Antimicrobial Resistance: Preventing the silent pandemic in aquatic food systems

World Antimicrobial Awareness Week – 18th November 2021

WorldFish and Partners: AMR research and development activities

Jerome Delamare-Debouteville and Chadag Vishnumurthy Mohan, WorldFish

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Our Vision

An inclusive world of healthy, well-nourished people and a sustainable blue planet, now and in the future.

Our Mission

To end hunger and advance sustainable development by 2030 through science and innovation to transform food, land and water systems with aquatic foods for healthier people and planet.

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We are part of CGIAR

Where we are?

WorldFish has
a global presence in
20 countries in
3 continents with
446 staff representing
30 nationalities

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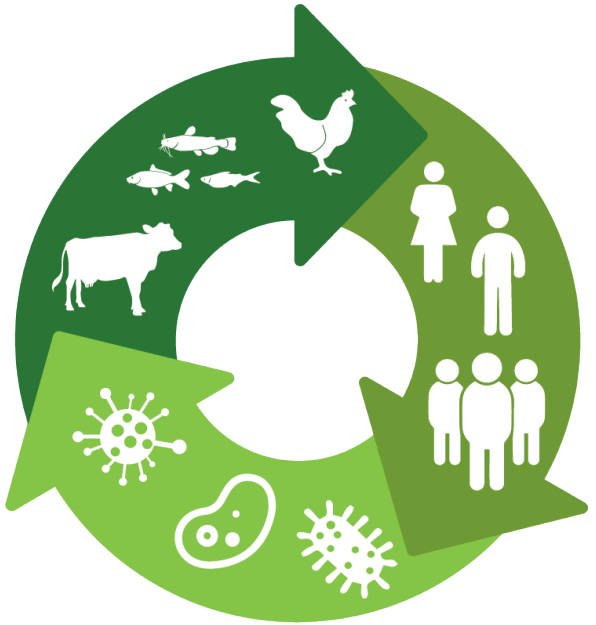
Aquatic food systems for people and planetary health

Aquatic foods are **essential** for ***Nourishing Nations and Transforming Food Systems.***

Fisheries and aquaculture can play a greater role in delivering healthy diets and more sustainable, equitable and resilient food systems around the world (**Blue foods assessment**).

Our challenge is to transform aquatic food systems to do better for humans (**safe/healthy food**), animals (**no/less disease**) and the environment (**clean**)



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Aquaculture growth and future challenges

- Currently, aquaculture is one of the **fastest growing food producing sector** in the world
- Global demand for aquatic foods will roughly **double by 2050** with aquaculture predicted to meet most of this demand complementing capture fisheries
- With intensification, **disease losses** are also increasing, impacting the **development and sustainability** of the aquaculture sector
- With the highest risk **located in LMIC** where people **rely the most on aquatic food systems** and where they are least equipped **to respond and adapt** to disease risks.

Diseases as drivers of AMU and AMR

For farmers **etiology makes little sense** compared to mortalities. Mitigation through overstocking and treatments including use of antimicrobial agents (e.g. antibiotics).

67 different antibiotics used in 11 major aquaculture producing countries, contributing to the global pool of antimicrobial resistance (AMR)

Antimicrobial use (AMU) in aquaculture differs from livestock farming due to greater diversity of farmed species and farming systems.

Antibiotic resistance mechanisms identical in fish, livestock and human pathogens

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Our understanding of AMU and AMR in aquatic food systems is limited

AMU in commercial aquaculture farms **is common**; various types of antimicrobials **are available** to purchase over-the-counter

The decision of farmers to resort to AMU is **influenced by several actors** (e.g. peers, input suppliers, extension service providers, consultants, regulators).

Understanding of behaviour and practice of farmers and value chain actors is **vital to design interventions** to tackle AMR problems in aquatic food systems.

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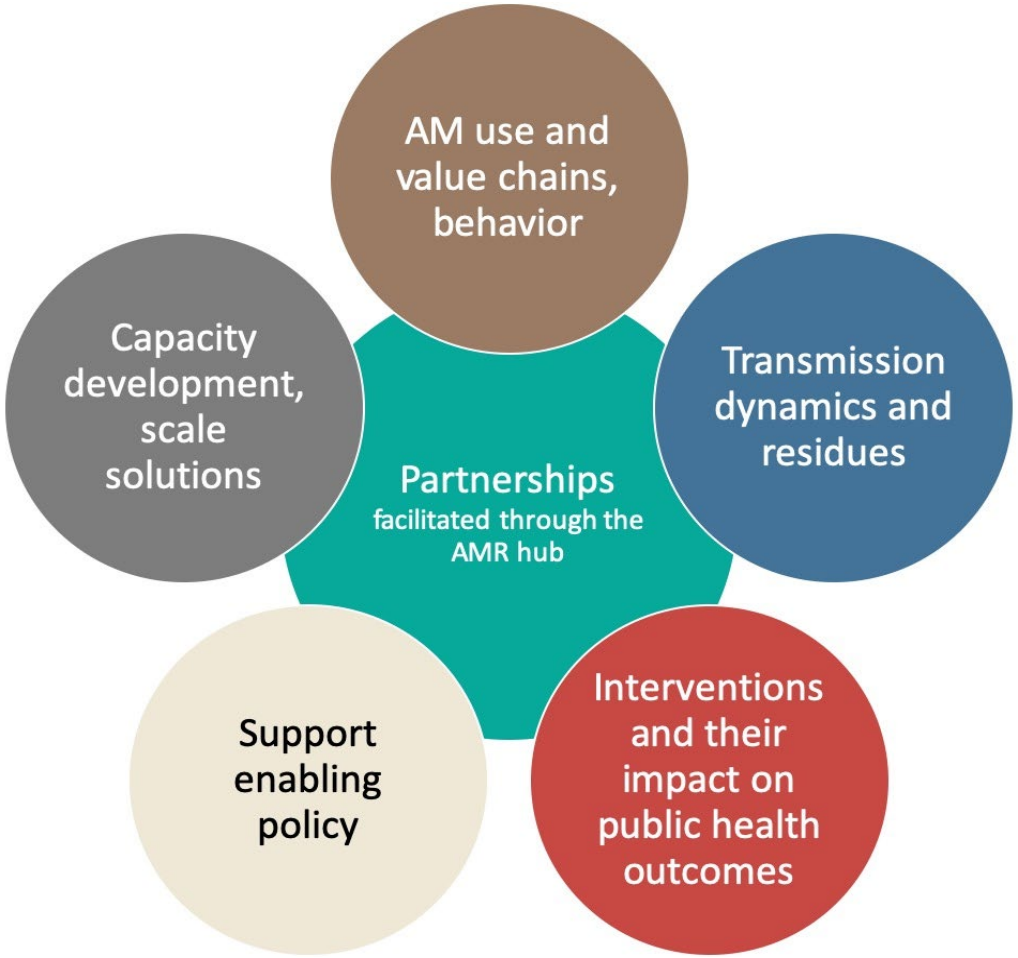
WorldFish Collaboration with Partners through projects



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AMR Resilience Project Global

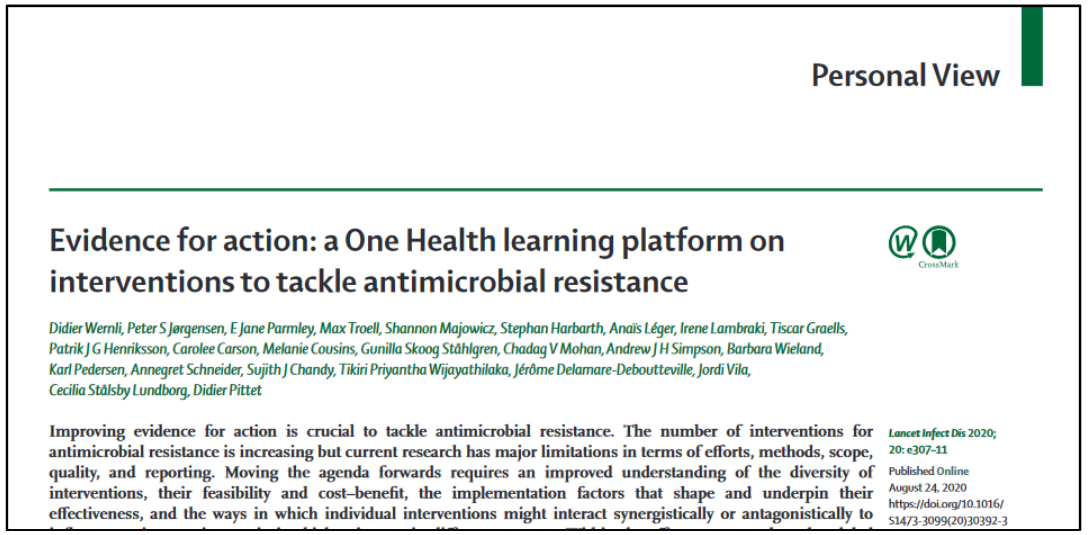
Jan 2019-Dec 2020

Joint Programming Initiative on Antimicrobial Resistance (JPIAMR)

Partners:

- Stockholm Resilience Center (SRC)
- University of Waterloo, Canada

Key messages: The project helped to better understand how interventions against antimicrobial resistance shape resilience and transformability. The project produced a learning platform to document which interventions work to limit antibiotic resistance across animal and human health.



Personal View

Evidence for action: a One Health learning platform on interventions to tackle antimicrobial resistance

Didier Wernli, Peter S Jørgensen, E Jane Parmley, Max Troell, Shannon Majowicz, Stephan Harbarth, Anaïs Léger, Irene Lambraki, Tiscar Graells, Patrik J G Henriksson, Carolee Carson, Melanie Cousins, Gunilla Skoog Ståhlgren, Chadag V Mohan, Andrew J H Simpson, Barbara Wieland, Karl Pedersen, Annegret Schneider, Sujith J Chandy, Tikiri Priyantha Wijayathilaka, Jérôme Delamare-Debouteville, Jordi Vila, Cecilia Stålsby Lundborg, Didier Pittet

Improving evidence for action is crucial to tackle antimicrobial resistance. The number of interventions for antimicrobial resistance is increasing but current research has major limitations in terms of efforts, methods, scope, quality, and reporting. Moving the agenda forwards requires an improved understanding of the diversity of interventions, their feasibility and cost–benefit, the implementation factors that shape and underpin their effectiveness, and the ways in which individual interventions might interact synergistically or antagonistically to

Lancet Infect Dis 2020; 20: e307–11
Published Online August 24, 2020
https://doi.org/10.1016/S1473-3099(20)30392-3

The Lancet Infectious Diseases; https://dx.doi.org/20.500.12348/4339

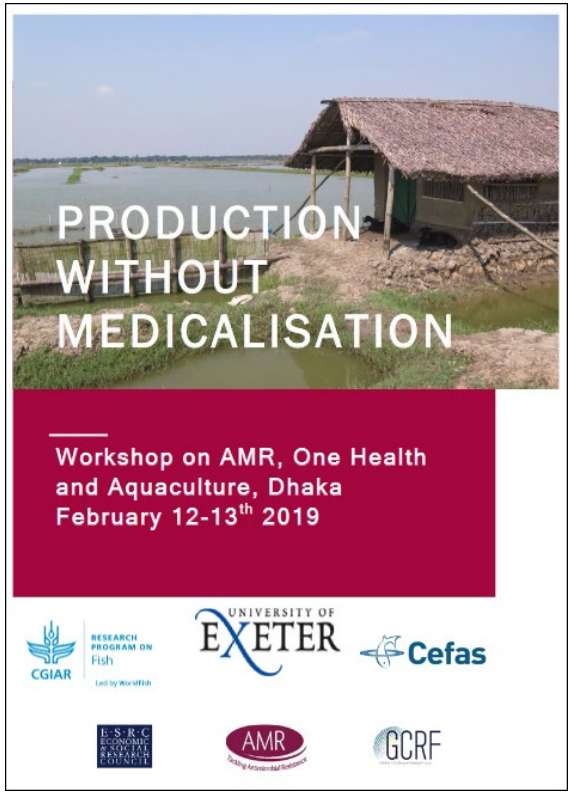
Production without medicalization Project Bangladesh

Jan 2018-Dec 2020

Partners:

- University of Exeter UK
- Centre for Environment, Fisheries and Aquaculture Science (Cefas) UK
- Veterinary Medicines Directorate (VMD)
- Animal and Plant Health Agency (APHA)
- Food and Agriculture Organization (FAO) in Dhaka

Key messages: Research and advocacy on the prudent and responsible use of AB and the need to change behaviour and practice of aquatic food value chain actors including small scale producers



https://hdl.handle.net/20.500.12348/3135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HUMANITIES | SOCIAL SCIENCES | BUSINESS

ARTICLE

DOI: 10.1057/s41599-018-0195-4 OPEN

The AMR problem: demanding economies, biological margins, and co-producing alternative strategies

Steve Hinchliffe[1], Andrea Butcher[1] & Muhammad Meezanur Rahman[2]

https://dx.doi.org/10.1057/s41599-018-0195-4

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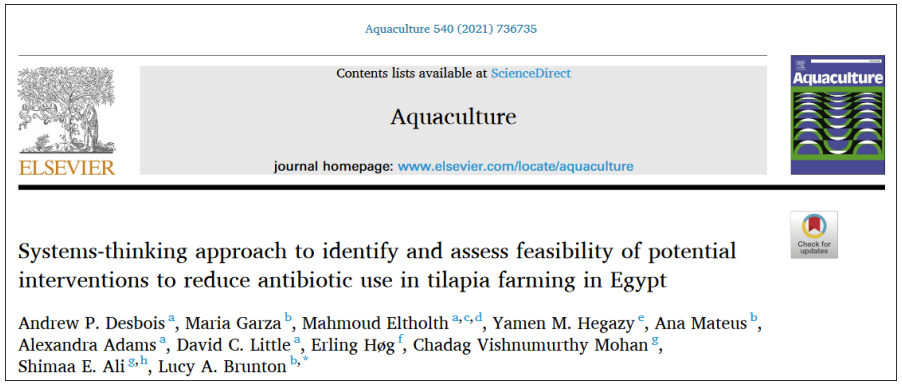
AMFORA Project Vietnam, Egypt and Global

Jan 2018-Dec 2020

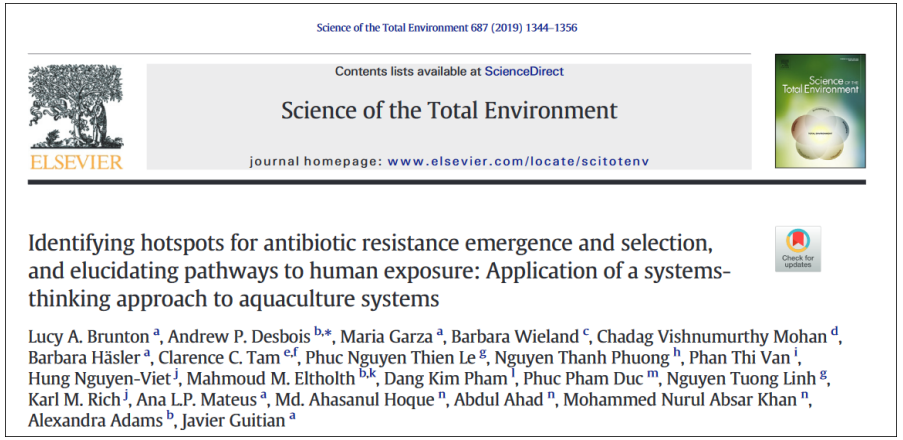
Partners:

- Royal Veterinary College (RVC) of London
- International Livestock Research Institute (ILRI)
- University of Stirling

Key messages: Applying a systems-thinking approach to aquaculture systems for identifying hotspots for antibiotic resistance emergence and spread in aquatic systems, elucidating pathways to human exposure and to identify and assess feasibility of potential interventions



https://doi.org/10.1016/j.aquaculture.2021.736735



https://doi.org/10.1016/j.scitotenv.2019.06.134

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Fleming Fund Bangladesh

June 2020-Dec 2021

Partners: ILRI for Fleming Fund (FF) Fellowships & DAI (USA) for FF Country Grant, DOF, BFRI, DOL, DLRI, ICDDRb, Cefas UK

Key messages: embedding aquatic food systems in Bangladesh AMR surveillance and One health works. Build capacity for veterinary AMR and AMU surveillance

Key outcomes:

- Mentoring of 2 FF Fellows from the Fish Inspection and Quality Control (FIQC) of the Department of Fisheries (DOF) Bangladesh: (1) AMR Laboratory Aquaculture and (2) AMR surveillance Aquaculture

- Collaborating with FF Country Grant in undertaking point prevalence surveys (PPS) on antibiotics use in public health, poultry and aquaculture. AMU data collected from 480 fish farms covering 6 districts in Bangladesh

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One Health Aquaculture Cefas project Bangladesh

Dec 2020-April 2021

Partners: Cefas UK; Exeter University, DOF, BFRI, DOL, DLRI, ICDDRb (Bangladesh)

Key messages: Formally introduce he concept of One Health approach for aquaculture to the authorities and stakeholders responsible for policies associated with environmental, human and animal health in national aquatic food production in Bangladesh.

Objectives:

- Assess the Bangladeshi aquatic foods system though the One Health lens
- Engage with policymakers
- Develop tools, methods and capabilities to test for COVID-19 in seafood and wastewater

link to workshop poster

Sustainable aquaculture through the One Health lens

G. D. Stentiford[1,2], I. J. Bateman[3], S. J. Hinchliffe[2,4], D. Bass[1,2], R. Hartnell[5], E. M. Santos[2,6], M. J. Devlin[7], S. W. Feist[1], N. G. H. Taylor[1,2], D. W. Verner-Jeffreys[1,2], R. van Aerle[1,2], E. J. Peeler[1,2], W. A. Higman[1], L. Smith[1], R. Baines[1], D. C. Behringer[8,9], I. Katsiadaki[1,2], H. E. Froehlich[10,11] and C. R. Tyler[2,6]

https://www.nature.com/articles/s43016-020-0127-5

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AMR Cefas project Bangladesh

Dec 2020-March 2022

Partners: Cefas UK, DoF, DAI, BLRI, BFRI, Khulna University, ICDDRb

Key messages: Facilitating future collaboration on COVID-19 responses through capacity building on AMR livelihoods

Objectives:

- Establish a pilot system and training for AMR surveillance focusing on fish and crustacean species
- Assessment of AMR at point of consumption via technical assistance and diagnostic services to strengthen and establish AMR surveillance
- Systems modelling undertake data gathering for AMU and AMR pathways and feedback

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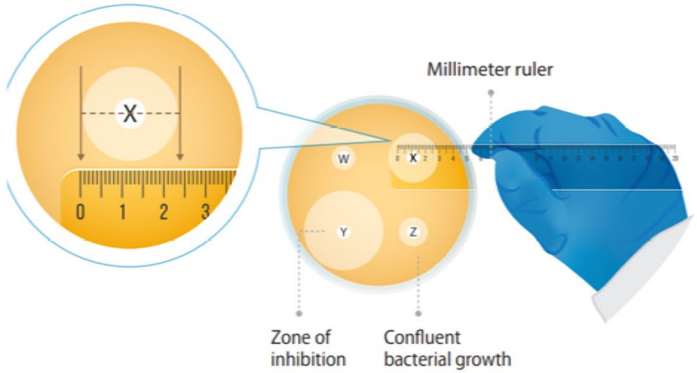
AMR Cefas project: Learning Resource Materials

Quick protocol for antimicrobial susceptibility testing (AST) in aquatic animal species from aquaculture and fisheries
https://hdl.handle.net/20.500.12348/4862

Disk diffusion method (based on CLSI guideline Vet03[1])

14 Measure inhibition zone diameter under appropriate illumination as per protocols.



15 Ensure zone sizes for reference strain are within range and determine epidemiological cut-off values (ECV/ECOFF)/clinical breakpoints if available.

		Interpretive categories and zone diameter, ECVs nearest whole mm	
Antimicrobial agent	Disk content	WT	NWT
W	25 µg	≥ 27	≤ 26
X	30 µg	≥ 28	≤ 27
Y	5 µg	≥ 30	≤ 29
Z	10 µg	≥ 18	≤ 17

Sampling materials for fish disease diagnostics
https://hdl.handle.net/20.500.12348/4836

Bacteriology sampling guide
https://hdl.handle.net/20.500.12348/4840

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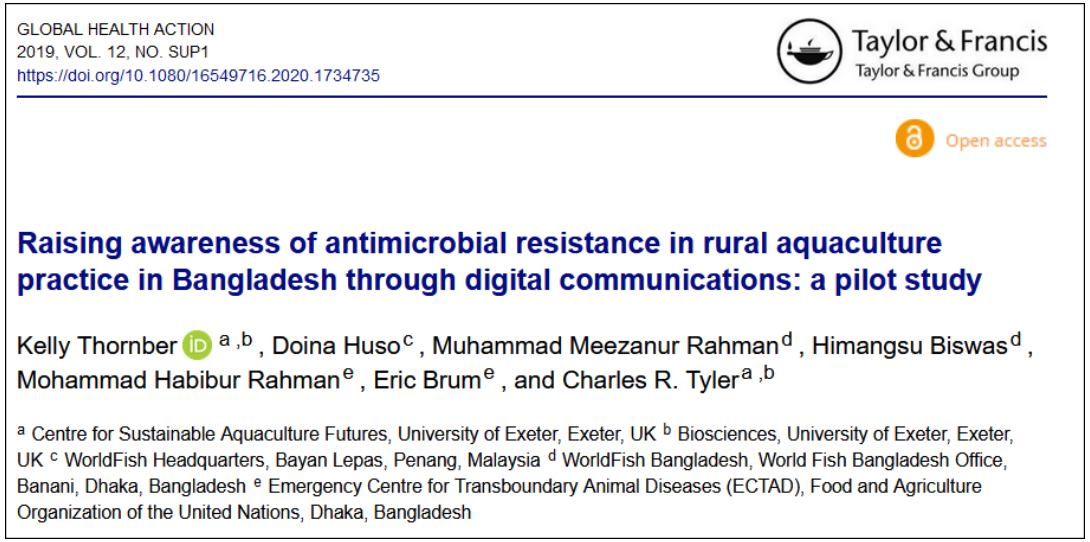
Antimicrobial resistance: Raising awareness



GLOBAL HEALTH ACTION
2019, VOL. 12, NO. SUP1
https://doi.org/10.1080/16549716.2020.1734735

Taylor & Francis
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Open access

Raising awareness of antimicrobial resistance in rural aquaculture practice in Bangladesh through digital communications: a pilot study

Kelly Thornber [a,b], Doina Huso[c], Muhammad Meezanur Rahman[d], Himangsu Biswas[d], Mohammad Habibur Rahman[e], Eric Brum[e], and Charles R. Tyler[a,b]

[a] Centre for Sustainable Aquaculture Futures, University of Exeter, Exeter, UK [b] Biosciences, University of Exeter, Exeter, UK [c] WorldFish Headquarters, Bayan Lepas, Penang, Malaysia [d] WorldFish Bangladesh, World Fish Bangladesh Office, Banani, Dhaka, Bangladesh [e] Emergency Centre for Transboundary Animal Diseases (ECTAD), Food and Agriculture Organization of the United Nations, Dhaka, Bangladesh

https://doi.org/10.1080/16549716.2020.1734735

- YouTube videos: AMR animation **for reducing antibiotic use in Bangladesh fish farming – through better practices** developed by SAF at the University of Exeter in collaboration with WorldFish and the FAO. Bangla version (link) and English version (link)
- Why Antimicrobial Resistance (AMR) in aquaculture matters for the One Health approach (YouTube link) and poster (link)

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Inspire challenge project: Rapid genomic detection of aquaculture pathogens (Jan 2020-June 2021)

Partners: The University of Queensland, Wilderlab, Centex Shrimp (BIOTEC/Mahidol University), GeneSEQ

Key messages:

- "Lab-in-a-backpack" uses nanopore sequencing technology and low cost, low waste sample preparation to generate whole pathogen genome sequence data from diagnostic samples without laboratory support
- Genome-based diagnosis of pathogens enables evidence-based treatment, epidemiological tracing, AMR surveillance and the production of simple low-cost, locally produced "autogenous" vaccines to protect the next crop
- Development of cloud-based identification tools that returns near real-time information on pathogen species ID, MLST (epidemiology) and molecular serotyping (vaccine formulation) (note: current classifiers covering most sequence types and serotypes of Group-B *streptococcus*).
- The source code is readily adaptable to create new classifiers for additional pathogens and a variety of other applications (e.g. acquired AMR genes to inform better treatment).

Links: poster | video abstract | TiLV amplicon paper | training pptx | cloud-based tool

CGIAR Platform for Big Data in Agriculture

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Actions and changes needed to address the key driver

https://doi.org/10.1111/raq.12633

Improved diagnostics
(e.g. pond site multiple pathogen detection systems, lab-in-a-backpack)

Implementation of farm level biosecurity and better management practices
(e.g. better extension services, practical field manuals, digital tools, learning tools)

Improving access to alternatives veterinary solutions autogenous vaccines
(e.g. autogenous vaccines)

Access to disease resistant fish strains
(e.g. WorldFish work on tilapia-GIFT and TiLV)

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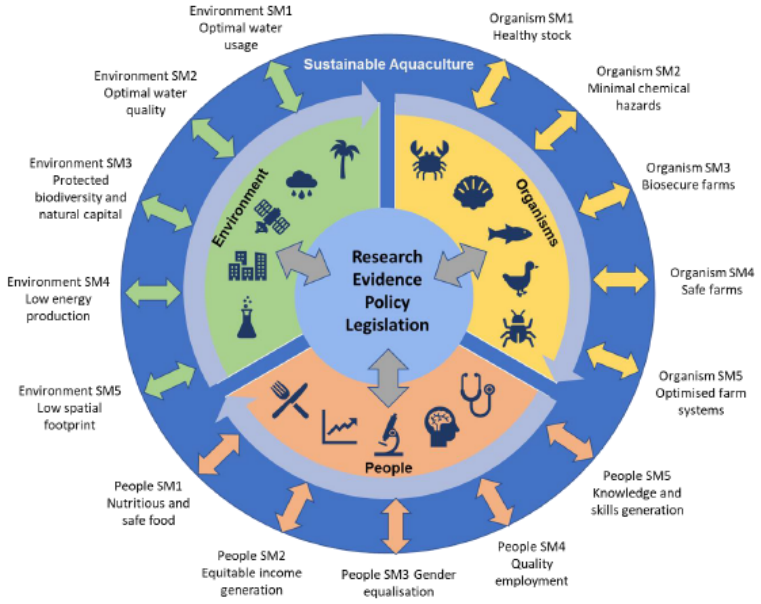
Moving forward into the One CGIAR

- AMR is a **product of actions of various actors and elements** involved in the food systems and beyond. **Collective action under a One Health framework** is necessary to tackle AMR in aquatic food systems.
- **Under the One CGIAR**, WorldFish is part of the **One Health IDT** and **AMR and food Safety** are **two key work packages** that WorldFish will support from the aquatic food systems perspective



Link

WorldFish works with partners and donors

CGIAR ANTIMICROBIAL RESISTANCE Hub

Stockholm Resilience Centre | Stockholm University

UNIVERSITY OF WATERLOO

UNIVERSITY OF STIRLING

UNIVERSITY OF EXETER

RVC Royal Veterinary College University of London

Department for Environment Food & Rural Affairs

AMR Tackling Antimicrobial Resistance

MAHIDOL UNIVERSITY BIOTEC-NSTDA

MRC Medical Research Council

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Centre for Environment Fisheries & Aquaculture Science

CGIAR Platform for Big Data in Agriculture Alliance

icddr,b

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

Bioversity International

CIAT International Center for Tropical Agriculture

The Fleming Fund

UKaid from the British people

Veterinary Medicines Directorate

IFPRI INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

GeneSEQ NEXT GENERATION SEQUENCING

WILDERLAB

DAI

ICARS INTERNATIONAL CENTRE FOR ANTIMICROBIAL RESISTANCE SOLUTIONS

FAO Food and Agriculture Organization of the United Nations

MOTT MACDONALD

Animal & Plant Health Agency

ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

CGIAR RESEARCH PROGRAM ON Livestock

CGIAR RESEARCH PROGRAM ON Agriculture for Nutrition and Health Led by IFPRI

CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems

LED BY: IWMI International Water Management Institute

CGIAR RESEARCH PROGRAM ON Fish Led by WorldFish

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Other WorldFish and partners AMR related outputs

- 2018: Tackling AMR in Bangladesh – a One Health approach. **FAO**. https://bit.ly/3Ct3AJb
- 2018: AMR in the Matrix – an irresponsible, irresistible parody. **BARA Bangladesh AMR Response Alliance.** https://bit.ly/3oBYqpo
- 2018: Unpacking factors influencing antimicrobial use in global aquaculture and their implication for management: a review from a systems perspective. **Sustainability Science**. https://doi.org/10.1007/s11625-017-0511-8
- 2018: An assessment of health management practices and occupational health hazards in tiger shrimp (*Penaeus monodon*) and freshwater prawn (*Macrobrachium rosenbergii*) aquaculture in Bangladesh. **Veterinary and Animal Science**. https://doi.org/10.1016/j.vas.2018.01.002
- 2018: Trade-offs related to agricultural use of antimicrobials and synergies emanating from efforts to mitigate antimicrobial resistance. **Science Forum 2018 Case Study. Rome, Italy: CGIAR Independent Science and Partnership Council.** https://bit.ly/3DzPNBX
- 2018: The role of infectious disease impact in informing decision-making for animal health management in aquaculture systems in Bangladesh. **Preventive Veterinary Medicine**. https://doi.org/10.1016/j.prevetmed.2018.03.004
- 2019 Poster: AMFORA: Applying a One Health systems modelling to formulate strategies for mitigating the risks to human health of ABR in aquaculture**. Royal Veterinary College University of London**. https://hdl.handle.net/20.500.12348/2660
- 2019: WorldFish joins new research partnership to tackle global problem of antimicrobial resistance. **WorldFish website**. https://bit.ly/30ICKjt
- 2019: AMR Blog Story. **CGIAR AMR hub website**. https://bit.ly/3kQhPli
- 2020: Combatting AMR in Aquaculture. **Q&A in Nature Outlook**. https://hdl.handle.net/20.500.12348/4570
- 2020: Evaluating antimicrobial resistance in the global shrimp industry. **Reviews in Aquaculture**. https://doi.org/10.1111/raq.12367
- 2020: Coevolutionary goverance of antibiotic and pesticide resistance. **Trends in Ecology & Evolution**. https://doi.org/10.1016/j.tree.2020.01.011
- 2021: Planetary boundaries and Veterinary Services. **World Animal Health Organization (OIE).** https://hdl.handle.net/20.500.12348/4873
- 2021: Reducing disease risks in fish through better detection, management and prevention**. WorldFish FISH CRP Program Brief**. https://hdl.handle.net/20.500.12348/4833
- 2021: Characterizing antibiotics in LCA—a review of current practices and proposed novel approaches for including resistance. **The International Journal of Life Cycle Assessment**. https://doi.org/10.1007/s11367-021-01908-y

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Thank You