Antimicrobial Surveillance in Aquaculture Species

Surveillance Guidelines

Nelly Isyagi, Olufemi Adedeji and Christopher Agbo

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Table of Contents

Acknowledgements

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Name	Position	Organisation
Dr Amina Ndanusa	Animal Health Group Member	LMS
Dr Doose Nguhemen	Animal Health Group Member	LMS
Dr Muhammed Gidado	Animal Health Group Member	LMS
Blessing Stephen	Project Manager	DAI
Abraham Ahmadu		DAI
Emilia Ezenwa		DAI
Mr Pwaspo Istifanus	Deputy Director, Fisheries and Aquaculture	Federal Department of Fisheries, Abuja
Mr Hassan Madu Shettima	Principal Fisheries Officer	Federal Department of Fisheries, Abuja
Mr Mfon Dominic	Principal Fisheries Officer	Federal Department of Fisheries, Abuja
Dr Maimuna Habib	Director/ Chief Veterinary Officer	Federal Department of Veterinary and Pest Control Services (Abuja)
Dr Peter F. Umanah	Director/ Chief Veterinary Officer	Federal Department of Veterinary and Pest Control Services(Abuja)
Dr Mabel Aworh	Assistant Director/ Principal Veterinary Officer	Federal Department of Veterinary and Pest Control Services (Abuja)
Dr Zainab Abdulkareem	Senior Veterinary Officer 1	Federal Department of Veterinary and Pest Control Services (Abuja)
Dr George Uzuagu	Assistant Director/ Principal Veterinary Officer	Federal Department of Veterinary and Pest Control Services (Abuja)
AIG (Dr) Aishatu Abubakar	President, Veterinary Council of Nigeria	Veterinary Council of Nigeria (Abuja)
Dr Ibrahim Ado Shehu	President, Nigerian Veterinary Medical Association	Nigeria Veterinary Medical Association (Abuja)
Dr Olaniran Alabi	Director/ Chief Veterinary Officer of Nigeria (CVON)	Federal Department of Veterinary and Pest Control Services (Abuja)
Dr Toch Okwor	AMR IPC Coordinator	NCDC
Dr Abiodun Egwenu	AMR Programme Manager	NCDC
Dr. Rasheed Macaulay	Director	Department of Veterinary Services, Lagos State
Dr. Taiwo Jolaoso	Director	Department of Veterinary Services, Ogun State

Dr. Foluke Ibitoye	Director	Veterinary Service Oyo State
Mr. Fabian Chinedo Ogbonne	Director (Representative)	NIOMR (Lagos)
Dr. Charity Oche	Lecturer	Federal College of Fisheries and Marine Technology (Lagos)
Dr. L.A. Agbabiaka	President	Fisheries Society of Nigeria (Lagos)
Mr. Andre Damola Samuel	President (Representative)	Catfish Farmers Association (Lagos)
Mr. Olusegun Ajayi Fowowe	President (Representative)	Fish Farmers Association of Nigeria (Lagos)
Mr. Eze Augustine	Chief Microbiologist/ Lab Manager	Nigeria Fisheries Laboratories, Lagos
Dr. Adebowale		Animal Care Lab (Lagos)
Mr Yemi Okunlade,	Laboratory Scientist	Veterinary Public Health and Preventive Med. lab UI (Ibadan)
Dr. Yomi Adeseko	Field Veterinarian	Input Supplier/Feed Miller (Lagos)
Prof. Jacob Kwaga	Dean, Faculty of Veterinary Medicine	Faculty of Veterinary Medicine, ABU (Zaria)
Dr. Olajumoke Modupe Edun	Director of Mariculture	Nigeria Institute for Oceanography and Marine Research (Port Harcourt)
Mrs olanike Oladosu	Assistant Director, Fisheries and Aquaculture	Federal Department of Fisheries (Lagos)
Dr. Benedict Muyiwa	President, Nigerian Fish Veterinarian Forum	Nigeria Fish Vet Forum , (Abuja)
Mr Danung Bitrus Monday	Fish Farmer	Nigeria Fish Vet Forum , (Abuja)
Prof Adedeji O.B.	Dean, Faculty of Veterinary Medicine	University of Ibadan, Ibadan
Dr Bala (Abuja)	Animal Health Group Leader	LMS
Dr. Olatoye I.O. ,	Technical Leader	University of Ibadan
Dr. Modupeola Ogunnoiki	Assistant Director/ Principal Veterinary Officer, OIE Aquatic Animal Health Focal Point	Federal Department of Fisheries, Lagos
Dr Ndahi Mwapu	Assistant Director/ Principal Veterinary Officer, OIE AMR Focal Point	Federal Department of Veterinary and Pest Control Services (Abuja)
Dr Nelly Isyagi (Joining virtually)	Country Grant Consultant for Aquatic Animal Health	Tanzania
Akinpelu M.M. (Ibadan)	Faculty of Veterinary Medicine	University of Ibadan
Prof. Ogundipe G.A. T.	Professor of Veterinary Public Health and Preventive Medicine	University of Ibadan, Ibadan
Mrs Agbai		Ministry of Health
Mrs Rita Okea	Director	Ministry of Environment

List of Figures

List of Tables

Abbreviations and Acronyms

AMR	Antimicrobial Resistance
AMU	Antimicrobial Use
AMRCC	National Antimicrobial Resistance Coordinating Committee
ARGs	Antimicrobial Resistant Genes
AS	Antimicrobial Stewardship
AST	Antimicrobial Susceptibility Testing
AU-IBAR	The African Union Inter-African Bureau for Animal Resources
CLSI	Clinical and Laboratory Standards Institute
CVO	Chief Veterinary Officer
ECOFF	Epidemiological Cut-Off Value
FAO	Food and Agriculture Organization of the United Nations
FDMD	Fish Disease Management Department
FDVPCS	Federal Department of Veterinary and Pest Control Services
FMARD	Federal Ministry of Agriculture and Rural Development
FME	Federal Ministry of Environment
FMH	Federal Ministry of Health
NAFDAC	National Agency for Food and Drug Administration and Control
MDA	Ministries, Departments and Agencies
OIE	World Organization for Animal Health
OH	One Health
WHO	World Health Organization

Definition of Terms

Resistomes	The antibiotic resistance genes (ARGs); these include genes in both pathogenic and non-pathogenic antibiotic-producing bacteria and all other resistance genes.
Passive disease surveillance	Surveillance done based on records kept by stakeholders.
Active disease surveillance	Actively searching for information from respective target communities or aquaculture establishments
Risk	The likelihood of the occurrence, as well as the likely magnitude of the biological and economic consequences, of an adverse event on animal or human health.
Risk analysis	A process comprising hazard identification, risk assessment, risk management and risk communication.
Risk assessment	An evaluation of the likelihood and the biological and economic consequences of the entry, establishment, and spread of a hazard within the territory of an importing country.
Risk communication	The interactive transmission and exchange of information and opinions throughout the risk analysis process concerning risk, risk-related factors and risk perceptions among risk assessors, risk managers, risk communicators, the public and other interested parties.
Risk estimation	The process of integrating the results from the entry assessment, exposure assessment, and consequence assessment to produce overall measures of risks associated with the hazards identified at the outset
Risk evaluation	The process of comparing the risk estimated in the risk assessment with the Member's appropriate level of protection.
Risk management	The process of identifying, selecting, and implementing measures that can be applied to reduce the level of risk
Reservoir	Living elements that harbour and can transmit resistomes or organisms harbouring ARGs to fish, humans, or the environment
Hotspot	The geographical location where resistomes and microbiomes accumulate or feature

Executive Summary

A country situation analysis of the status of antimicrobial resistance (AMR) by the Nigeria Centre for Disease Control (NCDC) revealed that AMR was broad, highly prevalent, and represents a health risk to humans, livestock, and the environment. Of great concern was the fact that similar antimicrobials were used to treat diseases caused by similar pathogens in both humans and animals, aquaculture notwithstanding. Unfortunately, there was limited data upon which the actual status of AMR could be determined and informed decisions for the control of foodborne AMR based upon.

The Nigerian National Action Plan against AMR (NAP) recommended surveillance as one of the major tools for the monitoring and control of AMR status, the development of evidence-based interventions, and the assessment of the impacts of interventions. The effectiveness of AMR surveillance in aquaculture depends on the extent to which each stakeholder records and shares data on antimicrobial use (AMU)/AMR, given their respective roles. Thus, a population-based aquaculture surveillance mechanism was proposed to facilitate monitoring, decision-making and reporting to reduce the likelihood of exposure of aquatic animal production systems to antimicrobials that could result in AMR among aquatic animals, reduce the AMR risks for humans arising from the usage of antimicrobial agents in aquatic animals, generate validated information to inform policy and practice, and to raise awareness among stakeholders and the public to promote antimicrobial stewardship for the benefit of the industry and society.

This document proposes a surveillance mechanism based on findings from the aquaculture situation analysis and stakeholder analysis adapted to international guidelines on the combat AMR in aquaculture. It outlines the surveillance approaches, stakeholder roles, reporting framework, sampling approach, data collection and management, risk analysis approaches, and surveillance operational requirements.

1.0 Background

The growing prevalence of antimicrobial resistance (AMR) and its implications for food safety, human health, animal health and the health ecosystem have become a global concern[9,29]. A country situation analysis on the status of AMR by the Nigeria Centre for Disease Control (NCDC) revealed that AMR was broad and highly prevalent and presented a health risk for humans, livestock, and the environment[24]. Of great concern was the fact that similar antimicrobials were used to treat diseases caused by similar pathogens in both humans and animals. Unfortunately, there was limited data upon which the actual status of AMR could be determined and informed decisions for the control of foodborne AMR made. This warranted in-depth assessments on the status of antimicrobial use (AMU) and AMR in Nigeria's major animal food value chains, namely the aquaculture, dairy, and poultry value chains[24,25].

The findings from the aquaculture AMR situation analysis report reaffirmed the concerns of the NCDC's national AMR situation analysis report. AMU in the aquaculture chain was found to be largely driven by economic gains and indiscriminate/extra-label use of antimicrobials as fish farmers attempted to prevent and offset losses arising from fish stress, disease and the use of sub-standard feeds. Fish farmers, processors and traders used antimicrobials as prophylaxis, to promote growth, improve the resilience of fish to stress, prevent mortality during live fish transportation and to control the spread of disease. Fish farms and consumers were also at risk of acquiring AMR resistant pathogens and genes from environmental sources. Contaminated water sources, run-off entering fish farms from land establishments and effluent from fish, poultry and livestock farms were among the environmental risk factors. These, coupled with the status of institutional and stakeholder linkages, were found to confer the overall AMR risk for the various aquaculture production systems used in the country and consequently, for the safety of aquaculture products. Antimicrobial stewardship among stakeholders in the aquaculture sector was also found to be weak.

The Nigerian National Action Plan against AMR (NAP) was developed and adapted to the Global Action Plan against AMR (GAP) to address the spread of AMR, minimize the negative impacts of AMR for human health and to sustain the efficacy of antimicrobial treatments in both humans and animals[25,29]. The goals of NAP and GAP cannot be achieved without the collection and analysis of data to monitor trends in AMU and AMR. Hence, the World Health Organization (WHO) launched the Global Antimicrobial Resistance Surveillance System (GLASS) to harmonize the collection, analysis and sharing of AMR data globally[32]. The GAP and consequently GLASS and NAP, adopted the One Health as a holistic approach to address AMR because the determinants for AMR cut across the human-animal-environmental interface. The World Organization for Animal Health (OIE) and the Food and Agriculture Organization of the United Nations (FAO) have as a result developed standards and guidelines to harmonize approaches used by countries for the surveillance of AMR in aquatic animals in compliance with the GAP to facilitate the monitoring and control of AMU/AMR in animal food value chains [6,8,9].

1.1. Justification for Population-Based AMR Surveillance in Aquaculture

Nigerian aquaculture currently produces about 30% of the domestic fish supply. Current Government policy is to transform the aquaculture sector into the country's major source of fish and other aquatic animal products for domestic for human consumption and regional trade[5,12,14]. The findings from the aquaculture situation analysis showed that antimicrobials were widely used in the country's commercial aquaculture production systems. Findings from secondary literature on the status of aquaculture AMR in the country augured with the findings from the Aquaculture Country Situation Analysis and showed potential impacts for fish health, fish food safety and environmental health. Multiple stakeholders from the human, animal and environment sectors were found to have direct and indirect roles in aquaculture AMU/AMR. The actions and status of AMR awareness among farmers, veterinarians, fish processors and traders, extension workers, input suppliers, diagnostic laboratories, terrestrial farmers, and policymakers directly influenced the pathways of aquaculture AMR. The situation analysis also revealed that these stakeholders hardly kept up-to-date data on AMU/AMR. The true magnitude of AMU/AMR in the sector could therefore not be ascertained by the situation analysis.

The NAP and GAP recommend the establishment of AMR surveillance as a major tool for the systematic collection of data to support evidence-based decision making and guide stakeholders' actions for antimicrobial stewardship. The multiplicity of stakeholders involved in aquaculture AMU/AMR however, creates a complex situation for establishing an effective and robust surveillance systems unless there's collaboration and complementary of actions between the various stakeholders. The effectiveness of AMR surveillance in aquaculture depends on the extent to which each stakeholder systematically and continuously records and shares data on their AMU/AMR, given their respective roles. In such a case, a population-based aquaculture AMR surveillance system becomes an anchor for a robust, cost-effect and sustainable surveillance system because it fosters coherence and complementarity among stakeholders for data collection and reporting.

1.2. Goals and Objectives of Aquaculture AMR Surveillance

The purpose for establishing a population-based aquaculture surveillance mechanism is to:

(i) Facilitate the monitoring, decision-making and reporting to reduce the likelihood of exposure of aquatic animal production systems to antimicrobials that may promote AMR in aquatic animals.
(ii) Reduce AMR risks for humans arising from AMU in aquaculture.
(iii) Generate validated information to inform policy and practice.
(iv) Raise stakeholder and public awareness on the status and implications of AMR in order to promote antimicrobial stewardship for the benefit of the aquaculture industry and society.

To accomplish these objectives, the aquaculture AMR surveillance needs to generate data that can be used to [8,9,29,33]:

- quantify and assess the trends of AMU in the aquaculture value chain;
- identify and document levels of AMR in different reservoirs and hotspots in the aquaculture value chain and its environment;
- characterize and describe AMR transmission pathways and determinants of resistance in aquaculture;
- clarify the association between aquaculture AMU and AMR;

- assess the relative contribution of the different aquaculture AMR transmission pathways to estimate transmission risk and rank AMR hazards posed by the different transmission pathways to fish, humans, and the environment;
- generate hypotheses and identify appropriate interventions to contain the emergence and spread of resistant bacteria and evaluate their effectiveness;
- develop targeted epidemiological and microbiological research for source attribution studies to identify risk factors and clinical outcomes of infections caused by resistant bacteria;
- inform risk analysis of foodborne, environmental, and aquatic biosecurity antimicrobial resistance hazards arising from aquaculture;
- guide the development and implementation of evidence-based policies and guidelines for the control AMU and AMR in the One Health sectors; and
- raise public awareness on current and emerging AMR hazards to foster antimicrobial stewardship.

1.3. The Scope of this Document

This document proposes a surveillance mechanism based on findings from the situation analysis and stakeholder analysis, which it adapts to international guidelines on combating AMR in aquaculture. As such it outlines the following:

- Surveillance approach
- Stakeholder roles
- Reporting framework
- Sampling approach
- Data collection and management
- Risk analysis
- Operational requirements

2.0. The Surveillance System

2.1. The Surveillance Approach

The NAP, OIE Aquatic Code and FAO guidelines for controlling AMR in aquatic animals that include the 12-point checklist for aquatic disease surveillance have been adapted to the findings of the aquaculture situation and stakeholder analyses to develop the surveillance system described in Table 1 below. [4,6,78,25]

Table 1. Surveillance Approach

Steps	Description	Remarks	Key Stakeholders
1. Scenario setting	• Indiscriminate AMU in aquaculture • Inadequate diagnostic capacity • Growing research evidence of aquaculture AMR with implications for fish health, public health, and environment	This describes the national status at any material time based on the occurrence of aquatic animal disease, and status and biosecurity control of AMU and AMR. The current scenario has been defined based on the findings of the aquaculture AMR situation and stakeholder analyses. It is envisaged that as practices change, so would the national scenario.	• NCDC – AMR Technical Working Group • FMARD • Representative practitioners and veterinary input suppliers • Representatives of academia and research • Fish Farmers Association representatives
2. Surveillance objectives	• Monitor AMU in the aquaculture value chain. • Identify and monitor the entry points for antimicrobials into the aquaculture value chain. • Identify and monitor the AMR hotspots and transmission pathways in the aquaculture value chain — fish, humans, and the environment	The overall aim for undertaking aquaculture AMR surveillance is to control AMU and the spread of AMR and promote the judicious use of antimicrobials in the sector. The systematic and continuous collection of data from critical points in the aquaculture value chain and production environment will help monitor and control AMU/AMR entry points, hotspots and transmission pathways.	• NCDC – AMR Technical Working Group • FMARD (Fish Health Department) • NAFDAC • FME • Academia and research • FMH
3. Population of interest	• Fish farmers, processors, and traders • Live fish markets (especially for	The aquaculture situation analysis revealed that these were the primary stakeholders who	• FMARD • NAFDAC • FME

	table catfish) • Animal health diagnostic laboratories • Fish feed mills • Veterinary pharmaceutical outlets • Veterinarians/aquaculture extension • Poultry and dairy farmers	influenced the use and distribution of antimicrobials and AMR in the aquaculture value chain and environment. The population size will be estimated based on annual government statistics on these categories	• Fish farmers and farmers associations • Fish feed manufacturers • Farmed fish processors and traders • Animal health diagnostic laboratories • Veterinary input suppliers and pharmacies • Aquaculture extension • Veterinarians • Terrestrial farmers • Academia and research
4. Clustering of ppathogens, antimicrobials and AMR	• Name of pathogen • Antimicrobial resistant genes • Treatments used against presumed/confirmed pathogens	The control of AMR is centred on identifying the pathogens, restricting the access and use of antimicrobials for aquatic animals, identifying resistance to given antimicrobials, and identifying, profiling, and assessing the epidemiology of resistant genes associated with aquaculture. The description and assessment of these form a basis for aquaculture AMR risk analysis.	• NCDC – AMR Technical Working Group • FMARD • Animal health diagnostic laboratories • Academia and research • FME • FMH
5. Case definition	• Location of case • Value chain • Production system	This defines the location, production system and conditions under which disease was identified	• Fish farmers, processors, and traders • Veterinarians and aquaculture

	• Clinical reports • Treatments administered. • Laboratory isolates and AST results	and/or the need for the justified use of a specific antimicrobial at any point within the aquaculture value chain. Given the findings of the aquaculture situation analysis, the disease identification at this point may be presumptive based on symptoms, such as in cases where it may not have been possible for the farmer/advisor to confirm disease presence in the laboratory.	extension • Animal health diagnostic laboratories • Veterinary/aquaculture input suppliers • Fish feed manufacturers • FMARD
6. Diagnostic testing	• Description of laboratory protocols • Level of diagnosis • Name and category of laboratories	The description of diagnostic procedures used to confirm the presence of a disease, isolate a pathogen, and verify the pathogen's AST profile. Standardized OH laboratory protocols (preferably following international standards) are recommended at this stage in lieu of the NAP OH surveillance objectives.	• NCDC – AMR Technical Working Group • FMARD • Animal health diagnostic laboratories • Veterinarians and aquaculture extension • Academia and research
7. Surveillance design and sampling	• Passive surveillance to obtain data on fish health, farm biosecurity, AMU, case definition, on-farm treatment failure, distribution and dispensing of antimicrobials, and laboratory results (isolates	The survey design and scope may change based on progressive changes in the sector's scenario. Given the diversity and scope of AMU/AMR associated with aquaculture (production systems, stakeholders, environmental	• NCDC – AMR Technical Working Group • FMARD • NAFDAC • FME • FMH • Fish farmers

	and ASTs) • Active surveillance to obtain evidence and determine the impact of AMR and antimicrobial residues in fish products at markets or during processing for human consumption, environmental hotspots, water sources, effluent from farms and animal by-products used as aquaculture inputs	conditions, socio-economic factors) the passive surveillance, principally through record-keeping, of stakeholder (producers, processor and traders) practices that directly relate to AMU is recommended. Active surveillance conducted by a multi-disciplinary OH team in the form of cross-sectional studies would then be restricted to priority pathogens, antimicrobials, and antimicrobial resistance genes to confirm trends observed in passive surveillance.	• Fish feed manufacturers • Farmed fish processors and traders • Animal health diagnostic laboratories • Veterinary input suppliers and pharmacies • Veterinarians and aquaculture extension • Academia and research • Social and environmental scientists • Human health personnel • Epidemiologists • Economists
8. Data collection and management	• Sample sources and collection • Data collection forms • Standardized laboratory protocols • Standardized field disease diagnostic protocols • Database (design, entry, and management) • Other information (mapping, GPS, etc.)	The systematic collection of data using standardized protocols across the board is key for comparative analysis, quality control and integration into the NAP. All collected collated data are to be relayed from the States to respective Federal Departments (Competent Authority) for onward transmission to the NCDC.	• NCDC – AMR Technical Working Group • FMARD (State and Federal departments) • Academia and research
9. Data aanalysis	• Data analysis methodologies – descriptive statistics and epidemiological analysis	The collation of data and reporting of epidemiological and socio-economic analyses of trends, risk	• FMARD • Academia and research

	• Reporting	estimation and impacts.	
10. Validation and quality assurance	• Statistical estimation • Pilot trials, external evaluation (peer review) • Audits and corrective measures		• NCDC – AMR Technical Working Group • FMARD • Academia and research • Regional and international technical partners (such as FAO, OIE, ECOWAS, Africa-CDC, AU-IBAR)
11. Human and financial resources	• Stakeholder engagement • Personnel (human resource needs) • Data collection • Cost of laboratory tests and operations • Data management and analysis • Cost of materials • Stakeholder training and institutional capacity building • Development and dissemination of data collection tools • Supervision and quality control • Communication	Operational requirements for effective and sustainable AMR surveillance.	• NCDC – AMR Technical Working Group • FMARD • Academia and research • Regional and international technical partners (such as FAO, OIE, ECOWAS, Africa-CDC, AU-IBAR) • Private sector
12. Risk analysis and communication	• Risk definition and hazard identification/verification • Entry assessments	Epidemiological assessments within the context of OH to assess and mitigate AMR risks from	• NCDC – AMR Technical Working Group

	• Exposure assessments • Consequence assessments • Risk estimation • Risk management • Risk communication	aquaculture to fish, humans, and the environment and vice versa. Establish nationally appropriate indicators such as epidemiological cut-off points. Develop evidence-based AMR control strategies and communication messages for stakeholders and the public to promote antimicrobial stewardship.	• FMARD • FME • FMH • Academia and research • Fish farmer associations • Professional associations/bodies • NAFDAC • Media

2.2. Key Stakeholders and Target Audience

The stakeholder analysis conducted as a sequel to the Aquaculture AMR Country Situation Analysis mapped and analyzed stakeholders' roles, levels of interest and influence on aquaculture AMU/AMR (Appendix 1). Based on this, the aquaculture AMR surveillance system seeks to engage, influence the behavior, and coordinate the actions of stakeholders in the sector to achieve antimicrobial stewardship (Figures 1 and 2).

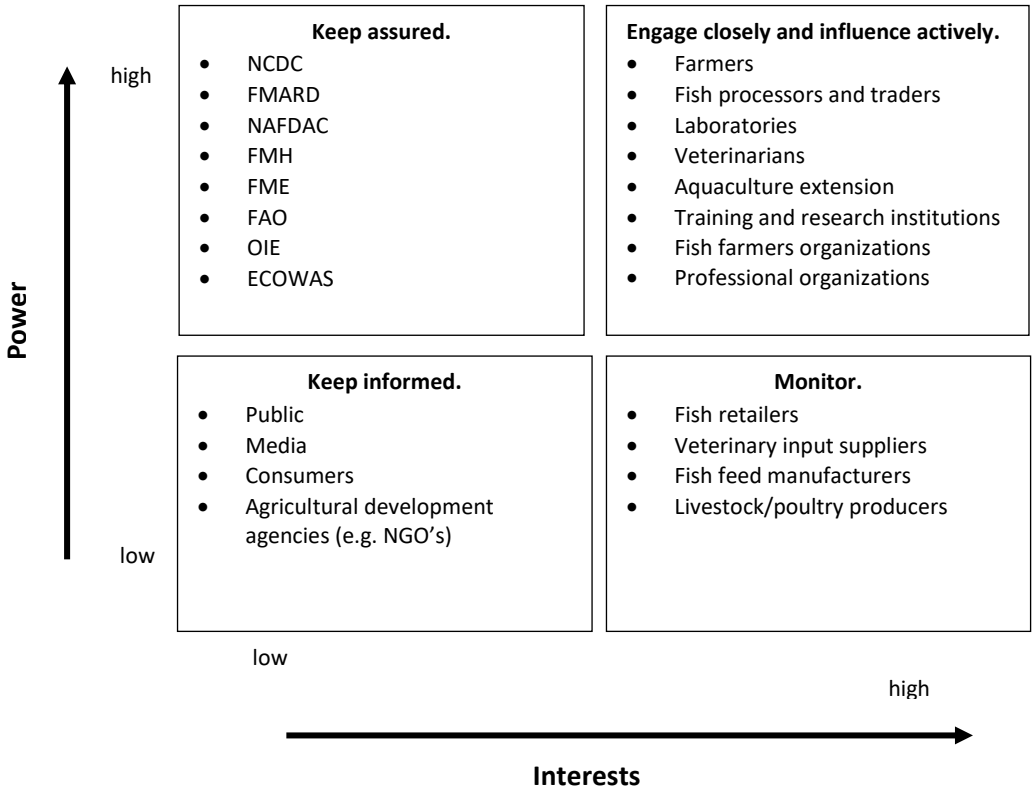

Figure 1: Objectives and Expected Outcomes of Surveillance from Stakeholder Behavior Perspective (Adapted from WHO, 2015).

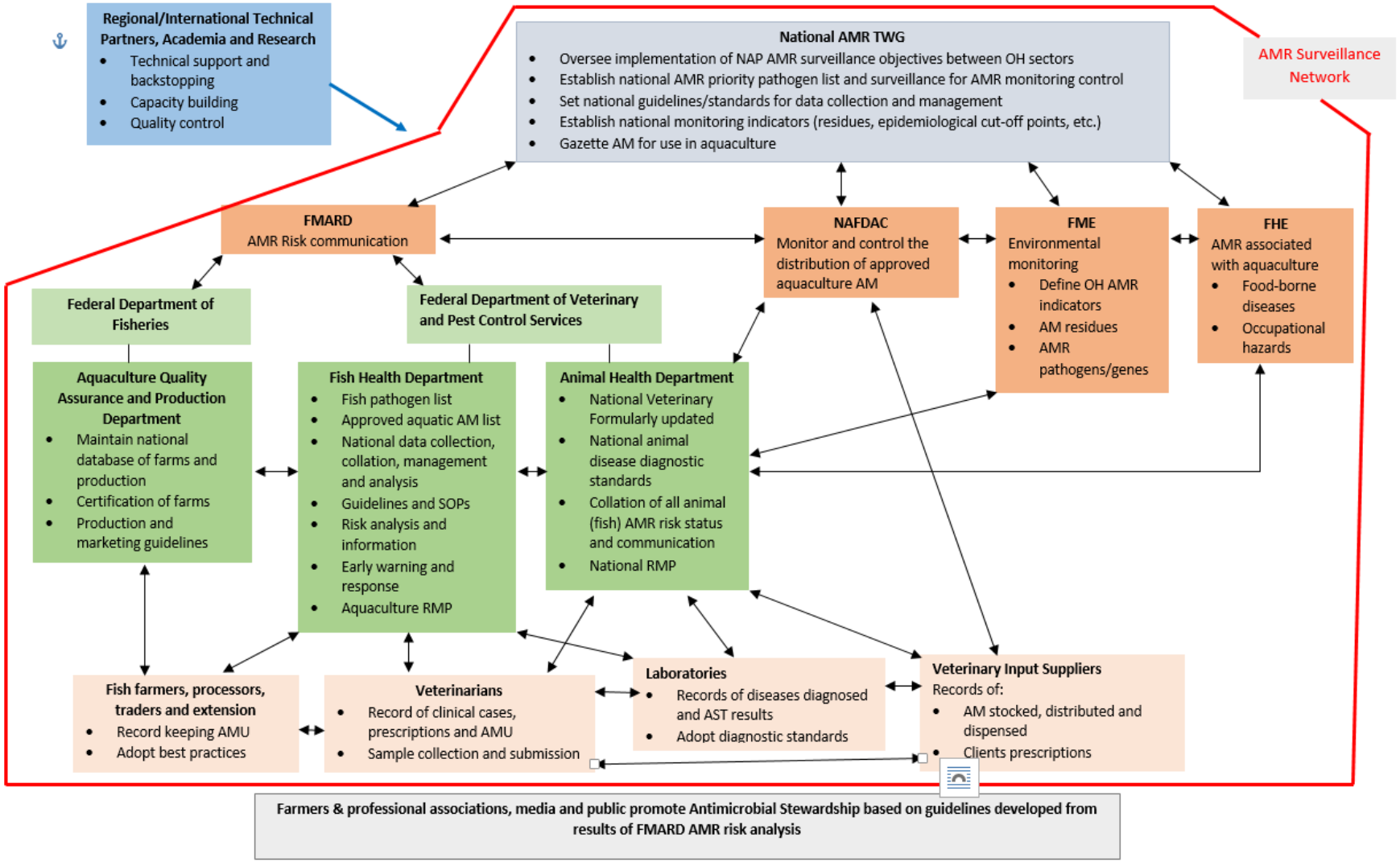

Figure 2: Key Stakeholder Roles Recommended for Aquaculture AMR Surveillance

2.3. Reporting Framework

Under the current governance structure, the surveillance and control of aquatic animal diseases falls under the Fisheries Department as the Competent Authority. The Aquatic Animal Health Focal Point is seconded to the Fisheries Department by the Chief Veterinary Officer, FVPCS (see figure 3 below).

Stakeholders however recommended that the Fish Health Department be moved to the FVPCS (figure 2 above). It was recommended that all aspects of animal health management and AMR control in food animal production be housed in the FVPCS to ensure standardization and harmonization of approaches used for the detection, surveillance and the reporting of AMU/AMR in aquaculture because it was the veterinary diagnostic laboratories and veterinarians responsible for confirmatory diagnosis of animal diseases and the recommendation of treatments. This would facilitate timely reporting following a unilateral vertical flow of information on the status disease and AMU from production units to the Chief Veterinary Officer (CVO) as recommended by the OIE. It would also enable the CVO to comprehensively supervise AMU in the food-animal production sector in compliance with the National Veterinary Formulary that would promote prudent and responsible aquaculture AMU.

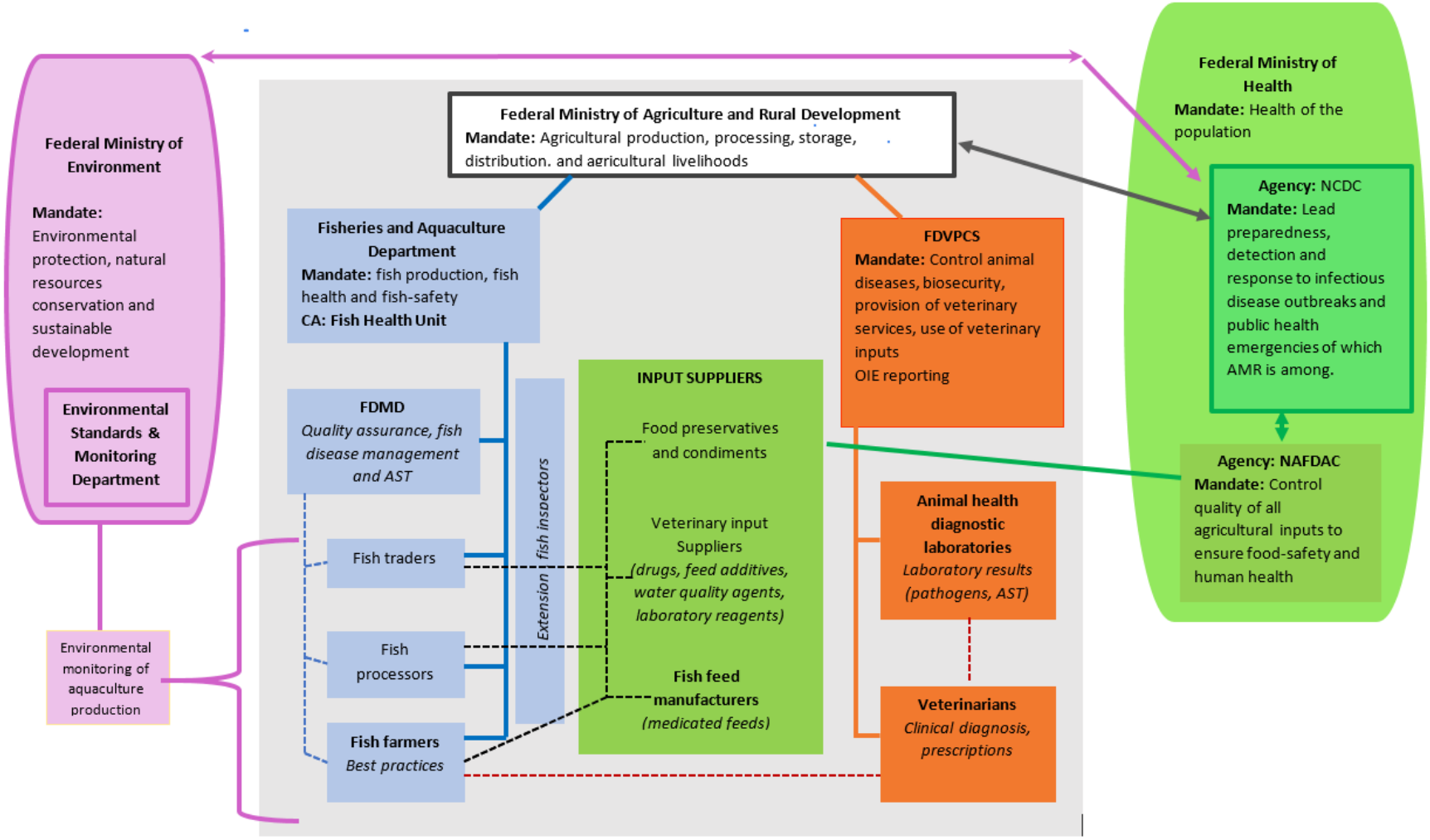

Figure 3: Current Reporting Framework. ***Solid lines*** show the reporting pathway to respective OH Ministries and eventually to AMRCC. ***Dotted lines*** indicate client-oriented reporting (not obligatory).

3.0. Data Collection and Management

Both quantitative and qualitative data need to be collected to obtain accurate information on the status of aquaculture AMU and AMR. Findings from the aquaculture situation analysis indicated a list of aquaculture pathogens that are susceptible to antimicrobial resistance and are likely critical points for AMU/AMR control in the aquaculture value chain (Tables 2 and 3). Residual antimicrobial monitoring and the monitoring of antibiotic resistomes enable the surveillance of AMR hotspots and transmission pathways [15,16,21,26,28,29, 33].

3.1. Antimicrobials and Pathogens to be monitored.

A priority list of antimicrobials and pathogens for monitoring in aquaculture must be made based on the national priority list, findings from the aquaculture situation analysis and recommendations from the OIE list of essential veterinary drugs [6,7,24,25,31]. Table 2 below presents the findings of the aquaculture AMR situation analysis.

Table 2: Status of Resistance to Antimicrobials Used by Fish Farmers.

Antibacterial Use in Nigerian Aquaculture	Used by Respondent Fish Farmers	Bacterial Isolates Found with Drug Resistance in Nigerian Aquaculture	Remarks
Penicillins			
Amoxicillin-clavulanic acid	+	*Aeromonas, E. coli, Pseudomonas, Salmonella, Staphylococcus,*	Anyanwu and Chah, 2016; Masefiu and Olasunkanmi, 2015
Ampicillin	+	*Aeromonas, Alcaligenes, Citrobacter, Enterobacter, Escherichia, Proteus, Pseudomonas, Salmonella, Serratia, Micrococcus, Staphylococcus, Streptococcus, Bacillus, Vibrio*	Anyanwu and Chah, 2016; Masefiu and Olasunkanmi, 2015; Igbinosa, 2016
Cloxacillin	+	n/a	n/a
Penicillin	+	n/a	n/a
Procaine penicillin	+	n/a	n/a
Ceftriaxone	0	n/a	n/a
Tetracyclines			
Tetracycline	+	*E. coli, Pseudomonas, Salmonella, Staphylococcus, Streptococcus, Aeromonas, Vibrio*	Source of tetracycline resistance most likely from livestock manure, dead animals, and aquaculture workers (Anyanwu and Chah, 2016),

			Masefiu and Olasunkanmi, 2015; Igbinosa, 2016
Oxytetracycline	+	n/a	n/a
Doxycycline		n/a	n/a
Cephalosporins			
Cephalexin	+	n/a	There is need to have data on 2nd, 3rd and 4th generation cephalosporins.
Quinolones and fluoroquinolones			
Ciprofloxacin	+	*Pseudomonas*	Anyanwu and Chah, 2016.
Enrofloxacin™	+	*Aeromonas*	Anyanwu and Chah, 2016.
Nalidixic acid	0	*E. coli, Salmonella, Pseudomonas, Staphylococcus, Streptococcus, Vibrio*	Anyanwu and Chah, 2016; Masefiu and Olasunkanmi, 2015; Igbinosa, 2016.
Ofloxacin	0	*Streptococcus, Staphylococcus*	Anyanwu and Chah, 2016; Masefiu and Olasunkanmi, 2015.
***N*orfloxacin**	0	*Salmonella*	Anyanwu and Chah, 2016.
Enrofloxacin	0	*Aeromonas*	Anyanwu and Chah, 2016.
Macrolides			
Tylosin	+	n/a	n/a
Erythromycin	+	*E. coli, Pseudomonas, Salmonella, Staphylococcus, Edwardsiella, Vibrio*	Anyanwu and Chah, 2016; Igbinosa, 2016.
Aminoglycosides		n/a	n/a
Neomycin	+	n/a	n/a
Streptomycin	+	*E. coli, Pseudomonas, Staphylococcus, Salmonella, Aeromonas*	Anyanwu and Chah, 2016.
Gentamicin	0	*E. coli, Pseudomonas, Staphylococcus,*	Anyanwu and Chah, 2016. Masefiu

		Salmonella, Streptococcus	and Olasunkanmi, 2015.
Novobiocin	0	*E. coli, Pseudomonas, Staphylococcus*	Anyanwu and Chah, 2016; Masefiu and Olasunkanmi, 2015.
Nitrofurans			
Furaltadone	+		
Nitrofurantoin	0	*Streptococci, Salmonella, E. coli, Pseudomonas, Staphylococcus*	Anyanwu and Chah, 2016.
Nitrobenzenes/phenicols			
Chloramphenicol*	+	*E. coli, Pseudomonas, Salmonella, Staphylococcus, Aeromonas, vibrio*	Anyanwu and Chah, 2016; Igbinosa, 2016.
Florfenicol	0	n/a	n/a
Sulphonamide and diaminopyrimidine	0	n/a	n/a
Sulphamethoxazole	0	*Pseudomonas, Salmonella, Staphylococcus, Vibrio*	Anyanwu and Chah, 2016; Masefiu and Olasunkanmi, 2015; Igbinosa, 2016.
Sulphamethoxazole/ Trimethoprim	0	*Staphylococcus, Streptococcus*	Anyanwu and Chah, 2016.
Colistin (polymyxin E)	+[i]	n/a	n/a
Aquaceryl™ (Trade name containing 2 classes of antibiotics)	+	n/a	Trade name that contains neomycin, erythromycin and oxytetracycline.

Notes to the table: **(+)** respondents in the survey conducted for the situation analysis mentioned they used this antimicrobial; (**0)** not among antimicrobials respondents used; **(n/a)** the AMR status of these antimicrobials in Nigerian aquaculture was not mentioned in the literature reviewed in the assignment. The fact that some antimicrobial were not mentioned by respondents in the survey , does not mean they were not used at all in Nigerian aquaculture.

3.2. Critical AMU/AMR Points within the Aquaculture Value Chain

Findings from the aquaculture situation analysis highlighted AMU/AMR determinants that would have to be monitored as critical points for aquaculture AMR control. Table 3 lists the critical points that would need to be monitored and controlled to minimize the development of AMR across the aquaculture value chain.

Table 3. AMU/AMR Monitoring and Control Points in the Aquaculture Value Chain (Adopted from the aquaculture AMR situation analysis)

Elements in the Value Chain	AMU	AMR
Water sources	• Use and disposal of antimicrobials upstream. • Antimicrobial residues	• Use and disposal of antimicrobials upstream. • Antimicrobial residues
Farms	• Sources of antimicrobials • Access to antimicrobials • Disease situation • Treatment recommendations • Administration of antimicrobials • Withdrawal periods • Sources of information on AMU	• Treatment recommendations • Administration of antimicrobials • Withdrawal periods
Feed	• Sources of antimicrobials • Treatment recommendations • Labelling • Distribution • Storage and milling	• Sources of antimicrobials • Treatment recommendations • Contaminated ingredients and water sources
Farm environment	• Disposal of unused drugs and medicated feeds • Effluent • pests	• Use and disposal of antimicrobials upstream • Disposal of unused drugs and medicated feeds • Effluent
Post-harvest handling, transportation and processing	• Fish condition and products • Sources of antimicrobials • Access to antimicrobials • Treatment recommendations • Administration of antimicrobials • Withdrawal periods • Fish holding facilities • Sources of Information on AMU • Antimicrobial residues	• Use and disposal of antimicrobials upstream • Antimicrobial residues
Market	• Fish holding facilities • Fish products • Antimicrobial residues	• Fish holding facilities • Antimicrobial residues

3.3. Data Collection

To optimise resources and stakeholder capabilities, effective passive and active surveillance will be done with the following objectives:

(i) Passive surveillance: will obtain quantitative and qualitative data on AMU and AMR from primary aquaculture AMU stakeholders. This will be done at the level of primary aquaculture practitioners,

(ii) Active surveillance: cross-sectional studies will be undertaken to monitor priority pathogens and their AST profiles, antimicrobial and residual levels, and resistomes.

3.3.1. Passive Surveillance

Table 4 summarizes the data to be collected during passive surveillance.

Table 4: Data for Passive Sampling

Stakeholder	Case Definition	Data to be Collected	Tools
Farmer	• Location • Water source • Production system • Species, age, size, and number • Management practices used • Symptoms and mortality • Presumptive diagnosis • Treatments • Response to treatments	• Production data • Species • Age of affected fish • Disease symptoms • Trade names of antimicrobials used • Dose given • Administration routes • Number of days administered • Withdrawal periods • Morbidity and mortality	• Farm production and health records • Antimicrobial treatment log • Receipts of purchase • Response to treatment • Antimicrobial labels • Medicated feed labels and batch numbers
Processors, transporters and Traders	• Location • Species, size, and number • Product	• Source of fish • Species • Size and number of fish • Disease symptoms • Trade names of antimicrobials used • Dose given • Number of days administered • Withdrawal periods	• Production and sales records • Antimicrobial treatment log • Receipts of purchase
Aquaculture Extension	• Farm and location • Fish health status • Level of implementation of best production and biosecurity practices	• Farm name and location • Case summary • Trade names of antimicrobials used	• Farm production system • Inputs and treatments used • Disease reports

	• Symptoms and mortality		
Veterinarian/Aquatic Animal Health Specialists	• Location • Production system • Level of implementation of best production and biosecurity practices • Clinical history • Clinical signs • Presumptive diagnosis • Confirmatory diagnosis • Remedial actions recommended	• Clinical history • Causes of diseases • Diagnosis • Treatments recommended • Administration routes • Withdrawal periods • Response to treatments	• Clinical reports • Laboratory reports • Prescriptions • Treatment reports/feedback • Label information
Laboratories	• Name and location of farm • Name and location of laboratory • Clinical report and presumptive diagnosis	• Pathogen isolation – confirmatory diagnosis • AST results	• Sample submission forms • Laboratory reports • Laboratory logs of tests done, pathogens isolated and AST profile
Veterinary Input Supplier	• Source and type of stock	• Contact and category of buyers • Purpose for use • Name and address of supplier	• Sales and distribution inventories • Receipts and invoices • Delivery notes • Prescription where the client has a copy
Fish feed manufacturer	• Requests for medicated feed • Labels	• Prescription • Request forms • Manufacturers name and address	• Prescriptions • Log of requests for production of medicated feed • Delivery notes • Sales Receipts and invoices • Batch numbers

3.3.2. Active Surveillance

Active surveillance of selected AMR reservoirs, hotspots and pathways will be conducted regularly at agreed frequencies after confirmation of actual risks and resource requirements. This may be done:

- seasonally concerning fish health status, given the findings of the situation analysis wherein diseases increased during the rainy season; or
- monthly for market data (food safety) because of the routine administration of antimicrobials for prophylaxis by producers and traders of live catfish (this has since been officially banned).

Active surveillance will be undertaken by a multidisciplinary team supervised by the Fish Health inspectors of the FMARD per the current institutional and governance structure for aquatic animal health.

Table 5: Active Surveillance

Risk Factor	Samples	Parameters
Animal • Species • Age of fish	• Fish tissue samples • Gut content • Gills • Skin/scales	• Pathogen isolates • Antimicrobial residue levels • AST profile
Production system • Tanks, ponds and cages • Management practices • Nature of farm • Access to advisory services	• Water source • Sediment/Soil • Fish feed	• Pathogen isolates • Antimicrobial residue levels • AST profile
Processing, handling and trading • Location in the value chain • Market commodity	• Water • Fish tissue samples • Gut content • Gills • Skin/scales	• Pathogen isolates • Antimicrobial residue levels • AST profile
Environmental • Location of farm and environmental sampling points (e.g., river); GPS • Season • Water resource • Effluent • Wild fish specimens • Livestock and poultry	• Water sources and effluent • Climatic and other environmental data • Sediment • Animal (fish, livestock, poultry) tissue and gut samples	• Pathogen isolates • Antimicrobial residue levels • AST profile

Adopted from aquaculture AMR situation analysis

3.3.3. Laboratories

It is envisaged that two categories of laboratories will initially play a role in AMU/AMR surveillance. State and private sector animal health diagnostic laboratories generally have a basic capacity for bacterial isolation and, in some cases, capacity for biochemical characterisation for species

identification and AST. In such situations, laboratories would need to specify the diagnostic procedures and quality assurance methods applied. This information would augment data collected on the national status of AMR during passive surveillance.

The universities, research centres and recently rehabilitated reference laboratories would have a better capacity to adapt designated international standards for AMR diagnosis and surveillance. At present, two aquaculture AMR reference laboratories have been established – the National Fisheries Laboratory and the laboratory at the Veterinary Faculty at the University of Ibadan. Nationally accepted NCDC protocols for AMR surveillance should be benchmarked on the Clinical and Laboratory Standards Institute (CSLI) and/or the European Committee on Antimicrobial Susceptibility Testing (EUCAST) guidelines and should follow the agreed-upon laboratory quality control and assurance systems. In national reference laboratories, the accepted methods for bacterial culture, microbiological identification, storage of isolates, and AST methods should be adopted.

3.4. Data Management

The data collected should be accurately and easily collated into the designated database for statistical and epidemiological analysis. Collected data need to allow the assessment of the contributions of geographical value chain location, aquaculture species, production systems and management methods to trends and risks for fish diseases, AMU and AMR transmission for both fish and humans. The contributions of socio-economic and environmental factors such as economic drivers, sources of information, climatic and weather patterns and stakeholder category need to also be assessed, given that these were found to be a major factors linked to AMU/AMR in the aquaculture value chain.[21,26,28]

Thus, it is proposed that field data be initially collected using questionnaires and entered into Microsoft Excel that is easily accessible to the majority of stakeholders within the sector. Thereafter the information could be uploaded into the designated NCDC statistical and epidemiological software. Several databases have already been developed to support AMR surveillance. Among these is the WHONET data management software that is freely available and offers a globally harmonized approach for submitting data to GLASS (https://whonet.org/). Agarwal et al., 2020 gives an example of how WHONET has been applied. Currently, WHONET is being piloted in Asia for use in aquaculture (Table 6).

Table 6: Features of WHONET and Examples of its Application in Aquaculture.

Features	Applications
• Laboratory configuration • Data entry and clinical reporting • Data analysis and report generation • Data exports to surveillance networks including WHO GLASS, EARS-Net, CAESAR, ReLAVRA, and JANIS • Support for CLSI human (M100, M45, M60, M61, access free resources) and veterinary (VET03, VET04, VET06, and VET08) antimicrobial susceptibility test breakpoints • Support for EUCAST human antimicrobial susceptibility test breakpoints. EUCAST veterinary breakpoints are in development. • New option for saving WHONET data as SQLite databases	FAO-USAID Regional Project on AMR in Asia. Addressing Antimicrobial Usage in Asia's Livestock, Aquaculture and Crop Production Systems (OSRO/RAS/502/USA). Status: ongoing. (http://www.fao.org/antimicrobial-resistance/projects/ongoing/project-3/en/)

4.0. Risk Analysis

4.1. Risk Assessment

Farm: Farm data assists the entry assessment of antimicrobials into aquaculture establishments. Data collected from the farm should identify the location of the farm physically and by ecological zone, describe the production systems, species, age group and sample source, and state whether the sample was from clinically affected or healthy fish. This is because of the diversity found within aquaculture production systems and the level of influence environmental factors have on fish production and health status. Data on other animals and the management systems employed for these should also be taken into consideration, given that by-products and effluent from such systems sometimes end up directly or coincidentally as inputs for aquaculture.

Laboratory Diagnosis: Laboratory results facilitate the assessment of the level of exposure to antimicrobials and AMR. They help establish the prevalent bacterial pathogens, commensals and resistomes within the production system, environment, or food product. Thus, it becomes possible to identify and describe the location and scope of reservoirs or hotspots and the transmission pathways.

In combination with other confounding factors such as stakeholder behavior, treatment practices, and virulence patterns, the consequence of AMR on fish, humans and the environment can be assessed. Established epidemiological cut-off values (ECOFFs) are among the useful epidemiological parameters that can be used in aquaculture AMR risk assessments [6,29,23].

4.2. Risk Estimation

According to the OIE (2019), the risk estimation integrates the entry assessment, exposure assessment and consequence assessment to elucidate the risks associated with identified hazards. The establishment of ECOFF values based on an integrated analysis of AST minimum inhibitory concentration (MIC) and surveillance data provides a monitoring indicator for AMR trends in wild- and non-wild-type bacterial populations associated with the aquaculture value chain [20,27].

Appropriate risk management interventions to control the spread of AMR and ensure aquaculture and public health biosecurity can be determined based on risk analysis [6].

4.3. Risk Communication

Key messages need to be elaborated to targeted audiences based on an assessment of their needs and expected communication outcomes [6,8,29]. Primary stakeholders who need to be closely engaged and actively influenced for antimicrobial stewardship require information on trends and simple practical tools to support them implementing and appreciating the value of minimizing aquaculture AMU and AMR. This is because the risk determinants for AMU occur and can most effectively be controlled within their production domain where they also directly affect productivity. Stakeholders in the sector whose enterprises are largely associated with the distribution of antimicrobials need to be monitored to ensure that the right quality and quantities are supplied to duly registered personnel for appropriate use.

The public authorities need to be assured with regularly updated evidence from surveillance on the effectiveness and impacts of implemented policies on AMU/AMR trends, aquaculture sector performance and biosecurity control, and public and environmental health. The public, media and consumers need to be kept informed on trends to raise and maintain awareness of AMR related public health concerns.

5.0. Implementation Plan and Budget

The surveillance implementation plan will involve the following actions summarized in Table 7. The total estimated budget for implementing aquaculture AMR surveillance plan is USD **1,936,247.51** only as indicated in table 8 below (see Appendix 2 for costing details).

The envisaged risks likely to affect implementation are associated with the willingness and ability of stakeholders to participate and contribute, transparency among stakeholders, timely availability of financial and material resources required for implementation, and acceptability by the public.

Table 7. Aquaculture Surveillance Implementation Plan

Item/Activity	Objectives	Time Frame		
		Short Term	Medium Term	Long Term
1. Establish a National aquaculture AMR surveillance team	• Establish a coordinating body. • Finalise surveillance objectives and methodology. • Develop and harmonize surveillance tools to be used by all segments of the value chain. • Officiate reporting pathways. • Establish resource requirements for implementation. • Establish national supervision for aquaculture AMR surveillance • Develop resource mobilization plan encompassing both public and private sector			
2. Stakeholder Mobilization, Public Awareness and Maintain Stakeholder Participation				
Stakeholder sensitization	• Raise public and stakeholder awareness. • Obtain buy-in from stakeholders			
Stakeholder training on the use of surveillance tools and antimicrobial stewardship	• Identify and recruit specific stakeholders to take part in sentinel surveillance • Capacity building for accurate record keeping and timely reporting			
Develop public awareness messages from surveillance outputs	• Maintain high levels of public awareness by actively engaging public and primary stakeholders through media messages, school programs, establishing feedback mechanisms			
3. Laboratories	• Build capacity for harmonized data collection • Equip and stock with recommended reagents. • Train laboratory technicians on agreed field sampling and laboratory diagnostic			

	protocols • Training on laboratory information management and reporting			
4. Pilot Surveillance Tools	• Test and validate agreed upon passive and active surveillance methodologies and tools before their roll-out nationally. • Confirm national protocols			
5. National Roll Out of aquaculture AMR surveillance	• Identify sentinel sites • Capacity building of associations, extension, veterinarians and aquaculturists. • Recruitment of national universities and animal health research into aquaculture disease, AST and AMR diagnosis and reporting • Re-invigorate and consolidate AMR reporting pathways. • Build capacity of federal Fish Health Department to collect, collate and undertake national monitoring, surveillance, risk analysis and communication on aquaculture AMR • Build capacity for feedback through both public and private sector channels. • Training of laboratory technicians, field veterinarians and fish health specialists from other laboratories and states at the aquaculture AMR reference laboratories in laboratory and field diagnostics • Training of fish farmers, processors, traders and feed millers on best practices			
6. Establish Public-Private Partnerships	• Engage and harness contributions of the private sector for data collection (especially in passive surveillance), reporting and establishing feedback mechanisms • Media communications for public awareness • Establish partnerships to effectively mobilize resources and harness capabilities of professional associations, producer associations, consumer associations, and tertiary institutions for data collection, research and development and adoption of antimicrobial stewardship • Resource mobilization			

Table 8. Summarized Aquaculture AMR Surveillance Budget

S/N	Activities	Total amount [₦]	Total amount [$]
1	**Establishment of National aquaculture AMR surveillance team**		
1.1	Develop TOR for aquaculture AMR surveillance team	₦ 1,030,000	$ 2,517.60
1.2	Develop surveillance, objective, strategy, sample frame and standardize SOPs/protocols for both active and passive surveillance	₦ 5,250,000	$ 12,832.42
1.3	Review and adopt surveillance objectives, strategy, sample frame and standardize SOPs/protocols for both active and passive surveillance with relevant stakeholders	₦ 7,471,275	$ 18,261.82
1.4	Functionalization of coordinating unit and funding for secretariat	₦ 13,075,500	$ 31,960.06
		₦ 26,826,775	$ 65,571.90
2	**Stakeholder capacity building**		
2.1	Conversion of data collection tool to mobile app	₦ 3,060,000	$ 7,479.47
2.2	Training on the use of data collection tools	₦ 38,595,950	$ 94,338.95
2.3	Supervisory visits by state departments to monitor/backstop use of data collection tools	₦ 13,320,000	$ 32,557.68
		₦ 54,975,950	$ 134,376
3	**Data collection and management**		
3.1	Develop and launch mobile apps to facilitate passive data collection from various stakeholders	₦ 41,180,000	$ 100,655.06

3.2	Database management	₦ 51,441,432	$ 125,736.78
		₦ 92,621,432	$ 226,391.85
4	**Laboratories**		
4.1	Equipment and consumables	₦ 40,959,769.72	$ 100,116.76
4.2	Refresher training of Lab technicians	₦ 32,778,900.00	$ 80,120.50
4.3	LMIS	₦ 11,629,280	$ 28,425.11
		₦ 85,367,950	$ 208,662.37
5	**Active surveillance**		
5.1	Travel/Logistics cost to conduct surveillance	₦ 455,850,000	$ 1,114,220.77
5.2	Develop TOR for field sampling teams	₦ 1,030,000	$ 2,517.60
		₦ 456,880,000	$ 1,116,738.37
6	**Data and risk analysis**		
6.1	Meeting to review and finalize report with surveillance team and selected stakeholders	₦ 11,106,400	$ 27,147.05
		₦ 11,106,400	$ 27,147.05
7	**Public Awareness**		
7.1	Development of advocacy tools and materials, and workshop to review materials	₦ 8,433,075	$ 20,612.72
7.2	Field testing of advocacy tools and materials	₦ 7,416,000	$ 18,126.71
7.3	Production of advocacy materials	₦ 47,900,000	$ 117,080.56

7.4	Training of 3 staff in public relation unit to identify media news and events for social media	₦ 630,000	$ 1,539.89
		₦ 64,379,075	$ 157,359.88
	Conversion rate = $409.12		
TOTAL BUDGET		**₦ 792,157,581.72**	**$ 1,936,247.51**

6.0. Concluding Remarks

Establishing and sustaining the surveillance mechanism will be a challenge unless all stakeholders from the public and private sectors are equipped to play their roles. Given the findings of the aquaculture AMR situation and stakeholder analyses, consideration needs to be given to the following to ensure the sustainability of aquaculture AMR surveillance:

1. Review and integrate AMR into the FMARD's current data collection tools for the Certification of Aquaculture Products and Fish Health and Farm Certification Protocols as well as FME Environmental Impact Assessment Guidelines. Support will need to be given to the respective ministries, departments and agencies (MDAs) to strengthen their capacities to effectively undertake the task of surveillance.
2. Capacity building of all stakeholders is critical for success. It would be important to conduct training and develop public awareness to create capacity within the population to recognize potential aquaculture AMU/AMR risks and respond appropriately through reporting, seeking professional advice, refraining from drug misuse, and disposing effluent in accordance with guidelines. Attention should be paid to the dissemination of credible information on AMU through the major channels through which aquaculture producers obtain their information such as social media, the internet, and the general media. Given the level of inquisitiveness and open-mindedness of children, school programs should be developed to raise awareness on AMR and promote antimicrobial stewardship.
3. Primary and secondary aquaculture AMU/AMR stakeholders actively use the internet. The use of social media, the internet, and mobile applications to support data collection and information dissemination would enhance coverage. Furthermore, since primary stakeholders need to be kept actively and continuously engaged in AMR surveillance, it will be important to actively engage producer and professional associations to promote best practices for antimicrobial stewardship as they were found to be the key fora that influenced stakeholder AMU/AMR behavior and through which stakeholders shared practical knowledge. Voluntary standards among stakeholders could be promulgated by such associations.
4. "*Laboratory capacity*" would have to be progressively built up across the country in all the 36 states, Federal Capital Territory and all 'private sector animal health laboratories' for competence in aquatic diagnosis, AST and AMU/AMR surveillance. The cost implications are likely to be high, thus considerations may need to be given to the establishment of a tiered system whereby the basic standard would cover the needs for passive surveillance and preliminary identification of potential reservoirs or hotspots, and the reference laboratory would undertake the active surveillance with an emphasis on surveillance of resistomes and monitoring of antimicrobial residues (i.e. pathways and spread).
5. A feedback mechanism through which the information generated from the surveillance is regularly relayed back to the stakeholders and the public coupled with appropriate technical backstopping is key. This would enable stakeholders to value their roles in antimicrobial stewardship and foster voluntary record keeping, timely reporting, transparency, and contribution of resources for surveillance. An interactive website that is well popularized needs to be established under designated departments to ensure stakeholders' access to surveillance information on aquaculture AMR using data management tools such as WHONET. Evidence-based policies and interventions for AMU/AMR require the support of such a mechanism.
6. Resource mobilization: Resources for the implementation of the aquaculture AMR surveillance need to be assured because this will be a continuous and long-term process. Government budget lines need to be secured to guarantee implementation. Similarly, the private sector should be supported

to obtain affordable finance from states, federal and international donors to implement recommended actions for antimicrobial stewardship.

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Appendices

Appendix 1: Analysis of Stakeholder Roles, Level of Interest and Power to Influence aquaculture AMU/AMR

Stakeholder	Responsibilities/Roles	Level of Interest in AMU/AMR	Power of Influence AMU/AMR	Action
A. PRIMARY STAKEHOLDERS				
Farmers	• Fish farming • Use of antimicrobials to reduce mortality, increase productivity and profitability	High	High	Partner
Veterinary teaching hospitals and colleges	• Training • Knowledge generation • Outreach	High	Medium	Involve
Fisheries and aquaculture research institutes	• Training and research	High	Medium	Involve
National Fisheries Laboratory	• Certification of fish products and farms • Diagnostics • Advisory and clinical services to producers/industry	High	High	Partner
Veterinary Research Institute e.g. National Veterinary Research Institute (NVRI)	• Production of vaccines and offering services for the identification, control, and eradication of economically important livestock diseases through best practices and research excellence	High	High	Partner
Private diagnostic laboratories	• Profit • Diagnostics • Advisory and clinical services to producers/industry	High	High	Partner

Feed manufacturers	• Access to markets for feeds • Advise producers • Profits	High	Medium to high	Partner
Farmers' organisations	• Experience Knowledge sharing • Obtaining and sharing information • Increased production • Advocacy	Medium to High	High	Partner
Professional aquatic animal health service providers (private and public sector)	• Livelihoods and profit, • Advocacy	high	Low to medium	involve
B. SECONDARY STAKEHOLDERS				
Professional organisations: - NVMA - FISON - Environmentalists - Pharmaceutical industry/pharmacists	• Compliance with standards and ethics • Advocacy	High	High	Partner
Fish producer associations	• Livelihoods/profit, • Access to markets • Sharing of best practices	High	Low to medium on policy	Involve
The National Agency for Food and Drug Administration and Control (NAFDAC)	• Regulate and control the manufacture, importation, exportation, distribution, advertisement, sale and use of food, drugs, cosmetics, chemicals, medical devices, and packaged water in Nigeria for the protection of human health. • Feed safety	High	High	Partner
FMARD	• Responsible for information and management	High	High	Partner

	of livestock pests, distribution of pesticides and provision of veterinary services. • National Veterinary Formulary • Feed and fish safety			
NCDC	• Public health • OH • Influence national formularies	High	High	Partner
FMARD (state and regional veterinary and fisheries officers)	• Animal health and compliance for purposes of trade, public health, food security and safety, animal welfare, livelihoods, and environmental integrity	High	High	Partner
Civil society (NGOs, CBO, farmer and other producer and industry associations)	• Advocacy	High	Medium	Involve
FME Wildlife, fisheries and environmental managers and conservationists	• Environmental sustainability Ecosystem health and services, • Biodiversity	Medium	Medium to high	Involve/partner
FMH	• Zoonoses and food safety	High	Medium	Involve
Other non-governmental in-country projects or programs on aquaculture production and/or health/biosecurity	• Productivity • Livelihoods • Developing beneficiary capacity and practical skills • Adoption of best practices	High	High	Partner
Industry (manufacturers and suppliers of inputs)	• Sales volume and profit	High	Medium to high	Involve
Traders and transporters	• Sales volume and profit	High	Low	Involve
ECOWAS	• Regional harmonization and integration on transboundary animal disease control, animal	High	High	Partner (through FMARD)

	and human movement, trade of commodities, regional risk mitigation,			
International multi-national partners (OIE, FAO, WHO, WTO, etc)	• Harmonization of international standards; implementation, policy development, resource mobilization, and technical support	High	High	Partner (through FMARD)
C. OBSERVERS				
Consumers	• Food security, nutrition, and safety	High	Low to medium	Involve
Media	• Information dissemination • Income	Low	High	Involve
Public	• Information	Low	Low	Inform

Appendix 2: Detailed Cost Tables

*A further breakdown of the costing for the Laboratory equipment and consumables is shown in annex I

Detailed workplan for the aquatic species AMR surveillance

S/N	Cost Drivers	Details	KPI	Timeline	Units	Duration	Unit cost (NGN)	Total (NGN)	Comments
1. Establishment of National aquaculture AMR surveillance team									
1.1. Develop TOR for aquaculture AMR surveillance team									
1	Consultancy	Interstate transport	TOR for surveillance team developed		1	1	120,000.00	120,000.00	Consultant to meet in-house teams and develop criteria for team members and TOR
		Airport shuttle			1	1	60,000.00	60,000.00	
		DSA			1	5	70,000.00	350,000.00	
		Consultancy fee (Local consultant)			1	5	100,000.00	500,000.00	
							Total	**1,030,000.00**	
1.2. Develop surveillance, objective, strategy, sample frame and standardize SOPs/protocols for both active and passive surveillance									
1	Consultancy	Consultancy fee (International consultant)	Draft protocols, standard and quality assurance system developed		1	15	250,000.00	3,750,000.00	Cost for international and local consultant, to draft SOPs, objectives strategies etc.
4		Consultancy fee (Local consultant)			1	15	100,000.00	1,500,000.00	
							Total	**5,250,000.00**	
1.3. Review and adopt surveillance objectives, strategy, sample frame and standardize SOPs/protocols for both active and passive surveillance with relevant stakeholders									

1	Consultancy	Flight (International)	Protocols, standard and quality assurance system finalized		1	1	600,000.00	600,000.00	Cost for international and local consultant to support the review process
		Interstate transport			2	1	120,000.00	240,000.00	
		Airport shuttle			2	1	60,000.00	120,000.00	
		DSA (International consultant + Local)			2	4	70,000.00	560,000.00	
		Consultancy fee (International consultant)			1	4	250,000.00	1,000,000.00	
		Consultancy fee (Local consultant)			1	4	100,000.00	400,000.00	
2	Accommodation , Hall & DSA	Hall			1	3	300,000.00	900,000.00	
		Tea Break			17	3	3,000.00	153,000.00	Total of 17 participants (15 participants + 2 consultants)
		Lunch			17	3	4,000.00	204,000.00	
		Interstate transport			9	1	120,000.00	1,080,000.00	Assumed 15 participants with 9 persons coming out of state
		Accommodation			9	4	25,000.00	900,000.00	
		Per diem			9	4	16,000.00	576,000.00	
		Transport allowance			6	4	10,000.00	240,000.00	Assumed 15 participants with 6 persons in state.
3	Workshop Materials	Stationery			17	1	1,500.00	25,500.00	
		Flipcharts			4	1	5,000.00	20,000.00	
		Marker			2	1	5,000.00	10,000.00	

		Printing			1	1	50,000.00	50,000.00	
		Miscellaneous			1	1	-	355,775.00	5% of total cost of workshop
4	IPC	Face Mask (Pack)			3	1	5,000.00	15,000.00	
		Veronica bucket			1	1	10,000.00	10,000.00	
		Hand sanitizer			3	1	4,000.00	12,000.00	
							Total	**7,471,275.00**	
1.4. Functionalization of coordinating unit and funding for secretariat									
1	Secretariat Function	Personnel to manage secretariat	Coordinating unit functional		2	12	70,000.00	1,680,000.00	Coordinating Officer and 1 assistant is recommended. Cost added as salary top up paid as performance bonus.
		Technical Assistant (Consultant)			1	12	450,000.00	5,400,000.00	
		Printer			2	1	200,000.00	400,000.00	
		Office chair			9	1	50,000.00	450,000.00	
		Office table			3	1	60,000.00	180,000.00	
		Office cabinet			3	1	85,000.00	255,000.00	
		Miscellaneous			1	1	-	610,500.00	5% of total cost
		Flatscreen display			2	1	560,000.00	1,120,000.00	
		Laptops			3	1	300,000.00	900,000.00	

		Monthly running cost for Secretariat			1	12	150,000.00	1,800,000.00	For airtime, occasional courier, chart printing, and other office consumables
		Internet modem			1	1	40,000.00	40,000.00	
		Internet subscription			1	12	20,000.00	240,000.00	
							Total	**13,075,500.00**	
							Grand Total for theme 1	**26,826,775.00**	
2. Stakeholder capacity building									
2.1. Conversion of data collection tool to mobile app									
1	Consultancy for translation of tool to mobile app	Interstate transport	Consultant to develop training templates and conduct training.		2	1	120,000.00	240,000.00	1 consultant and 1 app developer. Consultant to development training materials and conduct training, app developer to support training.
		Airport shuttle			2	1	60,000.00	120,000.00	
		DSA			2	10	70,000.00	1,400,000.00	
		Consultancy fee (Local consultant)			1	10	100,000.00	1,000,000.00	Days to support app as content expert
		Consultancy fee (App Developer)			1	3	100,000.00	300,000.00	App developer to participate in training and trouble shoot
							Total	**3,060,000.00**	
2.2. Training on the use of data collection tools									

1	Accommodation , Hall & Per diem	Hall	Training on data collection tools conducted		2	4	300,000.00	2,400,000.00	Training in 2 groups i.e., 2 Halls. 80 people (2 per state (72), 2 from FCT, 8 from Federal). Participants assumed to already have smart phones.
		Tea Break			80	4	3,000.00	960,000.00	
		Lunch			80	4	4,000.00	1,280,000.00	
		Per diem			80	4	16,000.00	5,120,000.00	
		Accommodation			80	5	25,000.00	10,000,000.00	
		Intrastate transport			80	1	120,000.00	9,600,000.00	
2	Training Materials	Stationery			80	1	1,500.00	120,000.00	
		Flipcharts			1	1	5,000.00	5,000.00	
		Marker			1	1	5,000.00	5,000.00	
		Internet modem			3	1	40,000.00	120,000.00	As internet back up for training
		Internet subscription			3	1	20,000.00	60,000.00	
		Printing			1	1	50,000.00	50,000.00	
		Printing of finalized document			500	1	2,500.00	1,250,000.00	
		Miscellaneous			1	1		1,486,950.00	5% of total cost of workshop
3	IPC	Face Mask (Pack)			1	1	5,000.00	5,000.00	
		Veronica bucket			1	1	10,000.00	10,000.00	
		Hand sanitizer			1	1	4,000.00	4,000.00	
							Total	**38,595,950.00**	

2.3. Supervisory visits by state departments to monitor/backstop use of data collection tools									
1	Logistics	Transport allowance	Surveillance conducted		37	24	10,000.00	8,880,000.00	1 per states (36), 1 from FCT. 2 visits per month for 12 months
		Internet allowance			37	24	5,000.00	4,440,000.00	
							Total	**13,320,000.00**	
							Grand Total for theme 2	**54,975,950.00**	
3. Data collection and management									
3.1. Develop and launch mobile apps to facilitate passive data collection from various stakeholders									
1	Development of mobile app	Consultant fee for analysis and planning	Mobile app developed		1	10	100,000.00	1,000,000.00	
		API/App (user interface) development			1	1	20,000,000.00	20,000,000.00	One off outsourced cost in comment
		Cloud Server			1	1	4,920,000.00	4,920,000.00	Annual costs
		Stack technology and platform updates			1	1	4,100,000.00	4,100,000.00	Annual costs
		Monthly maintenance			1	12	430,000.00	5,160,000.00	
		Outsourcing of customer interphase			1	12	500,000.00	6,000,000.00	
							Total	**41,180,000.00**	
3.2. Database management									
1	IT	Acquisition and installation of a server	Database set-up		1	1	12,250,000.00	12,250,000.00	This includes physical Server computers, Operating system, Server

							Rack, UPS and Setup and Installation
		Internet Infrastructural set up	1	1	1,000,000.00	1,000,000.00	
		Annual broadband subscription	1	1	7,000,000.00	7,000,000.00	Internet infrastructure with adequate bandwidth for server and cover for organization
		Air conditioner	2	1	216,800.00	433,600.00	1.5Hp
		Colored printer	1	1	250,000.00	250,000.00	
		Steel cabinet	2	1	85,000.00	170,000.00	
		Office chair	5	1	50,000.00	250,000.00	
		Acquisition and installation of computers	10	1	300,000.00	3,000,000.00	32GB RAM
		Website	1	1	2,000,000.00	2,000,000.00	Nominal figure for all costs to incur in developing managing website
		Miscellaneous	1	1	-	1,317,680.00	
		ICT/Website Manager	1	12	350,000.00	4,200,000.00	1 year salary
		Epidemiologist	1	12	490,846.00	5,890,152.00	1 year salary, junior management salary equivalent
		Statistician	1	12	300,000.00	3,600,000.00	1 year salary
		Assistant statistician	2	12	150,000.00	3,600,000.00	2-year salary

		Data entry clerk			3	12	80,000.00	2,880,000.00	Monthly payment estimate based on need.
		Content developers			2	12	150,000.00	3,600,000.00	1 year salary, as salary top-up for in-house content development or equivalent for outsourcing.
							Total	**51,441,432.00**	
							Grand Total for theme 3	**92,621,432.00**	
4. Laboratories									
4.1. Equipment and consumables*									
1	Equipment	See list on laboratory sheet	Equipment and consumables procured		1	1	1	29,960,034.72	See breakdown on laboratory sheet
2	Consumables	See list on laboratory sheet			1	1	1	10,999,735.00	
							Total	**40,959,769.72**	
4.2. Refresher training of Lab technicians									
1	Consultancy	Interstate transport	Training of lab technicians conducted		1	1	120,000.00	120,000.00	Engagement of STTA. For travel to state to support data collection process
		Airport shuttle			1	1	60,000.00	60,000.00	
		Consultancy fee (Local consultant)			1	14	100,000.00	1,400,000.00	
1	Accommodation , Hall & Per diem	Hall			2	4	300,000.00	2,400,000.00	80 people (2 per state (72), 2 from FCT, 6 from Federal) [Training to be done in 2 batches of 40 people each]
		Tea Break			80	4	3,000.00	960,000.00	
		Lunch			80	4	4,000.00	1,280,000.00	

		Per diem			80	4	16,000.00	5,120,000.00	
		Accommodation			80	5	25,000.00	10,000,000.00	
		Interstate transport			80	1	120,000.00	9,600,000.00	
2	Training Materials	Stationery			80	1	1,500.00	120,000.00	
		Flipcharts			2	1	5,000.00	10,000.00	
		Marker			2	1	5,000.00	10,000.00	
		Printing			2	1	50,000.00	100,000.00	
		Miscellaneous			1	1		1,560,900.00	5% of total cost of workshop
3	IPC	Face Mask (Pack)			2	1	5,000.00	10,000.00	
		Veronica bucket			2	1	10,000.00	20,000.00	
		Hand sanitizer			2	1	4,000.00	8,000.00	
							Total	**32,778,900.00**	
4.3. LMIS									
1	IT	LMIS and data management	LMIS system set-up		1	1	5,000,000.00	5,000,000.00	
		Filing cabinet			1	1	85,000.00	85,000.00	This includes Server computers, Operating system, Server Rack, UPS and Setup and Installation
		Internet modem			1	1	40,000.00	40,000.00	
		Monthly internet subscription			1	1	20,000.00	20,000.00	

		Air conditioner			2	1	216,800.00	433,600.00	1.5HP
		Office chair			5	1	50,000.00	250,000.00	
		Office table			5	1	60,000.00	300,000.00	
		Acquisition and installation of computers			2	1	300,000.00	600,000.00	32GB RAM
		Colored printer			1	1	200,000.00	200,000.00	
		Monthly running cost for IT			1	1	100,000.00	100,000.00	Monthly operational fund for chart printing, toners, couriers etc.
		Steel cabinet			1	1	85,000.00	85,000.00	
2	HR	ICT Manager			1	12	350,000.00	4,200,000.00	1 year salary at 350,000 per month
		Miscellaneous			1	1	-	315,680.00	5% of total cost
							Total	**11,629,280.00**	
							Grand Total for theme 4	**85,367,949.72**	
5. Active surveillance									
5.1. Travel/Logistics cost to conduct surveillance									
1	Logistics	Fueling/Transport for sample collection from 12 states	Surveillance conducted quarterly		37	4	12,500.00	1,850,000.00	Quarterly for 37 states
		Hilux vehicles for laboratory			12	1	35,000,000.00	420,000,000.00	
		Maintenance of vehicles			12	6	300,000.00	21,600,000.00	Nominal cost of routine service 6 monthly on new

									vehicle
		Shipment of sample by road			20	4	70,000.00	5,600,000.00	Assuming 20 states will ship by road and another 17 will ship by air
		Shipment of sample by air			17	4	100,000.00	6,800,000.00	
		Cold chain equipment			37	1	-	-	Incorporated into lab cost
		Cost of conducting test and analysis			1	1	-	-	Test will be conducted in lab
							Total	**455,850,000.00**	
5.2. Develop TOR for field sampling teams									
1	Consultancy	Interstate transport	TOR developed		1	1	120,000.00	120,000.00	Desk and meeting at no extra cost with in-house team members
		Airport shuttle			1	1	60,000.00	60,000.00	
		DSA			1	5	70,000.00	350,000.00	
		Consultancy fee (Local consultant)			1	5	100,000.00	500,000.00	
							Total	**1,030,000.00**	
							Grand Total for theme 5	**456,880,000.00**	
6. Data and risk analysis									
6.1. Bi-annual Meeting to review and finalize report with surveillance team and selected stakeholders									
1	Consultancy	Interstate transport	Report finalized		2	1	120,000.00	240,000.00	Cost for 1 National consultant, to work with Epidemiologist and
		Airport shuttle			2	1	60,000.00	120,000.00	

		DSA	2	10	70,000.00	1,400,000.00	Statistician to prepare reports and facilitate review meeting. (Costing is for meeting happening biannually and is double costed)
		Consultancy fee	2	10	100,000.00	2,000,000.00	
2	Accommodation , Hall & Per diem	Hall	2	3	300,000.00	1,800,000.00	
		Tea Break	84	3	3,000.00	756,000.00	
		Lunch	84	3	4,000.00	1,008,000.00	Meeting is Bi-annual. Participant 42 persons (1 per state and FCT and 5 federal)
		Transport allowance	84	3	10,000.00	2,520,000.00	
3	Meeting Materials	Stationery	84	1	1,500.00	126,000.00	
		Flipcharts	4	1	5,000.00	20,000.00	
		Marker	2	1	5,000.00	10,000.00	
		Publication of reports	500	1	500.00	250,000.00	
		Printing	2	1	50,000.00	100,000.00	
		Meeting (Organization meeting)	2	1	100,000.00	200,000.00	Nominal cost for courier, data, and airtime for organization of meeting
		Miscellaneous	2	1	-	518,400.00	5% of total cost of workshop
4	IPC	Face Mask (Pack)	2	1	5,000.00	10,000.00	

		Veronica bucket			2	1	10,000.00	20,000.00	
		Hand sanitizer			2	1	4,000.00	8,000.00	
							Total	**11,106,400.00**	
							Grand Total for theme 6	**11,106,400.00**	
7. Public Awareness									
7.1. Development of advocacy tools and materials, and workshop to review materials									
1	Consultancy	Interstate transport	Advocacy tools and materials developed		1	1	120,000.00	120,000.00	To development of advocacy tools, kits and
		Flight (International)			1	1	600,000.00	600,000.00	
		Airport shuttle			2	1	60,000.00	120,000.00	
		DSA			2	10	70,000.00	1,400,000.00	material (1 international and 1 local)
		Consultancy fee (Local consultant)			1	10	100,000.00	1,000,000.00	
		Consultancy fee (International consultant)			1	10	250,000.00	2,500,000.00	
2	Accommodation , Hall & Per diem	Hall			1	3	300,000.00	900,000.00	
		Tea Break			25	3	3,000.00	225,000.00	
		Lunch			25	3	4,000.00	300,000.00	
		Transport allowance			25	3	10,000.00	750,000.00	
3	Workshop materials	Stationery			25	1	1,500.00	37,500.00	
		Flipcharts			1	1	5,000.00	5,000.00	
		Marker			1	1	5,000.00	5,000.00	

		Printing			1	1	50,000.00	50,000.00	
		Miscellaneous			1	1	-	401,575.00	5% of total cost of workshop
4	IPC	Face Mask (Pack)			1	1	5,000.00	5,000.00	
		Veronica bucket			1	1	10,000.00	10,000.00	
		Hand sanitizer			1	1	4,000.00	4,000.00	
							Total	**8,433,075.00**	
7.2. Field testing of advocacy tools and materials									
1	Logistics	Per diem/allowance			72	3	16,000.00	3,456,000.00	12 persons per state (6 states), 1 per geopolitical zone
		Transport allowance			72	3	10,000.00	2,160,000.00	
		Daily logistic for focus groups			6	3	100,000.00	1,800,000.00	Daily logistic for transport/fuel, light refreshment for focus groups etc.
							Total	**7,416,000.00**	
7.3. Production of advocacy materials									
1	Advocacy materials	Radio jingles and airing	Advocacy materials produced		4	6	1,000,000.00	24,000,000.00	Radio jingle in English, pidgin and 3 major Nigeria languages to be aired across 6 geopolitical zones
		Billboards			9	1	1,000,000.00	9,000,000.00	4 per state and additional 5 strategic national positioning

		Social media campaign and social marketing			1	1	5,000,000.00	5,000,000.00	Nominal cost. To be outsourced per annum
		Production of Advocacy materials, kits, packs, posters			1	1	7,500,000.00	7,500,000.00	Nominal cost breakdown to be determined by nature of materials and number
		Pamphlets			12,000	1	200.00	2,400,000.00	2,000 copies per geopolitical zone
							Total	**47,900,000.00**	
7.4. Training of 3 staff in public relation unit to identify media news and events for social media									
1	Training	Training cost	Training conducted		3	1	150,000.00	450,000.00	Trained personal will take over outsourced consultant/PR firm role in year 2
		Data allowance			3	12	5,000.00	180,000.00	Monthly data allowance for 3 staff
							Total	**630,000.00**	
							Grand Total for theme 7	**64,379,075.00**	
							Workplan Grand Total	**792,157,581.72**	

Annex 2.a: Laboratory costing

S/N	Cost Drivers	Details	KPI	Timeline	Units	Unit cost (NGN)	Total (NGN)	Comments
4. Laboratories								
3.2. Equipment and consumables								
1	Equipment	First aid kit			1	51,000.00	51,000.00	
2		Eye wash station			1	49,640.00	49,640.00	
3		Safety shower			1	33,345.00	33,345.00	
4		Backup power generator for bacteriology laboratory			1	4,000,000.00	4,000,000.00	Referenced pricing based on mikano
5		UPS			4	350,000.00	1,400,000.00	1.5KVA/1500VA UPS
6		Batteries (for priority equipment installation)			5	55,000.00	275,000.00	Assumed same price as UPS
7		CO2 cylinders or gas converter for CO2 incubator			na	-		
8		Dedicated computer for the microbiology laboratory			2	300,000.00	600,000.00	
9		Biosafety cabinet class IIA2			1	1,667,250.00	1,667,250.00	
10		Biosafety Cabinet floor stand			1	7,004.00	7,004.00	
11		Autoclave for waste management			1		-	

12		Table top incubator (standard atmosphere); 194 L		1	758,689.76	758,689.76	
13		405L incubator (standard atmosphere)		1	2,526,931.96	2,526,931.96	
14		CO2 Incubator		na	-		
15		Light microscope		1	507,584.00	507,584.00	
16		Bunsen burner		1	36,300.00	36,300.00	
17		Loop Sterilizer		1	295,000.00	295,000.00	
18		Anaerobic Jar		1	223,300.00	223,300.00	
19		Hotplate for slide drying		1	88,000.00	88,000.00	
20		Stainless Steel Petri Dish Can		1	18,000.00	18,000.00	
21		Benchtop nephelometer with appropriate tubes		na	-		
22		Double distillation water purification system		1	2,350,000.00	2,350,000.00	
23		Portable conductivity meter		1	391,500.00	391,500.00	
24		Water bath		1	290,000.00	290,000.00	
25		Laboratory glass washer		1	5,596,600.00	5,596,600.00	
26		Filtered air drying cabinet (hot oven)		1	2,200,500.00	2,200,500.00	
27		Analytic balance (0.01 g)		1	80,000.00	80,000.00	

28		Precision balance (0.001 g)		na	-		
29		Autoclave for media preparation		1	4,227,120.00	4,227,120.00	
30		Hot plate stirrer		1	180,600.00	180,600.00	
31		pH meter		1	200,000.00	200,000.00	
32		Carboy for dispensing distilled water		1	121,500.00	121,500.00	
33		1 Set of mechanical single channel micropipettes		na	-		
34		Vortex		1	220,000.00	220,000.00	
35		Refrigerator: 2°C to 8°C		1	778,000.00	778,000.00	
36		Low temperature freezers (-15°C to -35°C)		1	481,650.00	481,650.00	
37		-80°C freezer for biorepository (storage of bacterial isolates)		na	-		
38		Aluminum freezer racks for -80°C freezer		na	-		
39		Cryoboxes for storage of isolates		na	-		
40		Cryoblock		na	-		
41		Freeze dryer for biobanking		na	-		
42		Desiccator (+ silica gel or		1	24,900.00	24,900.00	

		equivalent desiccant)					
43		Triple packaging specimen transport kits (UN 2814 compatible)		10	5,852.00	58,520.00	
44		Automatic pipette controller		1	180,600.00	180,600.00	
45		Nichrome wire inoculating loop		1	15,000.00	15,000.00	
46		Counting chamber		1	7,000.00	7,000.00	
47		Callipers or ruler		1	19,500.00	19,500.00	
48		Automated Blood culture system including service plan – **Small capacity** (<75 cells)		na	-		
49		Automated Blood culture system including service plan – **medium capacity** (75 -150 cells)		na	-		
50		Automated Blood culture system including service plan – **large capacity** >150 cells		na	-		
51		Blood culture bottles – Aerobic (Adult)		na	-		
52		Blood culture bottles – Anaerobic (Adult)		na	-		
53		Blood culture bottles – Anaerobic (Adult) Pediatric		na	-		

		aerobic						
54		Automated Antimicrobial Susceptibility Testing Platform (Vitek 2)			na	-		
55		MALDI TOF mass spectrometer (Vitek MS)			na	-		
						Total	**29,960,034.72**	
1	Consumables	MacConkey Agar (MAC)			1	17,500.00	17,500.00	500 g
2		Nutrient Agar			1	17,500.00	17,500.00	500 g
3		Blood Agar Base			1	18,000.00	18,000.00	500 g
4		Mueller Hinton Agar (MHA)			1	19,500.00	19,500.00	500 g
5		Tryptone (Trypticase) Soy agar (TSA)			1	20,000.00	20,000.00	500 g
6		DNAse Agar			1	29,000.00	29,000.00	500 g
7		Mannitol Salt Agar			1	19,000.00	19,000.00	500 g
8		Buffered Peptone Water (Dehydrated media)			1	17,000.00	17,000.00	500 g
9		Bertani (LB) medium			10	12,000.00	120,000.00	10 x 50 swabs per case
10		Sodium hydroxide solution 1M (1N)			1	2,500.00	2,500.00	1 L
11		Hydrochloric acid, 37%			1	8,000.00	8,000.00	1 L
12		NaCl solution			1	9,000.00	9,000.00	1 kg

13		Glycerol	1	3,500.00	3,500.00	500 mL
14		Hydrogen peroxide (H2O2)	1	2,500.00	2,500.00	1 L
15		Chromogenic Agar selective for ESBL	1	177,031.00	177,031.00	Comparable product pricing used. Millipore product
16		Triple Sugar Iron Agar (TSI)	1	17,000.00	17,000.00	500 g
17		Azide Dextrose Broth	1	89,807.00	89,807.00	500 g
18		PYR broth	1	53,886.00	53,886.00	20/Pk (0.5 mL). Price for 50/PK Quoted. Millipore product.
19		PYR Reagent	1	38,642.00	38,642.00	50/Pk (0.75 mL/ampule). Equivalent pricing for 15m drop bottle. Hardy Diagnostic
20		Slanetz and Bartley	1	-	-	Not identified
21		Rappaport-Vassiliadis soy peptone.	1	12,365.00	12,365.00	1 Liter. Quoted: HKM, Broth 500g
22		Tetrathionate broth + iodine.	1	47,970.00	47,970.00	1 Liter. HiMedia Quoted. Note extreme wide price range, limited differentiating detail
23		XLD agar	1	1,950.00	1,950.00	500 g
24		Salmonella Polyvalent O	1	67,743.00	67,743.00	Quoted; 2 ml vial, edge product
25		Salmonella Polyvalent H	1	67,744.00	67,744.00	Quoted; 2 ml vial, edge product
26		Bolton selective enrichment broth	1	128,056.00	128,056.00	Quoted: 500g, Brand Millipore

27		Microaerobic gas pack (CampyPak or CampyGen)		2		-	Not identified
28		Charcoal-containing agar		1	169,965.00	169,965.00	Quoted; Dehydrated charcoal agar base, 500g
29		Sodium Hippurate broth		1		-	Quoted: Sodium Hippurate Broth - Media - BBL® Prepared Tubed and Mycoflask® Media, 16.5 by 102mm tube, pack of 10
30		Ferric chloride reagent		1	23,452.00	23,452.00	Quoted: 25ml, brand Remel
31		Virkon S		1	33,206.00	33,206.00	Quoted: Virkon S, Broad Spectrum Disinfectant 10lbs pail of powder.
32		Disk dispenser		1	191,347.00	191,347.00	Quoted: Oxoid Brand, Antimicrobial Susceptibility Disk Dispenser, 6 Oxoid disk cartridges, 90mm diameter plates. NOTE: Quoted dispenser may require brand specific cartridges
33		Ampicillin (AMP)		5	9,500.00	47,500.00	Quoted: Oxoid brand cartridges (5 cartridge - 50 disc) for ALL single disc based on Nigerian market. Limited market availability. Combination disc sets much more common place.
34		Ceftriaxone (CRO)		5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
35		Cefepime (CEP)		5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
36		Ertapenem (ETP)		5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
37		Meropenem (MEM)		5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG

38		Gentamicin 120 µg (GEN)	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
39		Streptomycin (STM)	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
40		Chloramphenicol (CHL)	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
41		Tetracycline (TET)	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
42		Tigecycline (TGC)	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
43		Linezolid (LIN)	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
44		Quinupristin-dalfopristin	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
45		Cotrimoxazole (SXT)	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
46		Nalidixic acid	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
47		Ciprofloxacin (CIP)	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
48		Pefloxacin	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
49		Erythromycin	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
50		Vancomycin (VAN)	5	9,500.00	47,500.00	5 Cartridge – 50 discs/CTG
51		Polymyxin powder	1	141,000	141,000.00	Quoted: British Pharmacopoeia standard, powder as sulphate, dry dark storage of mix at 2-8 degrees centigrade. 100mg
52		Neomycin powder	1	58,436	58,436.00	Quoted: Pharmaceutical Secondary Standard, powder as sulphate. 1g
53		Florfenicol disc	1	9,500.00	9,500.00	Oxoid brand quoted. 5 Cartridge – 50 discs/CTG

54		Chloramphenicol disc		1	9,500.00	9,500.00	Not seen. Nominal pricing for related items quoted. 5 Cartridge – 50 discs/CTG
55		Ceftazidime (CTZ)		n/a	-	-	Not priced due to 'na' in number
56		Clavulanic Acid		n/a	-	-	
57		Colistin (CST)		n/a	-	-	
58		Novobiocin supplement		5		-	Quoted: 5 vail, 40mg concentration, HiMedia Brand
59		*E.coli* ATCC® 25922		1	69,290.00	69,290.00	culti loop (5/pk) or equivalent
60		*E.coli* ATCC® 35218		1	65,559.00	65,559.00	culti loop (5/pk) or equivalent
61		*K. pneumoniae* ATCC® 700603		1	123,123.00	123,123.00	culti loop (5/pk) or equivalent
62		*S. aureus* ATCC® 29213		1	62,361.00	62,361.00	culti loop (5/pk) or equivalent
63		*S. aureus* ATCC® 43300		1	122,057.00	122,057.00	culti loop (5/pk) or equivalent
64		*E. faecalis ATCC® 29212*		1	67,691.00	67,691.00	culti loop (5/pk) or equivalent
65		*Campylobacter jejuni ATCC® 33560*		1	115,128.00	115,128.00	
66		*Campylobacter coli ATCC® 33559*		1	151,372.00	151,372.00	
67		*Enterococcus faecium (VRE) ATCC 12202*		1	131,118.00	131,118.00	
68		Overalls		18	7,500.00	135,000.00	

69		Gloves	10	38,000.00	380,000.00	per carton
70		Hair nets	10	1,500.00	15,000.00	per pack
71		Rubber boots / Wellington boots	12	7,000.00	84,000.00	per pack
72		Rubbish bag for paper towels/ plastic bag for used overalls	10	1,800.00	18,000.00	per pack
73		Disposable paper towel	10	1,200.00	12,000.00	per pack. Quoted: Kitchen rolls which are thicker and more absorbent
74		Scrubbing brush	10	1,000.00	10,000.00	pcs
75		Plastic bins with lids	10	5,000.00	50,000.00	pcs
76		Scalpels	10	1,200.00	12,000.00	pcs
77		Scalpel blades	4	2,500.00	10,000.00	pcs
78		Disposable sterile plastic Petri dishes	10	22,000.00	220,000.00	per carton
79		Sterile disposable spoon or tongue depressor	5	2,000.00	10,000.00	
80		Sterile whirl-pack	50	97,539.00	4,876,950.00	Quoted: Pack of 500 bags, 36oz (1L plus), freeze at any temperature
81		Leakproof zip lock bags	50	6,000.00	300,000.00	
82		Rubber mallet	4	1,112.00	4,448.00	
83		50 mL Falcon tubes	3	120,000.00	360,000.00	per carton

84		96-well plate			500	1,334.00	667,000.00	Quoted: 2.2ml well plates
85		Glass tubes			5	8,000.00	40,000.00	per carton
86		Laboratory Coats			10	4,500.00	45,000.00	
87		ChromAgar supplement			1	133,250.00	133,250.00	Quoted: CHROMagar, Dehydrated media, 5L.
88		CCDA Campylobacter supplement			1	56,971.00	56,971.00	Quoted: Millipore Sigma brand, 5 vails, 500ml each, 2-8 degrees centigrade storage
89		Rambach Agar			1	88,074.00	88,074.00	Quoted: MilliporeSigma, 1L
90		Rambach agar supplement			1	67,743.00	67,743.00	Quoted: 5 vails
						Total	**10,999,735.00**	

Annex 2.b.: Cost assumptions

Cost Assumptions

S/N	Cost drivers	Unit cost	Comment
	Daily Subsistence Allowance		
	Accommodation	25,000	
	Per diem	16,000	
	Transport allowance	10,000	
	Internet allowance	5,000	
	Workshop logistics		
	Hall	300,000	
	Stationaries	1,500	
	Tea	3,000	
	Lunch	4,000	
	Flipcharts	5,000	
	Marker	5,000	
	Workshop printing	50,000	
	Miscellaneous	5% of workshop cost	For minor unplanned expenditure
	Distribution of printed documents	100,000	
	Printing of IEC material	500	

	Printing of report	500	
	Printing of document (Manuals, handbook)	3,750	During meetings documents would be copied/printed for all participants
	Infection prevention and control (IPC) materials		
	Face masks	5,000	
	Hand sanitizers - 1 bottle	4,000	
	Veronica bucket	10,000	
	Transportation/DSA		
	Interstate Transport (Local)	120,000	For flight or cost of taxi to and from state
	Flight (International)	600,000	
	Airport shuttle	60,000	
	DSA	70,000	DSA for consultant is in lieu of reimbursable
	Intrastate Transport	100,000	Covers for most of all intrastate transport by road but payment would be by kilometers
	Fueling per trip	12,500	
	Shipment of sample by road	70,000	
	Shipment of sample by air	100,000	
	Personnel		
	Consultancy fee per day (International)	250,000	
	Consultancy fee per day (Local)	100,000	
	Junior TA/Consultant	450,000	Monthly salary

	Consultancy fee (App Developer)	2,000,000	For entire period
	Data manager	300,000	Monthly salary
	ICT/Website Manager	350,000	Monthly salary
	Epidemiologist	250,000	Monthly salary
	Statistician	200,000	Monthly salary
	Content developer	150,000	Monthly salary
	Laboratory technician	70,000	Monthly salary
	Data entry clerk	80,000	Monthly salary
	Laboratory manager	200,000	Monthly salary
	Office equipment		
	Laptop/Computer	300,000	
	Flatscreen display	560,000	
	Printer	200,000	
	Internet modem	40,000	
	Air conditioner (1.5 HP)	216,800	LG as reference pricing, inverter AC; pricing at 20% mark up for contracting
	Monthly internet subscription	20,000	
	Office chair	50,000	
	Office cabinet	85,000	
	Colored printer	250,000	

	Office table	60,000	
	Personnel to manage Secretariat	70,000	Monthly salary
	Monthly running cost for Secretariat	100,000	
	Cost of Hilux van	35,000,000	
	Billboards	1,000,000	
	Radio jingles	1,000,000	
	Pamphlets	200	