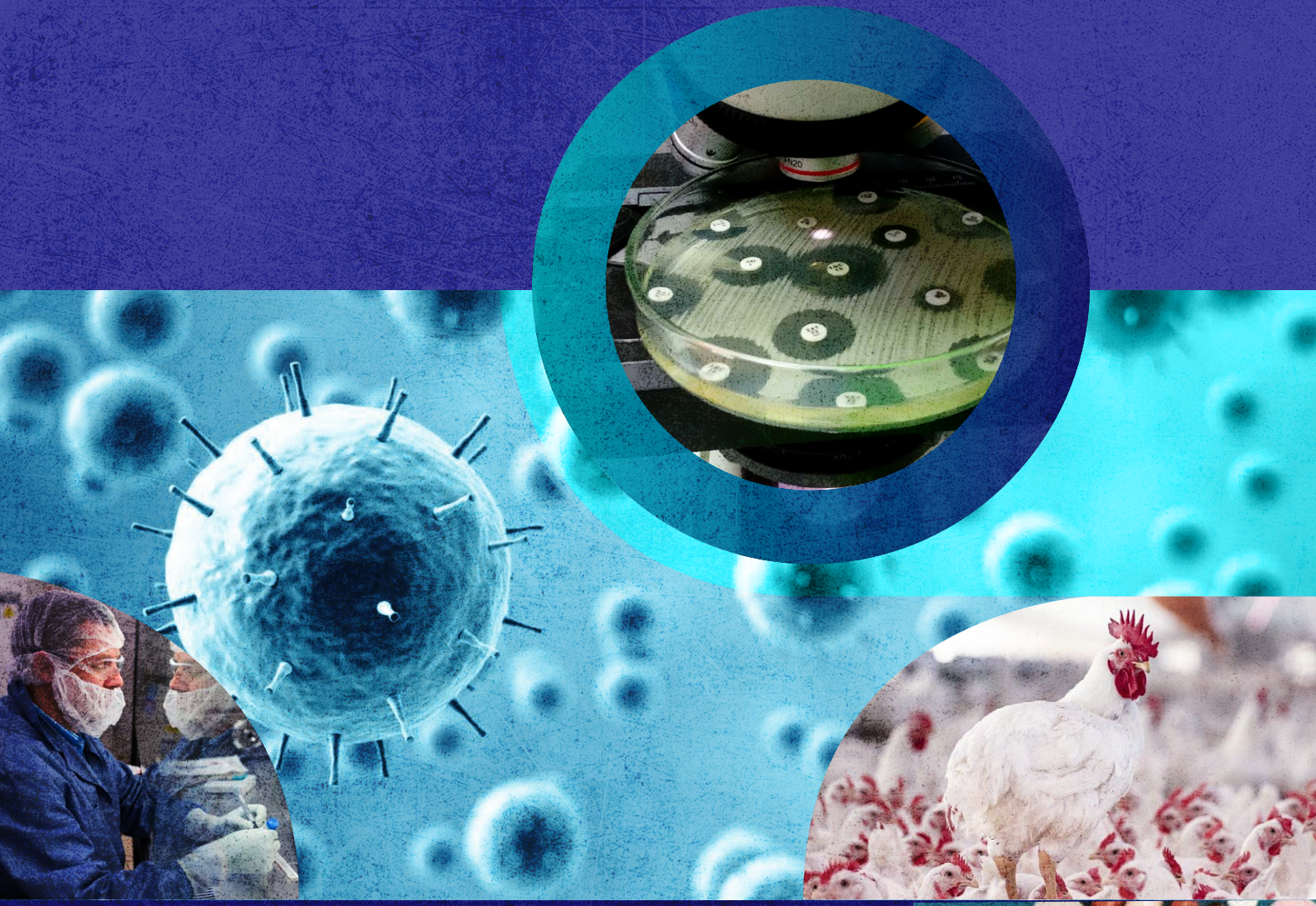
FACE
CII-Jubilant Bhartia
Food and Agriculture Centre of Excellence

CII
Confederation of Indian Industry



Industry led AMR Stewardship in **Animal Agriculture**

Published by Confederation of Indian Industry(CII), The Mantosh Sondhi Centre, 23 Institutional Area, Lodi Road, New Delhi – 110003; Tel: +91-11-45771000, Email: info@cii.in, web: www.cii.in

Contents

Acknowledgements

This report is a product of consultations with various stakeholders involved in dairy, poultry and fisheries value chain. CII is grateful to individual experts and specialists for their valuable inputs and insights during the preparation of this report.

Our special thanks to the following experts for their participation and contribution towards this report:

- **Prof (Dr) P K Shukla**
  President, Indian Poultry Science Association and Head,
  Department of Poultry Science,
  College of Veterinary Science and A.H., DUVASU, Mathura
- **Dr Shirish Nigam**
  President, Indian Federation of Animal Health Companies and Managing Director,
  EW Nutrition South Asia
- **Dr Shivasharanappa N**
  Senior Scientist (Veterinary Pathology),
  ICAR-National Institute of Veterinary Epidemiology and Disease Informatics (NIVEDI)
- **Dr Suresh S T**
  Managing Director, Karnataka Milk Federation (Nandini)
- **Dr Gaurav Rathore**
  Principal Scientist,
  ICAR-NBFGR (National Bureau of Fish Genetic Resources)
- **Dr Elan Cheran**
  Vice President, Society of Aquaculture Professionals (SAP)

CII FACE Study Team

Study conceptualization and execution
A V Rajamany, Roli Pande, Kavery Ganguly

Research and Report Writing
Pragya Joshi, Pawan Kumar Pareek

List of Abbreviations

ABST
Antimicrobial Susceptibility Testing

AINP-AMR
All-India Network Project on AMR

AMR
Antimicrobial Resistance

AMU
Antimicrobial use

ARGs
Antimicrobial resistance genes

ASEAN
Association for South-East Asian Nations

AST
Antibiotic Sensitivity Testing

Bamul
Bangalore Milk Union Limited

BMGF
Bill & Melinda Gates Foundation

BOD
Biochemical Oxygen Demand

CAA
Coastal Aquaculture Authority

CII FACE
Confederation of Indian Industry Food and Agriculture Centre of Excellence

CMP
Clean Milk Production

CMT
California Mastitis Test

CONS
Coagulase-negative Staphylococcus

COVID-19
Coronavirus disease 2019

CRAU
Certified Responsible Antibiotic Use

DAHD
Department of Animal Husbandry and Dairying

DCS
Dairy Cooperative Society

EBL
Enzootic Bovine Leukosis

EHP
Enterocytozoon hepatopenaei

EIC
Export Inspection Council

ESVAC
European Surveillance of Veterinary Antimicrobial Consumption

EU
European Union

EU-RASFF
European Union Rapid Alert System for Food and Feed

FAO
Food and Agriculture Organization

FPOs
Farmer Producer Organizations

FSSAI
Food Safety and Standards Authority of India

GAHPs
Good Animal Husbandry Practices

GDP
Gross Domestic Product

GLG-AMR
Global Leaders Group on AMR

GMPs
Good Management Practices

GP
Grandparent

IBR
Infectious Bovine Rhinotracheitis

ICAR
Indian Council of Agricultural Research

IEC
Information, Education and Communication

IFC
International Finance Corporation

ILT
Infectious Laryngotracheitis

IMC
Indian Major Carps

INFAAR
Indian Network for Fishery and Animal Antimicrobial Resistance

KAP
Knowledge, Attitude, and Practices

LMICs
Low- and Middle-Income Countries

MPEDA
Marine Products Export Development Authority

MRLs
Maximum Residue Limits

MRSA
Methicillin-resistant *Staphylococcus aureus*

NARMS
National Antimicrobial Resistance Monitoring System

NDDB
National Dairy Development Board

NGOs
Non-Governmental Organizations

NIVEDI
National Institute of Veterinary Epidemiology and Disease Informatics

NSPAAD
National Surveillance Program on Aquatic Animal Diseases

OECD-FAO
Organisation for Economic Co-operation and Development - Food and Agriculture Organization

OTC
Over the counter

OTC
Oxytetracycline

PCR
Polymerase Chain Reaction

PMP-AMR
Progressive Management Pathway for Antimicrobial Resistance

POC
Point-of-care

PPPs
Public-Private Partnerships

R&D
Research & Development

SAUs
State Agriculture Universities

SOPs
Standard operating procedures

State AH Depts
State Animal Husbandry Departments

UN
United Nations

US
United States

USAID
United States Agency for International Development

USD
United States Dollar

VFD
Veterinary Feed Directive

WHO
World Health Organization

WOAH
World Organization for Animal Health

Executive Summary

Antimicrobial Resistance (AMR) is emerging as a critical global health emergency with far-reaching consequences for human, animal, and environmental well-being. The World Health Organization (WHO) has identified AMR as one of the top 10 global public health threats. The animal agriculture sector accounts for approximately 70% of global antimicrobial use.

India, with its rapidly growing animal agriculture sector, is poised to become the fourth-largest consumer of veterinary antibiotics by 2030, intensifying the urgency for AMR mitigation strategies. Beyond public health, AMR presents a significant economic challenge. The World Bank estimates that AMR could reduce global GDP by up to 3.8% by 2050 and lead to a 7.5% decline in global livestock output. India is already experiencing the economic impact through export rejections of aquaculture and dairy products due to antibiotic residues, leading to revenue losses and increased compliance burdens that threaten long-term market access and competitiveness.

Globally, the policy landscape is evolving in response to this threat. International frameworks such as the UN Political Declaration on AMR (2024), the Codex AMR Guidelines, and the Global Leaders Group on AMR (GLG-AMR) emphasize the need for responsible antibiotic use and stronger antimicrobial stewardship. India has taken early steps through initiatives like the All-India Network Project on AMR in Livestock and Fisheries (AINP-AMR), but field-level adoption, diagnostic coverage, and surveillance systems remain limited.

The global shift towards responsible antimicrobial use is also unlocking new market opportunities. Rising consumer demand for antibiotic-free and certified animal products, stricter import regulations, and rapid advances in veterinary diagnostics, ethnoveterinary medicine, and homeopathic alternatives are reshaping value chains. India is uniquely positioned to lead in this space, leveraging its strengths in herbal veterinary products, digital technologies, and a wide network of semi-organized producers. By proactively adopting AMR-responsible practices including certification schemes, digital traceability systems, and investments in safe and effective alternatives India can transform AMR from a looming threat into a strategic opportunity.

Recognizing this critical need, the Confederation of Indian Industry Food and Agriculture Centre of Excellence (CII FACE) convened four focused stakeholder consultations across the dairy, poultry, and fisheries sectors. These consultations aimed to map ground-level challenges, identify sector-specific mitigation opportunities, and foster dialogue among key actors. As part of an industry-led initiative, the report captures insights from over 160 stakeholders including government bodies, veterinary professionals, academic institutions, farmers, startups, and industry leaders committed to combating AMR in animal agriculture.

The World Bank estimates that AMR could reduce global GDP by up to 3.8% by 2050 and lead to a 7.5% decline in global livestock output.

Key Drivers and Challenges to Combat AMR in Animal Agriculture

India's animal agriculture sector is witnessing rapid growth, increased intensification, and rising demand for animal protein. However, this progress has also heightened the risk of antimicrobial resistance (AMR), driven by systemic gaps, regulatory weaknesses, and on-ground practices. Major key drivers and challenges related to accelerating misuse and overuse of antibiotics across the animal agriculture sector includes:

Unregulated and Indiscriminate Antibiotic Use

In poultry and aquaculture, the prophylactic, metaphylactic and growth-promoting use of antibiotics is widespread, often without prescriptions or dosage control. In dairy, while antibiotic use is primarily therapeutic, non-adherence to withdrawal periods is a critical concern—driven by economic pressure on smallholders who cannot afford to discard milk, resulting in residue contamination and increased resistance risks.

Weak Farm-Level Practices

Poor hygiene, low vaccination coverage, and limited adoption of biosecurity protocols heighten disease incidence, increasing dependence on antibiotics. Smallholders, especially in dairy, often resort to self-medication due to limited veterinary access.

Low Awareness and Training

Farmers, para-vets, and local input suppliers often lack awareness of AMR risks and alternatives. Inadequate training in antimicrobial stewardship and absence of standardized treatment protocols further compound misuse.

Limited Access to Quality Veterinary Services and Inputs

Antibiotics are frequently procured from unqualified agrovets. Substandard or misused antibiotics contribute to treatment failure and resistance.

Inadequate Diagnostic and Surveillance Infrastructure

Most districts lack functional laboratories for antibiotic sensitivity or residue testing. Where labs exist, the absence of standardized protocols hinders consistent data generation.

Environmental Drivers

In aquaculture, antibiotic residues from hospital waste, animal manure, and surface runoff contaminate water bodies, creating hotspots for resistance gene transfer.

Lack of Regulatory Enforcement

Over-the-counter sales, off-label antibiotic use, and gaps in permitted antibiotic lists especially in fisheries highlight the need for clearer guidelines and stronger oversight.

Recommendations

Despite these challenges, the transition toward AMR-responsible animal agriculture presents significant economic and innovation opportunities for India. Growing domestic and global demand for antibiotic-free and certified animal products offers Indian producers a competitive edge. Emerging solutions such as diagnostics, herbal alternatives, probiotics, phage therapy, and digital traceability tools hold great promise but require strong enabling systems including robust surveillance, veterinary capacity building, and incentive-based policies.

Stakeholder consultations highlighted six strategic pillars for action:

Targeting Core Challenges	Develop species-specific antimicrobial use guidelines, enforce prescription-only antibiotic sales using a triplicate system, and regulate over the counter and extra-label antibiotic use.
Improving On-Farm Practices	Standardize hygiene, vaccination, and biosecurity protocols, scale up safe alternatives such as probiotics and herbal formulations, and introduce certification schemes like “Antibiotic-Free” labelling to incentivize good practices.
Strengthening Infrastructure	Upgrade district-level laboratories for antimicrobial resistance and residue testing, establish water quality monitoring system, and promote digital tools for traceability and record-keeping.
Driving Behaviour Change	Conduct awareness campaigns and stewardship training, establish model antibiotic-free farms for demonstration and peer learning, and counter misinformation through verified advisory services.
Building Partnerships	Engage cooperatives, FPOs, and the private sector to improve input traceability and outreach and foster collaboration among ICAR institutes, veterinary colleges, startups, and producer organizations for localized innovation.
Enhancing the Government’s Role	Expand AMR and antimicrobial use surveillance systems, fund R&D on alternatives and resistance mechanisms, integrate AMR into veterinary and fisheries curricula, and monitor environmental contamination in coordination with State Pollution Control Boards.

Together, these interventions form a comprehensive roadmap for AMR mitigation across India’s dairy, poultry, and fisheries sectors. India now stands at a pivotal moment to reform its animal agriculture system. By leveraging multi-stakeholder collaboration and aligning with global best practices, the country can protect public health, secure its food systems, and emerge as a global leader in sustainable and responsible livestock and fisheries development.

Introduction

Antimicrobial Resistance (AMR) is a pressing global health crisis that threatens human, animal, and environmental health.

While AMR can occur naturally due to the adaptability of microbes, its emergence is significantly accelerated by the inappropriate and excessive use of antimicrobials in healthcare, agriculture, and animal husbandry. The World Health Organization has identified AMR as one of the top 10 global public health threats.

If left unchecked, AMR could result in 10 million annual deaths globally by 2050, with one-fifth of those potentially occurring in India (FAO). The economic implications are equally alarming, with projected global GDP losses of up to $3.4 trillion per year by 2030. Two-thirds of the anticipated growth in antimicrobial usage is expected to occur in the animal production sector particularly in pig and poultry farming where the demand for antimicrobials is projected to double in the coming decades. These challenges underscore the urgent need for coordinated, multisectoral action through the One Health framework.

Recognizing the critical nature of this issue, the United Nations General Assembly, World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO), World Organization for Animal Health (WOAH), as well as key economic and political platforms such as the G7, G20, G77, and the Association for South-East Asian Nations (ASEAN), have called for globally coordinated action to mitigate AMR through the rational use of antibiotics and to preserve their long-term efficacy.

This report captures key insights from a series of multi-stakeholder consultations held to address AMR in the animal agriculture sector, specifically in dairy, poultry, and aquaculture. It outlines the drivers of antimicrobial use, emerging risks, and context-specific mitigation strategies across these sectors. The recommendations in this report are intended to guide policymakers, industry players, academia, startups, and farmer organizations in strengthening antimicrobial stewardship while safeguarding animal productivity, food safety, and environmental sustainability. It also aims to serve as a reference for scaling evidence-based practices and shaping future interventions under India's One Health agenda.

The World Health Organization has identified AMR as one of the top 10 global public health threats.

Methodology

Recognizing the urgency of addressing Antimicrobial Resistance (AMR) within the animal agriculture sector, the Confederation of Indian Industry Food and Agriculture Centre of Excellence (CII FACE) organized a series of four focused stakeholder consultations. These consultations specifically covered the poultry, dairy, and aquaculture sectors three of the most critical livestock domains contributing to India's food system and antibiotic usage.

The objective was to identify sector-specific drivers of AMR, map practical mitigation opportunities, and facilitate a knowledge-driven dialogue among key actors across the animal health value chain.

Each consultation was curated to enable in-depth, cross-sectoral discussions.

The sessions were designed around the following key components:

- Identification of current antimicrobial usage patterns and associated challenges.
- Prioritization of actionable solutions for reducing antibiotic dependency and strengthening stewardship.

Each session was co-chaired by an industry leader and a representative from academia or research to ensure a balanced focus on both practical challenges and science-based interventions.

A wide and diverse group of stakeholders participated in the consultations, representing a broad cross section of the animal health ecosystem:

This multi-stakeholder approach ensured a 360-degree perspective, incorporating voices from policy, practice, innovation, and ground realities. The consultations were conducted in virtual mode to ensure broad geographic participation and inclusivity. Each session facilitated open discussions, experience sharing, and problem-solving. Specific themes such as surveillance, record-keeping, capacity building, policy needs, and technological enablers were discussed in depth. In total, 160 participants joined across all four consultations, contributing to a rich repository of insights, case examples, and recommendations that form the basis of this report.

This report stands apart in its approach and impact, it reflects a first-of-its-kind industry-led initiative on AMR mitigation in animal agriculture, spearheaded by the Confederation of Indian Industry (CII). Unlike typical research or regulatory-driven studies, this initiative brought together leaders from the poultry, dairy, and fisheries sectors to drive the agenda on responsible antibiotic use from within the industry. These stakeholders did not just participate passively but actively co-chaired sessions, contributed operational insights, and prioritized solutions that are realistic, scalable, and aligned with business viability. This inclusive, solution-oriented, and practitioner-informed process makes the recommendations highly implementable and sector-relevant.

Global Snapshot

The World Organisation for Animal Health (WOAH) estimates that more than 70% of antimicrobials sold globally are used in animals, particularly in intensive livestock and aquaculture systems.

Scale and Impact

- Antimicrobial Resistance (AMR) is a global public health emergency. In 2019, AMR was associated with approximately 4.95 million fatalities globally, with 1.27 million of those deaths being directly linked to bacterial AMR (WHO), making it a leading cause of mortality worldwide.
- The World Organisation for Animal Health (WOAH) estimates that more than 70% of antimicrobials sold globally are used in animals, particularly in intensive livestock and aquaculture systems.
- With global meat and dairy production projected to increase by 60% by 2050, antimicrobial use in animal agriculture is expected to rise unless mitigated by strong regulatory and sectoral interventions.

Regulatory and Policy Developments

European Union (EU): Banned use of antibiotics for growth promotion in 2006 and further tightened regulations in 2022 to restrict preventive group treatments.

United States (US): Implemented the Veterinary Feed Directive (VFD) in 2017, making veterinary oversight mandatory for medically important antibiotics in feed.

China: Phased out antibiotic growth promoters in animal feed since July 2020 and has piloted AMU surveillance systems.

Thailand, South Korea, Vietnam: Introduced bans and restrictions on certain antimicrobials, adopted National AMR Action Plans in alignment with the Tripartite Global Action Plan.

Surveillance and Integrated Monitoring

- The European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) and U.S. National Antimicrobial Resistance Monitoring System (NARMS) are established global examples of integrated AMU/AMR surveillance in food animals.
- WOAH Global Database on antimicrobial use now collects data from 160+ countries.

Despite progress, LMICs (Low- and Middle-Income Countries) often face challenges such as lack of diagnostic infrastructure, absence of electronic record systems, and minimal laboratory testing capacity.

Political Declarations and Global Commitments

United Nations Political Declaration on AMR (2024)

Adopted at the UN High-Level Meeting on AMR (September 2024). India was among the signatories.

Reaffirmed commitment to:

- Eliminate non-therapeutic use (e.g., growth promotion) of medically important antimicrobials in animals by 2030.
- Invest in surveillance, vaccines, and AMR alternatives.
- Strengthen One Health-based AMR governance systems.

Codex Guidelines on AMR

Codex Alimentarius adopted:

- "Code of Practice to Minimize and Contain AMR" (CAC/RCP 61-2005, Rev. 2021).
- "Guidelines on Integrated Monitoring and Surveillance of Foodborne AMR" (CAC/GL 82-2021).

These provide member states a clear framework to align domestic food systems with science-based, risk-proportionate AMR control strategies.

Global Leaders Group on AMR (GLG-AMR)

Established by the Tripartite to provide political leadership.

Urges nations to:

- Integrate AMR into national development, health, agriculture, and trade agendas.
- Invest in behavior change, biosecurity, and AMR-alternatives for animal health.

World Bank and G7/G20 Commitments

- World Bank (2017): Projected that AMR could cause up to a 3.8% decline in global GDP by 2050 if unaddressed.
- G20 Agriculture Ministers' Declarations (2023–24) acknowledged AMR as a threat to sustainable food systems and called for responsible antimicrobial use across the value chain.

Innovations and Alternative Strategies

Countries like Denmark, the Netherlands and Sweden have achieved >50% reduction in veterinary antimicrobial use without harming productivity, through:

- On-farm biosecurity
- Benchmarking
- Farmer education and
- AMR diagnostics

Rapid innovation is underway in:

- Phage therapy, immunostimulants, vaccines, and feed additives.
- Startups and multinationals are investing in veterinary AMR alternatives, especially in the aquaculture and poultry space.

The consultations organized by CII-FACE are highly aligned with India's commitments under these global declarations:

Global Priority	Alignment with India's Consultations (Poultry, Dairy, Fisheries)
Phasing out non-therapeutic AMU	Stakeholders acknowledged need to phase out growth promoters; focus on voluntary adoption
National One Health AMR Plan	Consultations bridged sectors—animal husbandry, food safety, and environment
Surveillance enhancement	Discussed integration of veterinary surveillance with aquaculture, dairy and poultry traceability
Alternatives to antibiotics	Explored adoption of vaccines, herbal feed additives, probiotics, and improved husbandry
Stakeholder accountability	Proposals included industry-led guidelines and farmer-level AMR stewardship pilots

India and AMR

India, with a livestock population of 536.76 million and 851.81 million poultry (20th Livestock Census), is one of the world's largest producers of milk and meat.

As the second-largest aquaculture producer globally, India's fish production reached 175 lakh tonnes in 2022-23, with 131 lakh tonnes from inland fisheries and 44 lakh tonnes from marine fisheries (dof.gov.in). However, the increasing use of antimicrobials in animal agriculture has raised significant concerns regarding the emergence and spread of antimicrobial resistance (AMR). With close and continuous contact between animals and the human population, India faces heightened risks of AMR transmission.

The use of antibiotics in animal agriculture serves multiple purposes, including disease treatment, disease prevention (prophylaxis), and growth promotion. In 2017, antimicrobial sales data for chicken, cattle, and pig systems across 41 countries projected global antimicrobial consumption from 2017 to 2030. India ranked fifth among the top ten veterinary antimicrobial consumers, with 2.2% of global sales, following China (45%), Brazil (7.9%), the United States (7.0%), and Thailand (4.2%) (FAO). By 2030, India's antibiotic consumption in food animal production is expected to increase by 312%, positioning it as the fourth-largest consumer of antibiotics in animals globally (FAO). Antimicrobial use in aquaculture is also expected to rise from 1,159 tonnes in 2017 to 1,537 tonnes by 2030 (FAO), further exacerbating the challenge. Inadequate biosecurity measures and the prevalence of intensive farming systems in India intensify the problem. More than half of the antimicrobials used in animals are excreted as waste, contaminating soil, water, and ecosystems, which further aggravate the situation. This widespread contamination poses severe risks to public health, animal productivity, and environmental sustainability.

AMR surveillance has been conducted across 32 districts in India, covering a diverse sample set that includes milk and rectal swabs from cattle, buffalo, goat, sheep, pig, and poultry.

Recognizing the critical need for surveillance and evidence-based action, the Indian Council of Agricultural Research (ICAR), with support from the Food and Agriculture Organization (FAO) and USAID, has initiated systematic monitoring under the Indian Network for Fishery and Animal Antimicrobial Resistance (INFAAR), now called as the All-India Network Project on AMR in Livestock and Fisheries (AINP-AMR). This surveillance initiative spans the dairy, poultry, and fisheries sectors, helping to map resistance patterns in key bacterial species and inform national strategies under the One Health approach. In the livestock sector, AMR surveillance has been conducted across 32 districts in India, covering a diverse sample set that includes milk and rectal swabs from cattle, buffalo, goat, sheep, pig, and poultry.

The findings indicate widespread use of antibiotics, particularly in organized and contract-based intensive farming systems. *Staphylococcus aureus* isolates exhibited high resistance to penicillin (approximately 72%), with comparatively lower resistance to erythromycin (19%)

and enrofloxacin (17%). Methicillin-resistant *Staphylococcus aureus* (MRSA) was also detected in 39 milk samples, pointing to a potential public health risk of milk-borne MRSA transmission. *E. coli* isolates showed varying resistance patterns, with pigs and poultry exhibiting higher resistance levels than dairy animals. Among all food-producing animals, poultry isolates had the highest resistance levels particularly to antibiotics such as ampicillin (58%), cefotaxime (52%), tetracycline (50%), nalidixic acid (47%), amoxiclav (36%), enrofloxacin (43%), and imipenem (~18%).

In the fisheries sector, AMR surveillance has covered both freshwater and marine systems. Freshwater fish samples were collected from farms located in 28 districts across 7 states namely Uttar Pradesh, Odisha, Himachal Pradesh, Jammu and Kashmir, West Bengal, Uttarakhand, and Andhra Pradesh. Meanwhile, marine fish surveillance focused on cage-cultured systems in 5 districts across 2 states Karnataka and Kerala where samples were drawn from 205 marine fish farms.

The data revealed that *S. aureus* isolates from aquaculture systems exhibited very high resistance to penicillin (91.3%), followed by erythromycin (36.1%) and cefoxitin (16.4%). Resistance to ciprofloxacin was most notable in freshwater fish (54.8%), compared to significantly lower resistance in shrimp (6.3%) and marine fish (18.8%). Coagulase-negative *Staphylococcus* (CONS) isolates were also prevalent, with the highest resistance recorded against penicillin (79.7%), followed by cefoxitin (33%), erythromycin (27.4%), and co-trimoxazole (13.8%). *E. coli* isolates in marine fish displayed substantial resistance to third-generation cephalosporins like cefpodoxime (66.9%) and cefotaxime (54.1%), with relatively lower resistance rates in freshwater fish and shrimp. *Vibrio* species, including *V. parahaemolyticus*, showed significant resistance to ampicillin (~56%) and cefotaxime (39.5%). *Aeromonas* species isolated from freshwater fish were found to be resistant to cefoxitin (42.7%), cefotaxime (26.3%), and co-trimoxazole (20.6%).

These findings underscore the diverse AMR challenges across production systems and aquatic environments. While antibiotic use in shrimp farming has been significantly curtailed largely due to export market compliance and stricter residue monitoring freshwater and marine fish production systems continue to exhibit high levels of resistance, with less regulatory oversight. The AINP-AMR surveillance has provided crucial, region-specific evidence that supports the development of targeted interventions and responsible antibiotic stewardship in aquaculture and livestock systems. This data-driven approach is key to advancing India's One Health agenda and ensuring the long-term safety and sustainability of food animal production.

In 2017, a comprehensive study titled Scoping Report on Antimicrobial Resistance in India (Sumanth et al., 2017) was undertaken to assess the national AMR landscape through a research mapping exercise. The review analyzed 2,152 scientific papers published by researchers based in Indian institutions between 2012 and 2017. Notably, only 70 studies (3.3%) focused on animals, revealing a significant gap in research attention towards AMR in the animal agriculture sector. Moreover, the majority of these animal-focused studies were limited to assessing resistance profiles of bacteria isolated from livestock, poultry, and aquaculture. Critical dimensions such as the frequency of antibiotic use, types of antibiotics administered, and the underlying reasons for their use by farmers and animal handlers were either underreported or completely absent. Most strikingly, the review found a complete lack of qualitative studies exploring farmers' knowledge, attitudes, and practices (KAP) regarding antibiotic use in food-producing animals. This shows a critical research gap in understanding the behavioral and systemic drivers of AMR in animal agriculture.

Without adequate insights into on-ground practices, it is challenging to design effective interventions or promote behavioral change. The report highlighted the need for interdisciplinary and farmer-centric research that goes beyond microbiological data and addresses the socioeconomic and cultural dimensions of antimicrobial use.

While the prudent use of antibiotics is crucial for treating animal diseases, their overuse and misuse contribute significantly to AMR. Antimicrobial drugs are vital for animal health, welfare, and productivity, as they contribute to food security, safety, and public health, thereby safeguarding livelihoods. However, the growing resistance to these drugs in livestock and fisheries sector, lead to ineffective treatments, increased disease severity, reduced productivity, and significant economic losses.

The AINP-AMR surveillance has provided crucial, region-specific evidence that supports the development of targeted interventions and responsible antibiotic stewardship in aquaculture and livestock systems.

Entry Points of Antimicrobials in Animal Agriculture Value Chain/ Stakeholders Involved

Understanding the entry points of antimicrobials across the animal agriculture value chain is critical for identifying targeted interventions and designing effective stewardship strategies.

These entry points differ across livestock (poultry and dairy) and aquaculture systems due to variations in production practices, regulatory oversight, and health management approaches. A system-level mapping also highlights the roles and responsibilities of diverse stakeholders including veterinarians, farmers, input manufacturers, traders, processors, and regulators who directly or indirectly influence antimicrobial use (AMU).

Entry Points of Antimicrobials in the Animal Agriculture Value Chain

Feed and Nutrition Stage

- Medicated Feed is a major route of non-therapeutic antimicrobial use.
- In poultry and aquaculture, antimicrobials are added as growth promoters or for prophylaxis, especially during the starter and grower phases.

Entry Point: *Feed mills, integrators, and informal mixers; often with weak labelling or regulatory oversight.*

Note: FAO (2020) noted that 90% of antimicrobial use in some LMIC poultry systems is through feed routes often without veterinary consultation.

Disease Prevention and Health Management

Antimicrobials are commonly used:

- For metaphylaxis—mass medication when some animals in a group are sick.
- For prophylaxis—before disease onset, especially during transport, vaccination, or climatic stress events.

Often used without diagnostics, contributing to sub-therapeutic and inappropriate AMU.

Entry Point: *Farmers, para-vets, unlicensed practitioners, and sometimes chemists dispensing directly without prescriptions.*

Therapeutic Use in Production Phase

Widespread and often unsupervised use of antimicrobials for treatment of:

- Mastitis, lameness, respiratory infections in dairy.
- Coccidiosis, necrotic enteritis in poultry.
- Bacterial gill disease, vibriosis in aquaculture.

Lack of culture/sensitivity testing means broad-spectrum antibiotics are used repeatedly.

Entry Point: *Direct purchase from agri-input dealers, veterinary pharmacies, or mobile vendors; often without adherence to withdrawal periods.*

Post-Harvest and Processing Stage

Residues of antimicrobials enter the food chain due to:

- Non-observance of withdrawal periods.
- Lack of residue testing at processing or export stages.
- Absence of standard testing protocols for milk, meat and fish.

Entry Point: *Processing units, slaughterhouses and collection centres where AMR monitoring is minimal or absent.*

Environmental Entry Points

- Manure, litter, and aquaculture effluent contain unmetabolized antimicrobials and resistant bacteria.
- These enter soil, water bodies, and nearby crop systems, contributing to environmental resistance build-up.

Entry Point: *Farm waste management practices, effluent from integrated farms, and lack of bioremediation infrastructure.*

Note: WHO-FAO-WOAH Tripartite (2023) flagged environmental AMR as the fastest-growing but least-regulated risk pathway.

Key Stakeholders Across the Value Chain

Stakeholder	Role in AMU or AMR Containment
Farmers (Poultry, Dairy, Fish)	First point of decision-making for AMU; sometimes lack access to qualified vets or awareness of AMR risks
Veterinarians & Para-vets	Provide diagnosis and treatment plans; key agents in stewardship if trained and regulated
Feed Manufacturers & Suppliers	Gatekeepers for medicated feed; can reformulate based on policy/regulation
Drug Manufacturers & Distributors	Control volume and formulation of veterinary antimicrobials; accountable for responsible marketing
Hatchery & Breeding Operators	Early-stage AMU influencers; impact disease load and AMU later in lifecycle
Pharmacists & Input Retailers	Dispense antimicrobials; often do so without prescriptions
Integrators (Vertical Supply Chains)	Influence AMU protocols, enforce internal standards, or drive AMR reduction across contract farms
Slaughterhouses & Processors	Residue detection, rejection protocols, and enforcement of withdrawal periods
Regulators (DAHD, FSSAI, State AH Depts)	Develop policies, monitor compliance, and license stakeholders
Export Agencies (MPEDA, EIC)	Enforce compliance for global markets, especially in shrimp and dairy exports
Consumers	Indirect stakeholders; rising demand for “antibiotic-free” or “organic” food influences market change
NGOs, Academia, Think Tanks	Catalysts for education, surveillance, One Health research, and policy advocacy

Economic Implications of AMR in Animal Agriculture

Antimicrobial resistance (AMR) in animal agriculture has far-reaching economic consequences that extend beyond animal health. It affects farm productivity, trade, public health expenditure, food security, and the long-term sustainability of the livestock and fisheries sectors. As countries scale up food animal production to meet growing demand, the economic burden of AMR, both direct and systemic, has become increasingly visible.

This section explores how AMR in animal agriculture impacts various nodes of the economy, and why economic arguments are becoming central to AMR policy dialogues globally and in India.

Direct Economic Impacts on Farmers and Livestock Producers

Losses Due to Treatment Failures and Increased Mortality

AMR leads to higher incidence of treatment failure for common infections in poultry (e.g., colibacillosis), dairy (e.g., mastitis) and aquaculture (e.g., vibriosis).

Infected animals take longer to recover, require repeated treatment or die prematurely, resulting in:

- Reduced feed conversion efficiency.
- Lower milk yield, weight gain or egg production.
- Increased cost of veterinary care.

Higher Input Costs

- When first-line antibiotics fail, producers often resort to more expensive or combination antibiotics.
- Recurrent infections and culling lead to increased costs for restocking and biosecurity.

Impact on Market Access and Trade

Residue Rejection and Export Losses

Non-compliance with Maximum Residue Limits (MRLs) has led to shipment rejections of:

- Shrimp exports to the EU, Japan, and US.
- Dairy products flagged by EU-RASFF.

Exporters incur:

- Direct losses from consignment rejections.
- Long-term reputation damage.
- Mandatory batch testing and documentation expenses.

Regulatory Costs

Importing countries are enforcing traceability and AMR monitoring standards (e.g., EU Animal Health Law 2022), which raise the cost of compliance for Indian exporters.

Systemic Impacts on Food Systems and Public Health

Food Insecurity and Reduced Productivity

AMR leads to periodic disease outbreaks (e.g., necrotic enteritis in poultry, fish kills in shrimp farms), destabilizing livelihoods and regional food supplies.

Smallholders are disproportionately affected due to:

- Limited access to diagnostics.
- High sensitivity to animal losses.
- Inability to absorb repeated economic shocks.

One Health Costs

Resistant bacteria from animal production environments enter human populations via food, water and contact, increasing:

- Healthcare expenditure.
- Antibiotic resistance in clinical infections.
- Insurance premiums and productivity losses.

Note: The World Bank estimates that by 2050, AMR could push 28 million people into poverty globally, with South Asia among the worst affected regions.

Macroeconomic Risks and Sectoral Forecasts

Impact Area	Projected Losses Due to AMR	Reference
Global GDP Reduction	Up to 3.8% by 2050	World Bank (2017)
Global Livestock Output Decline	7.5% loss in output	OECD-FAO (2018)
Healthcare Cost Increase (Global)	Additional USD 1 trillion/year	O'Neill Report (2016)

Hidden and Long-Term Costs

Loss of Antibiotic Efficacy as a Public Good

Antibiotics are a non-renewable resource; resistance erodes their value for both animal and human sectors. Their misuse in animals reduces future treatment options, creating a cascading cost across the One Health spectrum.

Research & Innovation Pressure

Rising AMR leads to increased demand for:

- New antimicrobials
- Alternatives (vaccines, probiotics, immunostimulants)
- Advanced diagnostics and precision livestock farming tools

The R&D burden is often transferred to governments and large private sector players, especially in LMICs.

The Economic Case for AMR Stewardship

Global studies demonstrate that investing in AMR containment yields strong cost-benefit returns:

- Every $1 invested in AMR surveillance and stewardship in the livestock sector yields $4–$6 in economic savings by reducing disease losses and maintaining market access (World Bank, 2017; FAO PMP-AMR model)
- In countries that adopted strict AMU protocols (e.g., Netherlands, Denmark), livestock productivity was maintained or even improved over time, disproving the assumption that antibiotics are essential for profitability.

The economic implications of AMR in animal agriculture are no longer theoretical, they are already manifesting through farm-level losses, export barriers, rising treatment costs and systemic risks. For a country like India, with its vast and informal livestock sector, AMR is not just a biosecurity issue but a food system's economic challenge. Recognizing this, CII-FACE multi-sectoral stakeholder consultations serve as a timely intervention to chart a sustainable, economically prudent path forward.

Emerging Market Opportunities

While Antimicrobial Resistance (AMR) poses serious risks to public health and food systems, the global shift toward responsible antimicrobial use is also opening new market opportunities.

These range from demand for antibiotic-free animal products and export diversification to innovations in diagnostics, feed and health management systems. Countries and companies that proactively adopt AMR mitigation strategies are now gaining a competitive edge in both domestic and international markets.

This section outlines the key emerging market opportunities that align with AMR stewardship in animal agriculture and the potential for India to become a leader in this space.

Rising Demand for Antibiotic-Free and Certified Products

Consumer-Driven Domestic Market

- Urban consumers are increasingly seeking food that is "antibiotic-free," "hormone-free," or "organic."
- Rising awareness of AMR, especially post-COVID-19, is influencing purchasing patterns for milk, poultry meat, fish, and eggs.
- This creates a premium market segment for producers who can offer certified antibiotic-free labels.

Export Opportunities

- EU, USA and Gulf markets are increasingly enforcing AMR compliance and residue controls as trade prerequisites.
- India can expand access to high-value dairy, seafood and poultry export markets by aligning with Codex and importing country standards on AMU and AMR.

Growth in Alternatives to Antibiotics

- There is a rapidly expanding global market for antibiotic alternatives, driven by policy bans and private sector reforms.

Probiotics, Prebiotics & Nutrition Feed Additives

- Used to maintain gut health and immunity in poultry and aquatic species.
- Indian companies are innovating in herbal formulations, synbiotics, and gut microbiome modulators.

Vaccines and Immunostimulants

- Prevent common bacterial and viral infections, reducing antibiotic need.
- Government partnerships with private firms (e.g., for foot-and-mouth disease, coccidiosis) are expanding vaccine penetration.

Phage Therapy and Nanotechnology

- Phage-based products and nanoparticle delivery systems for targeted therapy in aquaculture and poultry are attracting biotech investments.

Diagnostics, Surveillance, and Digital Solutions

- As regulators and supply chains shift toward traceability, there's demand for data-driven tools and on-farm diagnostics.

Rapid and Point-of-Care Diagnostics

- Detecting microbial infections and guiding appropriate antimicrobial use.
- Indian startups are piloting lateral flow kits, PCR platforms, and mobile-enabled testing solutions.

Farm Management and Digital Traceability

- Platforms that record antimicrobial use, flag resistance trends and generate compliance reports are emerging.
- Integration of IoT and blockchain for aquaculture traceability and dairy milk quality monitoring is gaining traction.

Note: The global animal diagnostics market is expected to surpass USD 10 billion by 2027, with India being a growth hotspot. The veterinary diagnostics market in India is expected to reach a projected revenue of USD 746.8 million by 2030. A compound annual growth rate of 13.6% is expected of India veterinary diagnostics market from 2025 to 2030.

Certification and Labelling Ecosystems

Emerging markets demand trust and verification. This opens up avenues for:

- Third-party certification for "antibiotic-free," "AMR-responsible," and "residue-safe" production.
- Retailer-driven labelling programs (especially in dairy and broilers).
- Private sector–NGO–regulator collaborations to develop national standards and labelling criteria.

Examples:

- "Certified Responsible Antibiotic Use (CRAU)" label in the US poultry sector.
- MPEDA's "Shrimp Without Antibiotics" pilot branding program for export units.

Green Financing and Investment Flows

AMR-Sensitive Investment Screening

- International lenders and impact investors are beginning to factor AMR risk into ESG frameworks.
- Companies with traceable, AMR-compliant systems stand to gain in capital access.

Public Support and PPPs

Government schemes (e.g., Animal Husbandry Infrastructure Development Fund) can be tuned to incentivize:

- Residue-free milk processing plants.
- Antibiotic-free integrated farms.
- AMR diagnostics and alternative R&D.

Note: IFC (International Finance Corporation) and BMGF have announced support for antimicrobial alternatives and vaccine research in LMICs, especially targeting aquaculture and poultry.

India's Competitive Advantage

India has a unique opportunity to lead in AMR-compliant animal agriculture due to:

- A strong base of herbal/ayurvedic veterinary products.
- IT and biotech capacity for developing diagnostics and traceability systems.
- A large number of contract farmers who can be reached through integrators and co-operatives.

AMR stewardship is not only a regulatory necessity, but also a market differentiator. Early adopters of AMR-responsible practices stand to benefit from:

- Premium pricing
- Trade resilience
- Investor confidence
- Innovation-driven growth
- Business Sustainability and Survival

CII-FACE efforts in this direction can be leveraged to mobilize the ecosystem, accelerate AMR-responsible certifications and catalyze innovation-led enterprise models in animal agriculture.

Consultation Learnings: Ground-Level Challenges and Mitigation Pathways

Dairy Sector

India's dairy sector, the largest in the world in terms of milk production and dairy animal population, is at a critical juncture in addressing antimicrobial resistance (AMR). Mastitis remains the most common reason for antibiotic use on farms, with increasing resistance observed even against newer drug combinations such as cephalosporins paired with tazobactam/sulbactam. Rising tetracycline resistance and emerging fungal mastitis are compounding concerns. With a growing market for value-added dairy products, ensuring milk quality and safety is more important than ever.

Purpose of Antimicrobial Use

Unlike the poultry and aquaculture sectors, the use of antimicrobials in dairy is primarily therapeutic. Mastitis is the leading cause, other causes include calf diarrhea, metritis, and pneumonia. However, diseases like Infectious Bovine Rhinotracheitis (IBR) and Enzootic Bovine Leukosis (EBL), though prevalent, remain neglected. IBR, which exacerbates metritis and pneumonia, is hyperendemic in India but underdiagnosed. EBL causes severe immunosuppression, increasing infection risks and the subsequent need for antibiotic use. Acknowledging and addressing these diseases is essential to rationalize antibiotic use.

Key Drivers of AMR in the Dairy Sector

Prevailing Unhygienic Conditions at the Farm Level

- Poor adoption of Good Animal Husbandry Practices (GAHPs) and Clean Milk Production (CMP) protocols results in increased disease incidence.
- Low levels of biosecurity at the farm expose animals to pathogens, contributing to the spread of infections.

Inappropriate Treatment Practices

- Premature discontinuation of antibiotics.
- Non-prescribed antibiotic use.

Laboratory Infrastructure Gaps

- Inadequate facilities for Antibiotic Sensitivity Testing (AST).
- Absence of standardized methods and SOPs.

Training and Awareness Deficit

- Limited knowledge among veterinarians, para-vets, and farmers.
- Weak extension systems to support behaviour change.

Poor-Quality Antibiotics

- Availability of substandard or counterfeit products.
- Leads to treatment failure and increased resistance.

Lack of Veterinary Treatment Guidelines

- No uniform, field-accessible protocols for disease management.

Limited AST Use

- High cost and low availability of test kits.
- Subsidized AST strips could support rational antibiotic use.

Neglected Diseases Beyond Mastitis

- IBR and EBL remain poorly addressed.
- Indigenous vaccines exist but lack widespread deployment.

Environmental Factors

- Poor water quality reduces disinfectant efficacy.

Unregulated Antibiotic Supply Chains

- Easy over-the-counter access through multiple informal channels.
- Frequent unsupervised use by para-vets, AI technicians, and community workers.

Measures to Reduce Antimicrobial Use and Combat AMR in the Dairy Sector

Addressing antimicrobial resistance (AMR) in the dairy sector requires an integrated approach that combines preventive animal health practices, institutional interventions, technology adoption, and farmer awareness.

Case Study

Mastitis Control Program at Bamul (Bangalore Milk Union Ltd.)

Launched in 2017–18, this program stands out as a notable intervention focused on mastitis reduction through non-antibiotic treatment and diagnostics at the Dairy Cooperative Society (DCS) level.

Key components and outcomes include:

- Introduction of milk sample screening and promotion of trisodium citrate as a non-antibiotic intervention.
- Reduction in mastitis prevalence from 31% to 21% over four years.
- Significant decline in antibiotic residues: beta-lactams reduced from 38% to 26%; sulfonamides from 14% to 2–3%; tetracyclines became negligible (2–4%).
- Integration of herbal and homeopathic treatments alongside allopathic care led to reduced treatment costs and improved cure rates.
- This program exemplifies how targeted interventions, backed by cooperative-level support, can yield measurable benefits in animal health and AMR mitigation.

Early Detection of Mastitis: Improved mastitis management using tools like the California Mastitis Test (CMT) allows for early identification of sub-clinical cases, preventing the need for broad-spectrum antibiotics. Though CMT is the most accessible field-level tool, innovations such as smartphone-based somatic cell counters are emerging and require validation and ecosystem support.

Management During Transition Period: Effective management during pregnancy and post-calving helps prevent mastitis, metritis, and metabolic disorders like negative energy balance. Good housing, nutritional support, and stress reduction during this period can reduce disease incidence and reliance on antibiotics.

Vaccination as Preventive Strategy: Vaccination is increasingly emphasized to prevent endemic infections such as IBR and EBL, which can cause secondary complications. A comprehensive disease control and vaccination strategy helps reduce antibiotic usage by preventing initial infection.

Selective Breeding for Disease Resistance: Breeding programs that emphasize low-mastitis trait animals, supported by sexed semen and genomic tools, offer a long-term strategy for disease reduction. Such selective breeding lowers the occurrence of mastitis and reduces the need for antibiotics.

Environmental Hygiene and Feed Quality: Maintaining cleanliness in housing areas, ensuring good waste disposal, and monitoring feed and water quality are critical in reducing disease occurrence. Studies from NIVEDI show AMR microorganisms presence in farm environments and animal handlers, underscoring the importance of environmental hygiene.

Demonstration Farms/Model Farms for Peer Learning: Model farms practicing clean milk production, antibiotic record-keeping, and good husbandry serve as live examples for other farmers. Field visits to such farms promote peer-to-peer learning and practical knowledge transfer.

Use of Ethnoveterinary and Homeopathic Alternatives: Institutions like Bamul and NDDB are actively promoting alternative therapies to reduce dependence on antibiotics. Training veterinarians in ethnoveterinary and homeopathy is enabling wider adoption of these methods in the field.

Antibiotic Residue Testing at Farm Level: Rapid residue detection kits that cover all FSSAI-listed antibiotics are essential for enabling farmers to test milk at the farm gate. This prevents contaminated milk from entering the value chain and builds farmer accountability.

Good Animal Husbandry Practices (GAHPs): Implementing GAHPs, such as maintaining good housing, hygienic storage of feed and fodder, proper milk collection systems, and clean farm surroundings significantly reduces disease risks. These practices create a healthy environment that reduces the need for antimicrobials. Biological testing of milk alongside routine fat and SNF testing should also be encouraged.

Management of High-Yielding Crossbred Animals: Crossbred animals with higher milk yields are more susceptible to health issues if not managed well. Poor housing, inadequate nutrition, and stress increase disease risks and the need for antibiotics. Small farmers are not able to provide adequate nutrition and proper management for these animals. Enhancing management protocols for such animals is essential. Farmers should be given trainings and awarness sessions should be conducted for maintenance of these high yielding breeds.

Mapping of Regional Antimicrobial Sensitivity: Developing and updating local antibiograms can guide veterinarians and farmers in choosing effective treatments. Reducing trial-and-error usage of antimicrobials through region-specific data can help target interventions and slow resistance buildup.

Major Concerns in the Dairy Sector Related to Antimicrobial Resistance (AMR)

Despite antimicrobials in the dairy sector being used primarily for therapeutic purposes, a range of systemic, behavioural, and infrastructural challenges continue to exacerbate antimicrobial resistance (AMR). These concerns stem from both on-farm practices and broader governance and market failures.

Low Awareness of Milk Withdrawal Period: There is limited understanding among dairy farmers about the importance of observing withdrawal periods post-antimicrobial treatment. Consequently, milk from recently treated animals often enters the supply chain, potentially containing antimicrobial residues. This not only poses a public health risk but also contributes to AMR spread through food consumption. Mass awareness campaigns are urgently needed to promote compliance with withdrawal periods and mitigate consumer exposure.

> The exclusive therapeutic use of antimicrobials in dairy, as opposed to growth promotion or prophylaxis, offers a comparatively lower resistance pressure, if appropriately managed.

Substandard Antimicrobials and Over-the-Counter Sales: A major concern is the easy availability of low-quality and substandard antimicrobials in the market. Coupled with unregulated over-the-counter (OTC) sales, this facilitates self-medication by farmers. High-end, third- and fourth-generation antibiotics are often used without veterinary consultation, exacerbating resistance development. There is a need for tighter control over veterinary drug distribution and improved accountability of pharmaceutical companies and distributors.

Shortage of Veterinary Workforce: India faces a significant shortage of veterinarians, trained paravets, and extension agents, especially in rural areas. This limits timely access to quality advice and treatment, pushing farmers toward self-diagnosis and misuse of antimicrobials. Strengthening human resource capacity at the grassroots is crucial for responsible AMU.

Economic Constraints of Smallholders: Low-cost dairy systems dominate rural India, making it difficult for smallholders to afford preventive healthcare or rapid diagnostics. Abrupt bans on antimicrobial use or costly alternatives are unlikely to succeed unless complemented with financial support mechanisms. All interventions must be practical, cost-effective, and inclusive.

Lack of Region-Specific Antibiotic Sensitivity Data: Empirical antibiotic use is widespread due to the absence of localized antibiograms. Trial-and-error methods are common, often involving broad-spectrum or potent antibiotics. Establishing region-specific AMR mapping and making antibiograms accessible to practitioners can help optimize treatment and reduce misuse.

Limited Access to Rapid Diagnostics: Point-of-care (POC) diagnostics and antimicrobial susceptibility testing (AST) are either unavailable or inaccessible at the farm level. This forces farmers and practitioners to initiate treatment without confirmatory diagnosis. Investing in validated, farmer-friendly diagnostics is essential for improving treatment precision.

Neglected Role of Pharmacists: Retail pharmacists play a central role in antimicrobial access but are largely excluded from AMR mitigation frameworks. Sensitizing and regulating pharmacists, especially those operating near dairy clusters, is critical to reducing irrational antimicrobial dispensing.

Environmental Factors: Poor water quality contributes silently to AMR. High BOD levels and hard water reduce the efficacy of disinfectants, increasing disease incidence. Environmental surveillance and management need to be integrated into AMR control strategies.

Plane of Nutrition and Disease Vulnerability: Nutritional deficits in dairy animals, especially crossbred cows and young calves, compromise immunity and raise susceptibility to infections like mastitis, metritis, and milk fever. Traditional feeding practices and economic constraints further aggravate this issue. Improving nutrition must be central to disease prevention strategies.

Challenges in Ethnoveterinary Adoption: Though ethnoveterinary medicine offers a viable alternative to allopathic antibiotics, its slow action and lack of standardized formulations make it less attractive to farmers. Field-ready pouches and scientifically validated protocols are needed to promote wider adoption.

Need for Alternative Medicine Validation: While alternative approaches such as herbal or homeopathic remedies are gaining attention, many lack scientific validation. Rigorous research, promotion, and integration of proven alternatives into veterinary advisory systems will enhance farmer confidence and uptake.

Poultry Sector

India's poultry sector is one of the fastest-growing segments of the livestock industry, it is a critical component of national food security and rural livelihoods. As the second largest egg producer and fifth largest poultry meat producer globally, India plays a significant role in feeding a growing population. However, the sector's rapid expansion has brought with it rising concerns over antimicrobial resistance (AMR). Unlike dairy, the use of antimicrobials in poultry is not limited to therapeutic purposes. Antimicrobials are frequently used for growth promotion, disease prevention (prophylaxis), and metaphylaxis, often without veterinary oversight. This widespread and, at times, indiscriminate use of antimicrobials has led to the emergence and spread of resistant pathogens. These resistant organisms can travel far beyond farm boundaries through meat, eggs, water, feed, and the environment, posing serious risks to animal, human, and environmental health, and placing AMR firmly within the One Health framework. Given its scale, consumer proximity, and potential for cross-border transmission, the poultry sector holds both a high-risk profile and a high-impact opportunity for AMR mitigation.

Purpose of Antimicrobial Use

In India's poultry sector, antimicrobials are commonly used not just for therapeutic purposes, but also for prophylaxis, metaphylaxis, and growth promotion. This widespread use stems largely from the high disease burden and economic pressure to maintain productivity and reduce mortality. Pathogens from the Enterobacteriaceae family-particularly *Escherichia coli, Salmonella* spp., and *Shigella*-along with *Clostridium perfringens* and *Campylobacter* spp., are among the most persistent and impactful disease-causing agents in poultry production. These pathogens are not only responsible for high morbidity and mortality rates but are also increasingly showing resistance to critically important antibiotics. Faced with rapid disease progression and limited access to timely diagnostics, many farmers and prescribers often turn to broad-spectrum or high-end antibiotics as the default treatment option. This has contributed to routine, and at times indiscriminate, antibiotic usage across production systems.

Key Drivers of AMR in the Poultry Sector

Overuse and Misuse of Antibiotics

- Used widely for treatment, prophylaxis, metaphylaxis, and growth promotion.
- Decisions often based on peer advice, not veterinary consultation.
- Indiscriminate use increases resistance pressure on microbes, accelerating resistance.

Use of Critically Important Antibiotics

- Antibiotics vital for human health misused in poultry despite restrictions.

Weak Biosecurity and Poor Farm Hygiene

- Substandard biosecurity, poor housing conditions, and lack of Good Management Practices (GMPs) raise infection risks.
- Wastewater and litter from farms contaminate the environment, facilitating spread of resistant genes.

Low Consumer Awareness and Demand

- Consumers rarely demand antibiotic-free poultry.
- Lack of awareness results in weak market demand for better practices and poor price realization for eggs and meat by farmers.

Inadequate Diagnostics & limited use of biologicals

- Limited use of PCR, AST, and other diagnostic tools.
- Field vets lack training and access to diagnostics.
- Limited availability and adoption of biologicals (e.g., for ILT, Mycoplasma).
- Compels producers to resort to antibiotics to manage secondary bacterial infections resulting from viral diseases like ILT, Mycoplasma etc.

Unregulated Antimicrobial Access

- Easy over-the-counter sales without prescription.
- No triplicate prescription or traceability system.

Measures to Reduce Antimicrobial Use and Combat AMR in the Poultry Sector

While the poultry sector is among the fastest-growing animal protein industries in India, its heavy reliance on antimicrobials particularly in the unorganized segment calls for urgent and systemic mitigation measures. A combination of biological alternatives, better management, improved biosecurity, and market incentives is essential for transforming practices across the value chain.

Adoption of Non-Antimicrobial Alternatives: Several promising alternatives are now available that can reduce dependence on antimicrobials while maintaining flock health. The use of prebiotics, probiotics, and postbiotics is gaining traction for improving gut flora and enhancing immunity. Feed additives such as butyric acid, essential oils, and herbal extracts have demonstrated the ability to reduce pathogen loads effectively. Additionally, bacteriophages; viruses that selectively target harmful bacteria are considered a cutting-edge solution due to their specificity, safety, and self-regulating nature. Their integration into poultry health strategies can minimize the need for broad-spectrum antibiotic use. Use of organic acids is also promising for managing pathogens in feed, water and in gut. The foundational role of balanced nutrition, including the right mix of protein, energy, vitamins, and minerals, was also emphasized for improving resistance to infections.

Implementation of Good Management Practices (GMP): Strong animal husbandry practices significantly reduce disease incidence and antimicrobial requirements. These include optimal housing, proper ventilation, clean drinking water, and regular flock health monitoring. Structured interventions such as mortality pits, fencing, and periodic disinfection have proven effective, especially in contract farming settings. However, these interventions are often economically viable only for large-scale operations. Smaller farms face challenges due to capital constraints, despite evidence that such investments improve productivity and profitability in the long term. The lack of consumer awareness around responsible farming limits the financial sustainability of GMP-adopting producers.

Incentivizing Farm-Level Biosecurity through Market-Based Tools: To encourage responsible antimicrobial use and biosecurity, participants recommended a "Star-Rating" system for farms (e.g., 2-star, 4-star, 5-star) based on their adherence to defined animal husbandry and hygiene standards. This system could enable progressive differentiation in the market, with higher-rated farms commanding premium prices. However, for such a system to succeed, consumer awareness and demand for responsibly raised poultry must be built in parallel.

Strengthening Biosecurity and Disease Prevention Protocols: Improved biosecurity is foundational to reducing infection pressure and thereby minimizing antimicrobial reliance. These measures must begin at the Grandparent (GP) and Parent Stock level to ensure vertical biosecurity and healthier chicks. Disease prevention strategies should prioritize vaccination against key viral infections that may not directly kill but predispose birds to secondary bacterial infections prompting antibiotic use. Comprehensive feed and water hygiene, pest control, and personnel hygiene protocols must be enforced. Participants emphasized that biosecurity alone is not sufficient; it must work in tandem with veterinary oversight, proper housing, and nutrition.

Scaling Surveillance and Laboratory Infrastructure: A glaring gap in India's poultry AMR response is the lack of surveillance infrastructure, especially at the state level. Few microbiological laboratories currently test for antibiotic resistance, mycotoxins, pesticide residues, or heavy metals all of which can compromise bird health and increase dependence on antimicrobials. The establishment of dedicated AMR Reference Laboratories in every state, networked with a central AMR monitoring system, was strongly recommended. These labs should offer affordable diagnostic services and support antibiotic sensitivity testing, enabling more precise and responsible antimicrobial use.

Major Concerns in the Poultry Sector Related to Antimicrobial Resistance (AMR)

Despite growing recognition of antimicrobial resistance (AMR) as a global health threat, systemic challenges across India's poultry value chain continue to undermine mitigation efforts. The sector's dependence on antimicrobials for prophylaxis, metaphylaxis, and growth promotion particularly in broiler operations has resulted in the unchecked emergence and transmission of resistant bacteria through food, water, and the environment. Several critical concerns continue to drive resistance in both commercial and backyard poultry systems.

Limited Awareness and Education on AMR Risks: A foundational barrier across the poultry sector is the low level of awareness among farmers, veterinarians, and input suppliers regarding the causes and consequences of AMR. Importantly, AMR is not yet adequately covered in the curriculum of veterinary colleges or poultry science courses, leading to gaps in the understanding of its long-term implications. There is also limited outreach at the field level, particularly among smallholders. Without informed veterinary guidance, producers often resort to informal advice or mimic neighboring farms. Consumer awareness is equally low, failing to create a market signal for antibiotic-free or responsibly raised poultry. Awareness-building efforts must be multi-level and sustained starting from academia and extending to public campaigns, producer networks, and slaughter points.

Over-the-Counter Sale and Misuse of Critically Important Antibiotics: Antibiotics are widely available across veterinary pharmacies and agri-input shops without the need for a prescription. This unrestricted access leads to misuse, overdosing, and the inappropriate selection of antibiotics including those categorized as "critically important for human medicine." Without diagnostic confirmation, farmers often resort to administering broad-spectrum or third- and fourth-line antibiotics as a first-line response to illness or mortality. A regulated prescription-based system with enhanced traceability is urgently required to curb this trend.

Shortage of Poultry-Specific Veterinary Services: India suffers from an acute shortage of qualified poultry veterinarians, particularly in rural and peri-urban districts where poultry farming is expanding rapidly. As a result, farmers are left to depend on paravets, feed dealers, or self-medication, none of whom are adequately trained in AMR-sensitive prescribing. The absence of field-level expertise also limits timely diagnosis, vaccination, or the promotion of biosecurity practices, exacerbating reliance on preventive antibiotics. Deploying a minimum number of poultry veterinarians per poultry population of the district was widely recommended by stakeholders.

Absence of Record-Keeping and Data Management Systems: A critical but often overlooked concern in the poultry sector is the lack of systematic record-keeping related to antibiotic usage, disease incidence, mortality rates, and treatment outcomes. Most farms, especially in the smallholder and unorganized segments, do not maintain any documentation of veterinary interventions or drug administration. This severely limits the ability to monitor patterns of antimicrobial use, identify emerging resistance trends, or evaluate the effectiveness of on-farm health practices. Establishing simple, standardized record-keeping tools even in paper or mobile formats can support better veterinary oversight, facilitate AMR surveillance, and promote more rational use of antibiotics at the farm level.

Economic Pressures and Absence of Incentives for AMR Reduction: Thin profit margins in the poultry sector often disincentivize investment in disease prevention, biosecurity upgrades, or diagnostics. For many producers, antimicrobials serve as a cost-effective "insurance policy" to prevent flock mortality. Without economic incentives, certification schemes, or premium pricing for antimicrobial-free poultry, the transition to responsible antimicrobial use remains difficult. Introducing a rating or recognition system such as "AMR-free" branding or Good Animal Husbandry Practices (GAHP) certification could offer producers a pathway to differentiate their products and recover costs.

Challenges in the Backyard Poultry Segment: Backyard poultry, though often seen as low-input and low-risk, presents unique AMR challenges due to complete absence of veterinary oversight, poor housing, and reliance on informal drug supply chains. Birds are often treated with leftover antimicrobials, or through advice from unqualified personnel. This segment is rarely covered under formal extension or regulatory frameworks. Tailored interventions are needed to address the specific vulnerabilities of backyard poultry, including mobile veterinary services, decentralized training modules, and easy-to-use alternative therapies.

Lack of Consumer Demand for AMR-Sensitive Poultry Products: Unlike global markets where "antimicrobial-free" labels fetch a premium, Indian consumers remain largely unaware of the connection between AMR and poultry production. As a result, market forces do not push producers to adopt safer practices. Retailers and supermarkets too seldom differentiate products based on AMU status. Increased public education and demand-side awareness could play a transformative role in driving responsible production practices.

Limited Regulation in Feed Mills: Feed mills are a critical control point in the poultry production chain, yet they often lack adequate management practices, biosecurity protocols, and regulatory oversight. Establishing and enforcing feed quality standards, approved ingredient lists, and hygiene protocols in feed mills is essential to safeguarding poultry health and preventing AMR transmission through feed.

Aquaculture Sector

Antimicrobial resistance (AMR) in the aquaculture sector, has emerged as a growing concern due to intensification of production systems over the past two to three decades. Initially, the sector reported minimal resistance issues. However, with the expansion of high-density farming practices, particularly in shrimp and finfish aquaculture, the use of antibiotics to prevent and treat disease outbreaks became more common thereby creating selective pressure for the emergence of resistant bacterial strains. In recent years, a notable decline in indiscriminate antimicrobial usage has been observed, especially in shrimp farming.

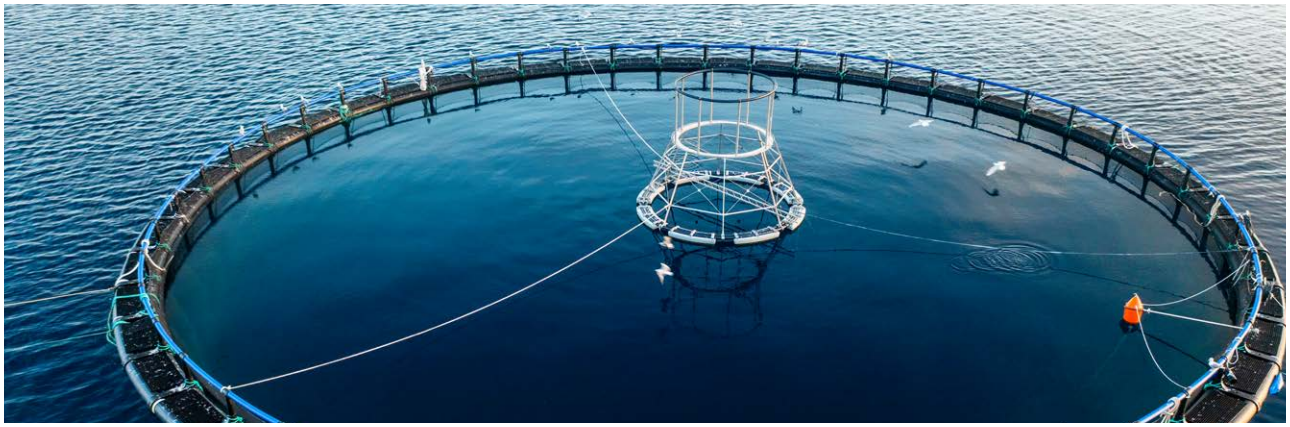
This positive trend is largely attributed to improved awareness among farmers, stringent export regulations, and proactive regulatory measures by authorities such as the Coastal Aquaculture Authority (CAA). The CAA mandates that only approved inputs be used in shrimp aquaculture, and products must be labelled “antibiotic-free.” Additionally, feed manufacturers are required to declare that their feed does not contain antimicrobials, further ensuring compliance. Today, the use of antibiotics in shrimp farming is minimal, with most of the produce intended for export markets like the United States and Europe, where rigorous food safety protocols demand zero tolerance for antibiotic residues.

Consequently, rejection rates due to antibiotic contamination remain low, reflecting the sector's maturity and commitment to responsible practices. However, challenges persist in the broader aquaculture landscape. In freshwater finfish farming, antimicrobial residues continue to be a concern, as domestic consumption dominates this segment and regulatory oversight is relatively weaker. Building upon successes in shrimp production, similar regulatory and awareness frameworks must now be extended to freshwater aquaculture to ensure sustainable, residue-free fish farming that protects both public health and market integrity.

Purpose of Antimicrobial Use

In India's aquaculture systems, antibiotics are primarily used for metaphylactic purposes. This widespread preventive use stems largely from the challenges farmers face in diagnosing diseases accurately and promptly. In species such as Indian Major Carps (IMC), Rohu (*Labeo rohita*), Pangasius *(Panga sianodon hypophthalmus)*, and shrimp, bacterial and parasitic infections are common and often misidentified or detected too late for targeted interventions. The absence of adequate diagnostic infrastructure particularly at the district or field level means that farmers frequently resort to broad-spectrum antimicrobials as a default response.

In shrimp farming, for example, infections like *Enterocytozoon hepatopenaei* (EHP), which mimic bacterial symptoms, are often treated with antibiotics despite being parasitic in nature. This misuse exacerbates antimicrobial resistance and reduces the efficacy of future treatments. Common Diseases in Aquaculture for which antimicrobials are used include Red Disease (associated with Hemorrhagic Septicemia), Columnaris Disease *(Flavobacterium columnare)*, Edwardsiellosis *(Edwardsiella tarda)*, Argulosis *(Argulus spp.)*, Gyrodactylosis *(Gyrodactylus spp.)*, Dactylogyrosis *(Dactylogyrus spp.)*, Dropsy (a symptom of systemic infections, both bacterial and parasitic) and Vibriosis *(Vibrio spp.)*, particularly in shrimp culture. Antimicrobials and chemicals commonly used in aquaculture include Enrofloxacin (a broad-spectrum fluoroquinolone), Oxytetracycline (OTC) Ciprofloxacin (another fluoroquinolone frequently used for prophylaxis), Furazolidone (a nitrofuran compound, although banned in many countries), Doxycycline (belonging to the tetracycline group), Malachite Green (used for fungal infections but now restricted due to toxicity), Cypermethrin (a synthetic pyrethroid used to control ectoparasites like Argulus). The reliance on such inputs often without laboratory confirmation or veterinary oversight poses significant risks not just for aquatic health but also for food safety and environmental integrity.



Key Drivers of AMR in the Aquaculture Sector

Intensification of Farming Systems

- Higher stocking densities increase stress and disease vulnerability in aquatic species.
- Frequent disease outbreaks prompt routine metaphylactic antibiotic use.

Metaphylactic and Non-Therapeutic Use of Antibiotics

- Antibiotics are often administered to entire populations as a preventive measure.

Extra-Label Use of Antibiotics

- Antibiotics formulated for poultry are often used in aquaculture without dosage adjustments, contributing to resistance development.

Abundant Use in Ornamental Fish Production

- Antibiotics are freely used since ornamental fish are not covered under food safety regulations.
- Wastewater from these units may contaminate shared water bodies, spreading resistant microbes.

Unqualified Prescribers at Field Level

- Antibiotics often recommended by untrained dealers or informal practitioners.
- Lack of aquatic health professionals aggravates misuse.

Absence of Permitted Antibiotic List

- While some antibiotics are banned, there is no clear list of permitted drugs with dosage or residue limits.
- Causes confusion and non-standard use across different aquaculture operations.

Environmental Contamination from External Sources

- Antibiotic residues enter aquaculture ponds through sewage, livestock manure, hospital waste, and industrial discharge.

Use of Poultry/Dairy Manure in Ponds

- Dairy and poultry manure used as pond fertilizer often contain antibiotic residues.

Shared Water Systems and Reuse

- Seepage, shallow borewell water, and pond water reuse can spread AMR between farms.
- Inadequate water separation protocols increase transmission risk.

Bulk Manufacturing and Unbranded Antibiotics

- Antibiotics produced in bulk and sold without branding or dosage instructions.
- Farmers use them indiscriminately due to low cost and easy access.

Inadequate Disinfection Protocols

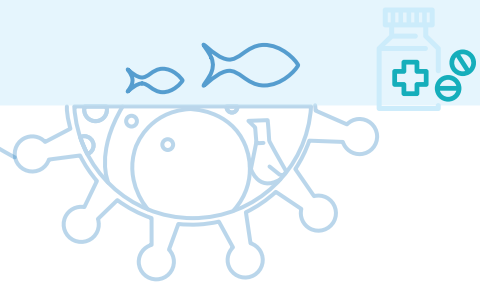
- Unlike shrimp farming, fish culture often skips pond disinfection before stocking.
- These disinfection steps could degrade antibiotic residues and should be standardized across the sector.

Overlooked Use of Other Therapeutics

- Focus remains on antibiotics, but antiparasitics, antivirals, and antiprotozoals also contribute to AMR.
- Regulatory mechanisms do not yet cover these other drug classes.

Inadequate Testing Facilities

- Shortage of labs for residue testing in fish, shrimp, and pond water.
- Limits ability to monitor, enforce, or correct antibiotic use at the ground level.



Measures to Reduce Antimicrobial Use and Combat AMR in the Aquaculture Sector

The aquaculture sector, particularly shrimp farming, has made significant strides in reducing antimicrobial use through awareness, regulatory measures, and adoption of alternative practices. However, widespread misuse persists in inland finfish and small-scale systems. Strengthening sustainable and responsible aquaculture practices is essential to prevent the escalation of antimicrobial resistance (AMR).

Promotion of Natural Alternatives and Nutraceuticals: A growing number of progressive farmers are shifting to natural products and nutraceuticals as viable alternatives to antibiotics. Substances such as turmeric, garlic, neem, and tobacco powder, along with vitamin C, probiotics, prebiotics, symbiotics, and other herbal formulations, are being used to improve immunity in fish and shrimp. These interventions not only support animal health but also reduce reliance on synthetic antimicrobials. Promoting such alternatives through extension services and product validation can significantly strengthen AMR mitigation.

Strengthening Disease Diagnosis and Testing Infrastructure: Accurate and timely diagnosis is a cornerstone of rational antimicrobial use. Stakeholders emphasized the need to improve access to district-level diagnostic and antimicrobial sensitivity testing laboratories. Updated detection methods especially those capable of distinguishing between viral, bacterial, and parasitic infections should be deployed widely. The “Report Fish Disease” app, developed under the National Surveillance Program on Aquatic Animal Diseases (NSPAAD), provides a platform for connecting farmers to laboratories, but awareness and usage remain limited. Field-level access to residue testing and antimicrobial susceptibility tools must be improved and made affordable to ensure precise and targeted treatment decisions.

Implementation of Standardized Disinfection Protocols: Shrimp farming has demonstrated the effectiveness of using disinfection protocols such as chlorine, potassium permanganate, and sodium hydroxide to degrade pathogens and antimicrobial residues in ponds. These protocols must be extended to fish culture systems. Mandatory inclusion of disinfection protocols in aquaculture SOPs will ensure improved water and pond hygiene, thereby reducing the risk of disease outbreaks and antibiotic misuse.

Improved Water Management and Stocking Density Control: Proper water quality management plays a vital role in fish and shrimp health. Practices such as the periodic application of lime, use of filtration systems, and the establishment of pre-treatment reservoirs for creek water are essential. Many farms reuse water across multiple culture cycles due to scarcity, which increases pathogen load. Encouraging pond preparation through drying, liming, and cleaning, is key to maintaining water quality. In addition, adherence to optimal stocking densities—such as maintaining 4,000 tilapia per acre instead of overstocking at 10,000—reduces stress and lowers disease susceptibility.

Biosecurity and Responsible Input Use: Biosecurity must be integrated with other farm management practices such as feeding, water treatment, and housing. Recommendations include low-exchange or closed-loop water systems, use of organic fertilizers over synthetic ones, and proper composting of bio-manure to degrade antibiotic residues. However, stakeholders noted that antimicrobial resistance genes (ARGs) can persist even after composting, suggesting the need for improved manure treatment methods. Additionally, the practice of using livestock or poultry manure in aquaculture ponds should be regulated to prevent cross-sectoral AMR spread.

Clear Guidelines on Antimicrobial Use: The sector urgently needs a consolidated list of permitted and prohibited antimicrobials, with dosage guidelines, withdrawal periods, and maximum residue limits. This list should be widely disseminated among farmers, hatchery operators, feed manufacturers, and drug suppliers to eliminate confusion and enable compliance. Similarly, robust regulatory mechanisms should be put in place to prevent the sale of bulk or unbranded antimicrobial formulations.

Awareness and Responsible Practices Across the Value Chain: Stakeholders highlighted the limited understanding of AMR among fish farmers and hatchery operators. Awareness campaigns must target the entire value chain including feed manufacturers, drug suppliers, and shrimp processors to emphasize topics such as responsible drug use, prohibited inputs, and withdrawal periods. Consumer education on antimicrobial-free aquaculture products can also create demand-driven incentives for better practices. Farmer Producer Organizations (FPOs), cooperatives, and private companies have a crucial role to play in conducting training and delivering AMR messaging at scale.

Environmental Surveillance and Inter-Sectoral Coordination: A system of continuous surveillance for antimicrobial residues in surface and ground water is urgently needed. Coordination between aquaculture authorities and State Pollution Control Boards should be strengthened to monitor effluent quality and mitigate contamination risks.

Major Concerns in the Aquaculture Sector Related to Antimicrobial Resistance (AMR)

Silent Spread of AMR in Finfish Aquaculture: While shrimp farming has moved towards reduced antimicrobial dependence due to export regulations, finfish farming continues to witness indiscriminate and undocumented antimicrobial use. Weak regulation, low awareness among farmers, and lack of diagnostic support enable silent and persistent misuse, contributing to the emergence of resistant bacteria in aquatic ecosystems.

Environmental Contamination and Cross-Sectoral AMR Risks: Shared water bodies, creek systems, and the use of livestock manure in aquaculture ponds increase the risk of antimicrobial residues and resistance genes entering the aquatic environment. This cross-contamination-especially from untreated livestock waste, hospital effluents, and municipal discharge—poses a major One Health concern by linking AMR in aquaculture with human and terrestrial animal sectors.

Lack of Accessible, Low-Cost Testing Infrastructure: Most fish farmers lack access to district-level testing labs for disease diagnosis, residue monitoring, and antibiotic sensitivity testing. This leads to empirical treatment using broad-spectrum antibiotics without evidence-based guidance. The high cost of existing tests further discourages proper monitoring, especially among smallholders.

Need for Regulatory Strengthening in Freshwater Aquaculture: Unlike shrimp aquaculture, freshwater aquaculture lacks a dedicated national authority for regulatory oversight. Currently, state-level fisheries departments are responsible, which leads to inconsistency in regulation, especially for inputs like seed and feed. Stakeholders highlighted a strong need to establish a National Freshwater Aquaculture Authority to regulate aquaculture inputs and practices across states, ensuring both food safety and trade readiness for domestic and international markets.

Enabling Mechanisms and Strategic Recommendations for Combating AMR Across Dairy, Poultry, and Aquaculture Sectors

Cross-Sectoral Learning

Lessons from the shrimp export sector such as traceability tools, laboratory screening, and stringent buyer norms should be documented and extended to finfish aquaculture and domestic markets. A key learning from aquaculture is the role of feed manufacturers in ensuring safe and responsible feed production. In other sectors as well, feed manufacturers should work proactively to develop and promote antibiotic-free feed solutions, strengthening transparency and supporting AMR reduction across the value chain. Cross-learning between dairy, poultry, and aquaculture sectors can further mainstream best practices and reinforce One Health-oriented AMR mitigation.

An integrated approach to antimicrobial resistance (AMR) mitigation is essential across dairy, poultry, and fisheries sectors. While the context and challenges may differ, there are several cross-cutting enabling mechanisms that can drive sustainable antibiotic stewardship, support productivity, and promote One Health resilience.

Targeted Towards the Core Challenges

Develop and Disseminate Clear Guidelines: Establish species-specific lists of permitted and prohibited antimicrobials for poultry, dairy, and aquaculture. Ensure timely updates and wide dissemination along the value chain.

Strengthen Regulatory Enforcement: Implement checks against over-the-counter sales, extra-label use, and the manufacture of unbranded or bulk antimicrobials particularly in poultry and aquaculture sectors.

Enforce Prescription-Based Sales and Triplicate Prescription System: As part of regulatory reform, ensure that all antimicrobials are sold only against prescriptions by licensed veterinarians and tracked through triplicate prescription system where one copy each retained by the prescriber, the user (farmer), and the dispenser (seller).

Targeted Towards Improving Practices

Standardize Farm-Level Protocols: Encourage biosecurity, hygiene, vaccination, and animal husbandry/ aquaculture best practices that reduce the need for antimicrobials.

Adopt and Scale Alternatives to Antimicrobials: Promote probiotics, prebiotics, herbal formulations, postbiotics, essential oils, organic acids and nanoparticle-based veterinary therapeutics across livestock sectors. Highlight innovations such as bacteriophages in poultry and probiotic-nano conjugates for mastitis in dairy.

Promote Vaccination and Biologicals: Expand access to vaccines such as Mycoplasma in poultry and explore biological replacements to reduce antibiotic dependence.

Certification and Market Incentives: Introduce schemes like “Antibiotic-Free” or “Raised Without Antibiotics.” Offer third party verified GAHP (Good Animal Husbandry Practices), clean milk/fish certification, and a star-rating system to drive practice improvement and market access.

Infrastructure

Strengthen District-Level Labs and Diagnostics: Upgrade labs for antimicrobial susceptibility testing (ABST), residue testing, and pathogen detection. Ensure harmonized testing protocols and field-deployable kits are available.

Build Water Quality Monitoring Systems: Create infrastructure to monitor antimicrobial residues in groundwater, aquaculture ponds, and surface water regularly, with real-time public reporting.

Promote Digital Traceability and Record-Keeping: Introduce mobile-based apps and logbooks in local languages for tracking antimicrobial usage, input history, withdrawal periods, and health monitoring. Ensure linkage with farm registration and certification systems.

Practices and Behaviour Change

Awareness Campaigns and Stewardship Training: Conduct IEC campaigns and capacity building for farmers, hatchery owners, feed manufacturers, and para-veterinary professionals. Emphasize risks of AMR and withdrawal periods.

Introduce Incentives for Good Practices: Provide market incentives, access to credit, or certification benefits to farmers adopting clean production and good practices.

Combat Misinformation: Curb reliance on unqualified sources by promoting verified advice from certified veterinarians or fisheries experts.

Establish Model and Demonstration Farms: Showcase antibiotic-free, biosecure, and traceable farm models across dairy, poultry, and aquaculture. Use them for exposure visits, hands-on training, and peer learning.

Partnerships

Engage FPOs, Cooperatives, and Private Sector: Leverage institutional networks to deliver training, promote traceable inputs, and strengthen antibiotic stewardship through supply chain engagement.

Institutional Collaboration and Knowledge Transfer: Encourage coordination between ICAR institutes, SAUs, veterinary colleges, IITs, startups, and producer organizations to enable regional customization and upscaling of solutions.

Foster Cross-Sectoral Learning: Document and replicate innovations such as the traceability system in shrimp exports across all sectors.

Role of the Government

Expand AMR and AMU Surveillance Infrastructure: India's All India Network Project on AMR in Fisheries and Livestock, coordinated by ICAR with FAO support, has laid the groundwork for surveillance. However, 20 laboratories are insufficient for national coverage. There is an urgent need to establish district-level surveillance units across all sectors. In parallel, AMU tracking systems must monitor dosage and frequency of antibiotic use across species. NIVEDI's digital reporting tool, soon available as a mobile app, is a step in this direction and should be scaled nationally.

Integrate Environmental Surveillance: Collaborate with State Pollution Control Boards to monitor antibiotic residues in sewage, coastal discharge, and water bodies.

Support Research and Innovation: Provide public funding for R&D in resistance mechanisms, AMR gene transfer, environmental contamination, and development of affordable therapeutics.

Mainstream AMR in Education and Extension: Incorporate antimicrobial stewardship and One Health in veterinary and fisheries curricula. Build a cadre of trained field professionals and advisors.

Together, these enabling mechanisms provide a roadmap for India to address AMR holistically across dairy, poultry, and fisheries. With sustained political will, institutional commitment, and stakeholder participation, these actions can help balance public health goals with economic sustainability and food security.

References

Codex Alimentarius Commission. Code of Practice to Minimize and Contain AMR (CAC/RCP 61-2005, Rev. 2021); Guidelines on Integrated Monitoring (CAC/GL 82-2021). 2021.

DANMAP. Danish Integrated Antimicrobial Resistance Monitoring and Research Programme Report. 2022.

DoF. 2023. Handbook on Fisheries Statistics 2022. New Delhi: Department of Fisheries, MInistry of Fisheries, Animal Husbandry & Dairying, Government of India. https://dof.gov.in/sites/default/files/2024-06/Handbook.pdf

European Medicines Agency (EMA). ESVAC Report. 2023.

FAO. 2024. Surveillance data of the Indian Network for Fishery and Animal Antimicrobial Resistance (INFAAR) – An analytical report 2019–2022. New Delhi. https://doi.org/10.4060/cc9303enThe

FAO. 2024. White paper: Antimicrobial resistance in the animal sector in India. New Delhi. https://doi.org/10.4060/ cc9535en

FAO. Progressive Management Pathway for AMR. 2021

FAO. The Progressive Management Pathway for AMR (PMP-AMR). 2021

Food and Agriculture Organization (FAO). The Future of Food and Agriculture: Trends and Challenges. 2017.

Global Leaders Group on AMR. Progress Reports 2023–2024.

Grand View Research. Global Animal Diagnostics Market Forecast. 2023

ICAR-NIVEDI. AMR Surveillance in Bovine Mastitis. 2022

IFC. One Health Investment Opportunity Brief: Diagnostics and Alternatives. 2022

IFPRI (2022). Economic Modeling of AMR and Trade Risk in Animal Agriculture

MPEDA. India's Aquaculture Export Performance Reports. 2019–2023

MPEDA. Shrimp Production & Certification Strategy Papers. 2023

Murray CJL, et al. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. The Lancet. 2022; 399(10325):629-655.

O'Neill J. Tackling Drug-Resistant Infections Globally: Final Report. 2016

OECD. Stemming the Superbug Tide: Just A Few Dollars More. 2023.

OECD-FAO. Agricultural Outlook 2018–2027

RASFF Portal. Rapid Alert System for Food and Feed, EU Data 2018–2023

Sumanth Gandra, Jyoti Joshi, Anna Trett, Anjana Sankhil Lamkang, and Ramanan Laxminarayan. 2017. Scoping Report on Antimicrobial Resistance in India. Washington, DC: Center for Disease Dynamics, Economics & Policy.

U.S. Food and Drug Administration. Guidance for Industry #213 and #209. 2017.

United Nations. Political Declaration of the High-Level Meeting on AMR. September 2024.

WHO, FAO, WOAH. Global One Health AMR Framework. 2023

World Bank. Drug-Resistant Infections: A Threat to Our Economic Future. 2017.

World Bank. Drug-Resistant Infections: A Threat to Our Economic Future. 2017

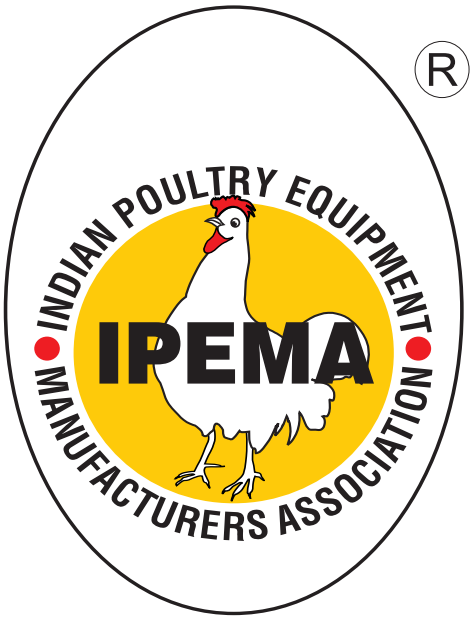
World Health Organization. Antimicrobial resistance. Retrieved May 24, 2025, from https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance

World Health Organization. GLASS Report 2024.

World Organisation for Animal Health (WOAH). Annual Report on Antimicrobial Agents Intended for Use in Animals. 2023.

Supported by

ew | nutrition



Confederation of Indian Industry

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering Industry, Government and civil society through advisory and consultative processes.

For 130 years, CII has been engaged in shaping India's development journey and works proactively on transforming Indian Industry's engagement in national development. With its extensive network across the country and the world, CII serves as a reference point for Indian industry and the international business community.

In the journey of India's economic resurgence, CII facilitates the multifaceted contributions of the Indian Industry, charting a path towards a prosperous and sustainable future. With this backdrop, CII has identified "Accelerating Competitiveness: Globalisation, Inclusivity, Sustainability, Trust" as its theme for 2025-26, prioritising five key pillars. During the year, CII will align its initiatives to drive strategic action aimed at enhancing India's competitiveness by promoting global engagement, inclusive growth, sustainable practices, and a foundation of trust.

Confederation of Indian Industry

The Mantosh Sondhi Centre
23, Institutional Area, Lodi Road, New Delhi – 110 003 (India)
T: 91 11 45771000 | E: info@cii.in • W: www.cii.in

Follow us on:

cii.in/facebook | cii.in/twitter | cii.in/linkedin | cii.in/youtube

Reach us via CII Membership Helpline Number: 1800-103-1244

FACE
CII-Jubilant Bhartia
Food and Agriculture Centre of Excellence

FACE is CII's Centre of Excellence dedicated to building efficiencies across the agricultural value chain from farm to fork. FACE is charged with the mission of improving competitiveness of India' agriculture and food sector by catalyzing innovation, building capacity and enhancing productivity across the value chain. FACE works with farmers, companies, development institutions and the government to

- Improve on and off-farm productivity through the dissemination of best practices and technological innovation
- Invest in capacity building initiatives and skill development for supply chain participants across the value chain
- Strengthen linkages across the value chain through market access initiatives, thereby reducing losses and increasing farmer incomes

FACE's service portfolio comprises commodity specific value chain assessments and supply chain advisory services for food and agri businesses, training and consulting services in the area of food safety, and sectoral research across different market segments. FACE also works on projects in PPP mode, to develop business models that are scalable and replicable across geographies.

CII - Jubilant Bhartia Food and Agriculture Centre of Excellence (FACE)
Confederation of Indian Industry

Andhra Association Building, 4th Floor
24-25 Institutional Area, Lodi Road, New Delhi-110003, India
T: +91 45771000 | E: face-info@cii.in | W: www.face-cii.in/