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ICS 67.020**

**Integrated Monitoring and Surveillance of
Foodborne Antimicrobial Resistance — Guidelines**



BUREAU OF AGRICULTURE AND FISHERIES STANDARDS

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Integrated Monitoring and Surveillance of Foodborne Antimicrobial Resistance —
Guidelines
PNS/BAFS 408:2025
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Foreword

In the Philippines, Republic Act (RA) No. 10611 (Food Safety Act [FSA] of 2013) mandates the DA and the DOH to develop and set the standards for labeling and advertising (DA & DOH, 2015). Consonant with this, Section 9 (Setting of food safety standards) of the FSA of 2013 stipulated that DA and DOH shall endeavor to harmonize national standards with international standards and thus, adopt Codex standards, except when these conflict with what is necessary to protect consumers and scientific justification exists for the action taken (DA & DOH, 2015). Meanwhile, Section 12 (Bureau of Agriculture and Fisheries Standards [BAFS]) of the RA No. 100678 (Organic Agriculture Act of 2010), as amended by RA No. 11511 mandates the DA-BAFS to formulate and update standards relevant to organic agriculture.

In 2022, the Technical Working Group (TWG) for the development of various Philippine National Standards (PNS) under the General Food Standards category convened to review applicable Codex standards for potential adoption as PNS. Various sectors—including DA-National Meat Inspection Service (NMIS), DA-National Dairy Authority (NDA), DA-Philippine Center for Postharvest Development and Mechanization (PHilMech), University of the Philippines (UP) Diliman-Natural Sciences Research Institute (NSRI), and the Philippine Society for Microbiology (PSM), Inc.—identified CXG 94-2021 (Guidelines on Integrated Monitoring and Surveillance of Foodborne Antimicrobial Resistance) as a priority for adoption based on studies, research trends, and regulatory, trade, and market requirements in the Philippines.

In response, the DA-BAFS initiated the development of the Philippine National Standard (PNS) on the Integrated Monitoring and Surveillance of Foodborne Antimicrobial Resistance — Guidelines with the guidance of a TWG in 2025. The TWG was officially created under the following Special Orders (SO):

1. SO No. 745, series of 2025 (Composition of Technical Working Groups (TWG) and Project Management Team (PMT) for the Development of the Philippine National Standards (PNS) for Agricultural and Fishery Products and Machinery); and
2. SO No. 1752, series of 2025 (Amendment to Special Order (SO) No. 745, series of 2025 - [Recomposition of Technical Working Groups (TWG) and Project Management Team (PMT) for the Development of the Philippine National Standards (PNS) for Agricultural and Fishery Products and Machinery]).

The TWG was composed of representatives from the relevant government agencies, academe/research institutions, and Civil Society Organizations (CSO). The draft PNS underwent a series of TWG meetings and stakeholder consultations conducted via online platforms and in-person before its endorsement to the DA Secretary for approval.

This PNS is an adaptation of the relevant provisions from the following Codex documents:

- a) Guidelines on Integrated Monitoring and Surveillance of Foodborne Antimicrobial Resistance (CXG 94-2021); and

Any modifications from the original Codex document to consider the conditions in the Philippines are written in italicized text for distinction. This document was written in accordance with the formatting and editorial rules of the DA-BAFS-Standards Development Division (SDD) Standardization Guide No. 1 (Writing the PNS).

Introduction

Antimicrobial resistance (AMR) is a global public health threat at the human, animal, and environmental interface, which necessitates a “One Health” approach. Monitoring and surveillance of foodborne AMR contribute to the food safety component of such an approach.

For the purpose of these guidelines, monitoring refers to the collection and analysis of foodborne AMR, antimicrobial use (AMU), and related data and information. Surveillance is the systematic, continuous, or repeated measurement, collection, collation, validation, analysis, and interpretation of data and trends from defined populations to inform risk analysis. These data may enable the measurement of the impact of risk management measures.

Ideally, the integrated monitoring and surveillance program/s include the coordinated and systematic collection of data or samples at appropriate stages along the food chain and within the food production environment, and the testing, analysis, and reporting of data. The integrated program/s includes the alignment and harmonization of sampling, testing, analysis, and reporting methodologies and practices, as well as the integrated analysis of relevant epidemiological information from humans, animals, foods, plants/crops, and the food production environment.

National priorities, AMR food safety issues, scientific evidence, *research and development*, capabilities, and available resources should guide the development of integrated monitoring and surveillance program/s, which should undergo continuous improvement as resources permit. This does not imply that a country needs to implement both monitoring and surveillance in all stages or areas covered by the program/s

The data generated by integrated monitoring and surveillance program/s provide valuable information for the risk analysis (risk assessment, risk management, and risk communication) of foodborne AMR. These data may also be useful for trend analysis, epidemiological studies, food source attribution studies, and research.

While this document’s focus is on foodborne AMR, there is an implicit connection between the goal of addressing foodborne AMR with the goal of reducing foodborne illness, and thus a connection to the national food safety control system.

These guidelines are intended to assist *competent authorities* in the design and implementation of integrated monitoring and surveillance program/s. They provide flexible options for implementation and expansion, considering resources, infrastructures, capacity, and priorities of countries. Each monitoring and surveillance programme should be designed to be relevant for national, and when appropriate, regional circumstances. While these guidelines are primarily aimed at action at the national level, countries may also consider creating or contributing to international, multinational, or regional monitoring and surveillance program/s to share laboratories, data management, and other necessary resources.

The design and implementation of monitoring and surveillance program/s should be assessed or re-assessed based on their relevance to foodborne AMR priorities at the national and, when appropriate, at the international level. Continuous improvement of the monitoring and surveillance program/s should take into account identified priorities and broader capacity issues. Continuous improvement may include: collecting more information or having new sources of data on AMU and AMR in humans, animals, and/or plants/crops, availability of food consumption, agriculture, and aquaculture production data, and improvement in cross-sector laboratory proficiency and quality assurance, and reporting.

Data generated from national monitoring and surveillance program/s on AMR in food should not be used to generate unjustified trade barriers.

These guidelines should be applied in conjunction with the *latest edition of the following documents*:

- a. *PNS/BAFS 368-2024 (Risk Analysis of Foodborne Antimicrobial Resistance — Guidelines)*;
- b. CXG 77-2011 rev. (2021) (Guidelines for Risk Analysis of Foodborne Antimicrobial Resistance); and
- c. CXC 61-2005. amd. (2021) (Code of Practice to Minimize and Contain Foodborne Antimicrobial Resistance)
- d. *Philippine National Action Plan on Antimicrobial Resistance (PNAP-AMR) (2024-2028)*

Design and implementation aspects of these Guidelines should also take into account *the latest edition of the following documents*:

- a. *PNS/BAFS 293:2020 (Principles and Guidelines for the National Food Control System)*;
- b. CXG 82-2013 (Principles and Guidelines for National Food Control Systems); and
- c. CXG 50-2004 rev. (2023) (General Guidelines on Sampling)

Where appropriate, the standards of other international standard-setting organizations, including the standards of the World Organization for Animal Health (WOAH) *Terrestrial Animal Health Code and Aquatic Animal Health Code*, and *FAO Regional Guidelines for the Monitoring and Surveillance of Antimicrobial Resistance, Use and Residues in Food and Agriculture*, should be considered. These guidelines may also be used, taking into consideration guidance already developed by other advisory bodies, including the World Health Organization (WHO) Advisory Group on Integrated Surveillance of AMR (WHO-AGISAR). *Integrated Surveillance of Antimicrobial Resistance in Foodborne Bacteria: Application of a One Health approach*

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1 Scope

These guidelines cover the design and implementation of integrated monitoring and surveillance program/s for foodborne antimicrobial resistance (AMR) and antimicrobial use (AMU) along the food chain and the food production environment.

This document does not cover the design and implementation of monitoring and surveillance of AMR and AMU in humans. However, in the context of overall AMR risk management under the One Health approach, relevant data, trends, methodologies, and epidemiological information from the human health sector should be considered in the development of integrated programs.

The microorganisms covered by these guidelines are foodborne pathogens of public health relevance and indicator bacteria. Antimicrobials used as biocides, including disinfectants, are excluded from the scope of these guidelines.

These guidelines were adopted from CXG 94-2021 (Guidelines on Integrated Monitoring and Surveillance of Foodborne Antimicrobial Resistance) with some modifications to consider the conditions in the Philippines.

2 Normative Reference

The document below is referred to in the text in such a way that some or all of its contents constitute the requirements of this Guideline. The latest edition of the referenced document (including any amendments) applies.

Codex Alimentarius Commission (CAC). (2021) Guidelines on Integrated Monitoring and Surveillance of Foodborne Antimicrobial Resistance (CXG 94-2021). <https://www.fao.org/fao-whocodexalimentarius/>

3 Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 adverse health effect

an undesirable or unwanted outcome in humans. In this document, this refers to the human infections caused by AMR microorganisms and determinants in food or acquired from food of animal/crop origin, as well as increased frequency of infections and treatment failures, loss of treatment

options, and increased severity of infections manifested by prolonged duration of disease, increased hospitalization, and mortality (BAFS-DA, 2024)

3.2

antimicrobial agent

any substance of natural, semi-synthetic, or synthetic origin that at in vivo concentrations kills or inhibits the growth of microorganisms by interacting with a specific target (CAC, 2021c)

3.3

antimicrobial class

antimicrobial agents with related *chemical* structures, often with a similar mode of action because of interaction with a similar target, and thus subject to similar mechanisms of resistance. Variations in the properties of antimicrobial agents within a class often arise as a result of the presence of different molecular substitutions, which confer various intrinsic activities or various patterns of pharmacokinetic and pharmacodynamic properties (BAFS-DA, 2024)

3.4

antimicrobial resistance (AMR)

the ability of a microorganism to multiply or persist in the presence of an increased level of an antimicrobial agent relative to the susceptible counterpart of the same species (CAC, 2021c)

3.5

Antimicrobial Susceptibility Testing (AST)

a process used to determine how effective an antibiotic is against a specific bacterial strain. It uses standardized methods (e.g., disk diffusion or tube dilution) to measure bacterial sensitivity or resistance to antimicrobial agents (Padhan & Pattnaik, 2022).

3.6

antimicrobial use (AMU)

antimicrobials intended for use as it relates to sales, prescriptions/orders, manufacturing, imports and exports, information on actual administration or application, or any combination of these antimicrobials used for food-producing animals or plants/crops (CAC, 2021c)

3.7

clinical breakpoints

are part of a system of categorizing microorganisms as susceptible (S and I) and resistant (R) to agents approved for use in the treatment of infectious diseases (EUCAST, 2025)

3.8**cross-resistance**

ability of a microorganism to multiply or persist in the presence of other members of a particular class of antimicrobial agents or across different classes due to a shared mechanism of resistance (BAFS-DA, 2024)

3.9**epidemiological cut-off value (ECOFF)**

for a given microbial species and antimicrobial agent, the epidemiological cut-off value (ECOFF) is the highest MIC for organisms devoid of phenotypically detectable, acquired resistance mechanisms. It defines the upper end of the wild-type MIC distribution and is typically written as X mg/L, while the wild type is written as $\leq X$ mg/L and the non-wild type as $> X$ mg/L (EUCAST, 2021)

3.10**food chain**

the production-to-consumption continuum includes primary production (food-producing animals, plants/crops, feed), harvest/slaughter, packing, processing, storage, transport, and retail distribution to the point of consumption (CAC, 2021c)

3.11**foodborne pathogen**

a microorganism present in food which may cause human disease/s or illness (CAC, 2021c, *modified*)

Note to entry: Disease or illness happens when people consume food contaminated either with the microorganism itself or with biological substance/s it produces.

3.12**food-producing animals**

animals raised for the purpose of providing food to humans (CAC, 2021a)

3.13**food production environment**

The immediate vicinity of the food chain where there is relevant evidence that it could contribute to foodborne AMR (CAC, 2021c)

3.14**hazard**

for the purpose of these guidelines, the term “hazard” refers to antimicrobial-resistant microorganism(s) and/or resistance determinant(s)

(CAC, 2021c)

3.15

indicator of AMU

a metric that combines a numerator with a denominator to contextualize the quantities of antimicrobial agents measured (CAC, 2021c)

3.15.1

unit of measurement

a metric that expresses the quantities of antimicrobial agents (i.e., the numerator) (CAC, 2021c)

3.16

integrated monitoring and surveillance

refers to the coordinated and systematic collection of data or samples across appropriate stages along the food chain and within the food production environment, followed by testing, analysis, and reporting. It includes the alignment and harmonization of sampling, testing, analysis and reporting methodologies and practices, as well as the integrated analysis of relevant epidemiological information from humans, animals, foods, plants/crops, and the food production environment (CAC, 2021c)

3.17

interpretive criteria

these are specific values, such as minimal inhibitory concentrations (MICs) or inhibition zone diameters, based on which bacteria can be assigned to categories of either 'susceptible', 'intermediate,' or 'resistant' (CAC, 2021b)

3.18

marketing authorization/s

process of reviewing and assessing a dossier to support an antimicrobial agent to determine whether to permit its marketing (also called licensing, registration, approval, etc.), finalized by granting of a document also called marketing authorization (CAC, 2021a)

admitted term: product licensing

3.19

Minimum Inhibitory Concentration (MIC)

lowest concentration of an antimicrobial required to inhibit the growth of a microbial population after incubation (Khan et al., 2024)

3.20

monitoring

refers to the collection and analysis of foodborne AMR, antimicrobial use (AMU), and related data and information (CAC, 2021c)

3.21**One Health approach**

a collaborative, multisectoral and trans-disciplinary approach working with the goal of achieving optimal health outcomes, recognizing the interconnection between humans, animals, plants and their shared environment (CAC, 2021c)

3.22**pathogen**

a microorganism that can cause infection, illness, or disease (CAC, 2021b)

3.23**plants/crops**

a plant or crop that is cultivated or harvested as food or feed (CAC, 2021c)

3.24**Risk Management Option (RMO)**

a specific action that could be implemented to mitigate risk at various control points throughout the food production to consumption continuum (CAC, 2021b)

3.25**surveillance**

the systematic, continuous, or repeated measurement, collection, collation, validation, analysis, and interpretation of data and trends from defined populations to inform risk analysis (CAC, 2021c)

4 Principles

Monitoring and surveillance of foodborne AMR should be comprehensive and guided by a coordinated approach among interested parties. Below are the key principles that guide efforts to mitigate the spread of foodborne AMR:

- 4.1** Principle 1: A One Health approach should be applied whenever possible and applicable when establishing monitoring and surveillance programs for foodborne AMR, contributing to the food safety component of such an approach.
- 4.2** Principle 2: Monitoring and surveillance program/s *should be* an important part of national strategies to minimize and contain the risk of foodborne AMR.
- 4.3** Principle 3: Risk analysis should guide the design, implementation, and

evaluation of monitoring and surveillance program/s.

- 4.4** Principle 4: Monitoring and surveillance program/s should be designed to generate data on AMR and AMU in relevant sectors to inform risk analysis.
- 4.5** Principle 5: Monitoring and surveillance program/s should be tailored to national priorities and should be designed and implemented to allow continuous improvement as resources permit. *Such continuous improvement should be guided by research and development (R&D) initiatives and evidence-based studies to ensure that monitoring and surveillance remain science-based, adaptive, and aligned with the Philippine National Action Plan on AMR and the national research agenda on AMR.*
- 4.6** Principle 6: Priority for implementation of monitoring and surveillance program/s should be given to the most relevant foodborne AMR and/or AMR food safety issues (which are the defined combinations of the food commodity, the AMR microorganism and determinants and the antimicrobial agent(s) to which resistance is expressed as described in the Guidelines for Risk Analysis of Foodborne Antimicrobial Resistance (CXG 77-2011) and *Risk Analysis of Foodborne Antimicrobial Resistance — Guidelines (PNS/BAFS 386:2024)* from a public health perspective, taking into account national priorities.
- 4.7** Principle 7: Monitoring and surveillance program/s should incorporate, to the extent practicable, the identification of new and emerging foodborne AMR or trends and should be designed to inform epidemiological investigation.
- 4.8** Principle 8: Laboratories involved in monitoring and surveillance should have quality assurance/management systems in place.
- 4.9** Principle 9: Monitoring and surveillance program/s should aim to harmonize laboratory methodology, data collection, analysis, and reporting across sectors according to national priorities and resources as part of an integrated approach. Use of internationally recognized, standardized, and validated methods and harmonized interpretive criteria, where available, contributes to the comparability of data, facilitates the multisectoral exchange and analysis of data, and enhances an integrated approach to data management, analysis, and interpretation.

5 Risk-Based Approach

- 5.1** For the purpose of these guidelines, a risk analysis approach—as described in the framework for foodborne AMR risk analysis (CXG 77-2011) and *Risk Analysis of Foodborne Antimicrobial Resistance — Guidelines (PNS/BAFS*

386:2024) *should* inform the development, implementation and evaluation of monitoring and surveillance program/s with data and scientific knowledge regarding the likely occurrence of foodborne AMR hazards along the food chain and their potential to pose risks to human health.

- 5.2 Monitoring and surveillance program/s *should provide* information for risk assessment *that, together with other* available data from other sources, may inform decisions on the appropriateness of control measures to minimize and contain foodborne AMR.
- 5.3 When information *on* foodborne AMR within a country is limited, monitoring and surveillance program/s *should* initially be designed *based on available* relevant data and/or scientific knowledge on AMR hazards and their potential to result in public health risks. AMR food safety issues *should* be identified *using* information *from various* sources, as described in the Guidelines for Risk Analysis of Foodborne Antimicrobial Resistance (CXG 77-2011) *and Risk Analysis of Foodborne Antimicrobial Resistance — Guidelines (PNS/BAFS 386:2024)*

6 Regulatory Framework, Policy, and Roles

- 6.1 Competent authorities *should* establish and maintain good governance for integrated monitoring and surveillance programs. As part of the *Philippine National Action Plan (PNAP)* for AMR, the competent authorities *should* be responsible for the monitoring and surveillance activities along the food chain, including the food production environment. They *should* ensure collaboration with *authorities responsible for* human health, animal health, plant/crop health, environment, and other relevant *stakeholders*.
- 6.2 Activities related to monitoring and surveillance program/s should involve a wide range of relevant stakeholders who may contribute to the development, implementation, and evaluation of integrated monitoring and surveillance.
- 6.3 Sharing of knowledge and monitoring and surveillance results with international organizations on a voluntary basis, should be encouraged since it may improve the global understanding of foodborne AMR and inform risk analysis.
- 6.4 Competent authorities *should identify a data repository and should* have access to all available relevant data sources in *the* country.

7 Key Considerations in the Implementation of an Integrated Monitoring and Surveillance Program/s for Foodborne AMR

7.1 Preliminary activities

7.1.1 Preliminary activities for implementation, *such as pilot studies, other R&D initiatives, and testing*, should be part of the framework for monitoring and surveillance program/s. They should be undertaken to provide valuable insights into the design of monitoring and surveillance program/s.

7.2 Establishing the monitoring and surveillance objectives

7.2.1 Competent authorities *shall* establish monitoring and surveillance objectives in *consultation with relevant stakeholders*. *This process shall* consider existing food safety programs, PNAP AMR, relevant data on AMR and antimicrobial use (AMU) , and *ongoing initiatives addressing* AMR across sectors, including human, animal, plant/crop, food, and the environment. Additionally, competent authorities *shall* identify and address challenges encountered in implementing monitoring and surveillance activities.

7.2.2 The following aspects should be considered:

- a. The primary reasons for data collection (e.g., to evaluate trends over time and space, to provide data useful for risk assessments, *and* to obtain baseline information).
- b. The representativeness of the data collection (e.g., randomized samples; systematic sampling).
- c. The setting of proposed timelines for sampling and reporting.
- d. A description of how and to whom the information will be reported and communicated.

7.2.3 Competent authorities should continuously improve monitoring and surveillance activities and progress according to the national objectives, priorities, infrastructure, technical capability, resources, and new scientific knowledge.

7.3 Considerations for prioritization

7.3.1 Competent authorities should consider the epidemiology and public health implications of foodborne AMR, AMU patterns, and available information on food production systems, distribution, consumption patterns, and exposure pathways in establishing monitoring and surveillance priorities.

7.3.2 Monitoring and surveillance priorities for microorganisms and resistance determinants, antimicrobial agents, and sample sources should be informed by national, regional, and international public health data and scientific knowledge where it exists.

7.3.3 Competent authorities should identify existing data sources and data gaps on foodborne AMR and AMU, including data required for risk analysis or

risk analysis results.

7.4 Infrastructure and resources

7.4.1 Once objectives and priorities have been established, competent authorities should determine the infrastructure, capacity, and resources required to meet the objectives.

7.4.2 The implementation of AMR monitoring and surveillance *should* proceed at a rate different from that of AMU monitoring and surveillance and vice versa. As both types of data benefit from a joint analysis, the components of the program/s *should be* aligned during development to allow for integrated analysis. The evolution of integrated monitoring and surveillance program/s *should not be required* to follow the order described in these guidelines strictly.

7.4.3 Competent authorities should consider where harmonization and standardization are required to meet monitoring and surveillance objectives as part of the initial planning. Competent authorities should also consider expanding and/or *integrating* monitoring and surveillance activities with other ongoing activities to optimize resources and efforts.

7.4.4 Competent authorities should also consider *coordinating* sampling and laboratory testing, *collaborating* with relevant stakeholders, and developing a plan for receiving, analyzing, reporting, and archiving data. A central repository facilitates data management and could improve the efficiency of data analysis.

8 Key Design Elements to be Established Before Initiating the Monitoring and Surveillance Activities

Designing the monitoring and surveillance program/s should consider the following elements:

8.1 AMR:

- a. the highest priority microorganisms, antimicrobial panels, and sample sources to target;
- b. points in the food chain and sampling frequency;
- c. representative sampling methods, sampling plans, laboratory analysis, and reporting protocols; and
- d. standardized and/or harmonized methodologies for sampling, testing, *data management*, and reporting.

8.2 AMU:

- a. antimicrobial distribution chains from manufacturing or import to end users, including sales/use data providers;
- b. Identification of the appropriate points of data collection and

stakeholders that can provide the data;

- c. a *validated* assessment of the need to establish a legal framework before initiating *the* collection and reporting of antimicrobial sales and use data in food-producing animals and plants/crops may be useful; and
- d. the collection of AMU data may be started on a voluntary basis in agreement with stakeholders who have these data.

- 8.3** Consideration should be given to additional information provided in the *World Organization for Animal Health (WOAH) Terrestrial Animal Health Code and Aquatic Animal Health Code, and FAO Regional Guidelines for the Monitoring and Surveillance of Antimicrobial Resistance, Use and Residues in Food and Agriculture*.

9 Components of Integrated Monitoring Surveillance Programs for AMR

This section is intended to provide an enabling framework that can be utilized to establish integrated monitoring and surveillance of foodborne AMR appropriate to the national situation, considering available resources.

- 9.1** Integrated monitoring and surveillance program/s for foodborne AMR should *at least* consider the following elements:

- a. sampling design;
- b. sampling plans;
- c. sample sources;
- d. target microorganisms and resistance determinants;
- e. antimicrobials to be tested;
- f. laboratory testing methodologies and quality assurance systems;
and
- g. data management activities.

- 9.2** The initial scope and design of the monitoring and surveillance program/s for AMR should consider previous research or surveillance findings, national priorities, *and* national and/or international experience and agreed recommendations. As the AMR program develops, the scope and design may be adjusted based on one or more of the following factors:

- a. monitoring and surveillance findings;
- b. epidemiology of antimicrobial-resistant microorganisms as available;
- c. risk profile and risk assessment findings; and
- d. evaluation of the integrated monitoring and surveillance program/s.

10 Sampling Design

10.1 The design of monitoring and surveillance for AMR programs *should* build on or integrate with existing programs, or *should* involve the development of new infrastructures and activities specifically to collect foodborne AMR data.

10.2 If data are collected through existing programs designed for another purpose, this *shall* be specified, and the methodologies, data limitations, and data interpretation *shall* be described.

10.3 The sampling design should consider *the* temporal and geographical coverage of data collection. Once a sampling design is established, consistency in sample types and methodology is desirable to achieve long-term comparability and accurate interpretation of results, especially when new *methods* are added and the program is adjusted.

10.4 Sampling plan

10.4.1 The sampling plan should describe the following:

- a. The procedure to collect a sample from the selected sample source(s) at the selected point(s) in the food chain.
- b. Sample size, statistical methods, and underlying assumptions (e.g. representativeness, frequency of recovery, the initial or expected prevalence of AMR in that microorganism, and the size of the population to be monitored) of the data used to calculate the number of samples and isolates.
- c. Statistical power, precision, and objectives of testing.
- d. Strengths and limitations that affect data interpretation.

10.4.2 The following elements should be considered in the sampling plan:

- a. Whether the sampling strategy is active (i.e., designed for AMR surveillance) or passive (i.e., using a system already in place).
- b. Target animal or plant/crop species, food commodities or food production environment.
- c. Point(s) in the food chain where the samples will be taken and the sample type.
- d. Strata (levels) or risk clusters (groups) to best meet surveillance objectives.
- e. Target microorganisms, resistance phenotypes, and resistance determinants.
- f. Frequency of sampling.
- g. Prevalence and seasonality of the microorganisms under study, if known.
- h. Standard operating procedures for sample collection:

- i. who should collect the samples;
 - ii. procedures for *the* collection of samples in accordance with the defined sampling strategy and to guarantee that traceability, biosecurity, and quality assurance are maintained from collection through to analysis and storage; and
 - iii. procedures for the *transport and storage* of the samples in order to maintain sample integrity for testing.
- i. Opportunities to collect *relevant* metadata if available.

10.4.3 The sampling plan's initial implementation *should* include a limited selection of sample sources at one or more specific points along the food chain.

10.4.4 As the program develops and implementation advances according to priorities and resources, the sample sources within the sampling plan should be broadened. This may include additional animal, plant, *or* crop species, production types, food commodities, or stages in the food chain to gradually be more representative of the populations of interest.

10.5 Sampling sources

10.5.1 The major direct and scientifically relevant indirect food exposure pathways should be considered when identifying sample sources to be included in the monitoring and surveillance program.

10.5.2 The selection of samples should reflect the population's production and consumption patterns and the likely prevalence of foodborne AMR. The prevalence of the bacterial species should be considered to maximize the likelihood of detection.

10.5.3 The integrated program/s should reflect food production in the country and cover samples from relevant stages of the food chain where there is science-based evidence that they could contribute to foodborne AMR. For integration, samples should be collected from the same species at different but relevant points along the food chain. Samples should be, to the greatest extent possible, representative of the target animals and plants/crop species and the epidemiological unit being targeted. Possible sample sources are:

10.5.3.1 Food-producing animals

10.5.3.1.1 Samples taken from healthy animals *shall* be collected on-farm and at slaughter, *whichever is applicable*. Collection of samples from animals not immediately entering the food chain *should* provide additional information on foodborne AMR at the population level, but *should* be a lower priority than those animals directly entering the food supply.

- 10.5.3.1.2** Samples *should* include feces, feed, water, or other relevant food production inputs at the farm level.
- 10.5.3.1.3** Sample *types* described in the *WOAH* Terrestrial Animal Health Code and Aquatic Animal Health Code *should be considered*, specifically the chapters on Harmonization of National Antimicrobial Resistance Surveillance and Monitoring programs and the Development and Harmonization of National Antimicrobial Resistance Surveillance and Monitoring programs for Aquatic Animals.
- 10.5.3.1.4** During slaughter, samples *should* include carcass swabs, caecal contents or lymph nodes. In some animal species, caecal contents or lymph nodes may be representative of the pre-slaughter environment and *should* provide an estimate of AMR arising at the farm level. Samples collected after slaughter (e.g., carcass) may provide an estimate of contamination arising from the slaughterhouse.
- 10.5.3.2 Food**
- 10.5.3.2.1** Food samples *should* be collected at processing plants, packaging plants, wholesale or retail, *where applicable*.
- 10.5.3.2.2** The place where the food samples are collected should reflect the production system in the country and the purchasing habits of the consumer (e.g., sampling open markets or chain stores).
- 10.5.3.2.3** At the retail level, food samples *should* include raw meat, fish or seafood, *milk and milk* products, other edible tissues, raw produce, and minimally processed food products. Food selection *should* be modified periodically in order to capture multiple commodities, seasonality, or where products have been identified as high risk.
- 10.5.3.3 Plant/crops**
- 10.5.3.3.1** The selection of plants/crops should be risk-based and/or guided by the relevant standard-setting bodies
- 10.5.3.3.2** Samples *should* be collected from farms, pre-harvest or post-harvest.
- 10.5.3.4 Food production environment**
- 10.5.3.4.1** The selection of samples from the food production environment should be risk-based and relevant to the food production system.
- 10.5.3.4.2** Samples may be collected from the immediate environment of food-producing animals and plants/crops, processing plants, wholesale facilities

or retail outlets, *where applicable* (e.g. soil, water, litter and bedding, organic fertilizers, sewage, and manure)

11 Target Microorganisms and Resistance Determinants

11.1 The target microorganisms and resistance determinants *shall* be selected based on their relevance to food safety and public health.

11.2 Bacterial species may include:

- a. Foodborne pathogens such as *Salmonella*, *Campylobacter*, or other foodborne pathogens, depending on national or regional epidemiology and risks.
- b. Indicator bacteria such as *Escherichia coli* and enterococci (e.g., *Enterococcus faecium* and *E. faecalis*), which can contaminate food and harbor transferable resistance genes.

11.3 Target microorganisms from aquatic animals and food of non-animal origin may be determined based on available scientific evidence and/or relevance to public health.

11.4 The selection of target microorganisms should consider the presence of high-priority AMR genes or mobile genetic elements and horizontal gene transfer in a given bacterial population.

11.5 Monitoring and surveillance program/s may begin with phenotypic susceptibility testing for AMR in representative foodborne pathogens and/or indicator bacteria. Options for expansion may include a broader range of foodborne pathogens, or indicator bacteria, testing for genetic determinants of resistance, virulence, and mobile genetic elements.

11.6 Bacterial isolates *should* be characterized to the species level, and, as feasible, molecular analysis of particular isolates that may present a public health concern should be undertaken.

12 The Panel of Antimicrobials for Susceptibility Testing

12.1 The panel of antimicrobials for phenotypic susceptibility testing should be harmonized within national monitoring and surveillance program/s to ensure continuity and comparability of data. Attempts should be made to use the same antimicrobial class representatives across sample sources, geographic regions, and over time.

12.2 The antimicrobials included in the panel should depend on the target bacteria, the clinical or epidemiological relevance of these antimicrobials, and should allow for the tracking of isolates with particular patterns of

resistance.

- 12.3** The antimicrobials included may take into account the classes and uses in the relevant animal and/or plant/crop production sectors, as well as their influence in the selection or co-selection of resistance. Antimicrobials that would give the best selection of cross-resistance profiling should be considered for inclusion in the panel. Other antimicrobials that have the potential for co-selection of resistance due to gene linkage may also be included, even if they are not used in animal and/or plant/crop production sectors.
- 12.4** Antimicrobials to be tested may be prioritized based on their higher priority ranking for human health, the national context, and/or their influence on the selection or co-selection of resistance.

13 Concentration Ranges of Antimicrobials

- 13.1** The concentration ranges used should ensure that both ECOFFs and clinical breakpoints, when available, are included to allow for the comparability of results with human data. The concentration range of each antimicrobial agent should also cover the full range of allowable results for the quality control strain(s) used for each antimicrobial agent.

14 Molecular Testing

- 14.1** Whenever possible, molecular testing should be conducted for the detection and characterization of resistance determinants and for epidemiological analysis according to country-specific scenarios and resources.
- 14.2** Molecular testing may be useful in addressing or confirming inconclusive phenotypic results and may be used for the detection of resistant microorganisms of high public health importance.
- 14.3** Molecular characterization may be used for the rapid identification of resistance clusters and during outbreak investigations.
- 14.4** Molecular characterization in conjunction with epidemiological information informs the determination of source and transmission chains, the detection of emergence and investigation of the spread of new resistant strains or resistance determinants, and source attribution by linking to molecular monitoring of pathogens or resistant microorganisms or resistance determinants across sectors.
- 14.5** Sequence data generated and stored with appropriate metadata may be

used for retrospective and prospective surveillance.

- 14.6** Molecular methods may allow for the integration of resistance data with other relevant public health data (e.g., virulence determinants, AMR determinants).

15 Laboratories

- 15.1** Laboratories participating in the monitoring and surveillance program/s should consider:

- a. Bacterial isolation, identification (to species and serotype level, where relevant), typing, and antimicrobial susceptibility testing (AST) using standardized and validated methods performed by trained personnel.
- b. *Having* quality assurance/management systems in place, or accreditation in accordance with national or international guidance.
- c. Participating in external quality *assessment, such as* proficiency testing in identification, typing, and AST of the microorganisms included in the monitoring and surveillance program/s.
- d. Being equipped with facilities and having procedures to maintain sample integrity, including appropriate storage temperatures and records that track the time between sample reception and analysis, and ensure traceability.
- e. Storing isolates and reference strains using methods that ensure viability and absence of change in the characteristics and purity of the strain.
- f. *Having* access to a national reference laboratory or an international laboratory that can provide technical assistance if necessary and carry out molecular characterization.

16 Methods and Interpretive Criteria

- 16.1** *AST* methods that are standardized and validated by the national or internationally recognized organizations should be used where available. *The adopted method shall be verified by the laboratory.*
- 16.2** Quality control strains of bacteria should be included and used according to international standards, where available, to support validation of results and data harmonization.
- 16.3** Interpretation of results for minimum inhibitory concentration (MICs) or disk diffusion should be undertaken consistently according to European Committee on Antimicrobial Susceptibility Testing (EUCAST) tables or the

Clinical and Laboratory Standards Institute (CLSI) standards, and should include quantitative results (i.e., inhibition zone diameters including the disk content or MIC values). When neither tables nor standards are available, program-specific interpretive criteria or categories may be used.

- 16.4** Categorization of the isolate and reporting of results may be undertaken based on the epidemiological cut-off values (ECOFFs), which should be reported as wild type, non-wild type, or by clinical breakpoint, which should be reported according to the interpretive category. The use of ECOFFs as interpretive criteria will allow for optimum sensitivity for the detection of acquired resistance, temporal analysis of trends, and comparability between isolates from different origins. Clinical breakpoints may differ between animal species and countries or regions. The interpretive criteria or category used should be included in the analysis and reporting of the data.
- 16.5** Raw quantitative data should be maintained to allow comparability of results, for early recognition of emerging AMR or reduced susceptibility in order to maximize the ability to analyze and compare results across sample sources.
- 16.6** Quantitative results are necessary for the analysis of resistance patterns over time and when retrospective data analysis is needed due to changes in clinical breakpoints or ECOFFs. Quantitative results are necessary for quantitative microbiological risk assessment.

17 Collection and Reporting of Resistance Data

- 17.1** The information collected and recorded may differ depending on the stage of sampling along the food chain, sampling design, and the specific monitoring and surveillance objectives. Sampling information should be recorded at the isolate and sample level to ensure consistency.
- 17.2** Information for each individual sample should include:
- a. reference to the general description of the sampling design and plan;
 - b. specific information about the origin of the sample, such as from what, where, and when the sample was collected;
 - c. general information to identify the isolate, bacterial species, serotype, other subtyping information as appropriate; and
 - d. specific information about the isolation of the bacteria and the AST (e.g., date of testing, method used, quantitative results). The interpretive criteria *of both qualitative and quantitative results* should be recorded.

- 17.3** Reporting of results from the monitoring and surveillance program/s should be timely.
- 17.4** Sample sources, analytical methods, AST methods, and interpretive criteria should be clearly described, and differences transparently explained to show where data may not be directly comparable.
- 18** **Components of Integrated Monitoring and Surveillance Program/s for AMU**
- This section is intended to provide an enabling framework that countries can utilize to establish monitoring and surveillance of AMU appropriate to their national situation, and which includes considerations of available resources. As such, monitoring and surveillance activities and the data collection may vary between countries.
- 18.1** For the monitoring and surveillance of AMU, including sources of data and the collection and reporting of AMU data in food-producing animals, the *WOAH's* Terrestrial Animal Health Code and Aquatic Animal Health Code should be considered.
- 19** **Design of an Integrated Monitoring and Surveillance Program/s for Antimicrobial Agents Intended for Use in Food-Producing Animals or Plants/Crops**
- 19.1** *Competent authorities should* collect different data types, *whether* sales and/or use, according to their monitoring and surveillance objectives. For example, antimicrobial sales data collection may evolve into antimicrobial use data collection.
- 19.2** The competent authorities should consider the limitations of each data type. It shall *specify* aspects of data collection or reporting for sales versus other types of use data, as outlined below:
- 19.2.1** *Competent authorities should* consider AMU data, along with other relevant epidemiological data, in interpreting the results from the AMR monitoring and surveillance program/s.
- 19.2.2** Sales data may be used to monitor trends, although they do not always reflect the actual use, administration, or application of antimicrobials.
- 19.2.3** *Competent authorities should consider* collecting antimicrobial use data at the farm/primary producer level, as this can provide information on the magnitude of species-specific use and on how and why antimicrobials are being administered.

- 19.2.4** *Competent authorities should establish a choice of units of measurement and/or indicators for AMU based on the method and scope of the data collection and the monitoring and surveillance objectives.*
- 19.2.5** The following elements should be considered when deciding on the approach to collect sales and/or use data:
- a. Identification of the scope of the data to be captured (e.g., the antimicrobial agents, classes, or subclasses). The scope may also consider mechanisms of antimicrobial action, relevant resistance data, and reporting requirements.
 - b. Development of a protocol to collect qualitative (e.g., types of antimicrobials on farm) and/or quantitative information on the antimicrobials intended for use in food-producing animals or plants/crops.
 - c. Harmonization of the nomenclature of antimicrobial agents with international standards, where available.
 - d. Identification of the plant/crop type and/or species of food-producing animals for which the antimicrobials were intended to be used.
 - e. Identification of the level of detail required to meet the surveillance requirements (e.g., production type, route of administration, or reason for use).
 - f. Information on antimicrobial dose, dosing interval, and duration.
 - g. Technical units of measurement for reporting antimicrobial sales or use.

20 Sources of AMU Data

20.1 Sources of data may include:

- a. **Sales data:** may be collected from *competent authorities in charge of registration of pertinent products*, marketing authorization holders, wholesalers, veterinarians, retailers, pharmacies, feed mills, farm shops/agricultural suppliers, pharmaceutical associations, cooperatives, or industry trade associations, or any combination of these.
- b. **Import data:** may be collected from the competent authorities in charge of registration of medicinal *and other pertinent* products, the marketing authorization holder, or customs. Care must be taken to avoid double-counting with sales data in the country, and take into account that some imported antimicrobials may not be intended for use within the country.
- c. **Use data:** may be collected from farm/plant health professional records, livestock/plant production company records, or estimated

from veterinary prescriptions or farm surveys.

- 20.2** Data on quantities of antimicrobials sold or used within a country may differ. Differences may include loss during transport (package damage), storage (due expiry date), and administration (whole package not administered), stock purchased and held for future use, and fluctuations in animal or plant/crop populations.

21 Collection and Reporting of AMU

21.1 Collection of data

- 21.1.1** The numerator may be an expression qualitatively describing AMU (e.g., classes of antimicrobial agents) or may be the antimicrobial quantity representing the amount of antimicrobial agents sold or used in food-producing animals and/or plants/crops. The calculation of the numerator should consider the quantities of antimicrobial agents that may be reported in different units of measurement according to monitoring and surveillance objectives and the types of data collected.

- 21.1.2** To interpret and/or analyze the data, considerations for the numerator may include identification of the antimicrobial agent or product, the quantity of packages sold or used, and the strength per unit.

- 21.1.3** The denominator, when used, is the total food-producing animal population or plant/crop area or quantities harvested that may be exposed to the antimicrobials reported during the monitoring and surveillance period. Relevance to the food production systems in the country may be considered. The denominator may provide the context for reporting and analyzing the sales and/or use data.

- 21.1.4** Additional considerations for the denominator may include the characteristics of the population of food-producing animals or plants/crops treated with the relevant antimicrobial during the monitoring and surveillance period (e.g., species, type, number, body weight, age).

21.2 Reporting of data

- 21.2.1** Multiple units of measurement and/or indicators for reporting of sales and/or use may be appropriate depending on the national situation and the monitoring and surveillance objectives.

22 Integrated Analysis and Reporting of Results

22.1 Management of data

- 22.1.1** *The competent authorities, in collaboration with interested parties, should facilitate the management of data. Databases should be structured, and where feasible, centralized or coordinated to allow for the appropriate and easy extraction of data when required and to accommodate expansion as the integrated monitoring and surveillance program/s improve.*
- 22.1.2** A confidentiality and data management policy should be put in place *in accordance with the statutory and/or regulatory requirements on data privacy*. Data should be collected and stored to maintain data integrity and to protect the confidentiality of personal and proprietary information.
- 22.1.3** To facilitate the management of data, ongoing or regular validation of the data should be considered.
- 22.1.4** A description of the sampling design/s and sampling plan/s, such as stratification and randomization procedures, for food-producing animals, plants/crops, food production environment, or food categories, should be recorded to link data within and across monitoring and surveillance components.
- 22.2** **Analysis of results**
- 22.2.1** The data from the integrated monitoring and surveillance program/s may be analyzed as described in the CXG 77-2011 (Guidelines for Risk Analysis of Foodborne Antimicrobial Resistance) *and PNS/BAFS 386:2024 (Risk Analysis of Foodborne Antimicrobial Resistance-Guidelines)* for risk assessment purposes and to inform the development and implementation of risk management options and policies to drive responsible and prudent use of antimicrobials to address foodborne AMR.
- 22.2.2** Analysis of data from the integrated monitoring and surveillance program/s may include the assessment within or between sectors across the One Health spectrum, to evaluate temporal or geographical trends over time, across host species, across bacterial species, or antimicrobial classes. When available, other contextual information, such as epidemiological data, may be considered.
- 22.2.3** The detailed methodology and the epidemiological context of the monitoring and surveillance program/s should be considered for the analysis. Where data are available, exposure pathways among people, food-producing animals, plants/crops, and their shared environment connecting resident bacterial populations may be incorporated into the analysis.
- 22.2.4** Data may originate from different monitoring and surveillance program/s, so comparability is an important consideration. The choice of analytic

approaches, when possible, should allow the investigation of relationships between AMU and AMR within or across food-producing animals, plants/crops, and human populations, provided that AMR and AMU data are representative of the target population.

22.2.5 Integrated monitoring and surveillance of foodborne AMR should be harmonized, when possible, across these sectors to assist in the understanding of relationships between AMR and AMU, including other factors that may influence the emergence and spread of AMR.

22.2.6 AMR data from relevant human isolates may be considered for inclusion in the analysis and reporting based on information from significant foodborne pathogens according to national epidemiological information and, whenever possible, indicator flora.

22.2.7 Integration of data from surveillance of human clinical isolates should facilitate the ability to identify trends in resistance to specific antimicrobials important for use in human medicine, as well as to identify trends in the occurrence of resistance between humans, food-producing animals, plants/crops, and/or food.

22.2.8 Statistical analysis should be *performed* to ensure proper interpretation of results.

22.3 Reporting of results

22.3.1 Results of integrated monitoring and surveillance program/s should be reported regularly, where resources allow.

22.3.2 Whenever possible, reports on the integrated monitoring and surveillance program/s data across humans, animals, plants/crops, food, and the food production environment should be made publicly available.

22.3.3 Transparent and open communication for the reporting of the results between the competent authorities and the different stakeholders, including the public, should be considered.

23 Evaluation of the Integrated Monitoring and Surveillance Program/s

23.1 Competent authorities should develop a framework and plan to facilitate the evaluation and review of monitoring and/or surveillance activities, which may include the following:

- a. identify the skills needed by evaluators;
- b. describe the monitoring and surveillance program/s to be evaluated, including the objectives and desired outcomes. This

may involve a specific or single component of the entire program/s (e.g., sample collection, laboratories, analysis, and reporting);

- c. identify relevant stakeholders for the evaluation;
- d. identify key performance criteria to be evaluated;
- e. collect data to facilitate evaluation based on the key performance criteria;
- f. consider relevant stakeholder input/feedback;
- g. report results of evaluation;
- h. draw conclusions on components of the evaluation;
- i. identify or provide identification of relevant monitoring and surveillance program adjustments; and
- j. share evaluation outcomes with stakeholders.

23.2 Evaluation of the integrated monitoring and surveillance program/s *should* provide assurance that the data and information reported are robust and the program objectives are being met. The evaluation *should* also guide the best use of data collection resources.

23.3 Evaluation and review should be undertaken at a frequency appropriate to integrate evolving monitoring and surveillance methodologies, identification of new resistance patterns, new exposure pathways along the food chain, and changing patterns of AMU in humans, animals, and plants/crops, and to respond to changing national priorities.

23.4 *In cases where* the design of the monitoring and surveillance program/s changes or expands, adjustments should ensure that the program/s' ability to identify trends over time remains, that historical data are maintained, and that the program continues to meet the established objectives.

24 Training and Capacity-Building

24.1 Competent authorities *should* support training and capacity-building as key components of the integrated monitoring and surveillance program/s.

24.2 Competent authorities *should be trained on* different aspects of the monitoring and surveillance program/s (e.g., data collection, analysis, interpretation, and reporting).

24.3 Competent authorities *shall spearhead the* training of relevant stakeholders on the monitoring and surveillance program/s.

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**Department of Agriculture (DA)
Bureau of Agriculture and Fisheries Standards (BAFS)**

**Philippine National Standard (PNS) on Integrated Monitoring and Surveillance
of Foodborne Antimicrobial Resistance — Guidelines**

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