

# AQUACULTURE ASIA

Women's SHGs make formulated feed

*Managing cannibalism in Wallago attu*

Farming hilsa

*Animal welfare*





## Aquaculture Asia

is an autonomous publication that gives people in developing countries a voice. The views and opinions expressed herein are those of the contributors and do not represent the policies or position of NACA.

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### NACA

An intergovernmental organisation that promotes rural development through sustainable aquaculture. NACA seeks to improve rural income, increase food production and foreign exchange earnings and to diversify farm production. The ultimate beneficiaries of NACA activities are farmers and rural communities.

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# AQUACULTURE ASIA

## Digital sequence information is not a 'genetic resource'

An important paper will be considered at the upcoming 18th Regular Session of the Commission on Genetic Resources for Food and Agriculture, 27 September – 1 October. The paper is "Digital sequence information on genetic resources for food and agriculture: Innovation opportunities, challenges and implications". Download the paper from: <https://www.fao.org/cgrfa/meetings/detail/en/c/1414719/>

The issue that concerns me is that many states are taking the position that information about the nucleotide base sequence in a piece of DNA or RNA is, of itself, a 'genetic resource'. Consequently, they argue that digital sequence information should be subject to the *Convention on Biological Diversity* and *Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to Convention on Biological Diversity*.

The implications of this position are that i) digital sequence information should be subject to sovereign ownership, as per the *Convention on Biological Diversity*, and ii) should therefore be subject to regulatory controls on 'access and benefit sharing', which could mark an end to the free exchange of digital sequence information.

In my opinion this interpretation is flawed and will have a host of negative consequences for genetic research, including for both conservation purposes and for food production. I have covered the consequences for regulating access to genetic resources elsewhere (collection permits, fees, lengthy delays and legal problems impeding legitimate research). But what about sequence information?

Consider a blank piece of paper. Write a sequence of letters on it, choosing from G, C, T and A. Let's say the sequence you wrote down happens to represent a sequence of base pairs from the DNA of an organism. Is it a genetic resource?

No it is not! Clearly, it has none of the properties of a genetic resource whatsoever. But you *could* study it, and perhaps learn something about the source organism. Perhaps the sequence could inform a selective breeding programme or tell you something about the organism's lineage, or help you design a marker. So, the information does potentially have value. But if it's not a genetic resource, what is it?

It's a *description* of a genetic resource, commonly referred to as *metadata* in library science and every other information discipline. It has value in exactly the same sense that records in a library catalogue have value: they enable you to discover and locate useful resources that you can subsequently utilise to generate value. Digital sequence information facilitates the process of discovery and location of genetic resources. It allows you to understand the properties and inter-relations of the underlying organisms or resources, which opens the *possibility* of manipulating genetic resources to generate valuable products.

It is apparent that many states still have overblown concerns about the possibility of "biopiracy". I put it to you that the value of the food, incomes, jobs and livelihoods generated through the everyday use of genetic resources by the agriculture sector vastly overshadows this risk. And yet somehow, this concrete, real-world benefit is missing from the debate.

Whether there are benefits to regulating access to genetic resources for research is debatable. But regulating access to information *about* genetic resources such as digital sequence information can only be counterproductive.

*Simon Wilkinson*



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# Opinion: Benefits of animal welfare in Indian aquaculture

By Karthik Pulugurtha and Haven King-Nobles, Fish Welfare Initiative

<https://www.fishwelfareinitiative.org/>

## Hundreds of dead fish a day

Like many fish farmers in the villages of Andhra Pradesh, India, Siva leased a pond from the Village Panchayat. The cost of leasing common lands, once inexpensive, has now risen dramatically due to the growth of aquaculture. Coupling the high lease cost with the other increased input costs, Siva really needed his operation to succeed so he could at least earn back the money he spent.

The grow out started well, with relatively few mortalities. But then more fishes started dying. And more. And more. Until a particularly bad week close to the harvest date, where hundreds were dying every day. These mortalities were caused by a number of issues impacting his pond, including low oxygen, argulus infestations and algal blooms. Working hard to turn the pond around, Siva spent more money following the advice of his neighbours and the local aqua businesses. None of it worked very well, and now there are only more chemicals in the still suffering fishes. And when the consumers finally purchase the fishes, their quality will only be lower.

## Parasites, disease and antimicrobial resistance in aquaculture

Unfortunately, the troubles Siva faces are not unusual. Parasites and disease are amongst the greatest issues affecting Indian aquaculture. Mishra et al. notes that disease has become “a primary constraint to sustainable aquaculture production and product trade.”<sup>1</sup> *Argulus*, a parasitic aquatic crustacean, is particularly endemic, with one study on Indian carp culture estimating total losses due to argulosis to be Rs 29,000 per hectare per year.<sup>2</sup>

Disease is unfortunately not the only issue aquaculture faces. Due to the proliferation of disease, farmers invest heavily in prophylactic antibiotic use. In



*Aqua farmer Siva with his fish farm in Andhra Pradesh*

addition to the investment such farmers take on, heavy antibiotic use has the concerning consequence of increasing antimicrobial resistance (AMR). One study, which found that India has amongst the highest rates globally of antimicrobial agents used in both humans and farmed animals, noted that aquaculture is one of the “drivers of environmental AMR in India.”<sup>3</sup> Scientists at the Central Institute of Fisheries Technologies-Vizag have recognised the problem of aquaculture-caused AMR, and are conducting a study to mitigate it.<sup>4</sup>

These high rates of disease and subsequent overuse of antibiotics only hurt the position of aquaculture in the eyes of the consumer, who is already exposed to critical investigations outlining the health implications of eating such fishes. At a time when consumers are increasingly concerned about food safety, aquaculture is doing little to reassure such doubts.

## The organic promise

So aquaculture faces serious challenges in India. Farming conditions are often poor, and occasionally toxic, far from the safe and nutritious fishes that consumers were promised. What can be done?

One approach here is to learn from similar models that have previously succeeded at improving Indian agriculture. Amongst those, one of the more successful has been the organic movement: The percentage of farms under organic production has more than doubled in the last 5 years.<sup>5</sup> Before these farms transitioned to organic, they, like many aquaculture farms, were suffering from an overuse of chemicals being used in the cultivation. Such inputs, in both agriculture and aquaculture, are costly to farmers. And they are certainly not healthy for the humans who consume them—one famous study in Hyderabad found pesticide residues in schoolchildren’s urine samples, at a rate 10-40 times higher than their US counterparts.<sup>6</sup>



The organic farming movement, while still relatively small, is taking positive first steps to mitigate these issues. And it's not only beneficial for consumers—farmers, now producing a better product, can fetch a price premium of 10 to 20%.<sup>7</sup> Although there are costs in transitioning from conventional to organic farming, long-term what's better for consumer may also be better for farmer.

Could aquaculture follow the organic model of eliminating chemical inputs? Perhaps fish farmers could eliminate antibiotic use in their ponds, but at least in the short term that could cause disease and parasite issues to skyrocket. Reducing chemical inputs is surely part of the solution, but it must be coupled with other paradigms.

## Animal welfare: Part of the solution

One paradigm that our organization, Fish Welfare Initiative, believes to be promising is that of animal welfare. This is not particularly complex—by animal welfare, we simply mean farming animals in such a way where they have a good quality of life, a life worth living. Instead of asking what will produce the greatest number of fishes possible, to consider animal welfare means to ask what is actually good for the fishes.

From our field visits and discussions with farmers, we believe that two of the most important animal welfare issues in Indian aquaculture are 1) water quality, and 2) stocking densities. We've talked with too many farms who suffer from poor water quality, just like Siva from the opening story above. And the lack of oxygen and other water quality issues are frequently exacerbated by the ponds being stocked beyond both the pond's carrying capacity as well as the FAO's recommended limit.<sup>8</sup> See our full initial report at:

<http://www.fishwelfareinitiative.org/fish-welfare-improvements>

On further reflection, it's hardly surprising that improving welfare leads the fishes to perform better. The same holds true for any type of animal: If you treat a dog better, it is less likely to develop some sickness. Even with humans, it's clear that a child that was shown care and compassion is much more likely to flourish than one shown abuse and neglect. The farmers we work with intuitively grasp this fact, and they usually want their fishes to flourish more than anyone. Yet their desire to change is not enough—farmers often lack the resources and the know-how to improve the welfare of their fishes.

With these challenges in mind, we're proud to announce the launch of the Alliance for Responsible Aquaculture (<http://fwi.fish/ara>), a coalition of fish farmers and local NGOs in Andhra Pradesh working to improve aquaculture by improving animal welfare standards. Our NGO, Fish Welfare Initiative, and the other NGOs are providing free-of-cost water quality testing and regular consulting to participating farmers, who in turn are raising healthier, happier fishes. Long term, we're working to establish market linkages such that these higher welfare fishes fetch a price premium at market, just as with organic produce today. We're currently beginning work in the Nellore and West Godavari districts and encourage any interested producer or collaborator to reach out via our website.

Across the world, the idea of treating fishes well to procure a better product has increasingly gained traction. Major retailers, such as Marks and Spencer in the UK, now include animal welfare policies for the seafood they source. In Egypt, where fishes are widely farmed in similar earthen pond systems as India, farmers who were facing similar antibiotic use challenges found that improving water quality and feed management reduced disease occurrences and thus reduced the need for antibiotics.<sup>9</sup> And animal welfare is certainly not a novel concept in India: Showing compassion for all living creatures is a duty of all Indians, per Article 51 (G) of the Constitution.<sup>10</sup>

Here in India, everyone works incredibly hard to pick the best food for their families—we're all familiar with the sight of parents going to great lengths to gather the healthiest produce for their families. And when it comes to buying fishes, people are even more careful. With the pandemic impacting so many lives, the need every parent feels to ensure their family's health and well-being has only deepened. We believe that by changing the paradigm towards fish welfare, aqua producers can rise to the occasion. There is perhaps no better way of honouring the care Indian consumers put into choosing food than by increasing the care with which we produce it.

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# Imparting skill on formulated fish feed preparation to women's self-help groups in villages – an experience

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## Farm-made pelleted fish feed

Fish feed is a major input in inland pond-based fish farming in India and accounts for around 55-60% of the total cost of production. Good quality feed ensures proper body growth of farmed fishes and helps to achieve the expected production level at the end of the culture period. In composite fish culture, major and minor carp fingerlings are fed twice daily during grow out continuously for 6-10 months till the fishes attain adult/marketable size. Livelihood-oriented small-scale aquaculture is practiced by progressive fish farmers with limited resources in remote villages in different districts of West Bengal and neighbouring eastern Indian states. For such farmers, it is desirable that supplementary pelleted feed is prepared for cultivable carps using locally available, affordable ingredients and made available to them. Such feed should have 25-32% protein content and be effective and affordable enough for fish farmers to purchase regularly while improving their profit margin.

Such pelleted feed, nowadays termed 'farm-made floating feed', is superior to hand-formed dough balls as fishes consume the former quickly, it is easy to apply, reduces wastage, and is nutritionally balanced with fat, carbohydrate, protein, minerals and binder components. It will meet the nutritional requirements of major and minor carps from fingerling stage up to adult. This feed may be prepared by individual fish farmers in their own farms, by members of farmer collectives who have formed registered fish production groups at Gram Panchayat level and by members of progressive women-led self-help groups (SHGs) in villages, not far from fish farms.

## Women's involvement in fish feed preparation

Production and sale of farm-made feed for carps and ornamental fishes to local farmers in the same Gram Panchayat or block, or a neighbouring block in the same district is an important women-friendly vocation, with good prospects and is suitable for them, contributing to empowerment of rural women. It can be adopted and implemented by them if they are trained properly; it is less capital- and labour-intensive; and as they gain expertise, they can begin in a medium scale commercially. Their participation in this income-generating activity can improve economy of rural families. Rural homemakers as entrepreneurs, literate and semi-literate, can adopt indigenous fish feed preparation professionally as a serious cottage industry through SHGs and can improve their earnings.

As discussed, farm-made floating pelleted fish feed preparation can become a profitable and sustainable income-generating entrepreneurial activity for women SHGs in rural



Above: Participants in a training programme at Kailashpur PACS. Below: Preparing fish feed.



Sample ingredients (in duplicate) for preparation of fish feed.



areas. Using such feed can help small-scale marginal fish farmers to improve fish production at minimum cost. The Directorate of Cooperation, Government of West Bengal (WB) aims at empowering underprivileged women in economically challenged sections of rural WB by imparting training in fish feed preparation, amongst other measures. Recently, the author demonstrated and disseminated knowledge on pelleted feed preparation for major and minor carps and aquarium fishes with care to 110 rural women SHG members in four programmes funded by the Directorate in South 24 Parganas District, WB.

## Primary Agriculture Cooperative Credit Societies and women SHGs

In the West Bengal State Government, the Directorate of Cooperation is headed by Registrar of Co-operative Societies. Each of the 22 Range Offices of this directorate covers a district, headed by one Assistant Registrar of Cooperative Societies or Deputy Registrar of Cooperative Societies (DRCS). Primary Agriculture Cooperative Credit Societies (PACS) at block level are one type of cooperative societies, essentially short-term credit cooperatives, registered at office of ARCS/DRCS at district headquarters. PACSs enrol women SHGs as their members, the latter becoming eligible for credit-linkage through PACSs which organise and nurture them. This is called 'Samabaay Krishi Unnayan Samity' in Bengali, formed with a cluster of villages in each block, by farmers and artisans and coordinated from district level.

At state level, the Directorate of Cooperation focuses on organisation of women SHGs aiming to empower women and ensure employment for youth. Upgrading skills through training for SHGs (for achieving self-reliance on a sustained basis) is a scheme implemented by the directorate, which also provides financial support; funds are sanctioned in every district in every financial year. With improvement of their vocational skill, women can undertake income-generating activities. SHGs are formed under the aegis of PACSs; training is imparted in cloth stitching, preparation of value-added food products, flower-based products, tailoring, embroidery, handicraft making, poultry farming, and women-friendly homestead fish culture.

## Venues of training and demonstration

In financial year 2020-2021, two kinds of training programmes (four in all) in the fishery sector were organised by office of DRCS, South 24 Parganas District headquarters: 1) Preparation of formulated fish feed for major and minor carps, and 2) Breeding and propagation of aquarium fishes and their feed preparation. Venues of the two programmes of first kind were: Raimonikhaki PACS, i.e., Raimonikhaki Samabaay Krishi Unnayan Samity (SKUS) Limited, Village Raimonikhaki, P.O. Bakultala, GP Dighirpar-Bakultala, Block Mathurapur-II, Dist. South 24 Parganas (organised during January 2-3, 2021) and Kailashpur SKUS Limited, Village and P.O. Kailashpur, GP Roydighi, Block Mathurapur-II, South 24 Parganas (organised during December 26-27, 2020). Venues of two programmes of second kind were: Uttar Krishnapur SKUS Limited, Village and P.O. Uttar Krishnapur, GP Amratala, Block Mograhat-II,



*Trainees and PACS officials at Raimonikhaki PACS.*



*Two groups of trainees at Raimonikhaki PACS preparing fish feed.*



*Trainees at Uttar Krishnapur PACS preparing fish feed.*

South 24 Parganas (organised during February 20-22, 2021) and Uttar Durgapur SKUS Limited, Village Uttar Durgapur, P.O. Jumai Naskarhat, GP Rabindra, Block Kakdwip, South 24 Parganas (organised during February 27 - March 1, 2021).



Each of two programmes of the first kind was of two-days and each of two programmes of the second kind was of three-days duration. The author was the resource person and demonstrator in all four trainings. Afore-mentioned four PACSs started their journey from the late eighties, and, like other PACS in West Bengal, have credit linkage with provision of training facilities for members of enrolled women SHGs which the PACSs have organised.

## Participants as first-time learners

These extension and skill-development oriented programmes (awareness creation about farm-made pelleted feed) were first of its kind organised by office of DRCS, South 24 Parganas in Mathurapur-II, Mograhat-II and Kakdwip blocks. In each of the first two programmes on 'Preparation of formulated fish feed for major and minor carps', participants included 25 local women representing six SHGs and in each of last two programmes on 'Breeding and propagation of aquarium fishes and their feed preparation', participants included 30 women representing ten SHGs. All the SHGs were 8-24 months old. Organising such programmes was indeed a noteworthy approach before International Women's Day 2021, which will contribute to rural society.

## Feed preparation for carps

In four hands-on training programmes, after detailed discussion on the importance, principles and practices of fish feed preparation and background knowledge in audio-visual lecture sessions, the author demonstrated the technique of pelleted feed preparation to trainees. In each of two programmes organised at Raimonikhaki PACS and Kailashpur PACS, trainees were introduced to the ingredients for feed preparation for carps in grow-out ponds from fingerling stage (25-40 g at stocking).

In each of two trainings, 25 trainees were divided into four groups. Each group followed two standard feed formulations separately, 400 g in quantity (sample) for each. The first one comprised musur dal chunnie (MDC; lentil pulses byproduct) 40 g, maize dust 40 g, rice bran 80 g, powdered mustard oil cake (MOC) 180 g, soyabean dust 40 g, powdered vitamin-mineral tablet 4 g, ghee residue 8 g, groundnut oil 8 ml, and a very little linseed sludge. Feed ingredients were weighed using an electronic weighing balance brought from a local grocery shop. In the second training, wheat flour 40 g used instead of MDC, which wasn't available.

The second formulation comprised rice bran 160 g, powdered MOC 100 g, powdered fish meal 60 g, maize dust 40 g, wheat flour 35 g, vitamin and mineral mixture 1 g, and soyabean oil 4 ml. In both cases, lukewarm water added @ 60-100 ml / 200 g to dry mixed feed. Trainees were informed about specific ingredients as sources of protein, fat, carbohydrate; sample feed had crude protein content of 25% and fat 2-4% content. The author guided trainees in all groups to do activities in succession, viz., segregation and labelling of already-procured raw materials/ingredients, grinding (pulverising) in a kitchen mixer-grinder, weighing accurate amounts and dry mixing in proper proportion, dough preparation, pelleting in hand pelletisers using a 3.0 mm die, drying of feed pellets at room temperature in plastic trays, and breaking pellets into



Sample feed prepared by trainees at Uttar Krishnapur PACS.



Sample feed ingredients weighed by trainees at Uttar Durgapur PACS.



Author in lecture session on backyard fish farming and feed preparation.

small particles by hand. Pelletisers were provided to each group of trainees in practical sessions; they were introduced to the die, pellet cutter and mode of operation.

Trainees were informed about local prices of good quality feed ingredients; the usefulness of 10-minutes of mild steaming of feed dough balls in pressure cookers; vitamin-mineral to be added after bringing it to room temperature. The



addition of a little powdered menthi, i.e., fenugreek, neem (*Azadirachta indica*) leaves, turmeric and garlic improves the quality of prepared feed; addition of sugarcane molasses @ 2-3% in feed improves digestibility; storing ingredients in dry locations; keeping plant-based ingredients in hot water before use to remove anti-nutritional factors; storing prepared feed for a maximum of 75 days; feed bagging as 2-10 kg packs with date of manufacture (DOM); use of sodium benzoate in bags as preservative.

Feed can be sold by SHGs to grow-out carp farmers @ INR 28-34/kg. Officials of each of four PACSs arranged the programmes nicely and provided all necessary assistance. They informed that large-scale grinder machine costs INR 16,000-22,000/-, atta chakki machine may be used and portable hand pelletiser (noodle maker or meat mincer) machine costs INR 2,200-6,000/-, made of steel/aluminium alloy, with a feed production rate 2-4 kg/hour (dry weight) and of diameter 1.5, 2.0, 3.0, 4.0 mm. Electricity and motor-operated pelletiser produces feed @ 40-50 kg/hour.

## Feed preparation for aquarium fishes

Breeding and propagation of freshwater aquarium fishes in cement cisterns and hapa cloth enclosures in backyard ponds has brought increasing employment opportunities for rural women SHGs in West Bengal through small- to medium-scale farming units. In 29 blocks of South 24 Parangas, among many others, there exist 167 women SHGs involved exclusively in this vocation and mostly they use costly imported aquarium fish feed. This scenario encourages other women SHGs to prepare and supply feed for the fishes. In each of last two hands-on training courses organised at Uttar Krishnapur PACS and Uttar Durgapur PACS, trainees were introduced to the ingredients required for feed preparation for cultivable aquarium fishes.

In each of the trainings, 30 trainees were divided into five groups. Each group followed one formulation developed by ICAR-CIFE Kolkata Centre, 200 g in quantity (sample) for each. It comprised powdered fish meal 30 g, soyabean meal 44 g, powdered ground nut oil cake 50 g, rice bran 32 g, wheat flour 24 g, starch powder 6 g, sunflower oil 4 ml, vitamin-mineral mix 2 g. Dried and pulverised petals of either China rose or marigold of quantity 8 g was necessary as fish body colour enhancer, but wasn't available locally. Steps for feed preparation and other particulars in these two trainings were followed as per that in other trainings on carp feed preparation, but the die in hand pelletiser used by trainees had 0.8-1.0 mm diameter. In technical and practical sessions, trainees in 'Breeding and propagation of aquarium fishes and their feed preparation' were informed about egg laying and live-bearing ornamental fish species, techniques for producing young ones, rearing, total income and expenditure involved, feed and water quality management, precautions, medicines, glass aquarium tanks and equipment, live feeds, aerators, immersion heaters, zooplankton nets, polythene packets for selling fishes and other aspects.



*Home-made formulated fish feed dry mix.*



*Meat mincer for fish feed preparation.*



*Motor-operated grinder and fish feed production unit.*



*Portable hand pelletiser for pelleted feed preparation.*

## End note

Interested members of selected SHGs, belonging to small holder farm families, were called to participate in the four needs-based training programmes. It enriched participating women (110 representing 32 SHGs in all), provided self-confidence and skill. They were encouraged to begin on a small- to medium-scale, to ensure regular supply of quality fish feed adequately at affordable price to local carp farmers and aquarium fish growers, to be used within 2-3 months from date of manufacture. Farmers in turn will realise better profits, can procure it at the farm gate and will certainly reduce their production cost. Farm-made pelleted fish feed should be made available to fish farmers in every corner of West Bengal. Women SHGs can also manage mini fish feed mill (capacity 200 kg/hour at 80% efficiency, 8 hours/day), if installed. Photocopies of detailed required printed information material in Bengali on the two subjects of training were provided to head of each of the participating 32 SHGs. Hand pelletisers were handed over to them permanently by PACS officials for use in days to come, to give these trained SHG members a real idea on how to market and sell the prepared feed and get a good return.

The author participated in a two-day training on 'Fish nutrition and feeding management in aquaculture' two years ago (February 2-3, 2019) at the University of North Bengal. As feedback, we learnt that most SHGs had started putting the knowledge gained into practice at home sites after discussing among themselves and hopefully will continue on with it. PowerPoint presentations of the author with attractive self-taken photos and lucid text matter left a good impression in them. Trainees followed COVID-19 protocols, used masks, sanitiser, and maintained distancing. More extension-oriented technology transfer programmes on preparation of balanced farm-made pelleted fish feed will be organised in days to come with funding support from the Directorate of Cooperation, Directorate of Fisheries and Project Director, District Rural Development Cell under the West Bengal Government in different districts involving more SHGs, and a standard package of practice as appropriate rural technology may be provided to them.



# Farming of the anadromous shad, *Tenualosa ilisha*: Signs of taking off in India

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Clupeids are important food fishes in high demand and hence are heavily exploited across the World. Most tropical clupeids are un-domesticated and caught from the wild. The species, *Tenualosa ilisha*, belonging to the family Clupeidae, is an economically important food fish in India, Bangladesh, Myanmar, Arabian countries, Pakistan, Malaysia, Thailand, Viet Nam, and Sri Lanka. Locally called hilsa, the species forms a rich fishery worth over US\$ 2.0 billion in the northern Bay of Bengal and associated rivers in India, Bangladesh, and Myanmar<sup>1</sup>. By nature, the species is anadromous; spawns in freshwater stretches of rivers and the juveniles migrate to saline offshore waters for growth and maturation and again migrate back to freshwater stretches of rivers for spawning. The populations of the species are declining globally<sup>2</sup>, largely due to overexploitation and habitat modifications. Its fishery has drastically declined in the Bay of Bengal bordering India<sup>3</sup>. Considering the excessive demand and very high market price of the fish and to ease fishing pressure on its wild stocks, there have been efforts for domestication and farming of the species in India, besides legislated natural stock management efforts. The early efforts on breeding, larval rearing and grow out in captivity of the species were not measurably successful<sup>4</sup>. However, the momentum on developing captive breeding and farming technologies for the species have been re-invigorated with research funding from the Indian Council of Agricultural Research (ICAR), New Delhi, through a multi-disciplinary and multi-institutional project, 'Stock characterization, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*)' since 2012.

## Pond rearing

Under the above project, captive rearing trials were started in freshwater ponds, of which, this study involved a freshwater pond of 0.5 ha area having 1.5 m water depth, situated along the bank of the Bhagirathi-Hooghly river at Godakhali, South 24 Parganas District, West Bengal.

The trial was conducted to generate the much needed biological, nutritional, physiological and environmental data on pond culture for standardisation. The pond was cleared of all macrophytes and predatory fishes by repeated netting and complete drying of the pond until the bottom soil cracked. After ploughing and shaping, water from the river was let into a settling pond to remove excess sediments and undesired flotsam. Water was then let into the culture pond and the excess water was let out through the outlet. Sluices fitted with steel wire meshes (0.5 to 2 cm mesh) were installed at the water entry and exit points for prevention of entry of unwanted fishes into the pond and escape of the stocked hilsa. The water quality was monitored regularly. The pond received tidal water influx during high tides through the sluice gate. Among



A day's catch of hilsa from Tipi wetland.

the 26 water quality parameters monitored simultaneously in the river stretch and the pond water, the water current, depth, and turbidity were significantly lower in the pond, while calcium and total hardness were marginally higher, rendering the pond water quality largely suitable for the species.

When the pond rearing trials began, the artificial breeding and seed production experiments were in the initial stages and started in parallel, and thus hatchery produced seeds for stocking and grow out rearing were not ready. Hence, for stocking in the experimental grow out pond,



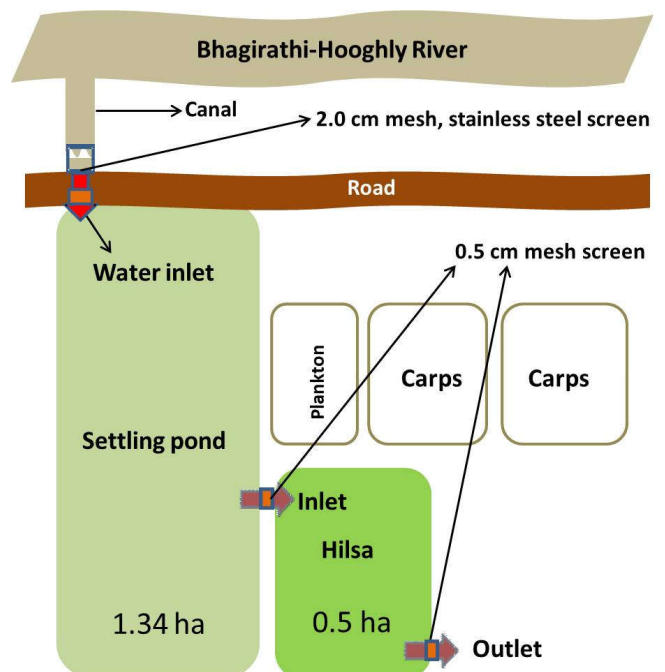


Netting for sample collection.

the seed materials were collected from natural sources during July-September. Juveniles were collected from the Bhagirathi-Hooghly River flowing nearby, using drag nets and lift nets of small meshes involving regular hilsa fishers and transported to the pond in well aerated circular containers of 500 l capacity. All possible care was taken to reduce stress to the fish during capture and transportation. The stocking size was  $7.12 \pm 1.25$  cm total length (TL) and  $5.85 \pm 1.5$  g in weight. The stocking density was 1,000/ha, considering the fast moving, plankton feeding nature of the fish and paucity of prior knowledge on appropriate stocking density. The river water brought natural food items of the species such as plankton into the pond, and plankton was also supplemented by collecting it from adjacent ponds fertilised in line with the culture of Indian major carps. The rearing trial was conducted for 22 months with a daily supply of plankton dominated by diatoms, copepods and cladocerans, which are among the major food items of the species. The length and weight increments were monitored monthly by sample netting.

From the initial size of stocking, the fishes grew to  $31.2 \pm 2.6$  cm TL and  $301.0 \pm 15$  g weight at the end of the trial. Being a clupeid, highly sensitive and having un-domesticated instincts, there were mortalities while netting and also due to other unknown causes. The dead specimens were usually found afloat after extensive decomposition, which constrained identification of the causes of mortality. The survival at the end of the trial was 23%. Due to the fast moving nature of the species, maintaining them in small land-based holding systems has been challenging. The low survival might have been due to some inadequacy in water quality, food avail-

ability or confinement of the pond. Extensive pond rearing trials are underway to standardise pond-based farming of the species.



Schematic layout of the ponds used for rearing hilsa.





Sample collection for growth monitoring.

## Potential for stocking in wetlands

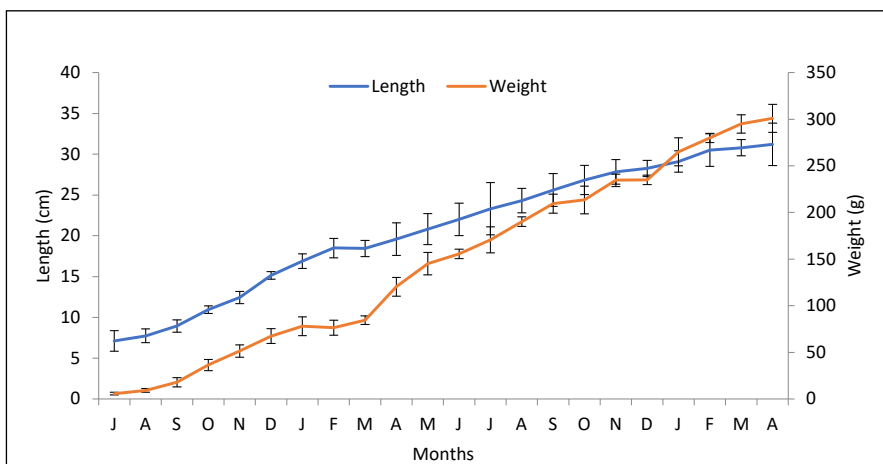
Though the species needs two different environments (saline and freshwater) during different stages of its life cycle, it has the potential to adapt to completely freshwater or low saline environments as evident from it being reported from wetlands<sup>5,6</sup>. This was also supported by an incidental harvest of the species

during the study period, in large numbers in commercial sizes from a floodplain wetland, locally called Tipi wetland, connected to the eastern bank of the river Ichamati in West Bengal. The wetland is about 120 km away from the sea face and within the tidal range from the Bay of Bengal. Having an area of 37.50 ha, the wetland receives water from river Ichamati and gets naturally stocked with freshwater and brackish water finfishes and shellfishes.



Water quality monitoring in the pond.

### Growth progression of hilsa reared in freshwater grow-out pond.

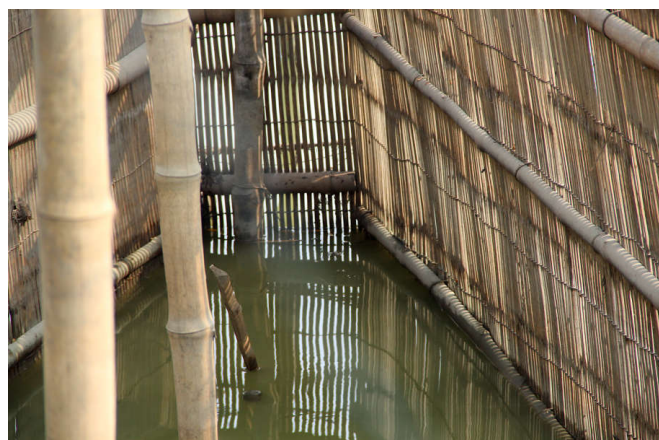


Size at harvest of hilsa from Tipi wetland.





Pond reared hilsa at marketable size.



Split bamboo screen sluice installed at water inlet.

Organised stocking of Indian major carps (*Gibilion catla*, *Cirrhinus mrigala* and *Labeo rohita*) along with exotic fish species (*Cyprinus carpio*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Oreochromis niloticus*) was also being practised by the wetland managers under a culture-based fisheries management mode, involving stocking and recapture of the stocked fish. The wetland maintained a depth of 1 to 1.5 m at minimum water level, which went up to 2.5 m during tidal feeding at high tides. The wetland has a majority sandy clay bottom and is devoid of dense macrophytes (as maintained by the wetland managers). The water quality was similar to fluvial ecosystems. The salinity, however, goes up to 9.0 ppt during April-May. The primary productivity estimated was 6.0 gC/m<sup>3</sup>/day, which indicated a moderate to highly productive nature. The wetland supported rich plankton resources with an abundance of diatoms, copepods and cladocerans. Water inlet and outlet to the wetland were managed through a connecting channel, regulated by a sluice gate fitted with bamboo mesh screens lined with HDPE net material.

Fishing in the wetland is seasonal from November to February, allowing the stocked fish seeds to grow to commercial sizes over a year. The total annual fish catch from the wetland was 45,000 to 60,000 kg, forming a yield of 1,216 to 1,621 kg/ha/year. Though hilsa has not previously been recorded from the wetland, a large quantity of it appeared in catches from the wetland during December 2015. The leaseholder of the wetland, Mr. Sanjoy Biswas, explained that when intensive fishing began in December, along with other stocked fish species, *T. ilisha* of marketable sizes appeared in 10 to 25 specimens each in daily catches, consecutively for a week. The total harvest of hilsa was 110 kg and was sold off at INR 400/kg, which was higher than the expected price of the stocked carps harvested. We recorded 22 specimens of at the size range 28.5 to 33.4 cm TL and 225.5 to 378.8 g in weight in a day's catch from the wetland. It appeared that the larval stages of hilsa have entered the wetland through the screens of the sluice gate during the breeding season (September-October) and grew in the wetland until the harvest in December next year. This showed that the rate of growth was faster in the wetland compared to the trial conducted in pond rearing. The ecological conditions of the wetland being fresh to mildly brackish and the availability of abundant food organisms, as well as the vast area for movement, must have supported the fast growth of the

species in the wetland. This incident suggested the possibility of stocking the species in wetlands of similar nature to successfully grow up to marketable sizes.

## Prospects

The encouraging rate of growth of the species in pond rearing trial and the harvest of auto stocked hilsa from the wetland demonstrated the potential of the species to grow in landlocked fresh to slightly saline water bodies to attain marketable sizes in one to one and half year. The possibility of utilising large wetland ecosystems for farming of the species, along with major carps would revolutionise hilsa production, once an adequate quantity of seed is available for stocking. Demonstrable captive breeding and seed production achievements having been made through stripping natural brooders<sup>7,8,9</sup> and the remarkable achievement of broodstock development in captivity and development of formulated larval and grow out feeds<sup>10</sup>, under the first phase of the project, farming of hilsa in captivity is taking off in India. With the second phase of funding from ICAR now in place, the species is currently under various stages of standardisation of broodstock development, captive breeding, larval rearing, and pond based aquaculture. Along with the ongoing efforts to breed and farm the species in ponds, trials on stocking them in wetlands of similar nature, which are abundant in West Bengal, may also prove to be a viable option for scaling up hilsa production.

## Acknowledgements

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# Some facts on cannibalism in *Wallago attu* and its management during captive seed production

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Wild caught *Wallago attu*.

*Wallago attu* is a bony fish in the Siluridae family and is considered to be a large catfish due to its large size availability in the wild, with fish reaching 45 kg. It is found in tanks, rivers, reservoirs and connected water bodies of the Indian subcontinent, Thailand, Vietnam, Cambodia and Indonesia. It is an excellent food fish due to high nutritional quality and softness of flesh, and lack of intramuscular spines. The shining silver colour of its body also attracts consumers.

This catfish is listed as an endangered species, and presently it is only available in the market occasionally, due to the decline of wild populations. Researchers from our institute have attempted captive production but encountered high losses due to cannibalism during its early life, which does not encourage its adoption for aquaculture. Cannibalism due to genetic and behavioural factors may persist throughout or disappear after certain life stage in many fishes, and may be species specific, but *W. attu* is known to be a highly predatory fish. It is necessary to understand the causative factors

governing cannibalism in this catfish. However, cannibalism can be initiated by rapid transfer from live to commercial feed, size differences during stocking, seasonal changes, feeding at long intervals, high density rearing, feed distribution, feeding method and size of feed etc. Many of these factors apply to this catfish as causes of cannibalism. Studies revealed that the management of some of these causes can reduce cannibalism during the seed rearing period for this species.

## Predatory nature of the catfish

*W. attu* is a mid-feeder in the water column. It may also swim on the surface or bottom of the water while feeding to seek an advantageous position for predation. Adults prefer to eat live fish or aquatic organisms. The fry are also predacious, showing cannibalistic tendencies. Certain morphological and anatomical adaptations favour its voracious predatory feeding



habit. The large, grasping mouth has a cleft that extends beyond the eye and bears a spacious buccal cavity. The lip region of the mouth bears sharp, backwardly directed teeth, which helps in holding the prey firmly without any chance of escape. The teeth-like gill rakers also serve as an additional grip on the prey. The folded internal wall of its bag shaped stomach provides a large space for bigger prey.

## Captive production

The male and female fish mature at the age of two and three years, respectively. *W. attu* is a monsoon breeder. Broodstock were regularly fed with boiled chicken viscera as feed along with low value live fish, which may serve as food at leisure. The bulging abdomen with round red papilla for female and pointed papilla as well as free oozing of milt in males were criteria for selecting broodstock of both sexes. Sometimes the optimum maturity of female fish was also judged by observing the uniform size of eggs through cathetering. Both male and female broodstock of 1.0-2.5 kg weight range were selected for induced breeding during June-July. The males and females were injected with Ovaprim (SGnRH + Domperidon) @ 0.3 ml. and 0.5 ml/kg body weight, respectively and kept separately. The fish were hand stripped after 8-10 hours post-injection and the eggs were mixed thoroughly with the stripped milt for 2-3 minutes before the addition of a little water and were released into circular hatching tank (1.5 m diameter, 1 m depth) with a provision of 3-5 litres water exchange per minute. The hatching of larvae started after 18-20 hours of incubation and was completed within 2-3 hours from the onset of hatching. The larvae were transparent and free swimming in nature. The initial weight and length of larvae were 2.0-3.0 mg and 5.6-6.5 mm, respectively. The larvae were transferred to rearing tanks for further rearing by feeding live feed or animal origin feed or in combination during the hatchery phase. Our experience on the cannibalism of larvae and its management during the hatchery rearing phase is described below.



*W. attu* mouth showing teeth in upper and lower jaw along with gill rakers.

## Causative factors of cannibalism and their management

### Rearing density

It is not wise to rear in high density during the larval or fry stages. Yield will be better using low-density rearing. Rampant cannibalism is obvious during high density rearing as the larvae have a more frequent chance of interaction. Predatory fry swim coolly with their siblings and bite them whenever they get a chance. Prey capture is always head or tail first, engulfing them gradually, and the movement of the predator becomes slow after swallowing the prey completely. Predatory larvae are ready

to consume another within hours. Hence rearing in low density improves survival by reducing interactions between fry.

### Rearing environment

Many of the Indian catfish species (*Clarias batrachus*, *Heteropneustes fossilis*, *Horabagrus brachysoma*, *Rita chrysea*, *Mystus cavasius* etc.) prefer dark environments or show hiding behaviour during some phase of their life in nature or during captive rearing. However, the rearing of larvae or fry in complete darkness does not help in reducing cannibalism. Vision might not play major role in predation during darkness, but probably the barbel and cutaneous sensory mechanisms are more important in detecting prey. However, rearing under red light improves the survival rate.

## Complexity of environment

Many predatory fishes at their early stage are reared in complex rearing environments with an aim to reduce interaction between the larvae or fry. The survival of *W. attu* larvae did not improve when shelters were provided in the rearing containers such as nets or thickly distributed plant twigs (*Hydrilla verticillata*). The predatory behaviour of the fish is responsible for its high cannibalism. The larvae or fry are never seen chasing prey. Rather, predatory larvae swim along with others and bite them whenever the opportunity arises. *W. attu* is a free swimmer and never seen hiding or seeking shelter.

## Provision of live feed

Provision of live feed as starter feed for these larvae was found to be suitable. The yolk sac is absorbed after around two days of life, after which they need immediate feeding with live feed such as mixed zooplankton, *Artemia* or chopped *Tubifex*. These feeds are suitable at their initial stage of life as their digestive system does not contain enzymes responsible for digestion of any complicated feed at an early age. Feeding the fish these live feeds in combination or one after another on regular basis serves to reduce cannibalism to some extent. *Artemia* or *Tubifex* are consumed instantly, and when fed a few hours apart from mixed zooplankton remain live in the water medium for longer period, which makes them suitable as a booster that larvae can consume at liberty between feedings.



Male brood fish (left) have a pointed genital papilla, whereas in females (right) it is rounded.

## Provision of animal origin feed

Fullness of stomach always reduces the desire for predation or cannibalism. It also depends on the suitable feed available during captive rearing. It was observed that the early life stages of the highly cannibalistic *W. attu* do not solely depend on the live feed as mentioned above. Trials of providing minced molluscan meat, fish muscle and liver revealed a high acceptability of liver meal by the larvae and fry, which lead to reduced predation to a large extent. Provision of this animal origin feed along with live feed also reduces aggression.

## Long intervals between feedings

Long intervals between feedings is not advisable while rearing a predatory fish. Hence over sufficient feed is supplied with an aim to allow larvae to feed at liberty. But a preferable feed like minced liver is not acceptable if it remains in water for a long time. Hence it is better to give the feed until they are satiated. The extra animal origin feed will decay and cause water quality problems if it remains in the water too long. Hence, frequent feeding at short intervals is necessary to reduce predation.

## Combination of feed

It is always advisable to provide suitable feed in combination to give fish enough scope to feed. The fullness of stomach may distract them from cannibalism. Live feed along with supplementary animal origin feed remains beneficial during rearing these larvae.

## Regular segregation

The larvae of this catfish begin their cannibalistic habit just after yolk sac absorption. Opportunistic larvae, after successful preying on their own kind, get an increased somatic growth rate. Hence, they achieve higher robustness and vigour after each predation, which in turn favours more frequent predation on weaker larvae. It is better to segregate them as quickly as possible to restrict their interaction with other slow growing larvae. Size variation is always considered to be a cause of dominance by larger individuals in a fish population.

## Conclusion

This catfish is cannibalistic. Keeping the larvae or fry full through frequent feeding is essential to reduce predation. Hence the feeding of suitable feed alone or in combination at regular intervals to the larvae, while rearing them under low population densities to reduce interactions, may reduce losses from cannibalism during their rearing phase.

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## Counting down to Aquaculture Millennium +20

Preparations towards the conference are well under way, and we are pleased to share some recent updates.

First, participation in the conference is free of charge – be sure to visit the registration page to apply! Already almost 2,000 people have registered. Of those over 1,000 are youth, 800 are women, with people hailing from 119 countries.

As an important change, Millennium +20 will be a hybrid conference, with a limited number of speakers and primarily local participants attending in person, and the rest attending virtually via video conference. While we would prefer to greet everyone in Shanghai in person, the ongoing COVID-19 pandemic, necessity for quarantine periods and associated uncertainties over international travel restrictions have urged a precautionary approach, we hope you understand.

On the positive side, a hybrid structure will allow far more people to attend, albeit virtually, thereby opening participation to many more stakeholders, most of whom would not have had the time or resources to travel. We will inform all participants on how to join the virtual event in the coming weeks.

Another positive development is that the entire GCA +20 will have simultaneous interpretation in the six United Nations languages: Arabic, Chinese, English, French, Russian and Spanish.

Under the guidance of the International Programme Committee, groups of subject experts are currently drafting nine thematic reviews of aquaculture. The reviews cover a full range of key issues impacting the future of aquaculture, and will be presented and discussed during the second day.

The draft thematic reviews will also be made available for comment by registered participants, with advanced drafts posted on the GCA website. Received comments, along with the discussion during the GCA +20, will be considered in the finalisation of the thematic reviews.

### Shanghai Declaration: Aquaculture for food and sustainable development

The Shanghai Declaration, a key output from the GCA +20, will represent a road map to optimise the role that aquaculture can play in achieving the 2030 Agenda for Sustainable Development.

A group of aquaculture experts has prepared a first draft, and a similar commenting process will be available to registered participants. We expect that a penultimate draft will be ready during the weeks prior to the GCA, with the final text adopted by the conference on the final day.

### Register to participate

To participate in the conference, please register at the conference website:

- <https://aquaculture2020.org/registration/>

We look forward to seeing you online in September!



# FAO Virtual Training Course on Surveillance and Monitoring of Antimicrobial Resistance in Aquaculture

*In collaboration with IHB-CAS and INFOFISH*

**26-30 July, 14:00-17:00 Bangkok time (GMT+7)**

Antimicrobials play a critical role in the treatment of diseases of humans, farmed animals, and plants. Antimicrobial resistance (AMR), however, is a growing and complex threat to global public health. It has been a worldwide problem in human and animal healthcare. Asia accounts for more than 87 percent of the world's aquaculture production, and antimicrobials are commonly used in aquaculture for the prevention and control of common aquatic animal diseases. Considering the scale of antimicrobial use in aquaculture in Asia, timely action is needed to address the AMR risks to the aquaculture industry.

Systematic and regular collection of high quality information on AMR in aquaculture is one of the most critical steps in mitigating AMR in this industry. The organisation of a regional training course is an appropriate entry point. This course primarily focuses on methodologies relevant to monitoring and surveillance of AMR in major bacterial pathogens of diseased aquatic animals in Asia. AMR monitoring and surveillance in aquaculture is not new in the region but experiences, approaches and capacities of the countries vary. Enhancing the coordination and strengthening capacities are necessary and of great regional value. It has been difficult to compare the data from aquatic animal pathogen programmes due to the lack of uniform sampling methods, susceptibility testing methods, test for antimicrobial agents, and interpretation criteria. These are the key elements to better understand the AMR status of bacterial pathogens in aquatic animals in a country. Countries are encouraged to adopt standardised, internationally harmonised antimicrobial susceptibility testing (AST) methods such as those published by the Clinical and Laboratory Standards Institute (CLSI). These methods provide reliable, reproducible data that can provide useful temporal trends in the occurrence and spread of AMR, and can identify emerging or specific resistance profiles.

The AMR action plan of FAO and One Health global strategy aim to foster wider awareness and develop the capacity for monitoring and surveillance of antimicrobial use (AMU) and AMR in aquaculture. Capacity for monitoring and surveillance is essential for the implementation of AMR national action plans. This training course is organised by FAO in collaboration with the Institute of Hydrobiology of Chinese Academy of Sciences (IHB-CAS), and INFOFISH. This is one of the efforts to enhance national capacity, through the support from an FAO regional technical cooperation programme: TCP/RAS/3702 Support Mitigation of Antimicrobial Resistance Risk Associated with Aquaculture in Asia.

## Objectives

- The main objective of this training is to enhance national laboratory capacity for effective surveillance and monitoring of AMR associated with aquaculture in Asia. The specific objectives are:

- To update participants on information on national AMU and AMR surveillance and monitoring.
- To familiarise participants with the regional guidelines on AMR surveillance and monitoring in order to have harmonised schemes of AMR surveillance and monitoring in aquaculture among countries.
- To facilitate collaboration on AMR monitoring and surveillance across the region.

## List of resource persons

- Dr Aihua Li, Professor, Aquatic Animal Health, Institute of Hydrobiology, Chinese Academy of Sciences (IHB-CAS), China, liaihua@ihb.ac.cn
- Dr Eduardo Leano, Expert on Aquatic Animal Health, Network of Aquaculture Centres in Asia-Pacific (NACA), Thailand, eduardo@enaca.org
- Dr Hu Kun, Director of the National Aquatic Pathogen Library, Shanghai Ocean University, China, khu@shou.edu.cn
- Dr Gaurav Rathore, Nodal Scientist of the Network Programme on AMR in Fisheries, Indian Council of Agricultural Research (ICAR), National Bureau of Fish Genetic Resources (NBFGR), Lucknow, India, grathore69@gmail.com
- Dr Christina Retna Handayani, Coordinator of Pest and Fish Disease Division, Directorate of Regional Aquaculture Development and Fish Health, Directorate General of Aquaculture, Ministry of Marine Affairs and Fisheries, Indonesia, handayani\_retna@yahoo.com
- Dr Thitiporn Laoprasert, Head of Aquatic Animal Health Research and Development Section, Division of Aquatic Animal Health Research and Development, Department of Fisheries, Ministry of Agriculture and Cooperatives, Thailand, tpetchinda@hotmail.com
- Dr Le Thi Hue, Deputy Head of Veterinary Drug Management Division, Department of Animal Health, Ministry of Agriculture and Rural Development, Viet Nam, LeHue1973@gmail.com
- Junxia Song, Senior Animal Health Officer, FAO AMR focal point, AMR unit head, Joint Centre for Zoonoses and Anti-Microbial Resistance (CJWZ), FAO, Italy.
- Dr Melba Reantaso, Aquaculture Officer, Lead Officer of Food Safety, Nutrition & Health, Fisheries Division, FAO, Italy, melba.

- Dr Patricia S. Gaunt, Professor, Aquatic Animal Health, College of Veterinary Medicine, Mississippi State University, USA.
- Dr Mary Gordoncillo, Regional Project Coordinator on AMR, FAO Regional Office for Asia and the Pacific (FAORAP), Thailand.
- Dr Yuting Deng, Associate Professor, Aquatic Animal Health, Pearl River Fisheries Research Institute, Chinese Academy of Fishery Sciences (PRFRI-CAFS).
- Dr Lan Jiang, Professor, Aquatic Animal Health, Pearl River Fisheries Research Institute, Chinese Academy of Fishery Sciences (PRFRI-CAFS), China.

## Registration and programme

To register for this event, or to view the programme details, please visit the INFOFISH website at the link below:

- <http://infofish.org/APFIC/index.php/amr-training>

*This article is reproduced courtesy of INFOFISH, from the link above.*

## Free webinar: Fish Vaccination: Theory, Innovations and Application

The Fish Health Section of the Asian Fisheries Society (FHS-AFS) invites all to a free Zoom webinar:

- When: August 4, 2021 (Wednesday); 13:00 PM Bangkok (GMT+7)
- Topic: Fish Vaccination: Theory, Innovations and Application

Please register in advance for this webinar. After registering, you will receive a confirmation email containing information about how to join the webinar. Register at the link below, or scan the QR code:

<https://bit.ly/fish-vaccination>

**Fish Health Section** | **Asian Fisheries Society**

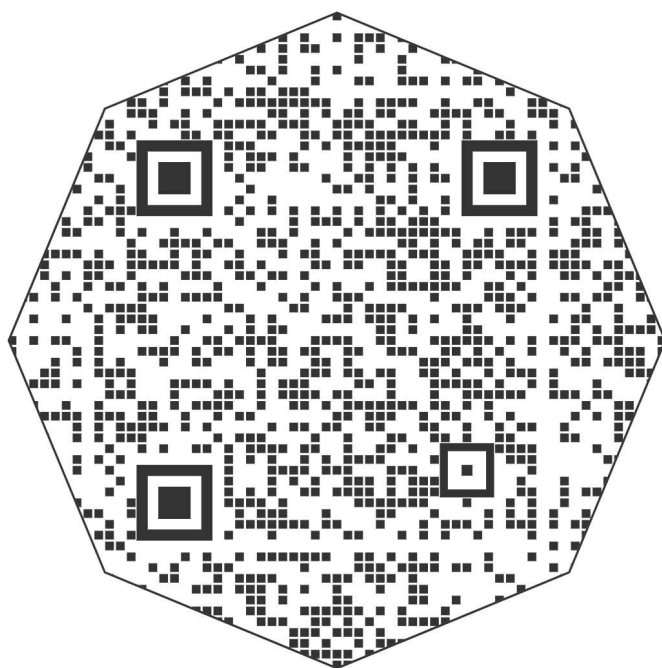
**Virtual Seminars on the Path to DAA11**  
(<https://www.daa11.org>)

**Fish Vaccination: Theory, Innovations and Application**  
(A Webinar)  
4 August 2021  
13:00-15:00 BKK time; GMT+7

**SPEAKERS:**

- DR. KIM THOMPSON**  
(Moredun Research Institute, United Kingdom)  
"Overview of fish vaccination - from principles to applications"
- ASSOC. PROF. WIN SURACHETPONG**  
(Kasetsart University, Thailand)  
"Tilapia lake virus: Understanding the host immunity and challenges for vaccine development"
- DR. ROBERTO CASCIONE**  
(VIRBAC, SEAsia and Middle East)  
"Fish vaccine: from vaccine development to field applications"

To join, please register in advance



## Quarterly Aquatic Animal Disease Report, October-December 2020

The Quarterly Aquatic Animal Disease report provides information about the status of aquatic animal disease in 21 participating states in the Asia-Pacific region. The diseases covered in the report are reviewed annually by the Asia Regional Advisory Group on Aquatic Animal Health. The report was first published in the second quarter of 1998. It is a joint activity between NACA, FAO and the OIE Regional Representation (Tokyo).

The 88th edition of the Quarterly Aquatic Animal Disease Report contains information from thirteen governments. The foreword provides an announcement on the new format for the Aquatic Animal Disease Report from January 2021 onwards. Download from: <https://enaca.org/?id=1155>



## Invasive disease linked to raw freshwater fish: Group B Streptococcus

In 2015, a bacterium called *Streptococcus agalactiae*, also referred to as Group B Streptococcus (GBS), caused a foodborne disease outbreak involving at least 146 people in Singapore, associated with the consumption of raw freshwater fish. The specific strain responsible for the outbreak was later identified as sequence type 283 (ST283). Invasive GBS ST283 disease is also found in other countries in and around Southeast Asia.

FAO has published a fact sheet and a risk profile for GBS ST283, which are available for free download. These documents provide guidance on risk reduction, and practical recommendations for food safety competent authorities.

Downloads:

- Fact sheet: <http://www.fao.org/3/cb4901en/cb4901en.pdf>
- Risk profile: <http://www.fao.org/3/cb5067en/cb5067en.pdf>



## International Crustacean Symposium 2021

The International Crustacean Symposium 2021 will be held from 7-9 December 2021 in Bushehr, Iran. The symposium is hosted by the Iranian Fisheries Science Research Institute. The theme of ICS 2021 is "New Approaches and Strategies for Sustainability of the Crustacean Industry and Adaption to Future Challenges".

The event aims to provide a sustainable platform for the participants to exchange information, ideas, and experience and also provides a unique opportunity to review the advances in the crustacean aquaculture industry development and sustainability of capture fisheries.

The symposium will feature presentations by keynote speakers on various general topics with participation of distinguished experts and decision makers, followed by poster presentations.

The official language of the symposium will be English. Abstracts of papers should be submitted by 20 July 2021. Researchers who are interested in publishing their paper in peer-reviewed scientific journals can submit their full paper after acceptance of their abstract.



**Network of  
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Asia-Pacific**

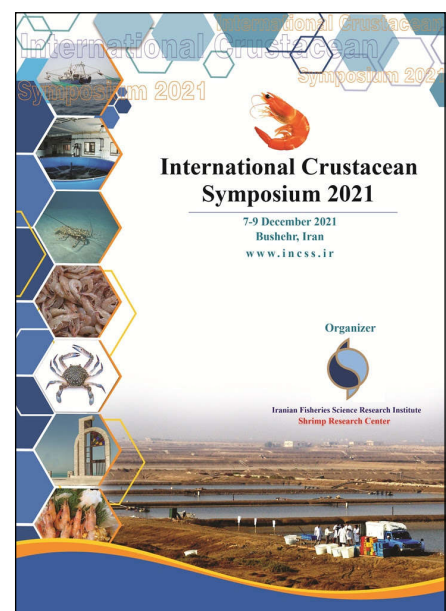
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NACA is a network composed of  
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Asia-Pacific Region.



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Workshops on the main topics of crustacean industry and a fisheries industry expo will be held during this event.

Web site: <https://www.incss.ir>