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Organización de las
Naciones Unidas para la
Alimentación y la Agricultura

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COMMITTEE ON FISHERIES

Thirty-fourth Session

1–5 February 2021

IMPLEMENTATION OF THE FAO ACTION PLAN ON ANTIMICROBIAL RESISTANCE (AMR) 2016–2020 IN AQUACULTURE AND THE PROPOSAL OF FAO ACTION PLAN ON AMR (2021–2025)

Executive Summary

This document sets out the progress report on the implementation of FAO Action Plan on Antimicrobial Resistance (AMR) 2016–2020 with particular reference to achievements in the aquaculture sector.

In line with the recommendation of the 128th Session of the FAO Programme Committee (June 2020), as endorsed by the 164th Session of the FAO Council (July 2020), this document also sets out the proposal of FAO Action Plan on AMR 2021–2025.

I. INTRODUCTION

1. At the 68th World Health Assembly in May 2015,¹ the Global Action Plan on Antimicrobial Resistance (GAP)² (with contributions from FAO and the World Organisation for Animal Health, the OIE) was adopted. At the OIE's 83rd General Assembly and at the 39th FAO Conference in 2015, Members made a commitment to support the GAP, and support the development of National Action Plans. This was followed by respective resolutions to crystalize AMR actions into the OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials (2016) and the FAO Action Plan on Antimicrobial Resistance 2016-2020.

2. During the 71st Session of the General Assembly of the United Nations (UNGA, September 2016), a political declaration was made during a high-level meeting on AMR. The UNGA called upon the Tripartite (i.e. FAO as global leader for food and agriculture, the OIE as global leader for animal health and welfare standards and WHO as global leader for human health) and other intergovernmental organizations to support the development and implementation of National Action Plans (NAPs) and AMR activities at the national, regional and global levels under the One Health platform.

3. The United Nations Secretary-General convened the Interagency Coordination Group (IACG) on AMR in May 2017 to provide guidance on approaches for ensuring sustained global action on AMR. The IACG completed its mandate on 29 April 2019 upon the handover of its report³ to the Secretary-General including 14 recommendations for progress in countries, innovation, collaboration, investment and global governance. The follow-up report to the UN Secretary General in 2019 provided highlights of progress made by Members and the Tripartite organizations in addressing AMR on the basis of the GAP. It also called for urgent support and investments to scale up responses at the national, regional and global levels.⁴

4. The FAO, WHO and OIE (the Tripartite) signed a Memorandum of Understanding (MoU)⁵ in May 2018 regarding cooperation to combat health risks at the animal-health-ecosystem interface within the "One Health Approach" context, and it identified Antimicrobial Resistance (AMR) as one of the top areas.

5. A Tripartite workplan for 2019–2020 was developed with five focus areas to be achieved through multisectoral collaboration: 1) implementation of the NAP on AMR; 2) awareness and behaviour change; 3) surveillance and monitoring of AMR and antimicrobial use (AMU); 4) stewardship and optimal use of antimicrobial agents; and 5) monitoring and evaluation.

6. In June 2019, an AMR Multi-Partner Trust Fund (AMR MPTF) was launched as a strategic, inter-agency and multi-partner initiative inviting countries, foundations, financial institutions and the private sector to support the Tripartite Work Plan on AMR to accelerate global, regional and national progress.

¹ apps.who.int/iris/bitstream/10665/193736/1/9789241509763_eng.pdf?ua=1

² www.wpro.who.int/entity/drug_resistance/resources/global_action_plan_eng.pdf

³ https://www.who.int/antimicrobial-resistance/interagency-coordination-group/IACG_final_report_EN.pdf?ua=1

⁴ UN. 2019a. Follow-up to the political declaration of the high-level meeting of the General Assembly on antimicrobial resistance. Report of the Secretary-General. (also available at <https://digitallibrary.un.org/record/3807197?ln=en>).

⁵ www.who.int/zoonoses/MoU-Tripartite-May-2018.pdf

II. HIGHLIGHTS OF ACCOMPLISHMENTS OF THE IMPLEMENTATION OF THE FAO ACTION PLAN ON AMR (2016-2020) IN AQUACULTURE

FAO Action Plan on Antimicrobial Resistance 2016–2020 (Action Plan)

7. The FAO Action Plan on Antimicrobial Resistance 2016–2020 (FAO, 2016) (Action Plan) supports the implementation of the FAO Conference Resolution 4/2015. This resolution is a call to action to both FAO Members and the Organization itself to address the multi-sectoral aspects of mitigating both the impact on, and the contribution of, the food and agriculture sectors to the threat posed by AMR. The Action Plan identifies four main focus areas:

- Focus Area 1: Improve awareness on Antimicrobial Resistance and related threats.
- Focus Area 2: Develop capacity for surveillance and monitoring of Antimicrobial Resistance and antimicrobial use in food and agriculture.
- Focus Area 3: Strengthen governance related to antimicrobial use and Antimicrobial Resistance in food and agriculture.
- Focus Area 4: Promote good practices in food and agriculture systems and the prudent use of antimicrobials.

Highlights of accomplishments in the implementation of the *Action Plan* in the aquaculture sector

8. The activities accomplished by the Fisheries Division were carried out under the auspices of the following: (1) Project FMM/RAS/298/MUL “Strengthening capacities, policies, and national action plans on prudent and responsible use of antimicrobials in fisheries”; (2) GCP/GLO/979/NOR “Improving Biosecurity Governance and Legal Framework for Efficient and Sustainable Aquaculture Production”; and (3) Strategic Programme 4 “Enabling more inclusive and efficient agricultural and food systems at local, national and international levels”.

9. Major activities carried out at regional and national levels included the following:

- Three regional workshops on AMR in aquaculture held in India (April 2017), Malaysia (August 2017) and Singapore (December 2017);
- National awareness and capacity-building activities undertaken at country level (India in 2019 and in Malaysia, the Philippines and Viet Nam in 2017); and
- AMU and AMR surveillance activities conducted at country level (Malaysia, the Philippines and Viet Nam in 2017).
- Regional hands-on training on Antimicrobial Resistance Susceptibility Testing in Fishery and Aquaculture Products in Bangkok (2017), and in Antimicrobial Residue Analysis in Fishery and Aquaculture Products in Hanoi (2017).
- Expert workshop on AMR risk assessment (2018).

10. All the above events/activities⁶ collectively achieved the following: (i) raised awareness, knowledge and skills; (ii) provided guidance in the conduct of AMU and AMR surveillance; (iii) provided opportunity for intensive exchange of information between country nationals and experts; and (iv) provided venues for better understanding of country situations with respect to their aquaculture biosecurity status, AMR-related activities and ongoing actions.

⁶ www.fao.org/fishery/nems/41001/ar; www.fao.org/fishery/nems/40956/en; www.fao.org/fishery/nems/40953/en

11. In terms of the four pillars of the FAO Action Plan on AMR 2016–2020 (FAO, 2016), additional details are provided below.

- 1) **Awareness** raising: Great improvement was achieved in awareness, knowledge enhancement, better understanding of AMR, AMU, food safety and quality aspects as well as policy, laboratory and farm level considerations. A Side Event during the Ninth Session of the FAO Committee on Fisheries Sub-Committee on Aquaculture (COFI/AQ IX) in October 2017 (FAO, 2017) represented the first formal AMR awareness raising initiative that targeted fisheries and aquaculture authorities. Participants to COFI/AQ IX comprised of 89 FAO Members and two associate Members, representatives from two specialized agencies of the United Nations and observers from seven intergovernmental and six international non-governmental organizations. AMR issues were also captured during the Sixteenth Session of the FAO Committee on Fisheries Sub-Committee on Fish Trade in September 2017. The visibility of AMR in general and AMR in aquaculture was further enhanced through presentations in a number of scientific meetings and other important meetings.⁷
- 2) **Evidence**: Collection of data on AMU and AMR was initiated based on preliminary surveillance in China, Malaysia, the Philippines, and Viet Nam. These can now serve as a benchmark that can be used as additional key references to support the further development and/or implementation of the NAP on AMR in these countries.
- 3) **Governance**: Examples of governance mechanisms established and activities carried out include: (i) coordination meetings involving different sectors; (ii) contribution to the aquatic component of the country NAP on AMR; (iii) formalization and finalization of the NAP on AMR; (iv) review of AMR-relevant legislation; and (v) inspection of importer premises (veterinary medicine products and raw materials to determine origin and use) and veterinary drug shops (those allowed to sell registered antibiotic products) and other shops not allowed to sell antibiotic raw materials directly to farmers.
- 4) **Best practices**: Based on country reports, activities related to best practices included, for example: (1) demonstrations of safe AMU; implementation of country Good Agricultural Practices (GAP) in aquaculture, e.g. in Malaysia (myGAP), Viet Nam (VietGAP) and the Philippines (PNS on GAqP); (2) implementation of relevant legislation; (3) increased research and development on fish vaccines. In addition, best practices guidance on responsible AMU is being completed for shrimp, carp and tilapia.

12. In terms of knowledge products and guidance documents, three publications (12.1 to 12.3) were issued and disseminated and the remaining two (12.4 and 12.5) are still in preparation. These publications support the four pillars of the FAO Action Plan on AMR.

- 1) *The performance of antimicrobial susceptibility testing programmes relevant to aquaculture and aquaculture products* (Smith. P. 2019. FAO Fisheries and Aquaculture Circular no. 1191. Rome, FAO). This technical paper addresses best practice guidelines for the performance of antimicrobial susceptibility testing of bacteria isolated from aquatic animals as part of a monitoring or surveillance programme or to provide guidance for clinical treatments of diseased animals. It contains six sections, namely: Section 1 - relevance of the document to the Action Plan; Section 2 - principles of antimicrobial susceptibility testing; Section 3 - standard protocols recommended for use in antimicrobial susceptibility testing of bacteria isolated from aquatic animals; Section 4 - design of programmes aimed at monitoring or

⁷ Asia-Pacific Aquaculture Conference (Kuala Lumpur, July 2017), 16th Meeting of the Advisory on Aquatic Animal Health of NACA (Bangkok, August 2017), WAS India (June 2019), 2nd OIE Global Conference on AMR and Prudent Use of Antimicrobial Agents: Putting Standards into Practice (Marrakesh, October 2018), 2018 World Aquatic Veterinary Medical Association Conference (St Kitts, November 2018)

surveillance of AMR associated with the use of antimicrobial agents in the rearing of aquatic animals; Section 5 - conclusions; and Section 6 - references.

- 2) *FAO Technical Guidelines for Responsible Fisheries No. 5 Suppl. 8, Recommendations for prudent and responsible use of veterinary medicines in aquaculture* (FAO, 2019). This document provides general advice in support of the implementation of the FAO Code of Conduct for Responsible Fisheries to assist countries in encouraging the prudent and responsible use of veterinary medicines (antimicrobial agents and other chemotherapeutants) in aquaculture production through appropriate government regulation and the promotion and encouragement of awareness and responsible use by the private sector.
 - 3) *Report of the FAO Expert Working Group Meeting “Scoping Exercise to Increase the Understanding of Risks of Antimicrobial Resistance (AMR) in Aquaculture* (FAO, 2020). This document presents the results of a risk profiling exercise done on two bacterial agents, *Streptococcus* spp. and *Vibrio parahaemolyticus*, which are important to both animal and human health. They affect tilapia and shrimp, respectively; top aquaculture species that contribute significantly to global food and nutrition security.
 - 4) *Responsible management of bacterial diseases in aquaculture* (in preparation): this publication is being prepared in recognition of the need to responsibly manage bacterial diseases in aquaculture, to reduce the use of antibiotics and thus avoid resistance, as well as find alternatives to antibiotics and is intended to a wide range of users. Some 38 pathogens belonging to six gram-negative (vibriosis, aeromoniasis, edwardsiellosis, pseudomoniasis, flavobacteriosis, infection with intracellular bacteria) and four gram-positive bacteria (mycobacteriosis, streptococcosis, renibacteriosis and infection with anaerobic bacteria) were considered as causing major bacterial diseases of cultured finfish, crustaceans and molluscs in fresh and marine waters. They were selected based on a set of criteria developed by experts, namely: (1) economic importance of affected species; (2) socio-economic impact; and (3) zoonotic potential.
 - 5) *Fish waste management: an assessment on potential production and utilization of fish silage in Bangladesh, Philippines and Thailand* (in preparation). This publication is a compilation of the studies conducted in selected countries in recognition of the need to manage and utilize fish by-products and wastes. Instead of discarding fish processing by-products and wastes, they can be converted into fish silage. Fish silage can be used to reduce the spread of pathogenic microorganisms found in dead fish or fish killed for disease control, due to the antimicrobial properties of the organic acids.
13. In addition to the above, innovation and partnership were enhanced as briefly described below:
- 1) **Innovation:** The project sparked innovation through the increased interest in looking into alternatives to antimicrobials such as: phytochemicals - plant-derived compounds; dietary acidifiers; short-chain fatty acids; bacteriophages; probiotics and prebiotics: short-chain carbohydrates (oligosaccharides); egg yolk antibodies; antimicrobial peptides; biofloc technology; quorum sensing; green water technology and specific-pathogen free technology. Innovation also examined the future of vaccination, particularly in the Asian region which has a low uptake of vaccination technologies. Innovations include multi-component vaccines, which might be appropriate for complicated and multi-infection disease conditions, automated fish injectors, multivalent vaccines, etc. Other innovations involve safer practices to integrated fish farming through novel systems such as fish-flowers, fish-vegetables (aquaponics), fish-fruit trees, polyculture (shrimp-tilapia), shrimp-mangrove, rice-fish, rice crayfish and rice-shrimp, and integrated multi-trophic aquaculture. However, these must be supported by good aquaculture and husbandry and biosecurity practices.

- 2) **Partnerships:** New partnerships were developed throughout the course of the project, including that with Croatia (Croatia Veterinary Institute), India (Nitte University), the Netherlands (Wageningen University), Singapore (Agri-Food and Veterinary Authority), the United States of America (Mississippi State University), EU, NACA, MSD Animal Health, SAR, China (City University of Hong Kong) and INFOFISH.
14. **FAO Reference Centres on Aquaculture Biosecurity.** Twenty-six institutions applied to become FAO Reference Centres on AMR in April 2017. Of these, 13 candidate institutions passed the evaluation process by a selection panel in February 2018, and four of the 13 were found to cover additional aspects in aquaculture production and health other than just AMR and were identified as candidate FAO Reference Centres on Aquaculture Biosecurity. The four Aquaculture Branch (FIAA) candidate centres are: (1) Yellow Sea Fisheries Research Institute (China), (2) Pearl River Fisheries Research Institute (China), (3) Nitte University (India) and (4) Mississippi State University (USA). The candidate centres are completing the external and internal requirements including ‘Areas of Collaboration’. It is expected that the designation process will be completed this year. The first meeting of the candidate centres was held in November 2019. A second meeting was planned this year, however, due to COVID-19 restrictions, it was held as a virtual Zoom meeting in June 2020.
15. **OSRO/RAS/502/USA: “Addressing Antimicrobial Usage in Asia’s Livestock, Aquaculture and Crop Production Systems** (being implemented by FAORAP). This ongoing project aims to promote a more prudent use of antimicrobials in the livestock and aquaculture production industries as well as the crop production sector in Asia, leading to minimizing the likelihood of AMR development and spread. Relevant activities to date include initial documentation and characterization of AMU in aquaculture (in Indonesia, Myanmar, Thailand, and Viet Nam), as well as the development of Regional Guideline on AMR Monitoring and Surveillance in aquaculture.
16. **TCP/RAS/3702: “Support mitigation of Antimicrobial Resistance (AMR) risk associated with aquaculture in Asia”** (being implemented by FAORAP). This is an ongoing project that will continuously provide capacity building opportunities to further improve awareness on AMR and enhance technical skills on AMR surveillance and best practices for recipient countries (India, Indonesia and Viet Nam).

III. PROCESS IN THE DEVELOPMENT OF THE FAO ACTION PLAN ON AMR (2021–2025)

17. **The mandate:** FAO’s overall mandate is to achieve a world without hunger, malnutrition and poverty, in a sustainable manner. To support implementation of the 2030 Agenda for Sustainable Development, key priorities of FAO include supporting the productivity and sustainability of agriculture, forestry and fisheries; reducing rural poverty; enabling inclusive and efficient agricultural and food systems; and increasing resilience of livelihoods to threats and crises. Antimicrobial resistance stands to jeopardize this mandate.
18. **The position to act:** FAO’s Fisheries Division supports implementation of FAO’s Code of Conduct for Responsible Fisheries (CCRF) (FAO, 1995) in the form of scientific advice, strategic planning, and training materials. The Code’s Section 9 on Aquaculture Development addresses prudent and responsible use of veterinary medicines in aquaculture.
19. In 2018, the 33rd Session of the Committee on Fisheries (COFI) recognized the importance of addressing AMR. A year later, the 10th Session of the COFI Sub-committee on Aquaculture⁸ (COFI/AQ) endorsed a multi-donor assisted, long-term global programme component on aquaculture biosecurity for improving aquatic animal health governance and management at all levels. This global programme consists of five major pillars; pillar I is focused on strengthening disease prevention at the

⁸ www.fao.org/3/ca7417t/CA7417T.pdf

farm level through responsible fish farming (including reducing AMR in aquaculture and the application of suitable alternatives to antimicrobials) and other science-based and technology-proven measures.

20. The 127th Session of the Programme Committee underlined the need for a new FAO Action Plan on AMR (2021–2025), and invited the FAO Committee on Agriculture (COAG) and COFI in their upcoming sessions to provide guidance on this.

IV. THE PROPOSAL OF FAO ACTION PLAN ON AMR 2021–2025

21. The Action Plan 2016–2020 will come to an end at the end of 2020. It has guided FAO's actions in food and agriculture to combat AMR within the focus areas of awareness, surveillance, governance and good practices. Achievements made have laid down a solid foundation for further actions with a robust One Health and multi-sectorial approach.

22. Lessons have been learned including the need for a strategic approach in order to boost FAO's leadership within the One Health context. During the implementation of the Action Plan 2016–2020 the importance of having a proper monitoring and progress reporting mechanism was revealed. Therefore, a results chain that will be used as a basis for monitoring FAO progress on AMR activities has been developed.

23. The 127th Session of the Programme Committee underlined the need for a new FAO Action Plan on AMR (2021–2025) and invited COAG and COFI in their upcoming sessions to provide guidance on it.

24. The 128th Session of the Programme Committee recalled that the 163rd Session of the Council invited COAG and COFI in their upcoming sessions to provide guidance for a new Action Plan of FAO for AMR 2021–2025, building on lessons learned and supported by inclusive consultations with Members.

25. In response, FAO has developed a new Action Plan on AMR 2021–2025 building on key lessons learned to date, and further addressing the below points:

- the need to strengthen the actions on AMU as one of the main drivers to combat AMR;
- emphasizing the need to strengthen the capacity of awareness activities to affect change by focusing also on engagement in calls to action and targeted field interventions; and
- ensuring that all AMR work is supported by mechanisms that promote sustainability in the long run.

26. The FAO Action Plan on AMR 2021–2025 lays out five objectives (as below) to focus efforts and accelerate progress, aligning with the Global Action Plan on AMR and the results chain, with corresponding outputs and outcomes. The five objectives are as follows:

- Increasing stakeholder awareness and engagement;
- Strengthening surveillance and research;
- Enabling good practices;
- Promoting responsible use of antimicrobials; and
- Strengthening governance and allocating resources sustainably.

27. The proposal of FAO Action Plan on AMR 2021–2025 is presented as an Annex to this document.



**Food and Agriculture Organization
of the United Nations**

The FAO Action Plan on Antimicrobial Resistance 2021-2025

**Supporting innovation and resilience
in food and agriculture sectors**

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**Food and Agriculture Organization
of the United Nations**

Foreword

We are at a tipping point. Due to antimicrobial resistance (AMR), drug-resistant infections are placing an ever-increasing burden on human, animal, plant and environmental health. Treatments have become less effective or ineffective. If left unchecked, the effects of the spread of AMR are not unlike the broad-reaching effects of a pandemic. Drug-resistant infections have the potential to join cardiovascular disease and cancer as leading causes of death. AMR may force tens of millions more people into extreme poverty, hunger and malnutrition. In addition, associated economic losses are projected at several percent of gross domestic product. However, we can prevent this from happening – if we act quickly.

Action against AMR is a race against time.

Antibiotics and other antimicrobials are being widely used – and misused – in attempts to control disease-causing microbes in animals, plants and people. Many are already succumbing to drug-resistant infections each year. This means that farmers, herders, growers, fishers and policy makers in agriculture – as well as stakeholders in other sectors – share responsibility for good AMR control.

Simply waiting for new drugs is not an option because of the extraordinary cost and difficulty of research and development. Buying more time for drug discovery and keeping antimicrobials working for as long as we can, depends on multi-sectoral initiatives for responsible antimicrobial use, as well as better practices that reduce the risk of infection and the need for treatment. The success of these initiatives will depend on good governance, evidence and surveillance and effective advocacy and behaviour change programmes.

Progress in these areas has been made but we have more work to do, based on the country self-assessment surveys conducted by the Tripartite comprising of the Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health and the World Health Organization.

The seeds of change were first planted by Members with Resolution 4/2015, followed by the FAO Action Plan on AMR 2016-2020, in support of the Global Action Plan. This updated FAO Action Plan on AMR 2021-2025 recognizes strides made and ongoing challenges. The aim is to help accelerate progress in developing and deploying multi-sectoral National Action Plans to tackle AMR by calling attention to strategic priorities and areas of expertise for FAO support. As resistant microbes are contaminating environments and spreading freely across sectors and borders, globally we are only as strong as our most vulnerable Members.

Thanks to the support of an initial group of resource partners, FAO has been able to establish its AMR Programme and make progress toward reducing AMR risks. However, this extrabudgetary approach is not sufficient for the longer-term. For resource efficiency and wider impact, work on AMR should also be mainstreamed into existing programmes for achieving the Sustainable Development Goals by tapping into stable funding sources. In this way, FAO can continue to work hand-in-hand with countries for food security, economic development, good nutrition and the sustainable use of natural resources. Improving control of AMR is necessary to meet all of these goals.

We can also build on the emergency and rehabilitation activities of past pandemics and zoonotic disease threats to strengthen agriculture systems and economies. FAO is applying modern science and technology and developing innovative approaches to help countries face new challenges and make agriculture more sustainable.

By working together, food systems, livelihoods and economies will be better protected from the destabilizing forces of untreatable illness. Many lives can be saved in this lifetime and for generations to come.

We are *One World* working together for *One Health*.

#OneWorldOneHealth

Maria Helena Semedo
Deputy Director-General

Acronyms

AMR	Antimicrobial resistance
AMU	Antimicrobial use
CAC	Codex Alimentarius Commission
FAO	Food and Agriculture Organization of the United Nations
FAO-ATLASS	FAO Assessment Tool for Laboratories and AMR Surveillance Systems
FAO-PMP-AMR	FAO Progressive Management Pathway for AMR
GAP	Global Action Plan
GDP	Gross domestic product
IACG	UN ad hoc Inter-agency Coordination Group on AMR
ICCPM	International Code of Conduct on Pesticide Management
IPPC	International Plant Protection Convention
LMIC	Low- and middle-income country
MPTF	Multi-partner trust fund
NAP	National action plan on antimicrobial resistance
OIE	World Organisation for Animal Health
SDG	Sustainable Development Goals
UN	United Nations
UNEP	United Nations Environment Programme
WHO	World Health Organization

Executive summary

Action against AMR is a race against time. The unchecked spread of antimicrobial resistance (AMR) is on track to make drug-resistant infections the cause of the next pandemic. AMR has the potential to make these infections join cardiovascular disease and cancer as leading causes of death. AMR may force tens of millions more people into extreme poverty, hunger and malnutrition. Associated economic losses are projected at several percent of GDP. However, we can prevent this from happening – if we act quickly.

Contributing towards the goal of **building resilience in the food and agriculture sectors by limiting the emergence and spread of AMR** depends on controlling AMR effectively as a shared responsibility among farmers, herders, growers, fishers and policy makers in food and agriculture – as well as other sectors. Preventative action will provide a strong **economic benefit** at low cost – especially when compared to the significant percent of GDP expected to be lost if AMR is permitted to develop into a **global emergency** through the widespread **failure of medicines**.

The **overuse and misuse of antimicrobials** in animal and plant production is influenced by an interplay of factors. These serve as targets for action to address challenges ranging from: i) treatment failures driving production losses and food insecurity; to ii) the significant loss of human life.

Once individuals become carriers of antimicrobial-resistant organisms, they **can easily spread AMR among communities and across borders**. AMR can also reach the general population by spilling over into agriculture products and the environment, contaminating waterways, wildlife and soil. Given the global interconnected web of transmission, a **multi-sectoral and multi-disciplinary approach** is **critical to the success** of national action plans (NAPs) for delivering on the Global Action Plan (GAP; WHO 2015).

This FAO Action Plan on AMR 2021–2025 lays out five key objectives (Figure 1) to help focus efforts and accelerate progress:

1. Increasing stakeholder **awareness** and **engagement**
2. Strengthening **surveillance** and **research**
3. Enabling **good practices**
4. Promoting **responsible use** of antimicrobials
5. Strengthening **governance** and allocating **resources** sustainably

The Action Plan also includes a results chain (Figure 2) and a detailed list of key activities (Tables 1–5) to help guide the development and deployment of NAPs and FAO support for Members.

KEY MESSAGES

- Globally we are only as protected as our most vulnerable members because resistant microbes cross borders
- A strong evidence base is needed to identify and manage AMR risks before they become large-scale emergencies
- Countries will benefit from surveillance and research to design AMR control programmes and monitor their effectiveness
- Stakeholders need to be enabled, empowered and incentivized to transform awareness of AMR risks into action
- Opportunities to boost profitability through more effective agriculture practices will also help to reduce the burden of infections and emergence of AMR
- Training stakeholders through better guidance on responsible practices will help to phase out growth promotion for animals and ensure judicious antimicrobial pesticide use for plants
- Equal access to expert advice, prescriptions and appropriate antimicrobials, as well as AMR-relevant policies and legislation, will help tackle the challenge of antimicrobial misuse while also boosting production
- Support is needed for research and innovations in antimicrobials, alternatives, diagnostics and production
- The economic case for market-based approaches and public and private investments can support resource mobilization to deliver national plans
- Mainstreaming AMR into programmes for achieving the SDGs will help accelerate progress and boost resilience to health crises for global prosperity

FAO brings expertise in aquatic and terrestrial animal health and production, food and feed safety, genetic resources, crop production, natural resource management, risk communication and behavioural change. FAO also supports regulatory frameworks, standards, target-setting, norm-setting and bottom-up processes of collective action.

FAO's support to tackle AMR has gained momentum. This needs to be maintained and accelerated in order to coordinate the global response for food and agriculture.

Background

Working together to feed our growing global population and protect it from drug-resistant infections

Sustainably feeding an expanding global population depends on how well we protect our food systems from growing threats. This is especially true when it comes to managing antimicrobial resistance (AMR), which is rapidly becoming one of the greatest threats to lives, livelihoods and economies (O' Neil, 2014). AMR is a process whereby microorganisms acquire a tolerance to antibiotics, fungicides and other antimicrobials, many of which we rely on to treat diseases in people, animals and plants.

One of the consequences of antimicrobial-resistant microorganisms is drug-resistant infections. Resistance is already making some diseases in humans, livestock and plants increasingly difficult or impossible to treat. It is undermining modern medicine, compromising animal production and destabilizing food security. The impact of AMR is further amplified by the slow and expensive process of discovering replacement medicines. For these reasons, AMR affects everyone and requires all of us to take urgent action. We need to keep antimicrobials working for as long as possible to buy time for new drug discovery. Together, we must combat the accelerating pace of resistance and make food systems more resilient.

This Action Plan of the Food and Agriculture Organization of the United Nations (FAO) supports the implementation of the Global Action Plan on AMR (GAP; WHO 2015). FAO's Action Plan serves as a roadmap for focusing global efforts to address AMR in food and agriculture sectors. Protecting food and health systems is a common need of our global society. We also share a responsibility to guard against economic losses as resistant microbes contaminate environments, cross borders and spread freely between people and animals. The time for action is now.

The benefits of acting now to strengthen and implement national plans

Action against AMR is a race against time. The world is expected to produce in the next 30 years the same amount of food as it has produced in the last 10 000 years combined (FAO, 2009; Wolcott, 2019). This heralds unprecedented pressure on our agriculture systems to deliver nutritious food safely and sustainably in the face of climate change, diminishing natural resources and global health threats, which include pandemics and drug-resistant infections.

Within the next 10 years, antimicrobial use (AMU) for livestock alone is projected to nearly double to keep pace with the demands of our growing human population (Van Boeckel *et al.*, 2015). Usage for aquaculture and plants is predicted to continue rising as well. The intensification and specialization of agriculture production is already contributing to infections that we are unable to treat. Moreover, these conditions will speed up the emergence and spread of resistance unless we act now to improve practices for AMR control.

Many improvements in agriculture practices to better control AMR – good nutrition, health, hygiene, sanitation, genetics, husbandry, welfare, environmental protection and growing practices – help boost production in addition to protecting against losses from infectious diseases. This can make agriculture more profitable and more sustainable.

In fact, there is a strong economic benefit for seizing this window of opportunity for implementing practical and preventive adjustments at relatively low cost now compared to the 1–5 percent or greater loss of GDP predicted for countries if AMR remains unchecked. By developing and applying national action plans (NAPs) on AMR, countries can also prevent tens of millions more people from being forced into extreme poverty (World Bank Group, 2017).

FAO is helping countries leave no sector behind

FAO is supporting Members strengthen their capacities to manage AMR risks in food and agriculture sectors. In support of inclusive protection, FAO champions multi-sectoral and multi-disciplinary responses coordinated through strong governance, informed by surveillance and research and which promote good production practices and responsible AMU. The expansion of communication and behaviour change initiatives is also urgently needed to effectively target the drivers of AMR and to empower stakeholders to improve their practices.

Since the advent of antimicrobials, the occurrence of resistant organisms in livestock has grown exponentially, with low- and middle-income countries (LMICs) included (Van Boeckel *et al.*, 2019). This trend is troubling for producers and for patients as a fraction of all drug-resistant infections in humans have also been associated with foodborne or animal sources (CDC, 2013; Mughini-Gras *et al.*, 2019). This supports the call for rapidly phasing out AMU for growth promotion and stronger guidance for preventive AMU in animal production (IACG 2019).

Widespread use of antimicrobials in animal and plant production is influenced by an interplay of factors across sectors (FAO 2016a; O’Neill 2015; Collignon *et al.* 2018; Caudell *et al.* 2020). These include:

- anthropological dimensions such as sociocultural, political and economic factors;
- limited biosecurity and production practices that lead to an over-reliance on antimicrobials;
- absent or inadequate oversight of AMU in agriculture with limited access to animal and plant health experts, as well as inadequate training and support for these experts;
- unregulated sales of antimicrobials without prescription; and
- Increased availability of counterfeit and low-quality antimicrobials, including products with harmful combinations and sub-therapeutic concentrations.

These are interconnected targets for action to address challenges ranging from: i) treatment failures that trigger production losses and jeopardize food security; to ii) the increased transmission risk of multi-drug resistant organisms – commonly known as “superbugs” – through environments and food chains (O’Neil, 2014; Smith and Coast, 2013).

COMPARATIVE ADVANTAGE

FAO has an on-the-ground network in more than 150 countries.

The Organization also has wide expertise in a variety of disciplines, including aquatic and terrestrial animal health, welfare and production; food and feed safety; crop production and protection; water and land stewardship; legal affairs, communication and behaviour change; surveillance and more.

In accordance with its mandate, FAO plays an essential role in supporting governments, producers, traders and other stakeholder groups to use antimicrobials responsibly to keep antimicrobials working and to protect food and agriculture sectors from the harms of AMR.

The Organization also hosts the Secretariat of the Codex Alimentarius Commission (CAC) and the International Plant Protection Convention (IPPC), supporting the work of these standard-setting organizations by providing them with scientific advice and assisting in the implementation of standards through support to countries.

FAO works closely with the OIE and WHO in a Tripartite initiative and this collaborative approach extends to other partners, reference centres, academic institutions and regional working groups for a coordinated global response to AMR.

Timely action can help limit the spread of foodborne and zoonotic antimicrobial-resistant organisms, which reach humans through a multitude of transmission pathways (FAO, 2016a). These transmission pathways include both direct contact with animals and indirect transmission through the environment and food supply chain. Transmission can originate at the point of production and then be carried by animals and plants into the food chain. Resistant organisms can also be introduced during the handling, processing, transport, storage and preparation of food products.

Once an individual becomes a carrier of antimicrobial-resistant organisms, they can easily spread AMR within and between communities. AMR can also reach the general population by spilling over from human and agriculture sources into the environment and wildlife populations, whereby people can be exposed through contaminated water, soil and agriculture products. Antimicrobials or their residues in terrestrial and aquatic environments – coming from sources such as drug manufacturing plants, untreated community sewage, wastewater/run-off from large animal operations and crops – are also generating selection pressure for the emergence of AMR and contributing to its spread. In parallel to managing AMU, a transition to more sustainable food production practices is essential to better control AMR.

The intermingled web of transmission pathways of antimicrobial-resistant organisms includes the potential for emergence and spread across all sectors and stages of the food supply chain. Therefore, a multi-sectoral and multi-disciplinary approach is critical to the success of NAPs. Successful NAPs are also critical for delivering on the GAP (WHO, 2015), in accordance with its Monitoring and Evaluation Framework (FAO, OIE and WHO, 2019).

FAO is providing support to Members through expertise in aquatic and terrestrial animal health and production, food and feed safety, genetic resources, crop production, natural resource management, risk communication and behaviour change, with attention to regulatory frameworks, standards, norm-setting and bottom-up processes of collective action.

Mainstreaming AMR into programmes for achieving the Sustainable Development Goals

FAO leads international efforts to achieve food security for all and recognizes that eradicating hunger – as part of the wider Agenda for Sustainable Development – can only be achieved through timely and widespread action on AMR. In May 2019, the United Nations (UN) Secretary General António Guterres affirmed that, AMR “is a global threat to health, livelihoods and the achievement of the Sustainable Development Goals.”

While there is no AMR-specific goal or indicator in the current SDG framework, AMR must be accounted for in global, regional and national plans because it is threatening the achievement of many goals (Wellcome Trust, 2018; World Bank Group, 2017), including:

- Ending poverty (SDG 1) and hunger (SDG 2);
- Promoting healthy lives and well-being (SDG 3);
- Clean water and sanitation (SDG 6);
- Responsible consumption and production (SDG 12);
- Protecting life below water and on land (SDGs 14 & 15); and
- Achieving sustained economic growth (SDG 8).

As women are less likely to be compensated – or compensated at a lower level – than men for their efforts in food production and food preparation (FAO, 2011), there is a disproportionate risk of exposure to resistant pathogens relative to financial compensation, highlighting gender equality issues as well (SDG 5). The ability to better manage AMR and prevent impacts on international relations depends too on strengthening global development partnerships (SDG 17).

Action on AMR is accelerating in line with funding

Since 2015, political commitment and international action against AMR has grown. Beginning in May 2015, the World Health Assembly resolution WHA68.7 (WHA, 2015) adopted the GAP on AMR (WHO, 2015), developed by WHO, FAO and OIE. The GAP emphasized the need for a “One Health” approach to combat AMR by involving all sectors of government and society and strengthening coordination between FAO, OIE and WHO. The main objective of the GAP is assisting Members in the development and implementation of multi-sectoral NAPs. The GAP also presented key actions for addressing AMR. A political declaration at the UN General Assembly in September 2016 (UNGA, 2016) additionally requested that the UN Secretary-General submit a report to Members on the implementation of the political declaration, including recommendations emanating from an ad hoc Inter-Agency Coordination Group on AMR (IACG).

In supporting implementation of the GAP, FAO’s Thirty-ninth Conference adopted Resolution 4/2015 (FAO, 2015) on AMR in June 2015, recognizing the importance of mitigating impacts of AMR in food and agriculture sectors and the role of FAO in tackling this global threat. The FAO Action Plan on AMR 2016-2020 (FAO, 2016b) was developed for implementation of this Resolution. FAO’s 41st Conference in June 2019 adopted a second Resolution on Antimicrobial Resistance (6/2019; FAO 2019a) which acknowledged and welcomed FAO’s efforts in addressing AMR as a “One Health” issue and agreed on the need for further support, through extra-budgetary resources. An AMR working group was also established in 2015, creating a mechanism for internal coordination among FAO technical divisions and regional and country offices. At the time of publication, donors for FAO AMR projects have included the United Kingdom, Russian Federation, the United States of America, European Union and Norway (FAO, 2020b).

FAO is supporting the standard setting work on AMR working to further broaden international coordination. In 2017, the Codex Alimentarius Commission, the risk management body of the Joint FAO/WHO Food Standards Programme, established a Task Force on Antimicrobial Resistance (FAO and WHO, 2020). The Task Force is developing science-based guidance on managing foodborne AMR, taking into account the work and standards of relevant international organizations and the “One Health” approach, to ensure that Members have the guidance necessary to manage AMR across the food chain.

In May 2018, FAO, OIE and WHO (the Tripartite) signed a Memorandum of Understanding to strengthen their long-standing partnership, with a renewed focus on tackling AMR (FAO WHO OIE, 2018). This led to a two-year (2019-2020) Tripartite Work Plan, with the involvement of the United Nations Environment Programme (UNEP), which was adopted by the 25th Tripartite Executive meeting (February 2019) and was subsequently signed by the Directors-General of FAO, WHO and OIE

FUNDED PROJECT RESULTS & FAO TOOLS

Funded projects were designed to boost the technical capabilities of countries and strengthen multi-stakeholder collaboration for developing and implementing NAPs in more than 40 lower-middle-income countries (UN 2019a). This includes support for countries to identify and commit resources for national plans.

FAO has facilitated access to resources and technical networks, deployed field interventions and studies promoting good practices and has developed a set of tools (FAO, 2020b) to assist countries in broadening their action on AMR to more food and agriculture sectors.

The FAO Progressive Management Pathway for AMR (FAO-PMP-AMR) has been developed to support countries in identifying actions needed for step-by-step improvements in AMR control and a tool for situation analysis of AMR risks is being used by countries to prioritize actions on the basis of a risk analysis.

FAO has developed a methodology to assess national legislation relevant for AMU and AMR, including the regulatory framework of antimicrobials, legislation aimed at preventing the contamination of food and the environment and legislation to improve animal and plant health status to minimize the need for antimicrobials.

Additionally, with the aim of assisting countries in assessing their national surveillance systems and laboratory diagnostic capacity for AMR detection, FAO has developed and deployed the Assessment Tool for Laboratories and AMR Surveillance System (FAO-ATLASS) in more than 25 countries and 100 laboratories.

(May 2019). All of the activities under the Work Plan directly contribute to the implementation of FAO's Action Plan on AMR and complement FAO's activities undertaken with regular and extra-budgetary funds.

In 2019, the Organization initiated the establishment of a technical collaborative network of FAO Reference Centres for AMR. Up to the date of publication, these included institutions from Denmark, Germany, Thailand, the United Kingdom and the United States of America (FAO, 2020a).

The IACG Report published in 2019 – to which FAO contributed through a body of technical advisors – includes 14 recommendations for progress in countries, innovation, collaboration, investment and global governance (IACG, 2019). The follow-up report to the UN Secretary General provided highlights of progress made by Members and the Tripartite Organizations in addressing AMR on the basis of the GAP. The follow-up report also called for urgent support and investments to scale up responses at the national, regional and global levels (UN, 2019a).

In June 2019, an AMR Multi-Partner Trust Fund (AMR MPTF) was launched as a strategic, inter-agency and multi-partner initiative inviting countries, foundations, financial institutions and the private sector to support the Tripartite Work Plan on AMR (FAO WHO OIE, 2020) to accelerate global, regional and national progress.

Most of FAO's work on AMR to date has been implemented through extra-budgetary funds via donor funded projects. Despite information gaps on AMU and the impacts of AMR in food and agriculture, particularly in LMICs, FAO's support to tackle AMR has gained a momentum that needs to be maintained and built upon to strengthen the resilience of agriculture and food systems. Many countries have developed NAPs (WHO, FAO and OIE, 2018), but challenges remain for fully operationalizing them in all relevant sectors. Success in meeting the challenge of AMR will depend on continuing coordination of a global response for food and agriculture.

For more information on FAO AMR programming achievements, see updates to the Programme Committee (FAO, 2019a).

FAO's vision

FAO envisions a world free from poverty, hunger and malnutrition (FAO, 2019b). A core value of this work is the practical and stepwise transformation of food systems in an economically, socially and environmentally sustainable way to achieve Agenda 2030 for global health and prosperity (UN, 2019b).

FAO's goals on AMR

AMR is derailing progress on the Sustainable Development Goals as more agriculture producers struggle to prevent and manage infections that threaten to disrupt food supply chains and thrust tens of millions more people into extreme poverty (World Bank Group, 2017). To respond to this challenge and realize its vision, FAO has established two main goals for its work on AMR:

1. Reduce AMR levels and slow the emergence and spread of resistance across the food chain and for all food and agriculture sectors
2. Preserve the ability to treat infections with effective and safe antimicrobials to sustain food and agriculture production

Through the achievement of these goals, FAO will work with stakeholders to increase the capacities of the food and agriculture sectors in managing AMR risks and building resilience to AMR impacts. By working together, FAO and partners will better protect food systems, livelihoods and economies from the destabilizing effects of AMR.

Objectives

The five objectives of the FAO Action Plan on AMR 2021-2025 are designed to help focus initiatives at every scale towards meeting the above goal and vision. These objectives (Figure 1) account for strides already made in addressing key challenges, as well as ongoing priorities for action and are intended as a guide for the programming of FAO, its partners and food and agriculture stakeholders worldwide.

These objectives, the results chain (Figure 2) and the key activities (Tables 1–5) can be used as a roadmap for accelerating progress towards setting and meeting national, regional and global targets. Success in containing AMR, keeping antimicrobials working and boosting the resilience of food systems will depend on targeted and sustained efforts in all five areas, which are mutually reinforcing.

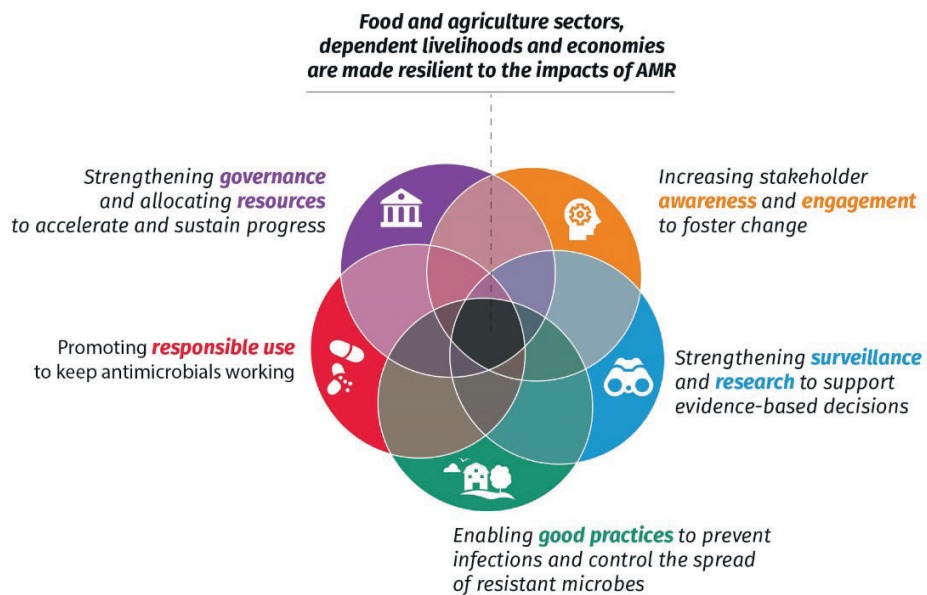


Figure 1. Effective control of AMR requires coordinated effort to meet all five objectives, in every country. Buying more time for drug discovery and keeping antimicrobials working for as long as we can, depends on multi-sectoral initiatives for responsible AMU, as well as better practices that reduce the risk of infection and the need for treatment. The success of these initiatives depends on good governance, evidence and surveillance and effective advocacy and behaviour change programmes.

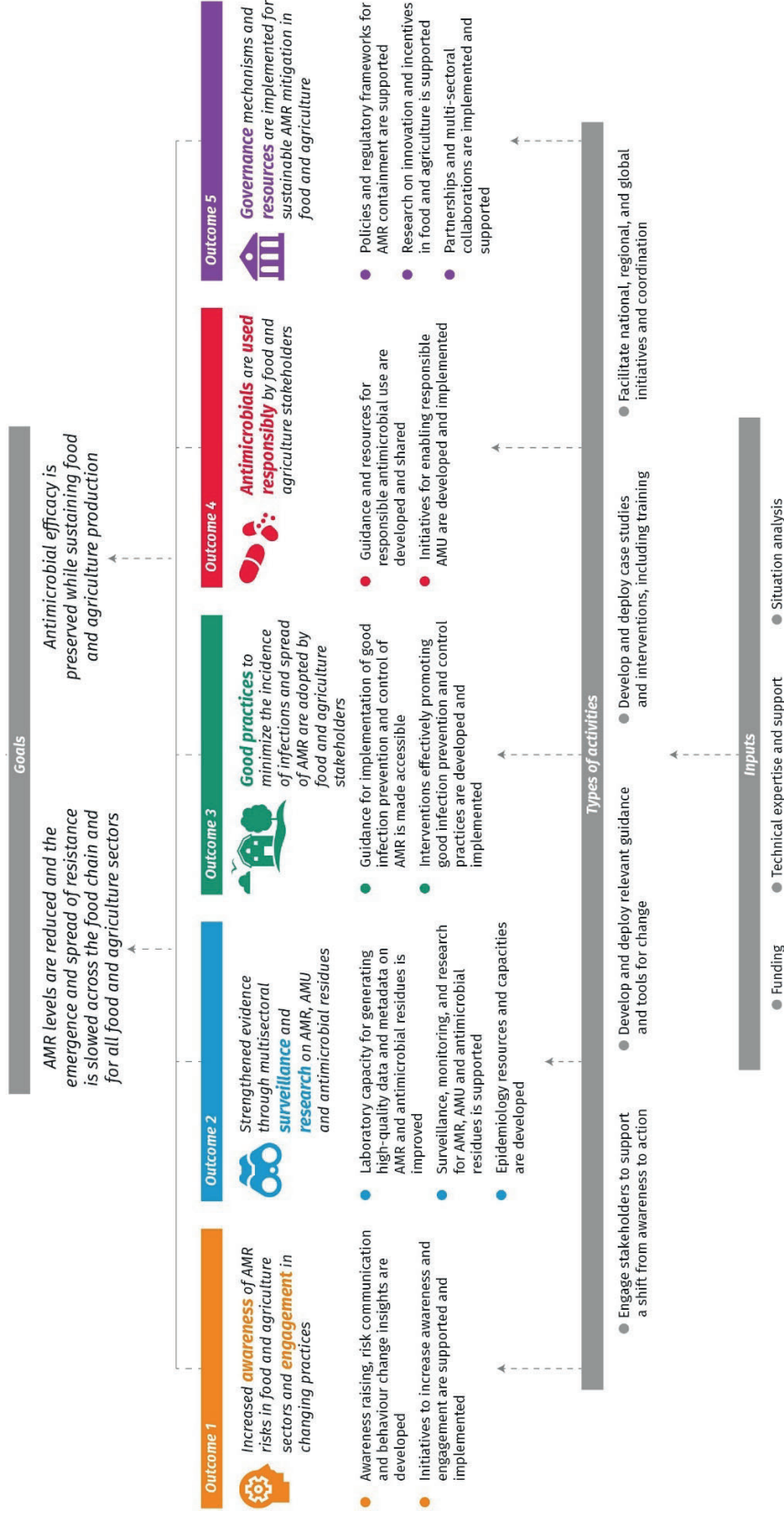


Figure 2. Results chain of inputs, activities, outputs and outcomes for limiting the emergence and spread of AMR and keeping antimicrobials working towards building resilience to AMR in food and agriculture sectors.

Objective 1: Increasing stakeholder awareness and engagement

Many factors drive food and agriculture stakeholders to misuse and overuse antimicrobials. These include persistent disease, limited access to expert advice, inadequate prescription systems and unequal access to appropriate antimicrobials. Barriers to change also exist. These range from structural, economic and environmental constraints to low awareness and risk perception, social norms that contradict good practices and the inability or unwillingness to adopt new practices that reduce AMR risks.

To address drivers of behaviour and barriers to change, FAO is continuing research on stakeholder perspectives to inform behaviour change strategies (Table 1). A key component of this programme is increasing stakeholder awareness of the individual and collective risks posed by AMR, the consequences of inaction and the benefits of choosing new practices.

Progress has been made in raising awareness among food and agriculture stakeholder groups and civil society. However, more work is required to reach every group and population. FAO plans to continue expanding its awareness efforts to promote change and reach new audiences. Now more than ever, focused efforts are urgently needed to transform awareness into action.

To achieve this, FAO will intensify efforts to engage stakeholders in collective problem solving and sustainable behaviour change through appeals to values and motivations. FAO will strengthen its ongoing programmes on risk communication and behaviour change to build knowledge, capacity and willingness for change. FAO will also analyse stakeholder decision-making contexts and pilot the application of behavioural insights to make risk-reductive behaviours easier and more appealing (Table 1). FAO will continue supporting Members to develop an enabling environment that facilitates change and ensures that stakeholders are active, committed and empowered to make that change a reality.

KEY MESSAGES

- Participatory approaches are needed to better understand stakeholder perspectives and motivations
- Barriers to change need to be identified and collaborative solutions piloted for an evidence-based approach to interventions
- Stakeholders need to be enabled, empowered and incentivized to transform awareness of AMR risks into action

Objective 2: Strengthening surveillance and research

Surveillance and research are essential to guide stakeholder decisions on how best to slow the emergence and spread of AMR for the good of food security and global health. Reliable data are needed on antimicrobial resistant microorganisms – their distribution, AMR profiles and prevalence – in addition to data on the extent of AMU and antimicrobial residues along the food and feed chains, as well as through the environment.

Strong surveillance and monitoring programmes collect risk-based epidemiological data on AMR, AMU and antimicrobial residues relevant to each agriculture sub-sector and specific value chain. This information then allows for timely assessment of risks to develop appropriate interventions and monitor their effectiveness over time for AMR control.

Given competing budget priorities, surveillance is also helpful for guiding resource allocation decisions that promote efficiency and preparedness by identifying risks before they become large-scale emergencies.

Some countries have implemented AMR surveillance programmes, while many will benefit from more support to improve laboratory capacity and develop AMR surveillance systems. Now is the time to broaden these efforts to ensure inclusive progress.

FAO plans to continue supporting Members in building and consolidating laboratory and surveillance capacity to generate, collect and analyse high-quality data within national surveillance systems (Table 2). FAO is also creating a global AMR/AMU food and agriculture data platform, complementing the work of WHO and OIE, to help countries detect emerging threats and evaluate the impact of their AMR prevention and control initiatives.

KEY MESSAGES

- Countries will benefit from improved data collection and analysis of AMR, AMU and antimicrobial residues
- Surveillance and research are needed to design AMR control programmes and monitor their effectiveness
- Data gathered inform efficient resource allocation decisions among competing priorities
- A strong evidence-base is needed to identify AMR risks before they become large-scale emergencies

Objective 3: Enabling good practices

Inadequate infection prevention measures and agriculture production practices are major drivers of the misuse and overuse of antimicrobials. This accelerates the emergence and spread of resistance. Also contributing to the spread of resistance are agriculture production practices that unintentionally release resistant microbes into soils and water through irrigation with untreated wastewater, use of manure or untreated biosolid fertilizers (i.e. sewage sludge) and their run-off.

The solution is to support good production practices that will have the dual benefits of reducing the negative impacts of AMR while also bolstering production. Many of these improved practices can also help to protect against potentially devastating losses from infectious diseases and make agriculture production more sustainable. Ensuring the safe handling, processing and storing of foods is also key in controlling the spread of resistant organisms. Moreover, addressing barriers to behaviour change is critical to create an enabling environment that facilitates the adoption of these good practices.

FAO will continue supporting Members in improving terrestrial and aquatic animal production to reduce the incidence of infections, thereby reducing dependence on antimicrobials through better health, hygiene, sanitation and biosecurity practices (Table 3). Ensuring access to vaccines for preventable diseases is particularly important to reduce the need for antimicrobials and avoid their misuse. The development of new vaccines is also needed, starting with diseases for which critically important antimicrobials are being excessively used.

There is also ample opportunity for innovation of alternatives to antimicrobials for treatment of infections and alternatives promoting good health and fast growth through improved genetics, husbandry and feeding. Additionally, phytosanitary measures are crucial to maintain plant health and production and to help control the spread of plant pests, while reducing reliance on antimicrobial pesticides.

KEY MESSAGES

- Good production practices will help to reduce the burden of infections, reducing the need for antimicrobials and the emergence of AMR
- Good practices also extend to managing the spread of AMR in the environment and transmission through the food chain
- There are opportunities to boost profitability through more effective agriculture practices
- There are opportunities to innovate for alternatives to antimicrobials for good health and fast growth in plants and animals

Objective 4: Promoting responsible use of antimicrobials

AMU and misuse are rising with demand for animal and plant products. Given few replacement drug candidates in research and development pipelines, existing antimicrobials need to be better protected from excessive and improper use in order to buy more time for the development of new drugs. At the same time, equal access to appropriate antimicrobials and expert advice is needed to treat infections.

Food and agriculture sectors are in peril because the misuse and excessive use of antimicrobials in food production is increasing the emergence and spread of AMR. This in turn is limiting treatment options. Therapeutic and preventive use of antimicrobials can be improved through better diagnostics and guidance, safely moving away from the use of critically important antimicrobials as a replacement for good practices and for growth promotion. There is evidence that interventions for controlling AMU in food-producing animals reduces the presence of antibiotic-resistant bacteria in these animals (Tang *et al.*, 2017). Therefore, better management of AMR is possible.

Antimicrobials are also being used as pesticides to treat plant diseases caused by bacteria and fungi. Despite incomplete evidence, quantity estimates for pesticide usage appear relatively lower in comparison to volumes used for animals. However, the unintentional spread of these substances may have negative impacts on human health and the environment (McManus, 2014). Moreover, their current use in plant production in many parts of the world is considered unsustainable. Growers may face significant losses from resistance unless action is taken to make use of antimicrobial pesticides a last resort.

In many LMICs, there is the added complication of a lack of oversight and regulation for the use of antimicrobials. Therefore, it is essential to encourage all stakeholders – from drug dispensers and sellers to users – to recognize antimicrobials as a public good and use them responsibly, while ensuring fair access to medicines when they are needed. FAO will continue supporting stakeholders to use antimicrobials judiciously, providing the necessary guidance and training for therapeutic and preventive use in accordance with best practices and international standards (Table 4).

KEY MESSAGES

- Improving access to expert advice, prescriptions and appropriate antimicrobials will help tackle the challenge of antimicrobial misuse
- Training stakeholders through better guidance for preventive AMU will help to reduce the excessive use of antimicrobials
- A first step to accelerate action on AMR is phasing out growth promotion for animals and using antimicrobial pesticides for plants as a last resort

Objective 5: Strengthening governance and allocating resources sustainably

Effective governance guides the sustainable management of AMR. This depends on political will and a well-informed institutional framework for innovating, evaluating and strengthening policies and legislation. Studies of different policy approaches, standards, norm-setting and targets at the national, sub-national and farm levels are needed. This research will help identify sustainable options that will yield the greatest impact and return on investment. Clarifying the case for public and private investments, as well as the case for stakeholder economic incentives, will raise the profile of AMR in political agendas and support resource mobilization for delivering national plans.

Drawing from its expertise, FAO will continue assisting Members and regional organizations (e.g. Regional Economic Communities) in operationalizing, monitoring and evaluating NAPs and strengthening country capacity through effective programmes, policies and legislation (Table 5). FAO has developed a methodology to assess national legislation spanning antimicrobial regulation, food safety, animal and plant health, and the environment. The FAO-PMP-AMR is helping countries assess AMR capacity and make stepwise improvements in AMR control. FAO will also continue supporting regional and international “One Health” initiatives and standard setting in collaboration with WHO, OIE and other international partners.

By fostering partnerships with the private sector, academia and other innovators, FAO will continue to build support for the research and development needed to combat AMR.

There is an array of market-based approaches that can further help to accelerate action on AMR. These approaches would also benefit from participatory action whereby actors involve stakeholders early in the development process. This way, stakeholders can develop a stronger sense of ownership and commitment. Constraints can also be better accounted for upstream of implementation for greater success and lasting results.

KEY MESSAGES

- Multi-sectoral and multi-disciplinary collaborations are needed for effective national plans and targets
- Strengthening policies and regulatory frameworks for AMR containment – as well as incentive-based approaches – present opportunities for accelerating action on AMR
- Support is needed for research and innovations in antimicrobials, alternatives, diagnostics and production
- The economic case for incentives and public and private investments can support resource mobilization to deliver national plans

Key Activities for 2021–2025

For achieving the goals and vision, FAO has developed a list of key activities (Tables 1–5) aligned with the five objectives (Figure 1) and corresponding outputs and outcomes in results chain (Figure 2). These activities are intended to guide FAO programming for a five-year period and will be amended as needed to reflect progress, new challenges and available resources.

Activities are aimed at global, regional, national and local levels and span sectors, including terrestrial and aquatic animals, crops and the environment. Activities will also build on the technical networks and regional working groups developed since the release of the first Action Plan on AMR (FAO, 2016b), including FAO Reference Centres.

Table 1. Key activities for achieving Outcome 1

Outcome 1: Increased awareness of AMR risks in food and agriculture sectors and engagement in changing practices	
OUTPUTS	ACTIVITIES
Output 1.1 Awareness raising, risk communication and behaviour change insights are developed	<ul style="list-style-type: none"> • Develop global, regional and national strategies for awareness raising, advocacy, risk communication and other behaviour change interventions (e.g. nudges). Capitalizing on inclusive and cross-sectoral participation, FAO and partners will develop these strategies to facilitate more impactful awareness and engagement initiatives. • Develop guidelines, templates, and other tools to aid partners in the development of their own, targeted products for awareness raising, advocacy, risk communication and behaviour change. • Develop surveys, media monitoring strategies and behavioural assessments to understand and measure engagement levels. Measurement of engagement will drive FAO's strategic vision for how and where to advocate, train, educate and apply behavioural insights to promote calls to action and social movements around AMR risk reduction. • Implement communication and behaviour change needs assessments of FAO and partners to ensure gaps are identified for effective design of Output 1.2 training and capacity-building initiatives. • Undertake behavioural diagnostics to identify AMR behavioural drivers and barriers to change in target populations; test pilot interventions via randomized controlled experiments; and use results to inform larger-scale interventions and behaviour change strategies. FAO will use statistical evidence and participatory approaches to drive the formulation of awareness and engagement interventions for sustained improvement in political and social action (jointly with output 3.2).
Output 1.2 Initiatives to increase awareness and engagement are supported and implemented	<ul style="list-style-type: none"> • Develop awareness raising, advocacy and risk communication products adapted to specific stakeholder groups and tailored to cultural contexts. These may include broadcast media, social media, participatory communication products, community engagement activities (e.g. theatre), augmented or virtual reality experiences and other interactive elements to boost engagement. • Deliver training to FAO and partners in awareness raising, advocacy, behavioural analysis and intervention design and evaluation to enable effective communication and behaviour change activities for social impact.

	<ul style="list-style-type: none"> • Support World Antimicrobial Awareness Week (WAAW) and related global, regional, national and local awareness campaigns, channelling lessons learned from Output 1.1. • Convene meetings for AMR advocacy across sectors to facilitate information sharing and coordination of stakeholder action. • Provide academia and civil society with guidance on how to include AMR in pre-service education to ensure civil servants and private sector service providers have the knowledge and skills needed to help their communities effectively control AMR.
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Table 2. Key activities for achieving Outcome 2

Outcome 2: Strengthened evidence through multi-sectoral surveillance and research on AMR, AMU and antimicrobial residues	
OUTPUTS	ACTIVITIES
Output 2.1 Laboratory capacity for generating high-quality data and metadata on AMR and antimicrobial residues is improved	<ul style="list-style-type: none"> • Continue the deployment of FAO-ATLASS through trained local assessors. These assessments evaluate baseline capacities and assist laboratories in improving detection and characterizations of AMR. This work also aids in the isolation and identification of bacterial species of interest for national AMR surveillance. • Develop a new tool for assessing existing laboratory capacity for antimicrobial residue testing in feed and foods of animal and plant origin, as well as for residue testing in the environment (soil and water). • Support Members with laboratory training, guidelines and protocols for antimicrobial susceptibility and residue testing to ensure that laboratory personnel are provided satisfactory competencies and resources for harmonized procedures that generate high-quality data for treatment of terrestrial and aquatic animal diseases and surveillance. • Develop external quality assurance guidance for AMR detection and characterization to tailor support for corrective interventions, ensuring the generation of high-quality data in laboratories participating in food and agriculture AMR surveillance systems. • Collaborate to support data-gathering and international efforts determining clinical breakpoints and epidemiological cut-off values for antibiotics used against bacterial pathogens causing animal diseases. • Support Members in the use of laboratory information management systems targeting AMR laboratory data collection, analysis and interpretation in the context of national surveillance.
Output 2.2 Surveillance, monitoring and research for AMR, AMU and antimicrobial residues is supported	<ul style="list-style-type: none"> • Continue the deployment of FAO-ATLASS for AMR surveillance systems to assist Members in identifying priority activities for building and improving their national AMR surveillance systems for the food and agricultural sectors. • Support a risk-based approach and prioritization of surveillance activities through the implementation of standards consistent with guidance of international standard-setting bodies • Continue supporting the development and implementation of regional frameworks and national programmes for multi-sectoral AMR, AMU and antimicrobial residues surveillance according to national needs, resources, cost-benefit analyses and global frameworks.

	<ul style="list-style-type: none"> • Develop and expand available guidelines for the design of risk-based integrated AMR/AMU surveillance. This includes assistance to Members as they progress in the implementation of their NAPs on AMR. • Develop in collaboration with partners guidelines for support to Members to collect AMU data at the farm-level to advise antimicrobial stewardship programmes. • Provide support for the implementation of local activities to monitor the quality of antimicrobial medicines intended for livestock. • Support risk analysis of AMR/AMU data to inform evidence-based interventions, mitigation and policy formulation. • Support collaborative multi-disciplinary research on how resistance develops, spreads and circulates within and across sectors and the impacts of AMR and AMU on food and agriculture.
Output 2.3 Epidemiology resources and capacities are developed	<ul style="list-style-type: none"> • Develop and pilot the FAO data platform to support Members in the collection of AMR and AMU data generated from the food and agriculture sectors. This includes data on plants and the environment based on the needs and capacity of Members. • Collaborate with OIE and WHO for building the Tripartite Integrated Surveillance System AMR/AMU to advance the global efforts for data on AMR in all sectors. • Develop and provide epidemiology training for AMR and AMU data management and analysis through standalone modules and integrated into existing FAO programmes for epidemiology capacity-building. This supports the implementation of national integrated AMR/AMU surveillance systems and risk analysis to inform initiatives and policies.

Table 3. Key activities for achieving Outcome 3

Outcome 3: Good practices to minimize the incidence of infections and spread of AMR are adopted by food and agriculture stakeholders	
OUTPUTS	ACTIVITIES
Output 3.1 Guidance for implementation of good infection prevention and control of AMR is made accessible	<ul style="list-style-type: none"> • Develop a repository of tools for infection prevention and control practices in food and agriculture including guidelines, e-learning, and training materials. • Review, document and share evidence on alternatives to the use of antimicrobials and innovations for improved infection prevention and control practices. • Develop guidance for improved management of animal diseases in key food production sectors (e.g. the Progressive Management Pathway on Biosecurity in aquaculture production), and support recommendations in collaboration with key partners including OIE and food production industry groups for improving animal health. . • Hosting the CAC, FAO will support the revision and update of its “Code of Practice to Minimize and Contain Antimicrobial Resistance” (FAO and WHO, 2015) to ensure wider applicability of good practices along the food chain. • Hosting the IPPC, FAO will support the development of guidance on phytosanitary measures including integrated pest management programmes that reduce the need for antimicrobial pesticides in plant production. • Develop guidance on agriculture waste management – including wastewater, manure and biosolids – and sustainable soil and land management practices to mitigate the spread of AMR in the environment.

Output 3.2 Interventions effectively promoting good infection prevention and control practices are developed and implemented	<ul style="list-style-type: none"> • Support the development of national programmes for the improved health of plants and terrestrial and aquatic animals, through good hygiene, sanitation and biosecurity practices, integrating AMR considerations. • Support the development of national and global vaccination programmes for terrestrial and aquatic animals integrating AMR considerations (e.g. prioritizing animal diseases responsible for highest levels of AMU) • Develop and deploy trainings for education of professionals to implement quality assurance systems along the food production chain. This will support governments, professional societies and accreditation bodies for training in food safety. • Deploy trainings on the application of specific infection prevention and control practices, including the appropriate diagnosis of diseases in terrestrial and aquatic animal health at the farm level (including small-scale producers). • Support the development and deployment of case studies as models for the effective uptake of good practices. Pilot different interventions (e.g. farmer field schools, behavioural insight applications) based on stakeholder assessments (e.g. knowledge, attitude and practice surveys, behavioural diagnostics and related methodologies) and desk research. Interventions showing the greatest positive impact on AMU and AMR will be considered targets for upscaling and further evaluation.
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Table 4. Key activities for achieving Outcome 4

Outcome 4: Antimicrobials are used responsibly by food and agriculture stakeholders	
OUTPUTS	ACTIVITIES
Output 4.1 Guidance and resources for responsible AMU are developed and shared	<ul style="list-style-type: none"> • Contribute to the development, revision and update of international standards for prudent use of antimicrobials in food and agriculture in collaboration with partners. These include but are not limited to the CAC “Code of Practice to Minimize and Contain Foodborne AMR”, OIE standards for responsible use of antimicrobials in animals and the International Code of Conduct on Pesticide Management (ICCPM) for crop and plant production. • Develop voluntary guidelines for responsible AMU in targeted sectors (i.e. animal, aquaculture, crops) supporting appropriate therapeutic and preventive use, and phasing out unnecessary non-therapeutic uses such as the use of antimicrobials for growth promotion in animals, starting with critically important antibiotics. • Develop a repository of tools and guidance materials promoting responsible AMU, including phasing out growth promotion.
Output 4.2 Initiatives for enabling responsible AMU are developed and implemented	<ul style="list-style-type: none"> • Build and maintain networks and platforms from global to national levels for the promotion of antimicrobial stewardship in food and agriculture initiatives among relevant stakeholders. • Deliver trainings on the responsible AMU in plant production and protection through the ICCPM to better control the use of antimicrobial pesticides (e.g. antibiotics for citrus greening and triazole fungicides in plant production). • Support the deployment of workshops and trainings on tools developed for guiding Members in the practical implementation of voluntary guidelines for prudent AMU

	<p>(e.g. prudent use in aquaculture (FAO 2019b), pigs and poultry (Magnusson et al. 2019)) and international standards (CAC, OIE, IPPC).</p> <ul style="list-style-type: none"> • Support governments and professional societies for training and education of producers and dispensers (veterinarians, para-veterinarians and extension services) on responsible AMU. • Carry out case studies and surveys associating specific animal diseases to AMU quantities and patterns (of use of critically important antimicrobials) to prioritize diseases leading to highest AMU and to analyse prudent AMU adoption levels among stakeholders. • Carry out value chain analyses of antimicrobials used for animal and plant health and stakeholder assessments to understand level of adoption of prudent AMU from local to global levels.
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Table 5. Key activities for achieving Outcome 5

Outcome 5: Strengthened governance and resource allocation for sustainable AMR mitigation in food and agriculture	
OUTPUTS	ACTIVITIES
Output 5.1 Policies and regulatory frameworks for AMR containment are supported	<ul style="list-style-type: none"> • Support Members and regional/subregional organizations in revising and updating policies and institutional frameworks for NAP implementation. FAO will continue utilizing its worldwide network and expertise to support countries in operationalizing, monitoring and evaluating their NAPs. • Support Members and regional/subregional organizations to revise and update legislation relevant for AMR and AMU in the food and agriculture sectors. • Support Members and regional/subregional organizations in phasing out of antimicrobials for growth promotion by providing the necessary guidance and options with accompanying legal underpinning. FAO will also support the phasing out of antimicrobials for growth promotion as part of the legal review and reform processes of countries and regional/subregional organizations.
Output 5.2 Research on innovation and incentives in food and agriculture is supported	<ul style="list-style-type: none"> • Support and strengthen partnerships and collaboration for research and development on innovations (new medicines, point of care diagnosis and alternatives to antimicrobials). FAO will foster partnerships with private sector, FAO reference centres for AMR, academia and other innovators. • Support the development of the economic case for protecting food systems from the impacts of AMR including but not only, assessments or pilot studies on phasing out of antimicrobials for growth promotion and AMU targets. • Support the development of AMR economic data for sectors under the FAO remit including knowledge-based and economic solutions (e.g. labelling schemes, subsidies, cost-benefit analyses) to better support the adoption of good practices and the generation of AMU/AMR data. In this context, FAO will support studies that reflect the possible outcomes of taking different economic policy approaches at national, sub-national and farm levels.
Output 5.3	<ul style="list-style-type: none"> • Support AMR global governance through high-level engagements.

Partnerships and multi-sectoral collaborations are implemented and supported	<ul style="list-style-type: none"> • Strengthen multi-partner collaboration by inviting new partners to engage with AMR and AMU work to promote cross-fertilization of ideas from across sectors. • Support and mobilize resources on national, regional and global One Health cooperation initiatives in relation to AMR through enhanced partnership at all levels. • Strengthen engagement with FAO Reference Centres on AMR for research, capacity development and technical assistance to Members. • Support development and implementation of NAPs on AMR through expanded deployment of FAO tools (e.g. FAO-PMP-AMR) for NAP operationalization and prioritization of activities.
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Monitoring Framework of the FAO Action Plan on Antimicrobial Resistance 2021-2025

For achieving its goals and vision, FAO has developed a results framework including a list of key activities (Tables 1–5 in Action Plan document) aligned with the five objectives and corresponding outputs and outcomes in results chain (Figure 2 in Action Plan document). The results framework is intended to guide FAO programming for a five-year period and will be amended as needed to reflect progress, new challenges and available resources.

FAO will also report on AMR in relation to the Sustainable Development Goals (SDGs), both for the indicators for which FAO is the custodian as well as the other SDGs to which FAO's AMR Programme contributes.

The following table describes the outputs to be delivered and their respective indicators under each of the five objectives of the FAO's Action Plan on AMR. These indicators are meant to monitor FAO's progress in the implementation of activities. This document also provides an initial step for further development of indicators at outcome and impact levels.

Outcome 1: Increased awareness of AMR risks in food and agriculture sectors and engagement in changing practices	
OUTPUTS	Output Indicators
Output 1.1 Awareness raising, risk communication and behaviour change insights are developed	1.1.i.1 Number of countries supported by FAO in the development of strategies for awareness raising, advocacy, risk communication and behaviour change. 1.1.i.2 Number of guidelines and capacity development tools provided by FAO to partners for the development of their own communication and behaviour change products. 1.1.i.3 Number of initiatives carried out with the support of FAO to assess stakeholder engagement, analyse barriers to change and evaluate engagement and behaviour change interventions.
Output 1.2 Initiatives to increase awareness and engagement are supported and implemented	1.2.i.1 Number of awareness raising, advocacy, risk communication and education products developed by FAO tailored to specific stakeholder groups and contexts. 1.2.i.2 Number of initiatives delivered by FAO, including trainings, campaigns and meetings, for AMR awareness raising, advocacy and behaviour change.

Outcome 2: Strengthened evidence through multi-sectoral surveillance and research on AMR, AMU and antimicrobial residues	
OUTPUTS	Output indicators
Output 2.1	

Laboratory capacity for generating high-quality data and metadata on AMR and antimicrobial residues is improved	<p>2.1.i.1. Number of laboratories that are part of national AMR surveillance systems for food and agriculture assessed using the FAO Assessment Tool for Laboratories and AMR Surveillance Systems (FAO-ATLASS).</p> <p>2.1.i.2 Development of a tool to assess laboratory capacity for antimicrobial residue testing in relation to food and agriculture.</p> <p>2.1.i.3 Number of laboratory trainings and/or resources (e.g. guidelines, protocols laboratory information management systems) on antimicrobial susceptibility or residue testing supported by FAO.</p>
Output 2.2 Surveillance, monitoring and research for AMR, AMU and antimicrobial residues is supported	<p>2.2.i.1. Number of national AMR surveillance systems for food and agriculture assessed using FAO-ATLASS.</p> <p>2.2.i.2 Number of countries benefitting from FAO support in the development and the implementation of their national AMR and/or AMU surveillance systems and frameworks.</p> <p>2.2.i.3 Number of research activities related to AMR/AMU surveillance and monitoring (e.g. scientific articles, expert meetings, technical reports) to which FAO has contributed.</p>
Output 2.3 Epidemiology resources and capacities are developed	<p>2.3.i.1. Development of the FAO AMR/AMU food and agriculture data platform to support Members' progress on AMR and AMU monitoring activities.</p> <p>2.3.i.2. Number of epidemiology trainings and resources (e.g. workshops, protocols) for AMR and AMU data management and analysis supported by FAO.</p>

Outcome 3: Good practices to minimize the incidence of infections and spread of AMR are adopted by food and agriculture stakeholders	
OUTPUTS	Output indicators
Output 3.1 Guidance for implementation of good infection prevention and control of AMR is made accessible	<p>3.1.i.1 Number of resources produced (e.g. repository guidance materials, e-learning courses) by FAO for promotion of good practices related to infection prevention and control of AMR in food and agriculture.</p> <p>3.1.i.2 Number of countries for which FAO supports capacity development to promote good practices for infection prevention and control of AMR as determined by International Standards (CAC, IPPC) in food and agriculture.</p>
Output 3.2 Interventions effectively promoting good infection prevention and control practices are developed and implemented	<p>3.2.i.1 Number of countries in which FAO provides support for integration of AMR considerations in national programmes for the health of terrestrial and aquatic animals and plants.</p> <p>3.2.i.2 Number of trainings delivered with the support of FAO to professionals (e.g. veterinarians, government officials, farmers) for the promotion of good infection prevention and control practices for AMR.</p>

	3.2.i.3 Number of studies (e.g. knowledge, attitudes and practices surveys, behavioural diagnostics) carried out with the support of FAO building knowledge on effective pilots and techniques for behaviour change and uptake of good practices.
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Outcome 4: Antimicrobials are used responsibly by food and agriculture stakeholders

OUTPUTS	Output indicators
Output 4.1 Guidance and resources for responsible AMU are developed and shared	4.1.i.1 Number of resources produced with FAO support promoting prudent AMU (e.g. repository, voluntary guidelines, e-learning courses). 4.1.i.2 Number of countries for which FAO supports capacity development to promote prudent AMU as determined by relevant International Standards.
Output 4.2 Initiatives for enabling responsible AMU are developed and implemented	4.2.i.1 Number of initiatives (e.g. meetings, workshops) contributing to the establishment of networks or communities of practice for antimicrobial stewardship facilitated through FAO support. 4.2.i.2 Number of practical trainings in the implementation of voluntary guidelines and international standards for responsible AMU supported by FAO. 4.2.i.3 Number of studies conducted with FAO's support to understand levels of adoption of prudent AMU and antimicrobial value chains in animal and plant health.

Outcome 5: Strengthened governance and resource allocation for sustainable AMR mitigation in food and agriculture

OUTPUTS	Output indicators
Output 5.1 Policies and regulatory frameworks for AMR containment are supported	5.1.i.1 Number of i) countries; and ii) regional/sub-regional organizations in which FAO has provided support to strengthen policies and institutional frameworks for NAP implementation (e.g. government-initiated follow-up meetings on formulation and implementing of policy recommendations, action plans and strategies, coordination activities). 5.1.i.2 Number of i) countries; and ii) regional/sub-regional organizations with legal frameworks assessed and recommendations for legal reform formulated using FAO tools, and/or taking into consideration the relevant international standards and good practices. 5.1.i.3 Number of i) countries; and ii) regional/sub-regional organizations supported to initiate a discussion on the phasing out, regulation or restriction of antimicrobials for growth promotion.
Output 5.2 Research on innovation and incentives in food	5.2.i.1 Number of case studies or economic impact assessments of the application of good practices and optimization of AMU supported by FAO.

and agriculture is supported	<p>5.2.i.2 Number of interventions supported by FAO to generate evidence on the economic incentives.</p> <p>5.2.i.3 Partnerships established on research and development (e.g. point of care diagnostics, alternatives to antimicrobials).</p>
<p>Output 5.3 Partnerships and multi-sectoral collaborations are implemented and supported</p>	<p>5.3.i.1 Number of initiatives (e.g. networks, regional frameworks, tripartite collaboration initiatives) supported by FAO to strengthen national, regional and global One Health collaboration in relation to AMR.</p> <p>5.3.i.2 Number of countries that have benefited from support by FAO to identify gaps and operationalize NAPs through the application of FAO tools (e.g. PMP-AMR, situation analysis of AMR risks).</p>

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Contact

E-mail: Antimicrobial-Resistance@fao.org

Web address: www.fao.org and www.fao.org/antimicrobial-resistance

Food and Agriculture Organization of the United Nations

Viale delle Terme di Caracalla
00153 Rome, Italy

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