

## Chadag Vishnumurthy Mohan: Rising tide of resistance

**Aquaculture is the world's fastest growing food-production sector, but as the industry grows, so does the amount of antibiotics used to keep farmed fish free of disease. Chadag Vishnumurthy Mohan, lead scientist at World Fish, a non-profit research organization in Penang, Malaysia, spoke to *Nature* about what must be done to keep antimicrobial resistance at bay.**

### Why are antibiotics used in aquaculture?

When there's an outbreak of disease on commercial fish farms, farmers tend to add antibiotics into the feed, even if they don't know whether it's a virus or bacteria that's causing the problem. Low- and middle-income countries in Asia and Africa, such as Bangladesh and Nigeria, often lack the tools to diagnose fish diseases, so the overuse of antibiotics is a particular problem there. These countries also often have fewer restrictions on the sale of antimicrobials compared with countries in Europe and elsewhere. And even when antibiotic use is regulated, the rules are often not strictly enforced.

### How does antimicrobial use in aquaculture cause problems for people?

Aquaculture is now widely accepted as one of the contributors to the rise in resistance in microorganisms that infect people. This rise begins with the presence of antibiotics in water excreted by fish, or in fish products themselves.

At World Fish, we're working closely with The International Water Management Institute (IWMI) in Colombo, Sri Lanka, to study how antimicrobials travel from aquaculture areas into other environments, such as estuaries and waste water. We also want to understand the transport of antibiotic-resistant bacteria in these water systems, with the goal of predicting where concentrations of resistant microbes are likely to be high.

### What else is being done to understand the industry's contribution?

Research in aquaculture has conventionally focused on a single pathogen at a time. But metagenomics tools can provide a snapshot of all the genetic material in an environment and reveal the complex community of



**Chadag Vishnumurthy Mohan investigates antimicrobial use in aquaculture.**

microorganisms in aquatic systems, known as the microbiome. Researchers in the United Kingdom have shown that some combinations of microbes are less favourable for the health of farmed aquatic organisms, and that some can protect against disease (W. Bass *et al. Trends Ecol. Evol.* **34**, 996–1008; 2019). We are seeking to characterize these disease-promoting environments and identify markers for them so that the microbiome can be used as an early-warning tool to assess the distribution and density of disease and antimicrobial resistance in certain locations.

### Has anywhere managed to significantly reduce antibiotic use?

Norway was one of the biggest users of antibiotics in farmed salmon 30 years ago, but it now uses almost none. It succeeded because it invested heavily in research and development to prevent, rather than treat, a bacterial disease called furunculosis. Now, salmon are often vaccinated against the disease and another one, called vibriosis.

Vietnam is taking a similar approach for catfish. The problem is, however, if a vaccine is developed in, say, Vietnam, it can't automatically be used in other big catfish producers such as India or Bangladesh. Data

on the vaccine's effectiveness have to be collected for a specific region, leading to a lengthy approval process in each country.

### What else needs to be done?

Ultimately, it's down to driving a change in behaviour. Education and raising awareness among farmers is key. Researchers should also explore whether rewarding farmers who use minimal antibiotics, such as through certification programmes, can help to reduce use.

Such incentives already exist in some parts of Asia. In Vietnam, Indonesia and India, for example, high-value aquaculture products, such as prawns, are subject to certification, which is often required for export. But similar approaches for foods for local communities, such as carp and tilapia, are yet to take off because many small farmers can't afford the expensive process of becoming a certified producer. And only a minority of consumers are swayed by a certification of sustainability — many are more concerned about the price.

### Interview by Natalie Healey

This interview has been edited for length and clarity.