POLICY BRIEF 2016

ANTIBIOTIC USE AND WASTE MANAGEMENT IN AQUACULTURE

CSE RECOMMENDATIONS BASED ON A CASE STUDY FROM WEST BENGAL

Centre for Science and Environment
New Delhi, India

Research director: Chandra Bhushan
Writers: Amit Khurana and Rajeshwari Sinha
Editor: Archana Shankar
Cover design: Ajit Bajaj
Production: Rakesh Shrivastava and Gundhar Das

Citation: Chandra Bhushan, Amit Khurana, Rajeshwari Sinha, 2016, *Antibiotic use and waste management in aquaculture: CSE recommendations based on a case study from West Bengal,* Centre for Science and Environment, New Delhi

Published by
Centre for Science and Environment
41, Tughlakabad Institutional Area
New Delhi 110 062
Phones: 91-11- 40616000
Fax: 91-11-29955879
E-mail: cse@cseindia.org
Website: www.cseindia.org

INTRODUCTION

Antimicrobial resistance (AMR) arises when micro-organisms survive exposure to a drug that would normally kill them or stop their growth. Antibiotic resistance (ABR) specifically is resistance to antibiotics that occurs in bacteria. It is globally recognized as an emerging public-health threat as antibiotics are becoming increasingly ineffective against disease-causing bacteria. ABR can lead to greater spread of infectious diseases, difficulty in treating common infections, uncertainty in success of high-end procedures, longer hospital stays and more expensive treatments. By 2050, AMR is estimated to lead to 10 million deaths per year and lost outputs worth US $100 trillion across the world.[1]

Antibiotic use leads to the emergence of ABR. Its misuse and overuse in both humans and animals accelerates it. In intensive food-animal production settings, as in poultry, pig and fish farms, antibiotics are routinely used for reasons other than treating sickness, i.e. for non-therapeutic purposes such as growth promotion and mass disease prevention.[2] Rampant use can lead to greater transfer of antibiotic residues and resistant bacteria into humans through food, direct contact and the environment.

There is an increased momentum the world over to address the threat from rising ABR. The World Health Organization (WHO) adopted a Global Action Plan to contain antimicrobial resistance in 2015 and member countries are to submit their respective National Action Plans by May 2017. The Plan recognizes the need to limit misuse and overuse of antimicrobials in humans and animals as well as contain the environmental spread of resistance. Global leaders have also committed to act on AMR at this year's United Nations General Assembly in September.

Addressing ABR is of huge significance to India because of the high prevalence of infectious diseases and limited focus on their prevention and control. So far, Indian efforts have been focused on addressing the human side of the problem. But efforts now must be directed towards limiting antibiotic misuse in animals.

The Centre for Science and Environment (CSE) in 2014 highlighted the rampant use of antibiotics in the poultry sector and presence of antibiotic residues in chicken meat. Earlier, in 2010, CSE had also found similar antibiotic-use practices in bees for honey. We now travelled across several districts of West Bengal—a major fish-producing state in India—and investigated into antibiotic-use and waste-management practices in aquaculture.

Our study shows that misuse and overuse of antibiotics is widespread in both brackish-water and freshwater fisheries in West Bengal. Our secondary research shows that this practice is common in other major fish-producing states like Andhra Pradesh. In states such as Bihar, Jharkhand and Odisha, use of antibiotics is slowly picking up.

Though there are standards, guidelines and an institution (even though weak) to manage the use of antibiotics and pharmacologically active substances in export-oriented brackish-water aquaculture, there are no regulations or an institutional setup for freshwater fisheries that accounts for two-thirds of India's fish production. In other words, while we are protecting the health of our export customers, we have no concern for domestic consumers.

Aquaculture, especially freshwater culture, will be a very important part of the agriculture sector in many landlocked states of the country. The potential to diversify, in an environmentally sustainable manner, into brackish water aquaculture in coastal states is also high. However, this sustainable growth can only happen if we do not fall into the trap of 'law of diminishing returns', by misusing and overusing antibiotics and other pharmacologically active substances.

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062, India, Ph: +91-11-40616000 Fax: +91-11-29955879
E-mail: s_rajeshwari@cseindia.org, k_amit@cseindia.org Website: www.cseindia.org

How bacteria become resistant

The emergence of resistance is a natural process. However, it accelerates and spreads by antibiotic misuse and overuse. While some bacteria are naturally resistant, antibiotic use exerts greater selection pressure on bacteria, causing susceptible populations to die and resistant ones to survive. At a cellular level, resistance is acquired through mutations in bacteria or transfer of genetic material (such as resistance genes) from other bacteria through horizontal transfer. Subsequently, the bacteria undergo structural and chemical alterations that render the antibiotic ineffective. These changes may include one or more of the following: reduced membrane permeability to the drug, alteration of the drug-binding site at the cell wall, enzymatic degradation of the drug and normal function of bacteria bypassing the drug-affected enzyme or pathway.

FISHERIES SECTOR IN INDIA

The fisheries sector includes fish that is captured from seas and rivers and those cultured in farms. In India, total fish production was 100.7 lakh tonnes in 2014–15. Over 65 per cent of this was from inland fisheries and the remaining from marine fisheries. The sector contributes a little less than 1 per cent to the Indian Gross Domestic Product.[3] Andhra Pradesh produces the highest quantity of fish (*see Table 1: Contribution by top five fish-producing states [2013–14]*).

Table 1: Contribution by top five fish-producing states (2013–14)[4]

	Contribution to Indian fish production (%)
Andhra Pradesh	21.1
West Bengal	16.5
Gujarat	8.3
Kerala	7.4
Tamil Nadu	6.5

Source: Handbook on Fisheries Statistics 2014, DADF; Note: Percentage contribution of states calculated based on total Indian fish production in 2013–14, 95.8 lakh tonnes

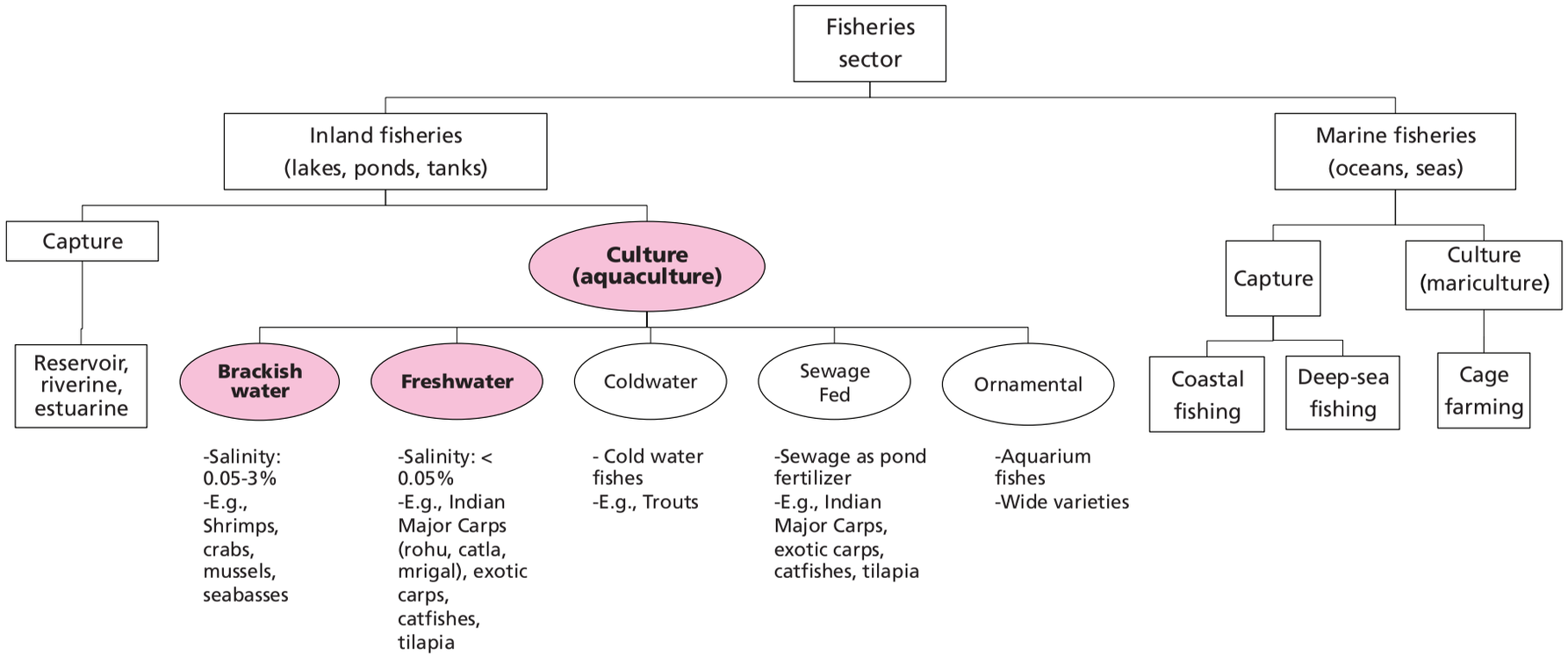
India ranked second in global aquaculture (farmed fish) production, with a share of about 6.6 per cent in 2014.[5] Inland aquaculture includes mainly culture in freshwater and brackish water (*see Fig. 1: Overview of the fisheries sector in India*). While fish from freshwater is primarily meant for domestic consumption, those from brackish water are largely exported. In 2014, the share of freshwater aquaculture in inland fisheries was 43.9 lakh tonnes, which is about 67 per cent of the total inland fish production.[6] The export sector is growing steadily, with 10.5 lakh tonnes of fish and fish products worth Rs 33,441 crore exported in 2014–15.[7] Frozen shrimps and fresh/frozen fish are key categories.[8]

Fisheries in West Bengal

With 16.7 lakh tonnes of fish production in 2014–15, West Bengal is the second largest fish-producing state.[9] It contributes over 16 per cent to Indian fish production. Of the 14.4 lakh tonnes of state inland-fish production, about 84 per cent is from freshwater culture, indicating a large contribution from inland freshwater farming.[10] West Bengal is also a major fish seed producer, accounting for 37–40 per cent of India's production.[11] About 70–80 per cent of the fish export from West Bengal is from brackish-water aquaculture.[12]

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062, India, Ph: +91-11-40616000 Fax: +91-11-29955879
E-mail: s_rajeshwari@cseindia.org, k_amit@cseindia.org Website: www.cseindia.org

Fig.1: Overview of the fisheries sector in India



Acknowledgement: Scope of fisheries, DADF

REGULATIONS AND GAPS

There is no comprehensive regulatory framework for freshwater culture. Guidelines are available only for tilapia, a freshwater fish. In contrast, coastal aquaculture guidelines are focused on export-oriented brackish-water culture. The current Indian standards for antibiotics in fish and fish feed largely draw from guidelines meant for coastal aquaculture *(see Table 2: Antibiotic use and waste management—key regulations/guidelines and gaps).*

Table 2: Antibiotic use and waste management—key regulations/guidelines and gaps

Key guidelines/ regulations	Key features	Gaps
Guidelines for Coastal Aquaculture, CAA Rules, 2005[13]	• Does not recommend semi-intensive and intensive farming • Prohibits a set of antibiotics;* provides MRLs in fish and fishery products for four antibiotics;** sets MRLs as 'nil' for other antibacterial substances • Mandates individual ETS for hatcheries and farms >5 hectares (ha); common ETS for < 5 ha • Provides standards for effluent discharge	• List of banned antibiotics is limited. Many can still be used as long as residues are not detected • Does not recognize non-therapeutic use
IS 16150 (Part 1–4): 2014, Fish feed specifications by BIS for carp, catfish, marine shrimp, freshwater prawn	• Prohibits use of a set of antibiotics in fish-feed manufacturing units*	• Guidelines are voluntary • Allows use of many other antibiotics as long as labelled • Does not regulate feed premix
Food Safety and Standards (Contaminants, Toxins and Residues) Regulations, 2011[14]	• Prohibits a set of antibiotics in sea-food processing units* • Provides tolerance limit for four antibiotics in seafood and fish/fish products **	• No list of prohibited antibiotics in fish/fish products • No provision for monitoring residues of antibiotics other than four with tolerance limits and leaves them unregulated
Rule 97 of Drugs and Cosmetics Rules 1945[15]	• Container of a veterinary medicine to be labelled 'Not for human use; for animal treatment only' and to bear a symbol depicting the head of domestic animal and withdrawal period of drug	- Does not mention if this is applicable/not applicable to fish; should be done to avoid confusion
Guidelines for culture of specific pathogen free *L. vannamei* in fresh water/inland farms[16]	• Prohibits use of certain antibiotics;* provides MRLs for only four antibiotics in fish/fishery products** • Recommends ETS for farms connected to open water sources adjoining brackish water areas; quality of water to conform to SPCB standards	• List of banned antibiotics is limited. Many could still be used as long as residues are not detected
Guidelines for responsible farming of tilapia[17]	• Recommends screening and treatment of outlet water before release during culture or post-harvest	• No standards specified for outlet water • Does not address antibiotic use
Effluent standards as per Environment (Protection) Rules, 1986	• General standards available for effluent discharge[18] • Industry-specific standards available for slaughter-house, meat-processing and sea-food industry	• No specific standards available for waste from aquaculture farms

* Nitrofurans including furaltadone, furazolidone, furylfuramide, nifuratel, nifuroxime, nifurprazine, nitrofurnatoin and nitrofurazone; neomycin, chloramphenicol, nalidixic acid, sulphamethoxazole, dapsone, sulfanoamide drugs (except approved sulfadimethoxine, sulfabromomethazine and sulfaethoxypyridazine), fluoroquinolones and glycopeptides

** Tetracycline, oxytetracycline, trimethoprim, oxolinic acid

Abbreviations: CAA: Coastal Aquaculture Authority; MRL: Maximum Residue Limit; ETS: Effluent Treatment Systems; BIS: Bureau of Indian Standards; SPCB: State Pollution Control Board

ANTIBIOTIC USE IN WEST BENGAL AQUACULTURE

Considering the significant contribution of West Bengal to Indian fish production, CSE decided to travel to key fish-producing districts in West Bengal to understand the practice of antibiotic use and waste management. Cumulatively, these districts accounted for about 52 per cent of the total fish produced in the state (*see Table 3*: *Fish production in key districts of West Bengal [2014–15]*). We visited a total of 22 farms, including six hatcheries, in May 2016. The research included traditional, semi-intensive and intensive freshwater and brackish-water farms and onsite discussions with farmers and farm owners. Inputs were also gathered from representatives of stakeholder government departments in the state and at the Centre, and pharmacists and feed suppliers at the local level.

Table 3: Fish production in key districts of West Bengal (2014–15)[19]

District visited	Inland fish production (lakh tonnes)	Contribution to total fish production in West Bengal (%)*
North 24 Parganas	1.94	11.6
South 24 Parganas	1.80	10.8
Purba Medinipur	1.59	9.5
Bardhaman	1.40	8.4
Nadia	0.98	5.9
Hooghly	0.96	5.8

* Total fish production is 16.7 lakh tonnes

Key findings

Antibiotic use is rampant across freshwater farms, brackish-water farms as well as hatcheries. Mostly, it is routine use aimed at mass disease prevention to maintain high productivity in farms. In almost half the cases out of 22 farms and hatcheries, routine antibiotic use was accepted or an evidence of antibiotic use was found on-site. Most of these are intensive farm settings, such as those from Purba Medinipur. Many of the remaining farms and hatcheries, such as in districts like North 24 Parganas, practise traditional aquaculture that does not involve the aggressive use of drugs and chemicals.

In general, antibiotics that were found to be used across farms and hatcheries include those not permitted, not labelled for use in fish or critically important for use in humans *(see Table 4: Antibiotics found to be used in West Bengal freshwater or brackish-water culture).* Given through feed and/or water, such mass preventive measures result in antibiotic exposure to entire fish stocks, including uninfected fish. Planned routine use of antibiotics is more prevalent in hatcheries than in farms to prevent infection in larvae or fry. Several issues contributing to such misuse and overuse of antibiotics were evident.

Types of fish farming

- **Traditional/extensive farming** entails both mono- and polyculture in large impoundments, with natural stocking and feeding, tide-based water exchange and no/minimal use of drugs and chemicals.
- **Semi-intensive farming** is characterized by monoculture, use of large ponds of uniform size, low stocking densities and occasional supplementary feeding. Fertilizers are used to develop plankton.
- **Intensive farming** entails large-scale fish production and is characterized by monoculture, high stocking density, regular use of supplementary feeds as well as drugs and chemicals, regular aeration and pump-based water exchange within a limited pond area.

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062, India, Ph: +91-11-40616000 Fax: +91-11-29955879
E-mail: s_rajeshwari@cseindia.org, k_amit@cseindia.org Website: www.cseindia.org

Table 4: Antibiotics found to be used in West Bengal freshwater or brackish-water culture

Antibiotic	Importance to human medicine*	Status as per CAA guidelines for brackish water
Oxytetracycline	Highly important	Permitted
Tetracycline	Highly important	
Enrofloxacin	Critically important	Prohibited
Ciprofloxacin	Critically important	
Norfloxacin	Critically important	
Ampicillin	Critically important	Not specified**
Dicloxacillin	Highly important	
Amoxicillin	Critically important	
Azithromycin	Critically important	
Cephalexin	Highly important	
Streptomycin	Critically important	
Kanamycin	Critically important	

*As per the WHO list of Critically Important Antimicrobials for Human Medicine (2011). ** This leads to a gap, i.e. such antibiotics could potentially be used as long as their residue is not detected

Unregulated availability of antibiotics

- **Over-the-counter (OTC) sale of antibiotics:** Antibiotics are Schedule H drugs—to be sold on prescription—but were found to be sold by pharmacists over the counter to farmers across districts. The antibiotics included ampicillin, amoxicillin, tetracycline, oxytetracycline, azithromycin, cephalexin, streptomycin and kanamycin.

  Unsupervised availability of antibiotics leads to indiscriminate use. Quacks at the local level were also said to have tie-ups with pharmacists, leading to overuse and misuse of antibiotics. Limited staff was cited as a reason for inadequate checking of OTC sale by concerned district drug-control representatives. With sole aim of productivity at farms, antibiotic use was found to be an easy and economical substitute for investment in better hygiene and sanitation at farms.

- **Use of antibiotics labelled for animals but not for fish:** Farmers were found to use veterinary grade antibiotics labelled for use in poultry or livestock, but not specifically fish. These include enrofloxacin, cephalexin, oxytetracycline and tetracycline. There was limited awareness aboout required dosage, which could vary depending on the body mass of animal or fish. Administered antibiotic dosage therefore varied among different farms and was based on farmer experience and word of mouth. Since the antibiotics used were not labelled for fish, there was no information on the withdrawal period. In such a scenario, there is no question of withdrawal periods being followed. When the absence of drugs approved specifically for fish was enquired about with the state drug control authority, CSE was asked to check with the Central Drug Control and Standards Organization (CDSCO).

- **Use of antibiotics labelled for use in humans:** Since there is inadequate check, antibiotic tablets and capsules meant for human use, such as those ampicillin, azithromycin, amoxicillin, ciprofloxacin, were also found to be sold. Most of these are critically important for humans. Farmers believed that if an antibiotic works for humans, it will work for fish and that such use has been fruitful in the past.

No professional disease management in fisheries

- **Fisheries science professionals not adequately trained and authorized to prescribe medicines:** There is little focus on fish pharmacology—the science of drugs—in the curriculum of fisheries science.[21] However, the responsibility of fisheries rests solely on

Antibiotic residues continue to be detected in fish/shrimp meant for export

Although the use of antibiotics in shrimp culture was mostly denied by farmers in West Bengal, the detection of residue positive samples and rejection of export consignments validate rampant use of antibiotics in fish and shrimp culture. In 2015, the list of noncompliant samples by the National Residue Control Plan for Aquaculture Products confirms the use of antibiotics such as chloramphenicol and nitrofuran in shrimp culture across India, including West Bengal.[20] Both these antibiotics are prohibited for use in shrimp culture. In May 2016, India recorded its highest number of rejections in shrimp exports over the last 15 years by the US Food and Drug Administration. Again, this was due to presence of banned nitrofuran and chloramphenicol. During 2012–15, European countries reported about 17 cases of Indian shrimp export products containing furazolidone, nitrofurazone and chloramphenicol or exceeding amounts of oxytetracycline.

fishery officers of the Department of Fisheries in the concerned state. Typically, fishery officers are graduates, postgraduates and PhDs and are not authorized to prescribe medicines. They are not registered medical practitioners or doctors for fish. This points towards a key policy gap. With no authorized prescription, how are Schedule H drugs such as an antibiotics dispensed by pharmacists?

Further, there is little thrust on fish diseases in the veterinary curriculum.[22] At the block level, therefore, livestock development officers or veterinary officers of the animal husbandry department do not cater to issues related to fisheries.

- **Farmers rely largely on peers, quacks, company representatives and self- discretion:** Farmers use antibiotics for fish irrespective of whether the infection is viral, bacterial or parasitic. They rely largely on inputs from big farmers, peers, quacks or company technologists who visit farms to sell their products. They also exercise self discretion. If a farmer seeks guidance from a fishery officer, it may not always be available because of additional administrative responsibilities on the officer and limited staff.

- **Inconsistency in recommending antibiotic use:** Handbooks and pamphlets circulated during training at district fisheries offices recommended the use of furazolidone, terramycin and chloramphenicol for disease prevention and treatment. Their use as growth promoters was also suggested, especially during winter when there is retarded growth. Antibiotics like furazolidone or chloramphenicol are prohibited for use in brackish-water culture. On the other hand, antibiotic-laden feed premixes that are promoted online for improving growth and body weight in fish can also influence use of antibiotics including those prohibited (*see Table 5: Feed premix with antibiotics promoted online for improving growth and body weight in fish [examples]*).

Table 5: Feed premix with antibiotics promoted online for improving growth and body weight in fish (examples)

Company	Brand	Antibiotic present
Neospark	Oxy-100-FS[23]	Oxytetracycline
Advanced Aqua Biotechnologies	DOX-ADD[24]	Doxycycline
	ADDCIP-M[25]	Ciprofloxacin
	FURZAZ-20[26]	Furazolidone
	OXYTREAT-5[27]	Tetracycline
Kaizen Biosciences	DOX-KZ[28]	Doxycycline
	OXYTREAT-10[29]	Oxytetracycline
	FURA TREAT-20[30]	Furazolidone
Vibrac India	Laybro Mix[31]	Colistin sulphate, Doxycycline

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062, India, Ph: +91-11-40616000 Fax: +91-11-29955879
E-mail: s_rajeshwari@cseindia.org, k_amit@cseindia.org Website: www.cseindia.org

WASTE MANAGEMENT IN WEST BENGAL AQUACULTURE

Aquaculture waste is largely liquid. It also contains unconsumed fish feed, dead fish, plankton, faecal matter, eggshells and chemicals, including antibiotics. All waste except chemicals can increase the organic load in water, which can act as a source of nutrition for bacteria, helping them to multiply. Continuous interplay between antibiotics and bacteria in water and wastewater can increase the reservoir of antibiotic resistance in the aquatic environment. Wastewater treatment can reduce the organic load and limit growth of bacteria, including those which are resistant. It can also help prevent easy passage of antibiotic residues into the environment.

CSE observed the following inadequacies in aquaculture waste management in West Bengal:

- **Discharge of untreated wastewater is common:** Across districts, farms and hatcheries, wastewater was discharged without treatment into canals from which the water was sourced, let out into sewage drains, reused in broodstock ponds or released into agricultural fields. Also, periodic water exchange was not practised. Solid waste on the other hand, including expired antibiotics, was disposed of by burying it in pits and that too in some cases.

- **Effluent Treatment System (ETS) not set up anywhere:** ETS comprises a sedimentation pond, a bio pond and an aeration pond. It helps remove large solid waste from effluents and disinfect water. There was no ETS observed in any farm or hatchery across six districts. Also, there was no form of either a sedimentation pond or aeration pond in place for large and small farms alike. This is despite the fact that the CAA guidelines for shrimp aquaculture mandate ETS for all hatcheries and farms above 5 ha, with 10 per cent of the total farm area to be designated for the same. While big farmers are found unwilling to invest in setting up an ETS, medium to small farmers are either unaware or prefer utilizing the designated ETS area for fish farming instead. Also, there is minimal supervision by the concerned Department of Fisheries or Coastal Aquaculture Authority because of limited human resources and outreach constraints.

- **No pollution monitoring by state pollution control board:** The Central Pollution Control Board (CPCB) along with the State PCBs is responsible for waste management. Aquaculture is considered more of agriculture than industry and waste from it is therefore not a priority for both. The Ministry of Environment, Forest and Climate Change (MoEFCC) does not include aquaculture in its categorization of industries with pollution-causing potential.[32] The CPCB as per the Environment (Protection) Rules, 1986 has set effluent standards for industry-specific settings like slaughter-houses, meat-processing and sea-food industry, but no such specific standards are present for aquaculture farms. However, the general standards for discharge of effluents apply. For brackish-water farms, the CAA guidelines for effluent standards are applicable *(see Table 6: Effluent discharge—CAA standards and general standards by CPCB)*. There are no standards for antibiotic residues in fish-farm waste by both.

- **Noncompliance of CAA guidelines:** Despite the CAA guidelines discouraging the conversion of agricultural land for aquaculture, most brackish-water farms were said to have been converted from agricultural lands taken on lease. This was also observed in the case of freshwater farms. Shrimp farm registration is mandatory with ETS as a prerequisite. However, the ground reality is different. It was understood that small farmers are not motivated by benefits of registration and big farmers often try to sidestep requirements. Moreover, intensive shrimp farming is widely practised despite CAA recommending only traditional/improved traditional and scientific extensive systems.

Table 6: Effluent discharge—CAA standards and general standards by CPCB

Parameter*		Standards for wastewater discharged from aquaculture farms, hatcheries, feed mills and processing units by CAA		General standards for discharge of effluents by CPCB			
		Coastal marine waters	Creeks estuaries when same inland water course is used as water source and disposal point	Inland surface water	Public sewers	Land for irrigation	Marine coastal areas
pH		6.0–8.5	6 .0–8.5	5.5–9.0	5.5–9.0	5.5–9.0	5.5–9.0
Dissolved Oxygen (DO), mg/l		Not less than 3	Not less than 3	–	–	–	–
Suspended solids, mg/l		100	100	100	600	200	100 (for process waste-water)
Free ammonia (as NH_3–N), mg/l		1	0.5	5.0	–	–	5.0
Biochemical Oxygen Demand (BOD), mg/l Max	3 days, 27°C	–	–	30	350	100	100
	5 days, 20°C	50	20	–	–	–	–
Chemical Oxygen Demand (COD), mg/l Max		100	75	250	–	–	250
Dissolved phosphate (as P), mg/l Max		0.4	0.2	5.0	–	–	–
Total nitrogen (as N) mg/l		2.0	2.0	–	–	–	–

*Source: General Standards for Discharge of Environmental Pollutants [The Environment (Protection) Rules, 1986]; Guidelines for regulating Coastal Aquaculture; '–' means no standard available; *Parameters are limited to those present in CAA guidelines*

Evidence: Antibiotic resistance from aquaculture

International studies over the last decade have highlighted that antibiotic use in aquaculture can contribute to the spread of antimicrobial resistance in the environment. Antibiotic resistant bacteria such as *Pseudomonas* spp., *Aeromonas* spp., *Enterobacter* sp., *Enterococcus* spp., *E.coli*, *Vibrio* spp., *Bacillus* spp., *Acinetobacter* sp. and resistant genes have been isolated not only from fish samples but also from aquaculture sites, pond water and bottom sediments, larval-rearing tanks, water and sediments from receiving environment.

In India, however, there has been no comprehensive assessment of antibiotic use or resistance in aquaculture and not much data exists in the public domain. Just few studies have been conducted wherein resistant *Aeromonas* spp., *E. coli*, *Vibrio* spp., *Salmonella* sp. and *Staphylococcus* sp. have been isolated from freshwater fish and shrimps. Resistant *Vibrio* spp. from shrimp culture environment and heterotrophic bacteria from freshwater culture environment has been reported.

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062, India, Ph: +91-11-40616000 Fax: +91-11-29955879
E-mail: s_rajeshwari@cseindia.org, k_amit@cseindia.org Website: www.cseindia.org

CSE RECOMMENDATIONS—A COMPREHENSIVE SET OF MEASURES TO LIMIT ANTIBIOTIC USE AND MANAGE WASTE IN AQUACULTURE TO CONTAIN ABR

The growth of the fisheries sector is of huge significance because of its potential to support nutrition security and livelihood security in the country. However, promotion of intensive aquaculture over the last decade has led to aggressive use of chemicals and environmental degradation. So far, the regulatory framework is focused on export-oriented brackish-water culture, but that too has achieved limited success in implementation. On the other hand, freshwater culture remains largely unregulated despite increasing intensification. We have to promote sustainable aquaculture that minimizes use of chemicals such as antibiotics and enables healthy food and healthy environment. To contain the emergence and spread of ABR from aquaculture, there is a need for a concerted multi-stakeholder action within a designated timeframe and with clear outcomes. In this, the DADF will have to play a central role.

CSE recommends that the following measures be adopted to regulate the fisheries sector and included in the Indian National Action Plan to contain AMR.

- **A separate regulatory framework for the freshwater fisheries sector should be developed and adopted**
  - It should include formulation of a new Act and Authority. This could be in line with the Coastal Aquaculture Authority;
  - It should promote sustainable freshwater culture and regulate chemical inputs (such as antibiotics) and waste discharge.

- **A national-level programme for issuing 'POND HEALTH CARDS' should be initiated by the DADF and implemented by the new Authority**
  - The programme should aim to promote the health of fish farms through a systematic farm-specific assessment and feedback mechanism. It should begin with intensive freshwater and brackish-water culture and gradually cover traditional farms. This programme could on the lines of the 'Soil Health Card' scheme that is in practice;
  - The implementation should be based on periodic testing and survey of water, sediment, inputs and farm produce for select parameters and diseases;
  - The DADF should develop and disseminate the required farm-level diagnostics and kits.

- **A Fisheries Council should be formed to ensure professional disease-management by the DADF in the fisheries sector**
  - Fisheries science professionals should be adequately trained and authorized to prescribe drugs;
  - The Fisheries Council should update and regulate the curriculum and practice of fisheries science professionals. This could be along the lines of the Veterinary Council of India.

- **Aquaculture waste should be recognized as a potentially polluting activity by MoEFCC in view of rising threat from AMR**
  - In line with certain industry effluents, waste from intensive aquaculture farms characterized by high chemical inputs should be recognized as a polluting activity;
  - The CPCB should formulate necessary regulations and underline the importance of waste monitoring;
  - It should set standards for no antibiotic residues and minimal bacterial load in discharged effluents;
  - State PCBs should adequately monitor waste management.

- **Unregulated availability of antibiotics need to be checked through adequate laws and enforcement by the CDSCO**
  - A list of antibiotics approved for aquaculture should be developed. It should not include critically important antibiotics for humans and factor in resistance trends in humans;
  - The Drugs and Cosmetics Act and Rules should recognize non-therapeutic use of antibiotics in food animals;
  - Stringent provisions should regulate manufacturing, sale and import of antibiotic-laden feed and feed premixes;
  - Rule 97 should be amended to specify symbolic representation of fish on labels of drugs for use in fish;
  - The state drug departments should ensure sale of approved and suitably labelled antibiotics against a prescription.

- **Antibiotic use database and tracking system should be developed by the CDSCO and DADF**
  - The CDSCO should develop an online system to track distribution and sale of antibiotics for human and animals;
  - The DADF should support this through generating antibiotic use trends in food animals, including fisheries.

- **An integrated surveillance system to monitor antibiotic residues and antibiotic resistance in fish and fish environment should be developed and led by the DADF**
  - The fisheries institutes of the Indian Council of Agricultural Research could be involved in generating data;
  - The FSSAI should be integrated to provide monitoring data of fish and fish products;
  - State PCBs should be involved to share monitoring data of waste from farms;
  - All surveillance information should be collated, analyzed and put in the public domain for guiding antibiotic-use policies. This data should further be integrated into the surveillance system on resistance in humans.

- **The FSSAI should develop a comprehensive framework for monitoring antibiotic residues and resistant bacteria in fish and fish products**
  - The framework should support testing and detection of all antibiotic use, including unapproved and off-label use;
  - It should detect and discourage use of antibiotics that are critically important for humans;
  - It should factor in resistance trends in humans and food animals in the country;
  - Residue monitoring framework of MPEDA could be adapted for antibiotics used in fish consumed domestically;
  - It should ensure periodic monitoring at the state level and public disclosure of collated results.

- **The Coastal Aquaculture Authority should mandatorily make registration and use of inputs which are free of all antibiotics**
  - The CAA's recent initiative to encourage manufacturers to register their antibiotic-free products should include all antibiotics rather than the few currently selected;
  - As only registered inputs such as feed and probiotics are allowed to be used by aqua farmers and hatchery operators, the initiative would be significant in limiting routine non-therapeutic use of antibiotics.

- **Antibiotics should not be allowed in fish feed. The BIS should amend relevant fish-feed standards and make them mandatory.**

- **Guidelines for coastal aquaculture should be strengthened with regard to regulating antibiotic use**
  - It should recognize and prohibit non-therapeutic use of antibiotics;
  - Use of antibiotics other than the four for which MRL is provided should be stated as prohibited. This will plug the gap wherein several antibiotics (other than those currently prohibited) could be used if residues are not detected;
  - Further, institutional capacity of the CAA should be strengthened to ensure implementation of its guidelines related to antibiotic use, farm registration and environment management.

- **State-level fisheries policy and its implementation should focus on sustainable aquaculture and regulate antibiotic use and waste**
  - All fish farms should be registered. Impact on environment assessment should be integral to registration;
  - Fisheries department should ensure coordination with departments of pollution control, and food and drugs;
  - The department should ensure implementation of best management practices.

- **The DADF should promote research on alternatives like probiotics and biofloc system, create greater awareness about responsible use of antibiotics and invest in building capacity.**

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062, India, Ph: +91-11-40616000 Fax: +91-11-29955879
E-mail: s_rajeshwari@cseindia.org, k_amit@cseindia.org Website: www.cseindia.org

REFERENCES

1. 'Tackling Drug Resistant Infections Globally: Final Report and Recommendations', http://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf, as viewed in August 2016.
2. Landers, T.F., Cohen, B., Wittum, T.E., Larson, E.L., 2012, A Review of Antibiotic Use in Food Animals: Perspective, Policy, and Potential. Public Health Rep., 127(1), 4–22, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3234384/pdf/phr12700004.pdf, as viewed in August 2016.
3. 'Fisheries Profile of India', DADF, http://dahd.nic.in/about-us/divisions/fisheries, as viewed in August 2016.
4. 'Handbook on Fisheries Statistics 2014', DADF, http://www.indiaenvironmentportal.org.in/files/file/handbook%20on%20fisheries%20statistics%202014.pdf, as viewed in August 2016.
5. 'FAO Yearbook. Fishery and Aquaculture statistics 2014', http://www.fao.org/3/a-i5716t.pdf, as viewed in August 2016.
6. 'The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all', http://www.fao.org/3/a-i5555e.pdf, as viewed in August 2016.
7. The Marine Products Export Development Authority, http://164.100.150.120/mpeda/marine_products_exports.php#, as viewed in August 2016.
8. 'Handbook on Fisheries Statistics 2014', DADF, http://www.indiaenvironmentportal.org.in/files/file/handbook%20on%20fisheries%20statistics%202014.pdf, as viewed in August 2016.
9. 'Handbook of Fisheries Statistics 2014-2015', Department of Fisheries, West Bengal, http://www.bengalfisheriesinvestment.org/pdf/5216a.pdf, as viewed in August 2016.
10. 'Handbook of Fisheries Statistics 2014-2015', Department of Fisheries, West Bengal, http://www.bengalfisheriesinvestment.org/pdf/5216a.pdf, as viewed in August 2016.
11. ' Handbook of Fisheries Statistics 2014-2015', Department of Fisheries, West Bengal, http://www.bengalfisheriesinvestment.org/pdf/5216a.pdf, as viewed in August 2016.
12. 'Handbook of Fisheries Statistics 2014-2015', Department of Fisheries, West Bengal, http://www.bengalfisheriesinvestment.org/pdf/5216a.pdf, as viewed in August 2016.
13. 'Guidelines for regulating Coastal Aquaculture', Guidelines annexed to CAA Rules, 2005, http://caa.gov.in/uploaded/doc/Guidelines-Englishnew.pdf, as viewed in August 2016.
14. 'Food safety and standards (contaminants, toxins and residues) regulations, 2011', FSSAI, http://www.fssai.gov.in/Portals/0/Pdf/Food%20safety%20and%20standards%20(contaminats,%20toxins%20and%20residues)%20regulation,%202011.pdf, as viewed in August 2016.
15. 'The Drugs and Cosmetics Rules 1945', http://www.mohfw.nic.in/WriteReadData/l892s/4350343543l421382269.pdf, as viewed in August 2016.
16. 'Guidelines for culture of SPF *L. vannamei* in fresh water/inland farms', DADF, http://www.dahd.nic.in/sites/default/files/fresh_inland%20farms%20%207.pdf, as viewed in August 2016.
17. 'Guidelines for responsible farming of Tilapia in India', DADF, http://www.dahd.nic.in/sites/default/files/Tilapia_policy_guidelines_Final%20%20%2016.pdf, as viewed in August 2016.
18. 'General standards for discharge of environmental pollutants', The Environment (Protection) Rules, 1986, http://cpcb.nic.in/GeneralStandards.pdf, as viewed in August 2016.
19. 'Handbook of Fisheries Statistics 2014-2015', Department of Fisheries, West Bengal, http://www.bengalfisheriesinvestment.org/pdf/5216a.pdf, as viewed in August 2016.
20. 'National Residue Control Plan for Aquaculture Products, Year 2015', EIC, http://www.eicindia.gov.in/services/Pre-Compliance/NRCP_AQ_P_2015.pdf,as viewed in August 2016.
21. 'New and restructured post-graduate curricula & syllabi-Fisheries Science, 2009', ICAR, http://www.icar.org.in/files/edu/Revised-PG-Course-Curricula-and-Syllabi/Fisheries%2030.4.2009.pdf, as viewed in August 2016.
22. 'Veterinary Council of India (Minimum Standards of Veterinary Education)— Degree Course (B.V.Sc. & A.H.) Regulations, 2016', http://www.vci.nic.in/writereaddata/MSVE_2016-1.pdf, as viewed in August 2016.
23. http://neospark.com/growth-afsp.html, as viewed in August 2016.
24. http://aabt.in/doxadd-doxycycline-hydrochloride-2/, as viewed in August 2016.
25. http://aabt.in/addcip-m-anti-biotic-feed-supplement/, as viewed in August 2016.
26. http://aabt.in/furzaz-20-furazolidone-20/, as viewed in August 2016.
27. http://aabt.in/oxytreat-5-anti-biotic-feed-supplement/, as viewed in August 2016.
28. http://www.kaizenbio.in/poultry/poultryDetailspages/poutry.html#tab5, as viewed in August 2016.
29. http://www.kaizenbio.in/poultry/poultryDetailspages/poutry.html#tabt, as viewed in August 2016.
30. http://www.kaizenbio.in/poultry/poultryDetailspages/poutry.html#taby, as viewed in August 2016.
31. https://www.virbac.in/home/products/by-therapeutic-segments/nutritional-feed-supplements/main/virbac-nutritional-feed-suppleme/laybro-mix.html , as viewed in August 2016.
32. http://pib.nic.in/newsite/PrintRelease.aspx?relid=137373, as viewed in August 2016.

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062, India,
Ph: +91-11-40616000 Fax: +91-11-29955879
E-mail: cse@cseindia.org Website: www.cseindia.org