Building Sustainable AMR Surveillance Capability in Singapore and the ASEAN region

A/P Aung Kyaw Thu

National Centre for Food Science

WOAH Collaborating Centres | Consortium for Food Safety in Asia and Pacific Webinar on "Approach and Research to Reduce Antimicrobial Use" on 23 Jan 2024, 1-3pm

Our responsibilities

Vision

Safe Food for All

Mission

To ensure and secure a supply of safe food

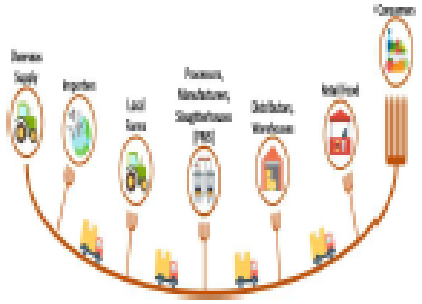
- The Singapore Food Agency (SFA) was formed on 1 April 2019
- SFA is a statutory board formed under the Ministry of Sustainability and the Environment to oversee food safety and security

New agency launched to strengthen food security and safety, from farm to fork

The new Singapore Food Agency will address all food-related issues, from food production to food hygiene. PHOTO: ST FILE

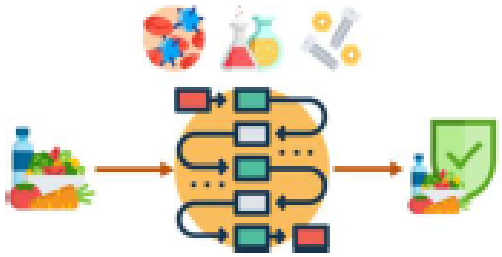
(straitstimes.com, 1 Apr 2019)

How SFA manages food safety – 3 principles



1 Farm-to-Fork Systems Approach

- To identify key stakeholders and control points along the farm-to fork food supply chain



2 Science Based Risk Assessment & Management

- To assess food safety risks using scientific knowledge and principles
- To manage food safety risks with the appropriate control measures

3 Joint Food Safety Responsibility

- For key stakeholders to mitigate food safety risks

SFA'S National Centre for Food Science (NCFS): Supporting SFA's mission to ensure a supply of safe food

Supports SFA's food safety functions

- Provides comprehensive range of testing services (Regulatory & Surveillance)
- Develops capabilities for new and emerging hazards
- Conducts food safety research, monitoring and risk assessment
- Capability building e.g. strengthen competency of local and regional labs

Regional and International Recognition

ASEAN Food Reference Laboratories

(1) Pesticide Residues
(2) Environmental Contaminants
(3) Mycotoxins
(4) Marine Biotoxins and Scrombrotoxins

World Organisation for Animal Health
Founded as OIE

WOAH Collaborating Centre for Food Safety

WHO Collaborating Centre for Food Contamination Monitoring

AMR: A cyclical link between food chain and One-Health ecosystems

AMR is a One-Health challenge. Microorganisms carrying resistance can be transmitted between humans, animals and the environment. Like other ecological sectors, antimicrobial resistant microorganisms are monitored and found in food chain globally as well as in Singapore.

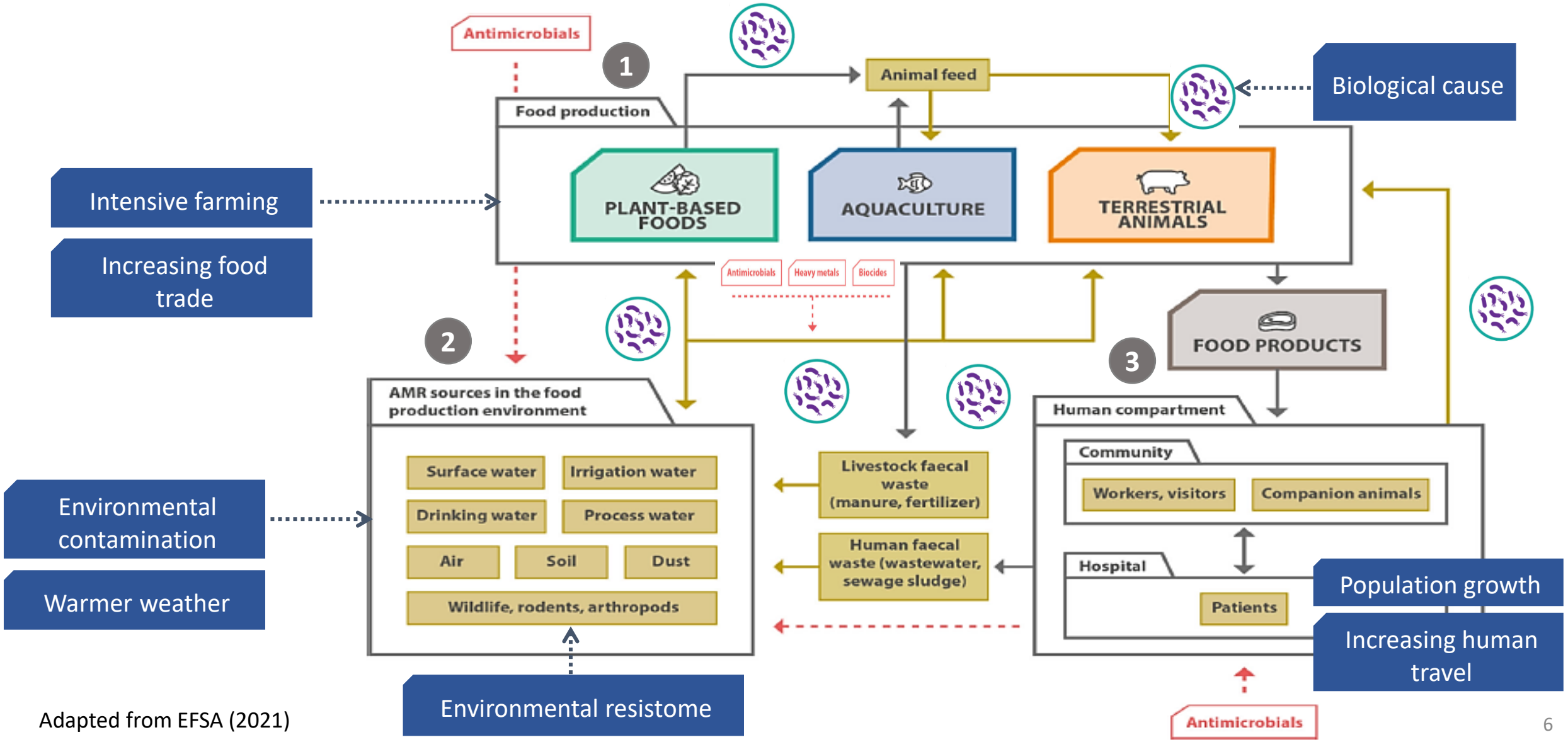
Drivers, sources and transmission routes

AMR in food chain: Singapore's context

SFA's efforts to address AMR

Drivers, source and transmission routes of AMR

Cyclical link between food production, humans and other ecological sectors globally

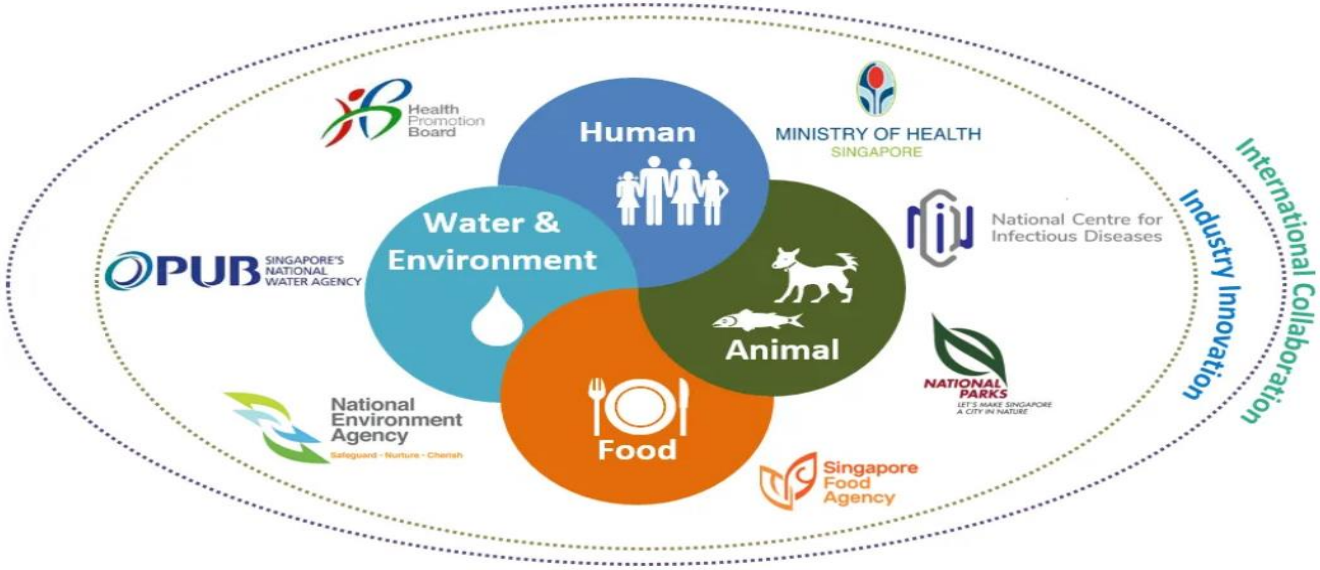


Adapted from EFSA (2021)

Singapore has established a multi-sectoral National Strategic Action Plan (NSAP) on AMR since 2017

- The National Strategic Action Plan (NSAP) was developed in November 2017 by One Health government agencies, and a Progress Report released in 2020.

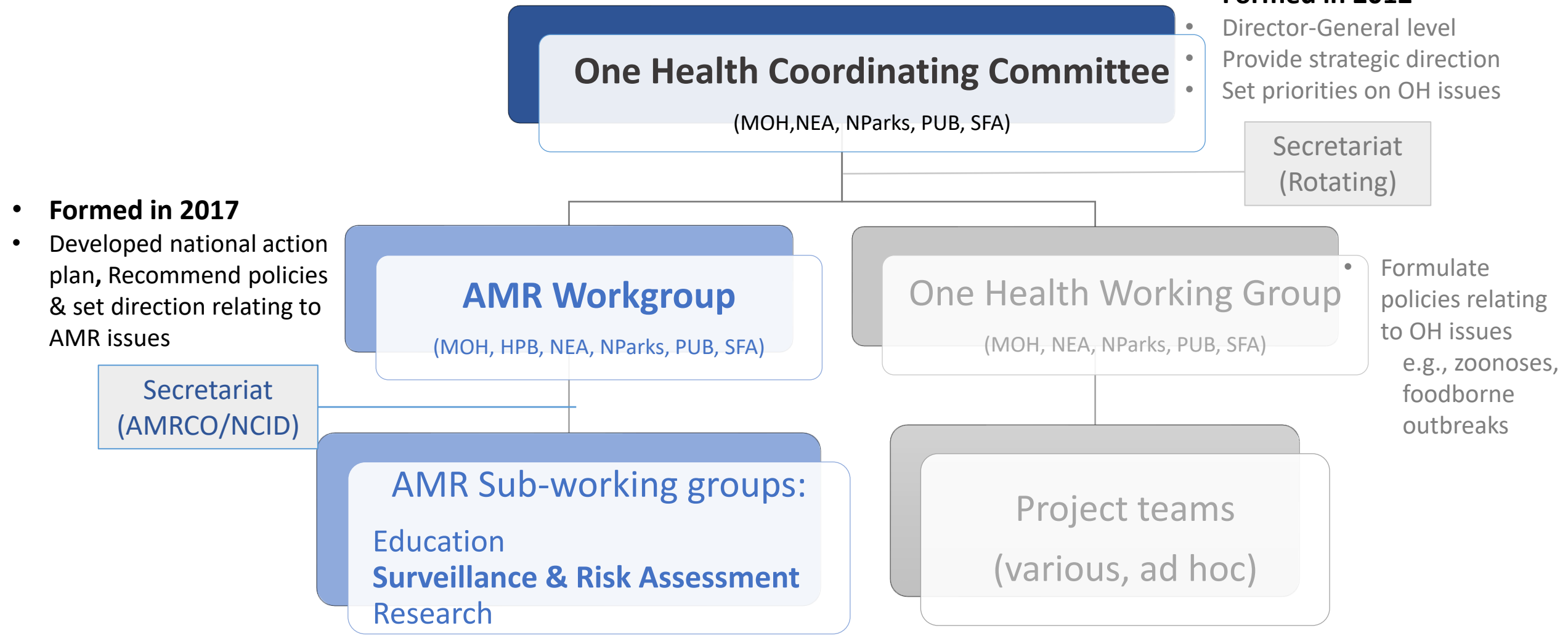
- The NSAP identified 5 core strategies to combat AMR, shown below:



Education	Surveillance & Risk Assessment	Research	Prevention and control of infection	Optimisation of AMU

→ Data from surveillance and research guide action in all strategies

One Health (OH) Structure in Singapore



- **Formed in 2012**
- Director-General level
- Provide strategic direction
- Set priorities on OH issues

- **Formed in 2017**
- Developed national action plan**,** Recommend policies & set direction relating to AMR issues

- Formulate policies relating to OH issues e.g., zoonoses, foodborne outbreaks

AMRCO/NCID: Antimicrobial Resistance Coordinating Office/National Centre for Infectious Diseases
MOH: Ministry of Health; NEA: National Environment Agency; NParks: National Parks Board; PUB: National Water Agency; SFA: Singapore Food Agency

One Health (OH) Surveillance Subgroup

A technical working group of the OH AMR Workgroup

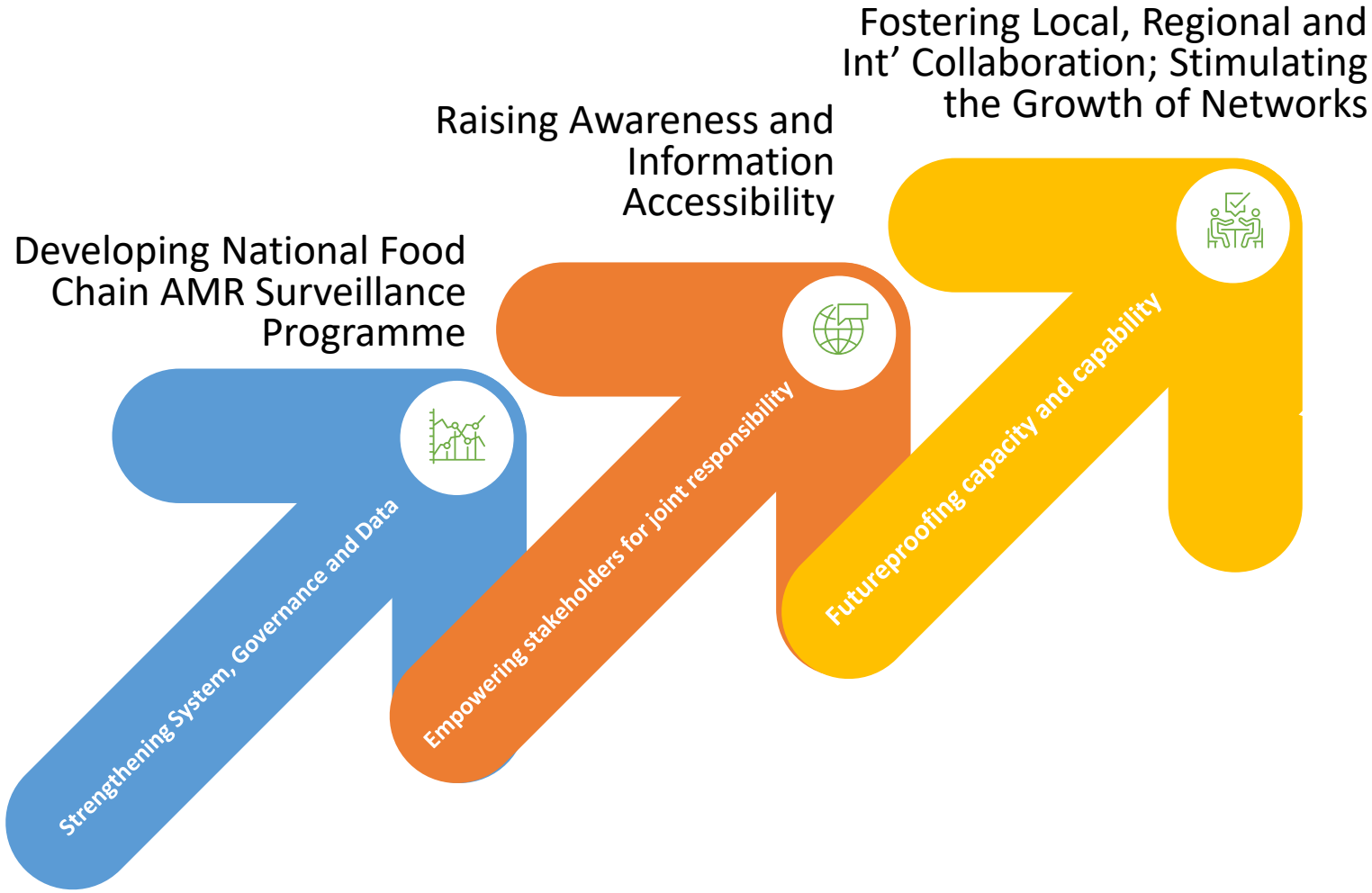
Members comprise

- Microbiologists and scientists from national labs for animal, food safety, environment & water quality
- Veterinarians
- Chair of National AMR Control Committee (NARCC, MOH)
- Clinical microbiologist advisor, Singapore General Hospital
- AMRCO (Coordinator)

TOR:

- Improve data sharing across sectors
- Joint reporting and risk assessment
- Establish an integrated AMR surveillance system

Key steps towards building sustainable AMR surveillance capability in Singapore and the ASEAN region



1. Developing National Food Chain AMR Surveillance

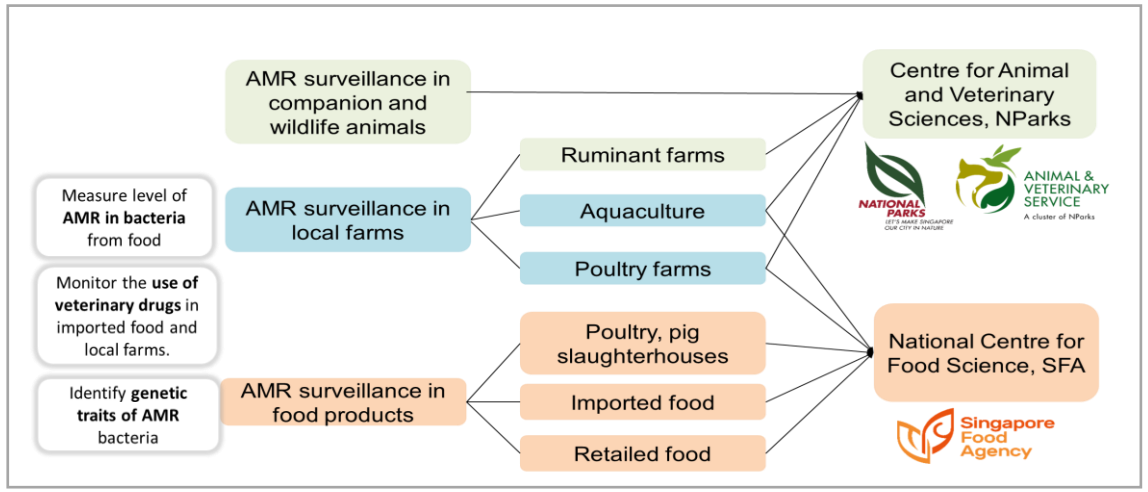
Strengthening System, Governance and Data

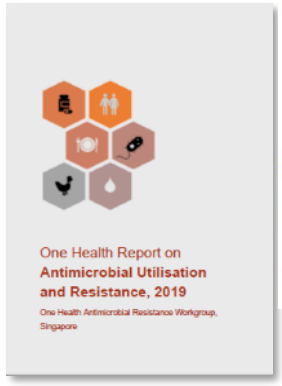
AMR surveillance in the food chain

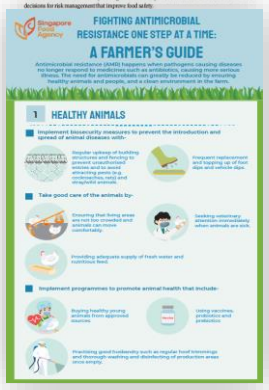
MONITORING AND EVALUATION

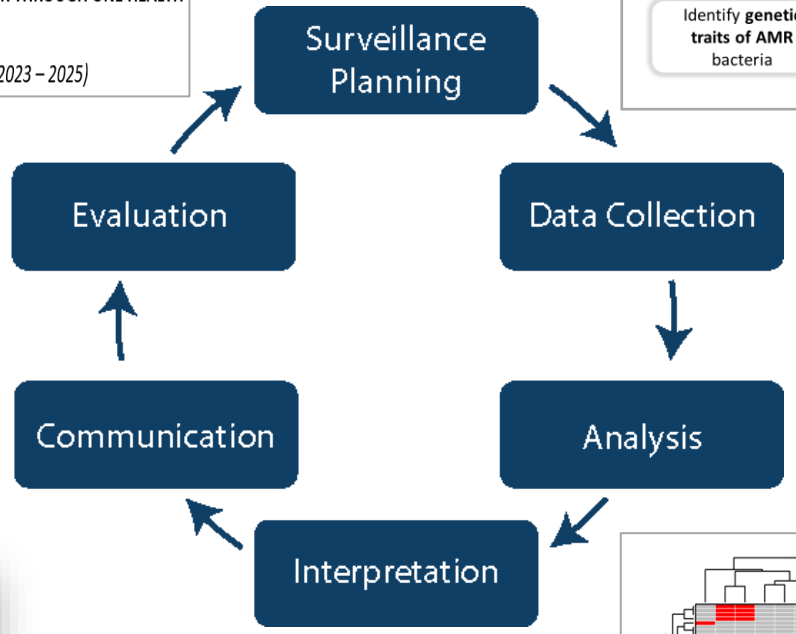
OF THE ASEAN STRATEGIC PLAN FOR COMBATTING AMR THROUGH ONE HEALTH APPROACH

Framework and recommended indicators (2023 – 2025)









DATA AND EXPOSURE SCIENCE

- Horizon Scan and Data Analytics
- Quantitative Risk Modelling

ACTIVE SURVEILLANCE

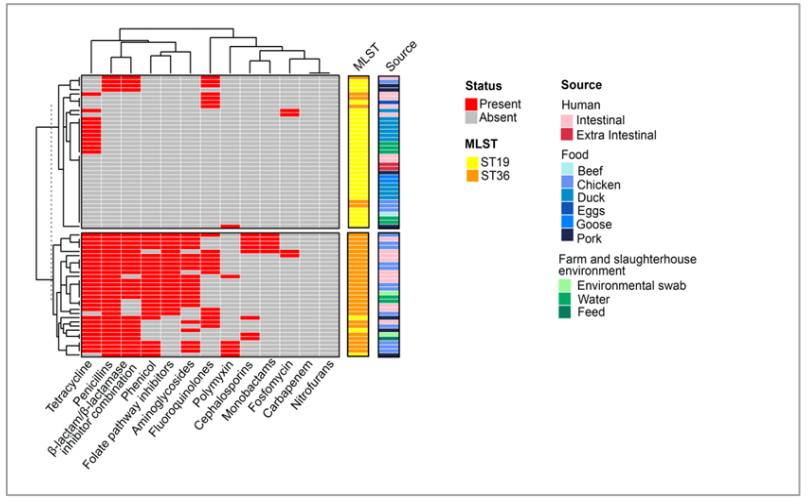
- AST of foodborne and veterinary bacterial isolates obtained through specific AMR surveillance programmes
- AMU surveys in local farms and veterinary industries
- Antimicrobial Residues Surveillance

PASSIVE SURVEILLANCE

- AST of bacterial isolates obtained through the existing monitoring programme across food chain and animal sector

GENOME MONITORING

- Genomic analysis of targeted bacteria from food, animals and humans



AMR Data Generation

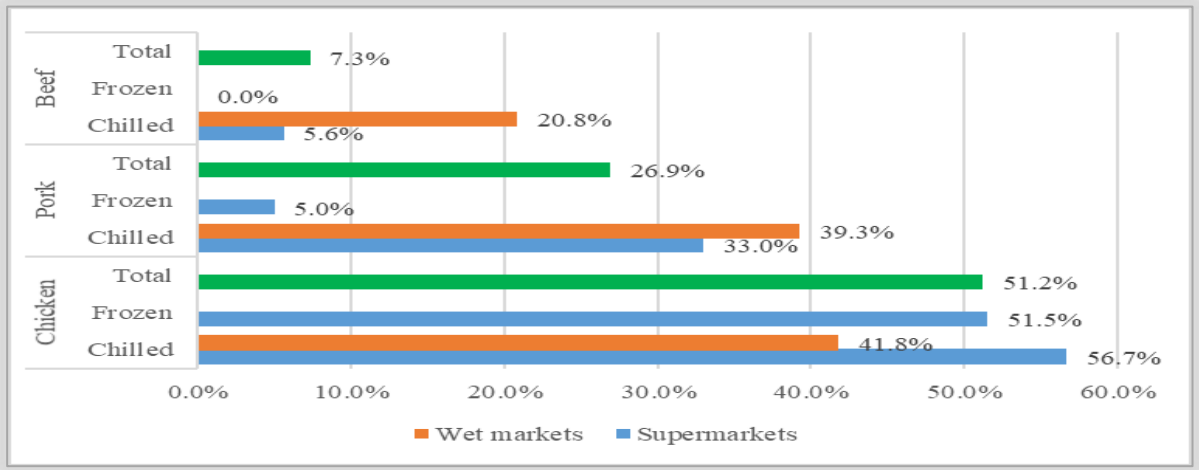
- Phenotypic AMR profile by AST
  - Methods: Disk Diffusion, E-test, VITEK AST, Broth microdilution using regional plates e.g. ASSECAF, ASSECB

  - Breakpoint interpretation: CLSI or EUCAST
- Genotypic AMR profile by PCR and/or whole genome sequencing (Illumina and/or Nanopore)
- Drug residue detection and quantification

AST: Antimicrobial Susceptibility Testing using Broth Microdilution Method

% ESBL E. coli in raw meat: Higher in wet markets than supermarkets

Retail practices and storage conditions can play a role in AMR bacterial contamination and proliferation



	Australia	Brazil	Holland	Indonesia	Malaysia	Spain	Thailand	New Zealand	USA	Unknown
Total	11.5% (16/139)	2.3% (42/130)	6.3% (1/16)	58.3% (14/24)	60.3% (41/68)	7.1% (1/14)	7.7% (1/13)	0.0% (0/19)	0.0% (0/11)	32.3% (10/31)
Chilled	13.7% (16/117)	44.0% (11/25)	0.0% (0/1)	58.3% (14/24)	60.0% (39/65)	0.0% (0/1)	NA	0.0% (0/12)	NA	27.6% (8/29)
Frozen	0% (0/22)	29.5% (31/105)	6.7% (1/15)	NA	66.7% (2/3)	7.7% (1/13)	7.7% (1/13)	0.0% (0/7)	0.0% (0/11)	100.0% (2/2)
Chicken	NA	67.2% (41/61)	NA	NA	67.9% (36/53)	NA	7.7% (1/13)	NA	0.0% (0/3)	29.2% (7/24)
Pork	25.0% (11/44)	2.3% (1/44)	6.3% (1/16)	58.3% (14/24)	33.3% (5/15)	7.1% (1/14)	NA	NA	0.0% (0/8)	50.0% (3/6)
Beef	5.3% (5/95)	0.0% (0/39)	NA	NA	NA	NA	NA	0.0% (0/19)	NA	0.0% (0/1)

Prevalence 0% 100%

Guo S et al. (2020)

Country of origin for samples from wet markets was not available, due to lack of labelling on these samples

Nearly 30% retail raw meat samples (n=634) found with ESBL E. coli.

The highest positive rate found in raw chicken meat (51.2%, 109/213), followed by raw pork meat (26.9%, 58/216) and raw beef meat (7.3%, 15/205).

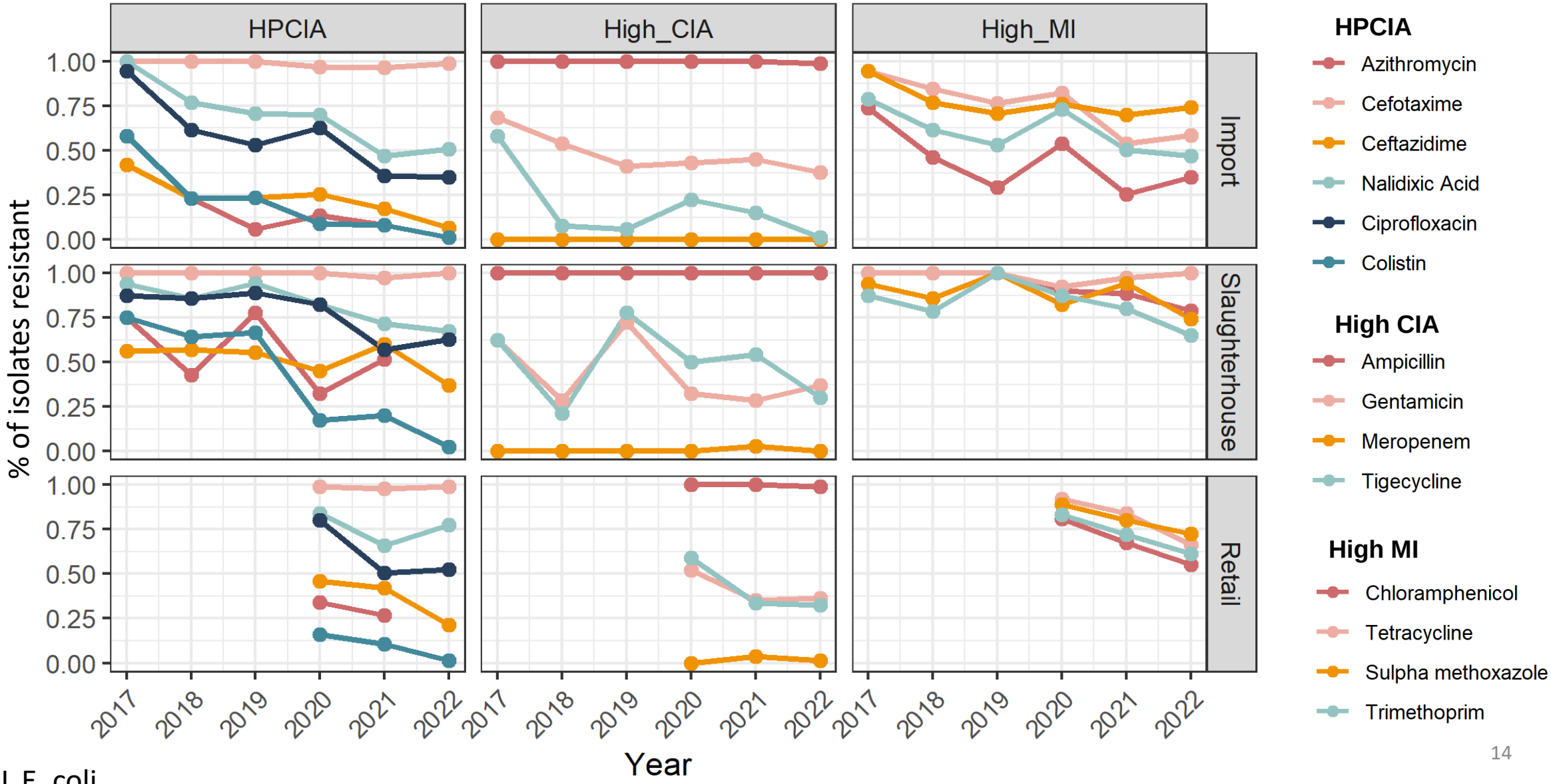
Positive rates in wet markets significantly higher than that of in supermarkets

- Retail process and storage may further contribute to the microbial contamination and proliferation.

Positive rates varied with sample categories across various countries

- Useful information for exchange with industry and competent authorities to heighten awareness.

Trends of % isolates resistant to high priority antimicrobials inform areas for future studies to further reduce AMR across the food chain



ESBL E. coli

Snapshot of antimicrobial consumption in local farms through annual reported sales of antimicrobials

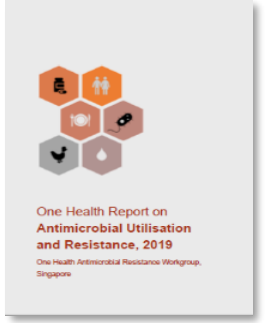
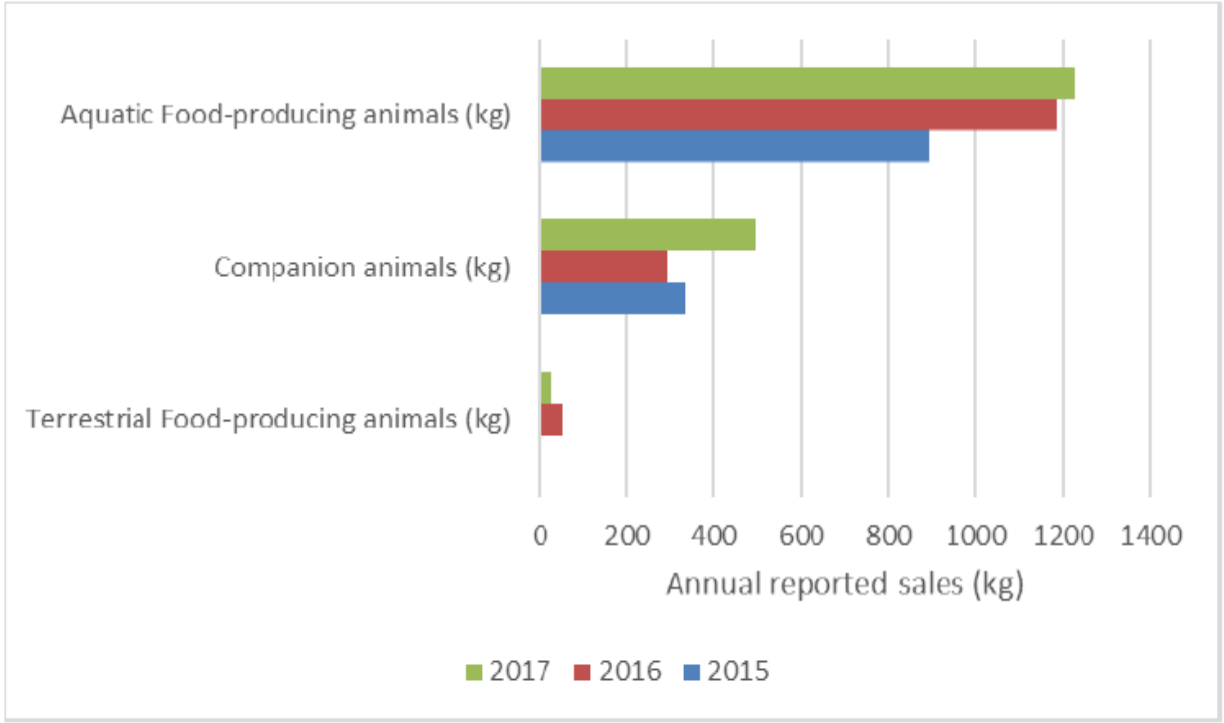
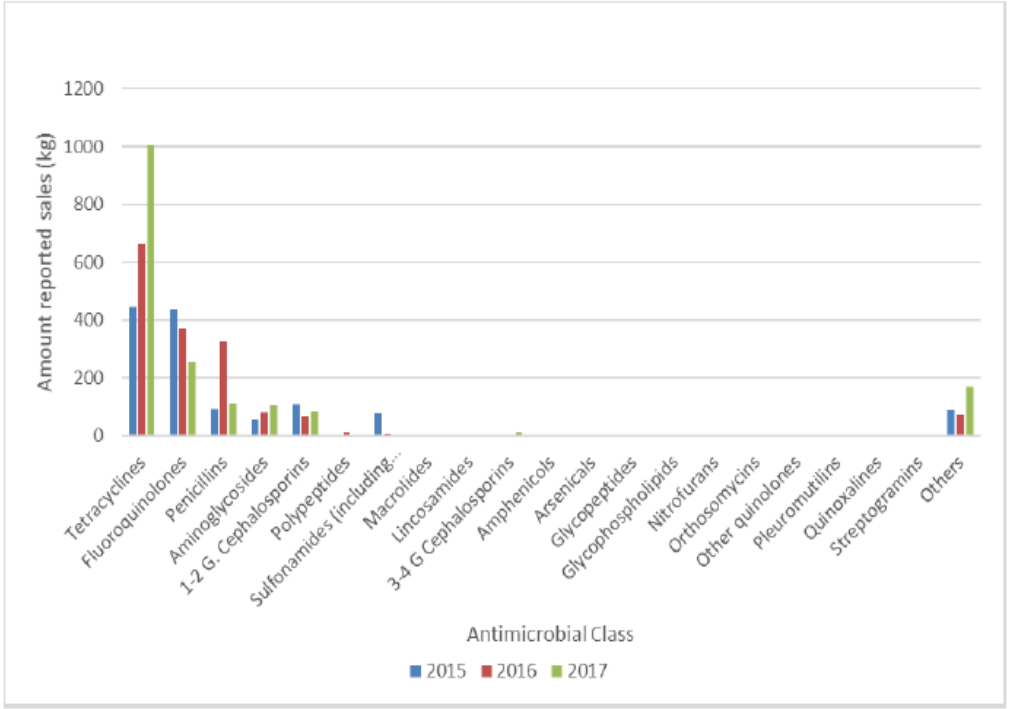


Figure 5: *Annual reported sales (kg) of antimicrobial drugs by animal sector, 2015 to 2017.*



Note: Reported sales to terrestrial food-producing animals in 2015 was <1.0 kg.

Figure 6: *Annual reported sales (kg) of antimicrobial drugs in the animal sector, by antimicrobial class, 2015 to 2016.*



For more information on the AMU Monitoring:
WOAH Monitoring of the Quantities and Usage Patterns of Antimicrobial Agents Used in Food-Producing Animals
https://www.woah.org/fileadmin/Home/eng/Health_standards/tahc/2018/en_chapitre_antibio_monitoring.htm; https://www.woah.org/app/uploads/2021/03/book-amr-ang-fnl-lr.pdf.
ReAct: https://www.reactgroup.org/toolbox/measure/consumption/animal/

Risk model estimated relatively low probability of illness from shellfish contaminated with AMR pathogenic Vibrio

		Farm-To-Home		
		$P_{ill,serving}$	$P_{ill,yearly}$	N_{cases}
Haemolytic	Average	5.7×10^{-3} $(0, 2.9 \times 10^{-4})$	3.4×10^{-2} $(0, 9.2 \times 10^{-2})$	1.7×10^{2} $(0, 4.4 \times 10^{2})$
	Minimally cooked	2.2×10^{-1} $(3.5 \times 10^{-3}, 6.6 \times 10^{-1})$	8.0×10^{-1} $(0, 1)$	3.9×10^{3} $(0, 4.8 \times 10^{3})$
	Moderately cooked	9.2×10^{-3} $(1.6 \times 10^{-6}, 4.4 \times 10^{-2})$	3.3×10^{-1} $(0, 1)$	1.6×10^{3} $(0, 4.8 \times 10^{3})$
	Highly cooked	1.8×10^{-5} $(0, 7.5 \times 10^{-5})$	6.7×10^{-3} $(0, 3.0 \times 10^{-2})$	3.2×10^{1} $(0, 1.4 \times 10^{2})$
Haemolytic and AMP-R	Average	3.4×10^{-3} $(0, 1.2 \times 10^{-4})$	2.8×10^{-2} $(0, 3.9 \times 10^{-2})$	1.4×10^{2} $(0, 1.9 \times 10^{2})$
	Minimally cooked	1.3×10^{-1} $(1.9 \times 10^{-3}, 4.5 \times 10^{-1})$	7.8×10^{-1} $(0, 1)$	3.8×10^{3} $(0, 4.8 \times 10^{3})$
	Moderately cooked	4.2×10^{-3} $(0, 1.9 \times 10^{-2})$	2.5×10^{-1} $(0, 1)$	1.2×10^{3} $(0, 4.8 \times 10^{3})$
	Highly cooked	6.2×10^{-6} $(0, 2.8 \times 10^{-5})$	2.6×10^{-3} $(0, 9.9 \times 10^{-3})$	1.3×10^{1} $(0, 4.8 \times 10^{1})$
	Average	3.5×10^{-3} $(0, 1.4 \times 10^{-4})$	2.8×10^{-2} $(0, 4.4 \times 10^{-2})$	1.4×10^{2} $(0, 2.1 \times 10^{2})$

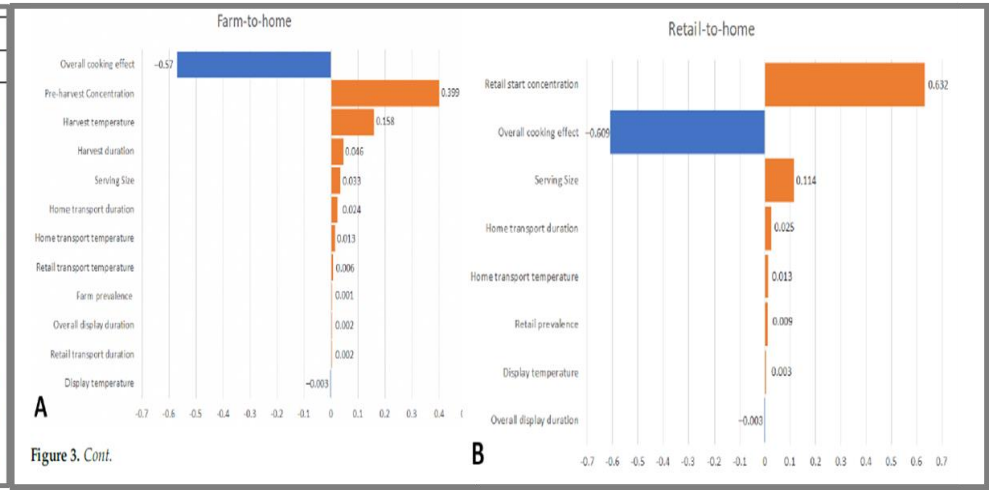


Figure 3. *Cont.*

microorganisms

MDPI

Article

Antimicrobial Resistance Risk Assessment of *Vibrio parahaemolyticus* Isolated from Farmed Green Mussels in Singapore

Hong Ming Glendon Ong [1,2], Yang Zhong [3], Chengcheng Hu [4], Kar Hui Ong [2], Wei Ching Khor [2], Joergen Schlundt [5] and Kyaw Thu Aung [2,6,*]

- Quantitative risk modelling work to estimate the risks of illnesses associated with the consumption of shellfish contaminated with AMR pathogenic Vibrio parahaemolyticus.
- The model estimated relatively low probability of illness per serving, translating to 2.9 and 6.2 cases per 100,000 population respectively.
- The sensitivity analysis showed that the **overall cooking effect, initial concentrations** of pathogenic V. parahaemolyticus, and **harvest duration and harvest temperature** were **key variables influencing the risk** estimates.
- Useful findings to make informed decisions for risk management that improve AMR and food safety risk.

Monitoring AMR bacteria and genes in aquatic farm environment and influence of water dynamic and seasons on AMR (2022-2025)

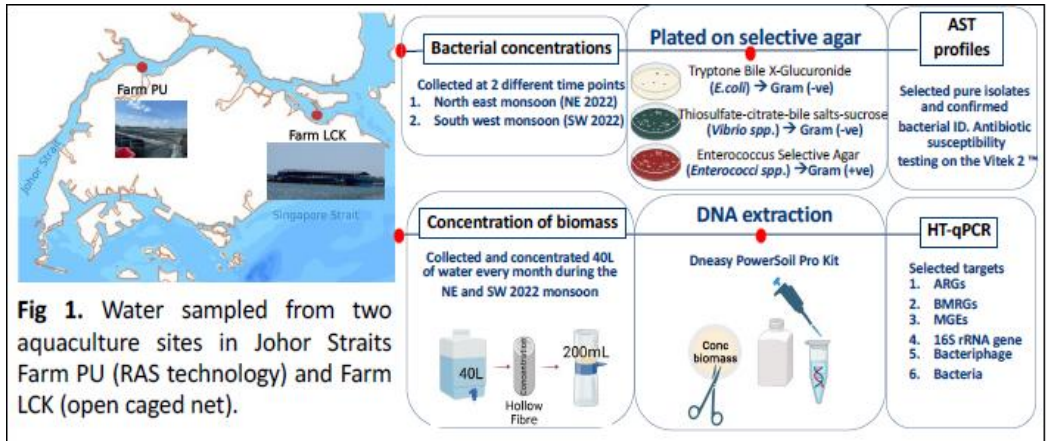
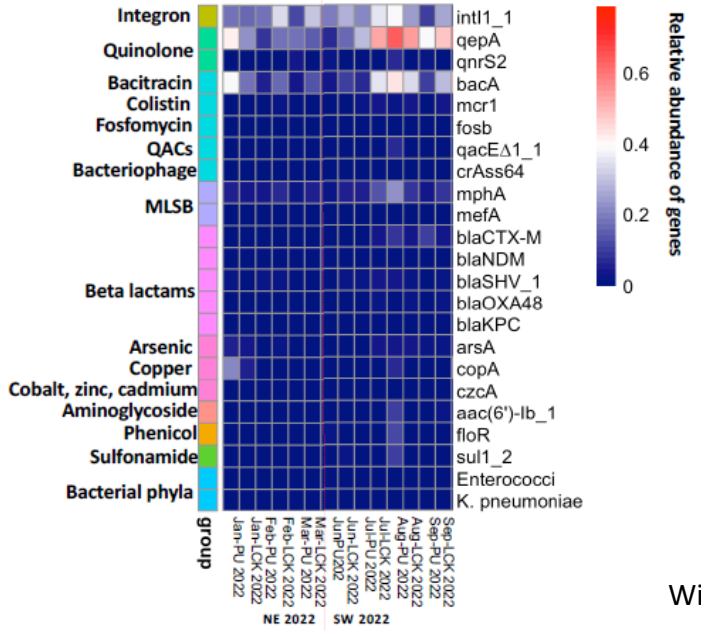


Fig 1. Water sampled from two aquaculture sites in Johor Straits Farm PU (RAS technology) and Farm LCK (open caged net).

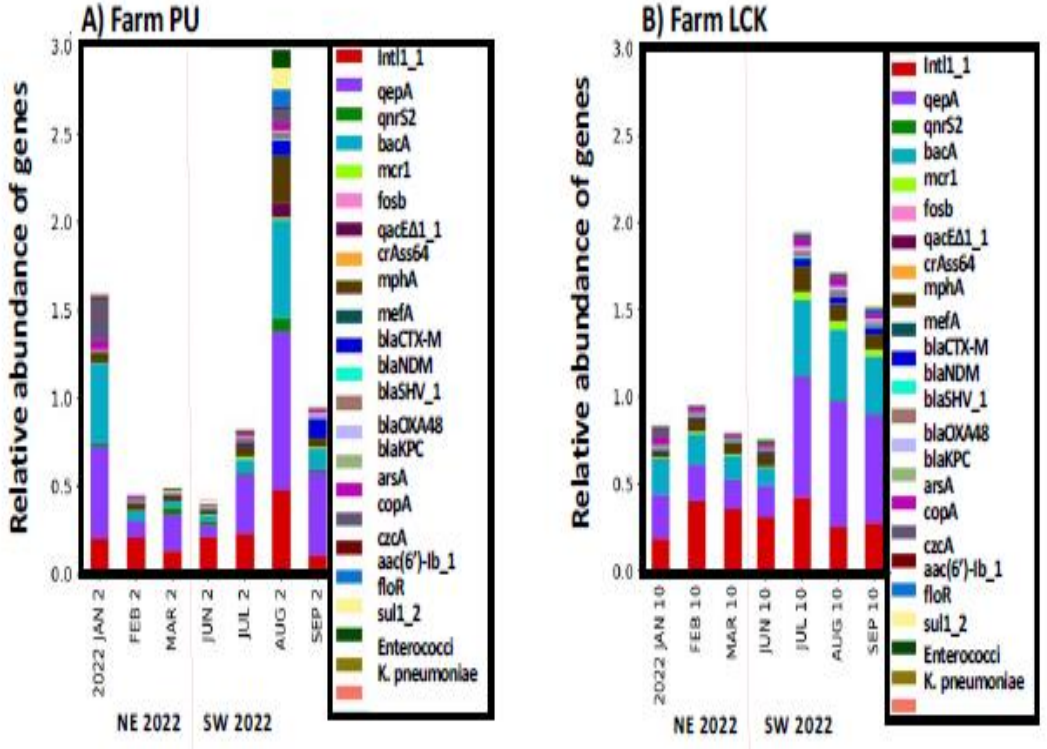
Occurrence of ARGs, BMRGs and MGEs in aquaculture farms



Antibiotic resistant bacteria and resistomes in coastal aquaculture sites in Singapore

Charmaine Ng[1], Goh Shin Giek[1], Tong Xuneng[1], Wei Ching Khor[2], Kyaw Thu Aung[2], Karina Gin[1,3]
[1]NUS Environmental Research Institute, Department of Civil & Environmental Engineering, Singapore 117576
[2]National Centre for Food Science, Singapore Food Agency, 7 International Business Park, Singapore 609919
[3]Department of Civil & Environmental Engineering, National University of Singapore, Singapore 117576

Cumulative abundance of genes detected at aquaculture sites



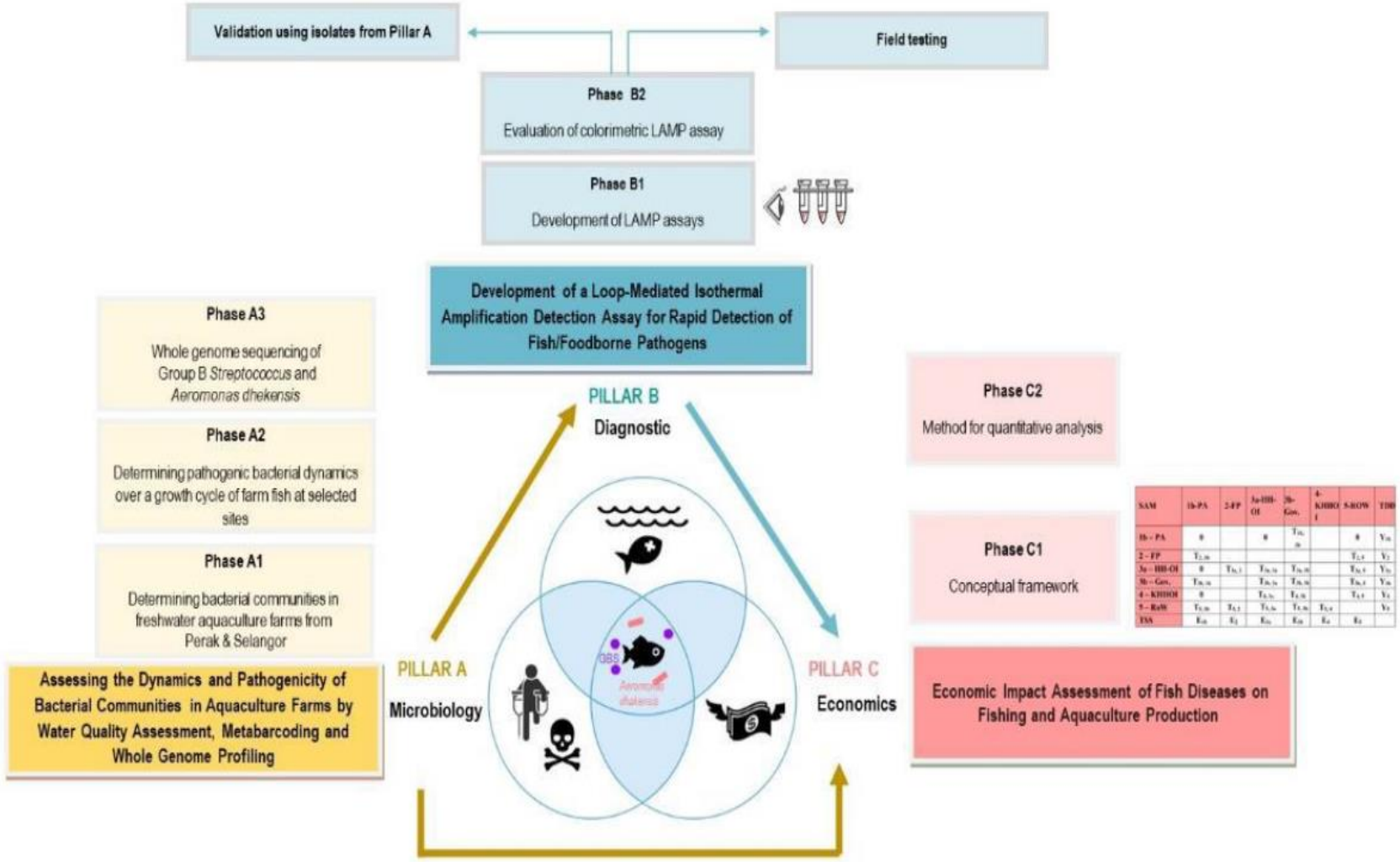
With National University of Singapore (NUS)

Understanding the Transmission of CTXM ESBL Genes Between Different One Health Reservoirs (2023-2025)

- Study bacterial community structure and resistance exchange networks (i.e., CTX-M and co-carriage with other resistance genes) of interconnected human and companion animals, food and environmental samples related to ESBL infected patients from a tertiary public health hospital
- Study resistance transmission pathways between the various human and non-human reservoirs

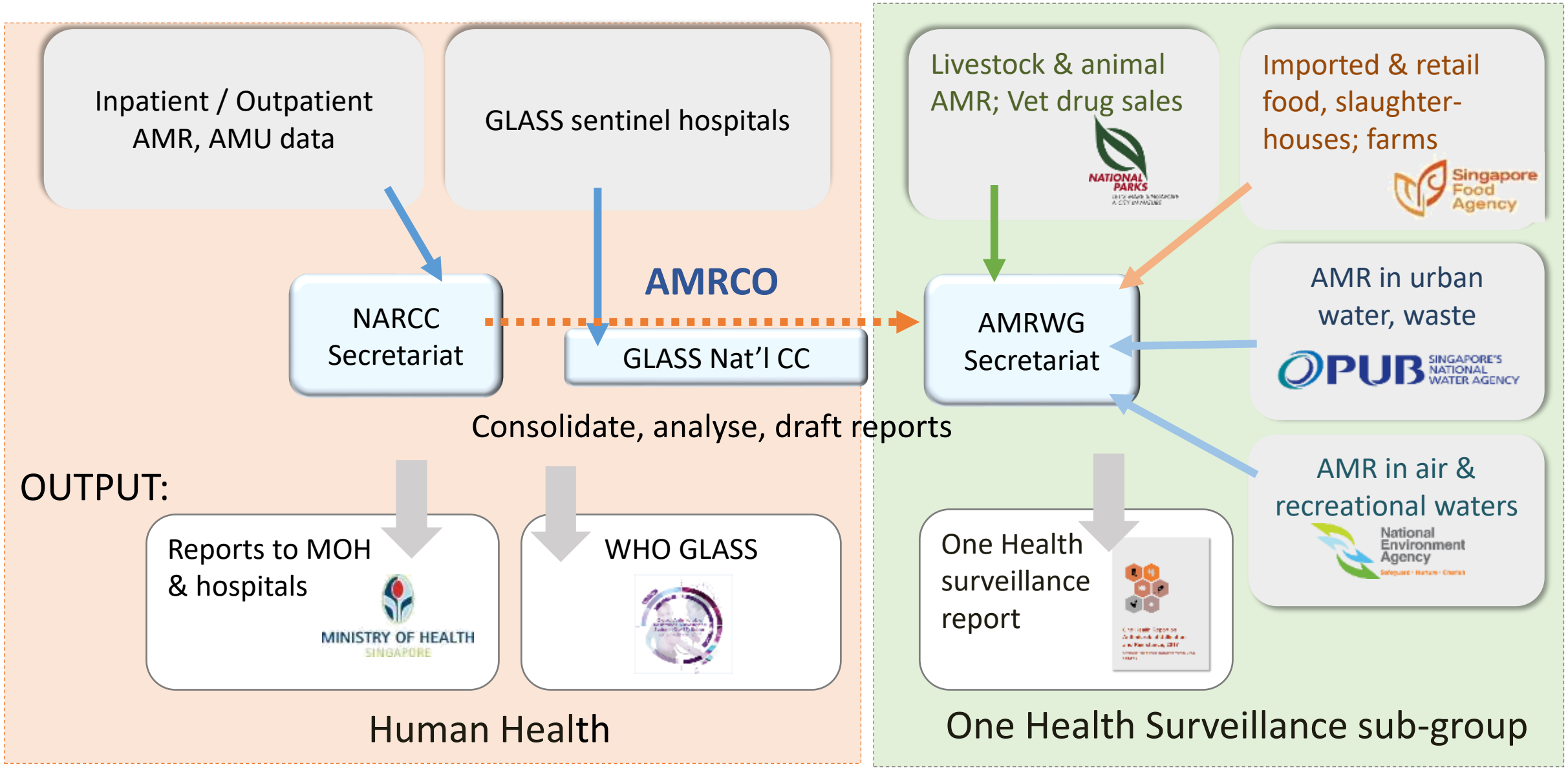
With Singapore General Hospital (SGH) and National University of Singapore (NUS)

Reducing Risk Of Fish/Foodborne Disease For Food Security, Human Health And Economy (2023-2025)



With University of Malaya (UM), Malaysia

Coordination of surveillance data and reporting at the national level



NARCC: National Antimicrobial Resistance Coordination Committee; AMRCO: Antimicrobial Coordinating Office; AMRWG: Antimicrobial Resistance Working Group; GLASS: Global Antimicrobial Resistance and Use Surveillance System: AMU: Antimicrobial Utilisation

A T L A S S

FAO Mission in Nov 2023

Singapore's attainment of PIP Stage 4

Stage 1 Limited	Stage 2 Moderate	Stage 3 Developed	Stage 4 Demonstrated	Stage 5 Sustainable
Very weak workflow organization and financial autonomy No or very weak capacities in AST No or weak quality assurance in the field of bacteriology/AST	Capacity of testing some samples for AST on few pathogens, Weak quality assurance system and/or unstandardized methods for AST and/or gaps in the management of biological material or data	Capacity to test in a standardized manner some samples for AST on few pathogens and to manage biological material and data with basic quality assurance procedures. Challenges may exist for the financial autonomy or the management	Capacity to test in a standardized manner a wide range of bacterial species and to manage biological material and data with robust and sustainable quality assurance procedures AMR data are shared irregularly or partially for surveillance	High-capacity laboratory able to test with a national/international standard a wide range of bacterial species, including fastidious species and to share the results regularly for surveillance or decision making + *For reference laboratories: able to characterize isolates with molecular tools, and to publish research*

This table summarize the minimum requirements that the laboratory should meet for each of the specific FAO-ATLASS PIP laboratory stages.

frontiers | Frontiers in Veterinary Science

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A systematic approach toward progressive improvement of national antimicrobial resistance surveillance systems in food and agriculture sectors

Nicolas Keck[1†], Michaël Treilles[1†], Mary Gordoncillo[2], Ouoba Labia Irène Ivette[3], Gwenaëlle Dauphin[1], Alejandro Dorado-Garcia[1], Suzanne Eckford[1], Emmanuel Kaball[1], Morgane Gourlaouen[1], Francesca Latronico[1], Juan Lubroth[1], Keith Sumption[1], Junxia Song[1] and Béatrice Mouillé[1*†]

[1]Food and Agriculture Organization of the United Nations (FAO) Headquarters, Rome, Italy, [2]Emergency Centre for Transboundary Animal Diseases (ECTAD), Regional Office for Asia and the Pacific, Food and Agriculture Organization of the United Nations (FAO), Bangkok, Thailand, [3]Regional Office for Sub-Saharan Africa, Food and Agriculture Organization of the United Nations (FAO), Accra, Ghana

The first Food and Agriculture Organization of the United Nations (FAO) Action Plan on antimicrobial resistance (AMR), published in 2016, identified the need to develop capacity for AMR surveillance and monitoring in food and agriculture sectors. As part of this effort, FAO has developed the "Assessment Tool for Laboratories and AMR Surveillance Systems" (FAO-ATLASS) to assist countries in systematically assessing their AMR surveillance system in food and agriculture. FAO-ATLASS includes two different modules for surveillance and laboratory assessment. Each module includes two questionnaires that collect either qualitative or semi-quantitative data to describe and score the performance of national AMR surveillance system data production network, data collection and analysis, governance, communication and overall sustainability in a standardized manner. Based on information captured in the questionnaire by trained assessors (1) tables and figures describing the outputs of the surveillance system are automatically generated (2) a Progressive Improvement Pathway (PIP) stage, ranging from "1-limited" to "5-sustainable", is assigned to each laboratory assessed in the country, each area of the surveillance system and also to the overarching national AMR surveillance system. FAO-ATLASS allows national authorities to implement a strategic stepwise approach to improving their AMR surveillance systems via the FAO-ATLASS PIP system and provides an evidence base for actions and advocacy. The implementation of FAO-ATLASS at regional and global levels can contribute to harmonize and better coordinate strategies aimed at implementing an integrated AMR surveillance system under the One Health approach.

KEYWORDS
FAO-ATLASS, antimicrobial resistance, surveillance, laboratory, assessment, food, agriculture, One Health

"Assessment Tool for Laboratories and AMR Surveillance Systems" (FAO-ATLASS) to assist countries in systematically assessing their AMR surveillance system in food and agriculture

With coordinated efforts from Singapore Food Agency (SFA), National Parks Board (NParks) and FAO

2. Raising Awareness and Information Accessibility

Empowering stakeholders for joint responsibility

Sharing AMR surveillance findings through scientific publications

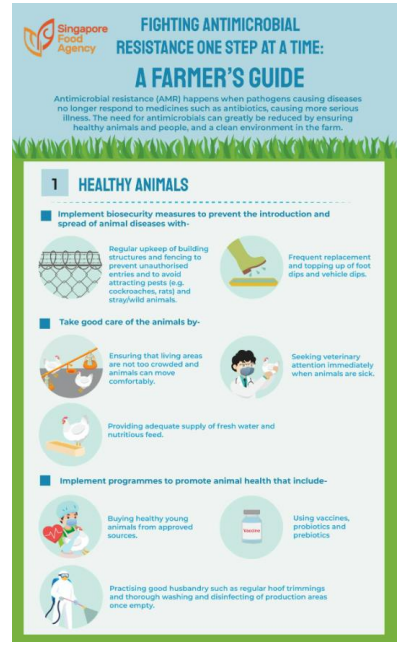
Raising stakeholders' awareness

- SFA AMR Webpage
- World Antimicrobial Awareness Week (WAAW) outreach
  - 18 – 24 November annually
- Collaborations with IHLs on education curricula and programme
- Outreach to local farmers on AMR and good AMU practices

Combatting Antimicrobial Resistance On A Costal Fish Farm(Video is also available with Chinese, Malay and Tamil subtitles)

Continued food safety vigilance and joint responsibility

- Good hygiene and manufacturing practices, including thorough cleaning, chilling, and avoiding cross-contamination, reducing exposure to bacteria, including those carrying AMR genes.
- In addition, thorough cooking is crucial as it destroys bacteria, including AMR bacteria present in food.



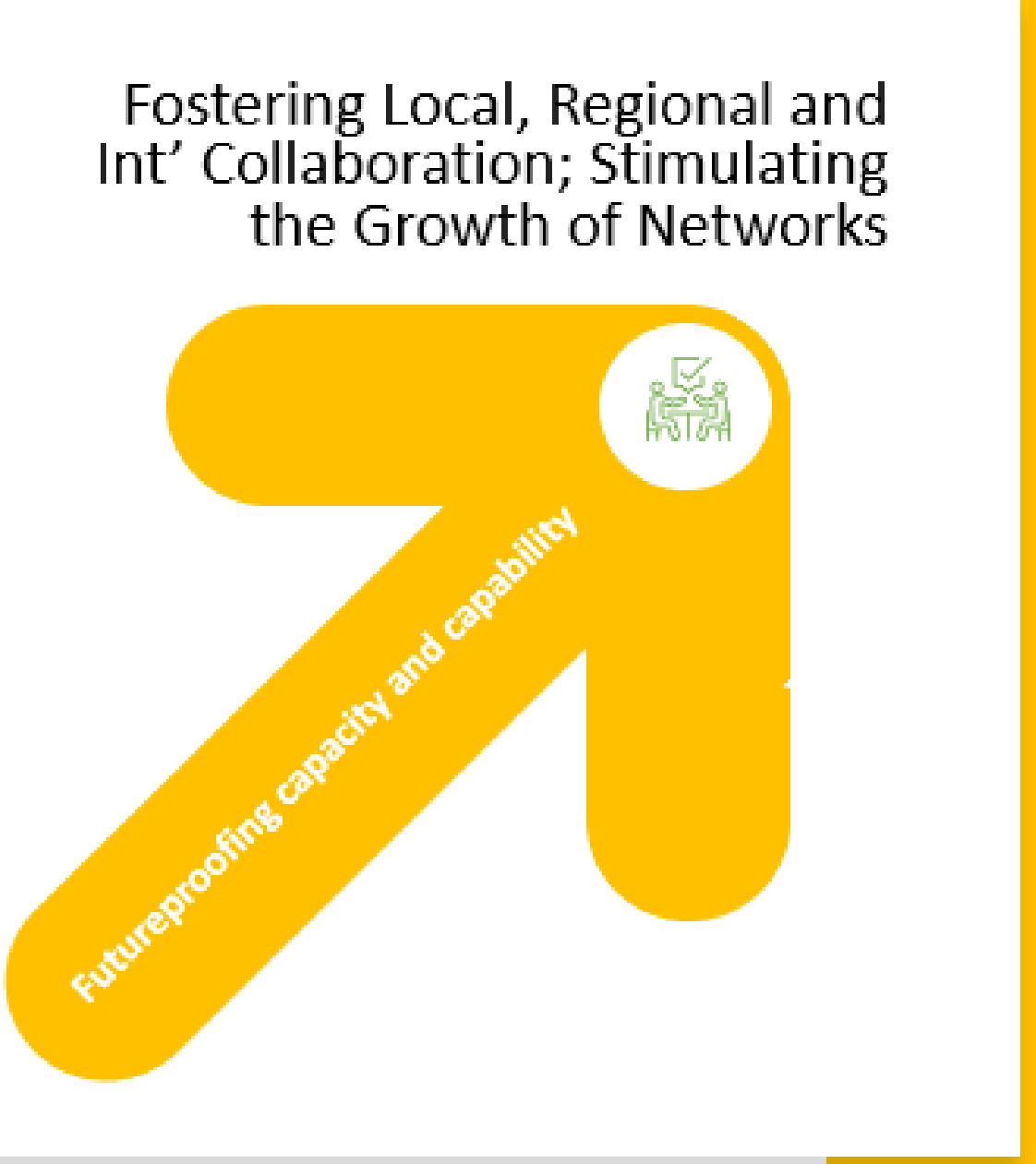
https://www.sfa.gov.sg/food-information/food-safety-education/antimicrobial-resistance

Working with local farms for prudent and responsible use of antimicrobials

- Control drug usage in local farms:
  - List of banned drugs
  - Prohibiting use of antimicrobials in growth promotion
  - Requiring proper recordkeeping of drug usage, observation of stipulated drug withdrawal periods
- Educate local farmers to:
  - Implement good animal husbandry practices for animal disease prevention and management, which would reduce use of antibiotics
  - Adopt prudent and responsible use of antibiotics

3. Fostering Local, Regional and International Collaboration

Stimulating the growth of networks; Futureproofing capacity and capability



Futureproofing capacity and capability of AMR food chain surveillance through interdisciplinary operational and applied research with IHLs

International efforts

- **One Health Global Leaders Group on Antimicrobial Resistance**
  - Established by Quadripartite Organizations (FAO, WHO, WOAH and UNEP), in consultation with UNSG, and launched in Nov 2020
- **ASEAN**
  - Singapore is lead country for AMR initiatives for livestock and aquaculture sectors
  - Strengthen regional capabilities through provision of training, such as drug residues testing of food products
- **FAO Collaborations**
  - Surveillance guidelines for livestock and aquaculture
  - Participating in missions to assess countries' AMR surveillance capabilities in livestock and food

1st FAO ATLASS Assessor training for Asia, 2018 Singapore

Strengthening regional strategies and capabilities

REGIONAL

RISK ANALYSIS OF ANTIMICROBIAL RESISTANCE ARISING FROM USE OF ANTIMICROBIAL AGENTS IN AQUACULTURE

2021

Performing Risk Analysis on Antimicrobial Resistance Arising from Use of Antimicrobial Agents in Aquaculture

Food and Agriculture Organization of the United Nations

Singapore Food Agency

2021

Regional AMR Monitoring and Surveillance Guidelines Volume 3

MONITORING AND SURVEILLANCE OF AMR IN BACTERIA FROM AQUACULTURE

2021

ASEAN GUIDELINES FOR THE PRUDENT USE OF ANTIMICROBIALS IN AQUACULTURE

GUIDELINE ON TECHNIQUES FOR VETERINARY DRUG RESIDUE DETECTION IN AQUACULTURE PRODUCTS

Drafted by Singapore Food Agency (SFA)

Oct 2020

PLAN OF ACTION FOR THE ASEAN COOPERATION IN COMBATTING AMR IN AQUACULTURE SECTOR (2021 – 2025)

SECTOR	: AGRICULTURE
SUB-SECTOR	: **AQUACULTURE**
RESPONSIBLE WORKING GROUP	: ASEAN SECTORAL WORKING GROUP ON FISHERIES (ASWGFi)

Combating AMR through local, regional and global partnerships

NATIONAL PARKS
LET'S MAKE SIN
OUR CITY IN

Singapore Food Agency
Safe Food For All

National Environment Agency
Safeguard · Nurture · Cherish

PUB SINGAPORE'S NATIONAL WATER AGENCY

Private Food Testing Laboratories

MINISTRY OF HEALTH SINGAPORE

Tan Tock Seng HOSPITAL
National Healthcare Group

Changi General Hospital

Singapore General Hospital
SingHealth

National Centre for Infectious Diseases

NUH National University Hospital

KK Women's and Children's Hospital
SingHealth

Alexandra Hospital

Jurong Health
Ng Teng Fong General Hospital

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

SMART NATION & DIGITAL GOVERNMENT OFFICE

NUS National University of Singapore

Think-tanks

Agency for Science, Technology and Research
SINGAPORE

Overseas Academia

OIE

FAO FIAT PANIS

asean

Overseas Regulators

Thank you

Building Sustainable AMR Surveillance Capability in Singapore and the ASEAN region

A/P Aung Kyaw Thu

National Centre for Food Science

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