN field staff in cooperation with two NGOs: CODEC and Speed Trust.

In total, around 80,000 household and commercial fish farmers were trained, of which 78% were female. AIN field staff also trained about 50,000 small-scale shrimp farmers. Training evaluation confirmed that nearly all farmers who were trained in better pond management adopted at least one of the training messages.

The training helped farmers boost their annual production by an average of 94 kg annually. At the start of the project, the baseline AIN survey showed an average fish production of 1697 kg/ha or an average of 136 kg from a household pond. In 2015–2016, production increased up to 2865 kg/ha or an average of 230 kg per pond—a significant increase given the

tough farming conditions faced by fish farmers, with limited access to credit.

The production increase also improved fish consumption, according to 78% of farmers interviewed during training evaluation.

To encourage production of higher quality carp seed, the project provided training to hatchery staff on improved hatchery management, particularly on using an oxygen tower to help aerate the groundwater usually used for hatching eggs. Now, nearly all carp hatcheries in the AIN project area have adopted these towers, which have improved water quality and increased the survival rates of small carp seed.

The project also assisted 85 hatcheries to source wild caught broodstock to replace their poorest quality broodstock. Between 2012 and 2015, a total of 71,230 kg of quality broodstock was distributed, which replaced about half of the broodstock held in the partner hatcheries.

To ensure that the quality of fish seed is maintained after it leaves the hatchery, the project provided training on good seed management practices to people involved in all stages of the seed supply chain.

The project trained staff from 85 carp hatcheries, which produce spawn (hatched eggs), and 558 nursery operators who raise spawn up to fingerlings. Training was also provided to 1200 seed traders, who deliver fish fingerlings to farmers.



Bina Majhi working in the carp hatchery, Hajipur village, Potuakhali. The AIN project provided quality brood and training on carp seed production technology.

Photo credit: AWW, Anisuzzaman/WorlFish

By 2016, after four years actively working in the field, AIN had reached 738,717 fish households with training and/or quality seed. From 2012 to 2016, the total increase in annual fish output was 254,567 metric tons worth USD 295 million.

Meanwhile, the adoption rate of key pond management methods increased on average from 27.3%–81.5% after training when farmers are more aware of the importance of good pond management and seed quality. Demand for good seed and increased competition between hatcheries has motivated hatcheries to put more effort into improving seed quality, which will help farmers further boost their production.



Abul Bashar shows a fish harvested from his pond.

Photo credit: Shovan Khan/Sabuz VerdiFish

## Empowering the private sector

Approximately 5 million fish farmers and 250,000 shrimp farmers are engaged in small-scale aquaculture in Bangladesh. WorldFish-trained local service providers (LSPs) have been able to effect positive change in the sector where, particularly in rural Bangladesh, many fish farmers have limited access to information about aquaculture. Without reliable advice many have made poor choices on how to manage their farms.

Despite working as a day laborer in a fish hatchery for several years, Rawshan Ara and her husband Md. Khalilur Rahman had little knowledge of good aquaculture practices. In 2011, her husband applied 100 kg of urea to their 0.16 ha homestead pond, a lethal amount for that size pond. “I saw fish started dying within a few hours.” By the end of the day 400 kg of fish had died—their entire crop.

To provide fish farmers like Rawshan with better access to information, AIN provided technical and facilitation skills training to fish feed and seed producers and sellers to enable them to become LSPs. These facilitators then shared aquaculture knowledge with their clients through group training sessions, which quickly created a large knowledge base among local farmers.

In the fifth year of the project (2015–2016), when the LSP model was adopted, AIN trained 1275 local as business LSPs. In 2016, those LSPs trained around 60 farmers each, totaling about 73,500 farmers, of which 80% had not received any training on aquaculture before.

In the first four years of the project, 130,000 small-scale farmers (80,000 fish farmers and 50,000 shrimp farmers) in southern Bangladesh were trained on improved technologies by 314 AIN project staff.

Although the initial capital investment and time spent training LSPs was high, after training the LSPs became self-sufficient and reported an increase in business as they became more recognized as experts in their communities. The facilitation skills gained through training are permanent assets to the community because the LSPs can continue training and transferring skills to others, long after the project has ended.

Besides aquaculture practices, the LSP-led farmer training covered topics such as vegetable growing on pond dikes, and the importance of consuming a nutritionally balanced diet, including fish.

AIN project staff evaluated the quality of LSP training sessions and found that 37% of LSPs were rated as having excellent training skills while 57% had good facilitation skills. Follow-up surveys of training participants showed they could answer 73% of questions correctly compared to 34% of non-trained farmers.

Following the devastating incident described earlier, Rawshan Ara attended AIN training sessions on aquaculture, dike cropping and nursery management in 2013 and 2014. She used her new skills and knowledge to successfully establish a fish nursery in Babuganj sub-district. In 2016, she received training and became a LSP, which has helped boost her profits further. “I am helping farmers with technical knowledge and supply quality fingerlings. It is also helping me to market my products and expand my business.”



Fry traders (patilwalas) on their way to sell quality fingerlings to local farmers.

The regular interaction between LSPs during AIN training has inspired further cooperation. At the sub-district level, associations are being formed to share experiences, exchange customer contacts and access government services, which are particularly useful for example during a disease outbreak.

AIN initiated the South West Aquaculture Advisory Network (SWAAN)—a collaboration between three universities, the DoF, the Bangladesh Fisheries Research Institute and private sector representatives—to answer questions from the field and identify the need for additional research.

The LSP model has created important sustainable benefits for both fish farmers and the LSPs, which should continue long after the AIN project has ended.



A shop owner and private sector facilitator explains the features of a product to a customer.

## Increasing access to quality fish feed

One of the most important inputs to aquaculture is fish feed, the quality of which can greatly affect a farmer's production. The fish feed that best maximizes production is a balanced feed that provides all essential nutrients for fish growth.

However, farmers in remote areas often have difficulty accessing quality feed, especially during the peak months of fish growth (July to October) when demand for feed is high. This is partly due to the cost of transporting feed to remote locations, and an insufficient amount of feed is being produced nationally to meet growing demand.

Most small-scale farmers feed their fish with homemade, unpelleted feed, containing a mix of agricultural by-products available in the local market. However, it does not contain the correct balance of nutrients and quickly disperses in the water, without allowing adequate time for the fish to eat. Although the cost of homemade feed is low, compared to commercially available pellet feed, it is inefficient and produces significant waste. To provide rural farmers with better access to quality feed, the AIN project focused on training farmers and government officials on good feed practices and training small feed mills called community feed centers (CFCs) to produce quality fish feed in line with government legislation.

In 2012, tailor-made information about efficient feeding practices for small-scale fish and shrimp farmers was integrated into the AIN farmer training program. AIN also trained 90 DoF officials and 101 large feed mill staff on the implementation of the Feed Act and Rules, and another 30 DoF officials on quality

feed formulation and production. Similarly 54 large feed mill managers were also trained on the same topics.

For Mizanur Rahman Mukul, a commercial farmer and owner of a CFC in Rajbari sub-district, the training helped him learn about feed formulation and how to produce better feed. "We can now prepare fish feed ourselves and feed fish more efficiently and we can even help others with their feed."

To improve feed availability, the AIN project assisted the farming community to develop 62 CFCs. A preference was given to large-scale fish farmers who had ongoing demand for feed for their own farm.

The CFCs received technical assistance that included training on all aspects of the production of quality feed. The project also provided the CFCs with equipment to improve their operations, such as weighing scales, sieves and water cooler motors, and connected them with ingredient wholesalers to access lower prices.

The feed centers provide the option for farmers to make feed, according to the feed formulations recommended by AIN, with their own ingredients such as rice bran, mustard oil cake, dried fish, maize and wheat flour.

Abdul Karim, another farmer from Rajbari sub-district, explained that it used to be difficult for small farmers like him to buy small quantities of feed. The dealers were only interested in selling to the large farmers. "But now we can easily buy or make our own feed from these mills."



A fish feed seller organizes his products in a shop.

Photo credit: Md. Masudul Rahman/WorlDfish

In 2016, CFCs supplied feed to 2000 farmers and the CFC operators trained about 3000 farmers on better feed formulation, feeding and feed management. This training created many new customers and increased the demand for CFC-produced feed. Consequently, the AIN-assisted CFCs produced and sold or used nearly 1700 metric tons of feed between 2014 and 2016.

The project found that quality feed use by farmers in the project area increased from 30% in 2012 to 46% in 2015, attributed to a combination of improved knowledge, feed quality and feed availability.

Better access to quality feed is helping rural farmers improve their fish production, which is a vital source of food, nutrition and income for many households.



Photo credit: Yousuf Tushar/WorldFish

Fish feed at a local factory in Jessore, Bangladesh.



## Higher fish and vegetable consumption boosts nutrient intake

In Bangladesh, a country crisscrossed with rivers and canals and located on the Bay of Bengal, fish is an important part of the household diet. Despite this, 36% of children under five years of age are stunted, 14% suffer from wasting and 33% are underweight.

Given sub-optimal consumption levels of fish and the fact that it is a rich source of micronutrients, including calcium, vitamin A, iron and zinc, and essential fatty acids that are needed for good health, especially in women and children, AIN worked to further increase fish consumption in line with World Health Organization recommendations and the government's goal to increase the amount of fish in people's diets from 15.4 kg/person/year to 20 kg/person/year.

As part of the project's farmer training, around 25% of the content focused on increasing knowledge of good nutrition, including dietary diversity.

The project encouraged farmers to grow vegetables, including orange sweet potato (OSP), the roots and leaves of which are high in vitamin A, around their fishponds. Between 2012 and 2015, the project distributed about 842,000 OSP vines to 7630 farmers. Of these, around half distributed an additional 2 million vines to a further 20,000 farmers.

Efforts to increase fish consumption were also successful, as evidenced by AIN surveys showing that 73% of respondents in 2012 said they had eaten fish in the previous 24 hours, which rose to 81% in 2015.

This increase was relatively even across income groups— 80% of people in the lowest income group

had eaten fish in the previous 24 hours compared to 88% of richer people. In addition, 78% of interviewed female farmers said their fish consumption increased, with 83% of the women saying that this was due to increased production. For pond owners, it was found that 60% of consumed fish was harvested from their own ponds, 35% from the market and less than 5% from their own catch from open water bodies. Interestingly, households that did not have a pond also increased consumption.

In addition, there was an increase in the Dietary Diversity Index (DDI)—which indicates the economic ability of a household to access a variety of foods—from 3.96 in 2012 to 4.27 in 2016. A field survey also found that after training, trained farmers could answer an average of 82% of nutrition-related questions correctly, farmers trained by the LSPs 72% and the control farmers, with no training supported by the project, 44%.

Another key nutrition-focused initiative of AIN was the introduction of mola, a small indigenous species (SIS) that when eaten whole is a rich source of micronutrients and vitamin A. Between 2012 and 2015, the project distributed 4700 kg of mola, to be cultivated with other fish, to 9100 household farmers.

In training, farmers learned not to remove the head of mola and other small fish like chela, darkina and puti, because it is the most nutritious part of the fish.

Previously, fish farmer Latika Biswas of Burirdanga village said she thought that mola was difficult to feed to children because it had many bones. "But we



An improved gher system with dike cropping in Southern Bangladesh.

learned how to mash the fish into a soft paste in the AIN training sessions. Mola has become a popular dish in our family now!"

AIN encouraged farmers to share their mola, once they had reproduced, with other farmers. This resulted in the transfer of a further 5600 kg of mola broods to an additional 37,500 farmers. Thus at least 46,600 farmers increased their production of mola between 2012 and 2015.

Together these nutrition-focused activities have helped households increase their consumption of fish and vegetables and diversified their diets, providing families with greater intake of vital micronutrients.



A family eating mola, a small indigenous fish species and an important source of micronutrients.

## Empowering women through aquaculture

In poor households in Bangladesh, where average income is USD 65.25 per month, women often face barriers that prevent them from fully participating in and benefiting from income generating livelihood activities such as aquaculture.

Women often cannot engage in livelihoods away from their home because they have little time to spare since their primary responsibilities are household duties and childrearing. Consequently, women often feed the fish and help clean the ponds—tasks seen as supportive—while men typically do the harvesting, as well as make most marketing and financial decisions.

To empower women to engage in income generating work and decision-making, especially around household income and expenditure, the AIN project included special gender awareness messages in its aquaculture training program. These messages were delivered through role plays and group discussions, aiming to create awareness of the gender-related barriers and highlight different approaches to addressing gender-related issues.

The training sessions reached 130,000 female and male fish and shrimp farmers. In the fish farming training groups, women represented 78% of participants, while in shrimp farmer trainings they represented 20%. Overall, women made up 55% of participants.

The gender and social messages helped create a positive change for women, according to feedback in focus group discussions with female participants after the training.

Women, most of whom had limited access to and control over homestead ponds, reported they were now able to decide on fish farming activities and were increasingly encouraged to do so by male household members. They said their status at home improved because they were now involved in generating an income. In the discussions, women also said their mobility had improved because men and women were increasingly making households decisions together.

Among the AIN field staff, women made up 20% of the extension facilitators who provided the training.

Among community facilitators (CF)—individuals elected to lead farmer groups and who provide training to their group on a voluntary basis, drawing on training provided by AIN—women made up 46%. This CF concept was an effective and sustainable way to continue building awareness of gender issues, at no extra cost to the project.

In 2015, the project introduced a new low-cost harvesting technology, known as a gill net, to help women harvest nutrient-rich mola fish easily and regularly from their household ponds (see breakout box). Training on gill nets was given to 155 women.

Together, these activities recognize and strengthen the important contribution that women make to aquaculture in Bangladesh, which was vital to AIN achieving its mission of boosting fish production and consumption.



Gill nets have better enabled women to catch fish.

## The gill net boosts women's involvement in aquaculture

Rural women often face barriers that prevent them from catching fish, which is considered a man's job. Additionally, commonly used cast nets do not suit the practical needs of women, and women are reluctant to enter a pond to harvest fish due to gender-related sociocultural norms.

To make harvesting of nutrient-rich mola accessible to women, the project developed a new harvesting technique.

A small gill net, with two mesh sizes that allow a larger range of fish sizes to be caught, is set and left in the homestead pond for about an hour, allowing a woman to go off and do other errands. She then easily pulls in the catch by herself, which is done without getting into the water, getting wet or exerting much strength. A gill net can be used every day at little cost, and a single harvest of mola should be enough for one meal for the average family.

To combat the sociocultural barriers women face and create acceptance of women performing this new harvesting role, AIN introduced social and gender consciousness-raising exercises with household and community members. Preliminary data showed some positive change in aquaculture-related decision-making, gender attitudes and self-efficacy. Women reported that the involvement of their spouse and family members had a positive influence on their adoption of the gill net.



Farmer demonstrating a gill net.

## Leveraging the power of information and communication technology (ICT)

In Bangladesh, challenges faced by rural fish farmers are often compounded by their distance from centers of commerce. The availability of advice on aquaculture and access to service providers is limited and formal banking or credit is difficult to obtain.

Further up the value chain, wholesale buyers have limited means to identify the source of poor quality produce and hold them accountable.

To help rural fish farmers and buyers overcome these problems, the AIN project developed a range of information and communication technology (ICT) applications. In addition, the project harnessed various technologies to improve the efficiency of its own activities.

Starting in 2013, the project supported a private sector agriculture call center to enable farmers to easily get advice on aquaculture and agriculture problems. The project trained the agents that were answering the calls in aquaculture and generated publicity for the service. Over 500,000 farmers have so far used the service and the numbers are increasing.

To help farmers find nearby private sector service providers, the project—along with the USAID-funded Agro-Inputs Project (AIP) and Agriculture Extension Support Activity (AESAs) projects—developed an online search database as part of a mobile phone application. The app, called “Krishi Yellow Page,” which links over 3000 service providers, can be downloaded for free from the Google Play Store. The app is becoming popular and similar development projects are expected to share information using the app in coming years.

In the aquaculture value chain, food safety is an important issue. Wholesale buyers want to know that a product is high quality and that quality standards have been followed in production. AIN worked with the US technology firm SourceTrace to develop an e-traceability system for shrimp. The e-traceability system allows a user to trace a product back to the producer via all intermediaries.

A five-month trial of the e-traceability system was done in combination with the setup of a model shrimp collection center. Located in Borodanga village near Khulna, the center is run by a group of 290 shrimp farmers, who jointly maintain the quality of the shrimp and sell jointly to a processing factory to receive a better price. The e-traceability system is expected to be rolled out beyond the initial trial in coming years.

In 2014, a group of six USAID Feed the Future projects, including the AIN project, hired a GIS coordinator to maintain GPS coordinates from all major stakeholders like hatcheries and feed mills. This data was collated into a central GIS portal for USAID-funded projects to produce maps using data from various projects and to increase coordination and data exchange between projects.

In 2014, with support from USAID’s Mobile Solutions Technical Assistance and Research (mStar) project, AIN reduced its use of cash by adopting a mobile banking system. This enabled field supervisors to send money to field trainers and training participants virtually using a mobile phone, instead of traveling long distances by motorbike to deliver in person. The initiative saved AIN an estimated 600 staff days per year, or USD 19,000 per



AIN staff deployed ICT throughout the project.

year. The transparency of the movement of funds was another major benefit.

The project expanded the use of the system to rural service providers in the aquaculture sector who often lack access to formal banking or credit, which is a problem when it comes to selling their products.

Commercial farmer and hatchery owner Sheikh Sagor, who started using mobile money in 2014, found that his remoteness was no longer a problem in receiving money from his clients or transferring money to buy equipment for his hatchery. "Mobile money saves me time, and the extra time I can use to expand my business." So far, Sagor has used the system to send and receive BDT 1,000,000 (USD 12,695) in a month and in the future, hopes to establish a merchant account to minimize his transaction fees.

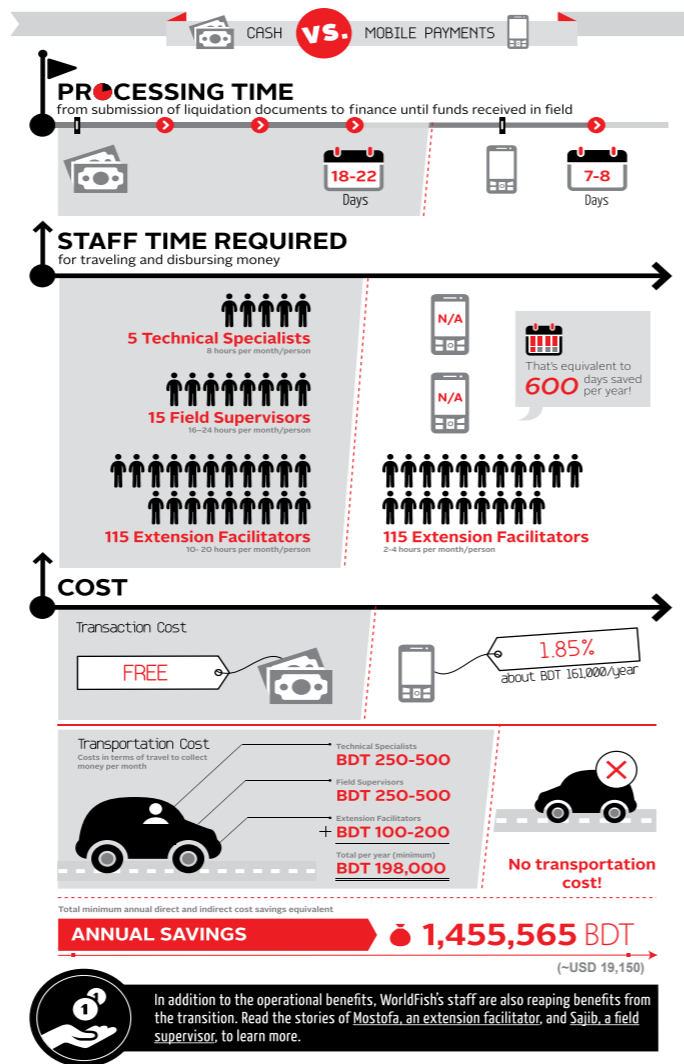
In the last year of the project, field staff used tablets to collect survey data from daily field visits. This enabled data to be recorded in a consistent format and uploaded immediately to a central database from where it was downloaded for analysis.

These technologies helped the project deliver effective services, helped fish farmers improve their productivity and provided quality assurance to buyers, which together strengthened the aquaculture sector in Bangladesh.

## CASH VS. MOBILE PAYMENTS

in Bangladesh | The Case of the USAID Aquaculture for Income and Nutrition project, implemented by WorldFish

In 2014, with support from USAID's mSTAR project, the Aquaculture for Income and Nutrition project transitioned from using a fully cash-based system to pay farmer training conveyances to one that is primarily done using mobile payments. The benefits from this transition are outlined below.



Source: FHI mSTAR project



A rural woman using mobile money.

## Conclusions and scaling up

Results from the USAID-funded AIN project show that the project's efforts to strengthen the aquaculture sector in 20 districts in Bangladesh had a major impact, particularly for poor rural households.

The training of trainers (TOT) approach adopted by the AIN project has proven successful in maximizing outreach. The trained implementing partner staff, government fisheries officers and LSPs (nursery pond operators, seed traders and feed traders) continue to provide advice and training beyond the project's lifetime. Developed and implemented ICT interventions supported better achieving AIN's goals and objectives.

Fish consumption in households receiving AIN support was higher in 2016 (19.5 kg/capita), compared to that in non-AIN activity households (16.8 kg/capita).

Project interventions made clearer the importance of having a nutritionally balanced diet for mothers and small children. In a country where with 41% of children under five are undernourished this increase is of critical importance. Fish, particularly small fish when eaten whole, are an excellent source of micronutrients such as iron, zinc, calcium, vitamin A and vitamin B12, as well as fatty acids and animal protein.

The emphasis placed on improving fish and shrimp seed quality, coupled with farmer training provided on improved and better management practices, resulted in a substantial increase in aquaculture production in the FTF zone of influence (FTF-ZOI).

Many tilapia hatcheries in the FTF-ZOI are now using genetically improved broodfish provided through project supported TBNs. By 2020 the RGIP aims to produce a third generation of rohu, one of the most popular fish in the region, in a unique partnership agreement with the DoF. A WorldFish impact study in 2016 showed that over 90% of all carp seed, and about 50% of all tilapia seed, are now produced by AIN partner hatcheries in the project area.

At the household level, training and access to improved seed provided by AIN activity-supported hatcheries have resulted in improved productivity in ponds for carp and SIS, and commercial ponds for carp, tilapia and shrimp. AIN has promoted a polyculture production model for household ponds allowing large fish (carps) to be reared alongside SIS. Adding dike cropping of vegetables to this has increased the availability of nutrient-rich foods that are easy to harvest for household consumption, with surplus sold to supplement household income. AIN training and advice on SIS have created opportunities for women to generate income from aquaculture by providing mola broodfish, gill nets to facilitate pond harvest and training on pond management.

Beyond the sizeable impact of the AIN project, there is immense scope to achieve even more in the Bangladeshi aquaculture sector with the right support and follow-up. Several AIN activities are ready to be scaled up at the national level. Tilapia seed from the project is already being distributed in some regions outside of the project area. The success of the private-sector led LSP model is already clear, suggesting that future interventions should adopt similar approaches such as market systems or M4P to achieve even greater impact at scale.

Some outcomes will require continued support to achieve their full potential. The genetic improvement program, for example, will need continued specialized assistance. Once genetically selected improved carp is available, it will be distributed throughout Bangladesh and even abroad if neighboring countries are interested. The distribution of SPF shrimp seed will be more successful if, in parallel, the quality control of wild-sourced shrimp seed is improved as per the Hatchery Law. The RGIP has laid a solid foundation and the Bangladesh Government is now discussing the way forward for establishing a formal partnership with WorldFish toward establishing the National Carp Broodstock Development Program, based on the project's experience.

Additional activities undertaken as part of AIN include exploration of technology to produce live feeds, rotifer and algae for high value aquaculture species like mud crab and mullet. This was demonstrated in cooperation with the Bangladesh Fisheries Research Institute (BFRI), and limited numbers of seed were produced. The BFRI is building on this experience, which should lead to the future production of crab, mullet and other high value indigenous species on a commercial scale. AIN also investigated high mortality in prawn (*Macrobrachium rosenbergii*) hatcheries in cooperation with international disease labs. A long-term solution to develop a disease-resistant strain of prawn has been proposed. The immediate solution would be for the private sector to apply for permission from the DoF to import SPF prawn broodstock to be used for seed production in Bangladesh.

Key to maintaining growth in aquaculture in Bangladesh and the associated benefits will be farmer access to support services, creation of feed labs to confirm feed quality and the establishment of an aquatic animal disease lab to identify diseases at an early stage. In addition, research capacity is needed to develop the technology applicable to the specific conditions and requirements of Bangladesh.

Besides helping boost fish production, household income and nutrition, and employment opportunities in the aquaculture sector, the successes and learning achieved through the AIN project can be used to improve national policies in support of further strengthening and improving poor and nutrition-targeted aquaculture in Bangladesh. This will ensure that fish farmers and their families—many of whom are poor and live in rural areas—have sustainable livelihoods and happy, healthy lives.



Photo credit: Din W. Shibly/WorldFish

Harvesting fish and prawn from a gher.





Photo credit: Back cover, A.M.M. Anisuzzaman

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